Municipal Zero Waste Methodology

A thesis presented in partial fulfilment of the requirements for the degree of

Doctor of Philosophy in Environmental Management

At Massey University, Turitea Campus, Palmerston North, New Zealand.

Jonathon Bruce Hannon

2022

Abstract:

This research originally undertook an extensive literature review, in order to develop a deeper understanding of how the phenomenon of zero waste interrelates with the alternative sustainability-framed movements responding to the crisis of waste and the failures of conventional waste management theory and practice. This initial work was translated into a series of publications that provide content for the foundational chapters (1. Literature review 2, Background/Context and 3. Methodology) of this thesis and provided the basis for identifying the problem statement, research objectives and hypothesis. A key focus of this research involved examining the critique of the zero waste movement, in particular the extreme assertion that, in a municipal context, zero waste is a chronic failure/impossible/doomed and is a super-mega proposition for which there is no blueprint or methodology. The value-proposition for research addressing this critique was established by examining the real-world New Zealand (zero) waste case-setting where a combination of misinformation, lobbying, and policy capture resulted in an abandonment of zero waste and a consequent regression in KPIs of the prior New Zealand Waste Strategy (NZWS:2002) entitled *Towards Zero Waste and a Sustainable New Zealand*. The published outputs of this research make the case that zero waste approaches can and should be scientific, practically successful, measurable and evidenced, a good economic investment, socially and culturally beneficial, framed in a continuum of learning and evolution, and democratically popular. Additionally, this research has provided new insights to the extreme scope, challenge, and intensely complex disciplinarity of the waste → zero waste transition spectrum. This has enabled visualising and reinterpreting the significant, but largely unmet interdisciplinary requirement of (zero) waste management, as a critical barrier to progress. Based on a three-stage review of policy analysis in (zero) waste management research, a specific methodology of mixed methods content analysis (formally annotated as MMR HCA-T-MZWM quant + QUAL(quant)) was designed to test and explicate the disputed existence of municipal zero waste methodology (MZWM). Detailed quantitative findings converge in the formation of an extensive hybrid embedded qualitative written narrative result that is the illustrated in four final graphic summary illustrations of the hypothesised MZWM. This ∞ infinity – continuum model offers a new conception of dynamic integrated elements and interoperative, interdisciplinary clusters comprising the MZWM. The ∞ infinity – continuum MZWM model embodies the disruptive, hyper-aspiration of zero waste in seeking maximum transition into a sustainable circular economy, and in extent and detail appears commensurate with the cited super-wicked complexity of waste issues. The ∞ infinity – continuum MZWM model provides a simple, yet meaning-laden graphic, abductive bridge between the UNSDG imperative and zero waste's innovation seeking and transformational ideals. The MZWM represents a key foundation for the critical next-step opportunity to develop an evaluation framework (ideally as an internationally agreed research framework encompassing further learning and experience) to systematically measure and enhance the performance of future municipal zero waste programmes.

Acknowledgements

Foremost, I would like to acknowledge my research supervisors Professors Chris Anderson and Robin Peace, for their faith in me and my work over many years. This has not been easy journey and without this longstanding guidance and support and the input of their expert knowledge and experience I would not have been able complete this project. I would also like to acknowledge the early input and guidance of Prof. Sarah McLaren. It has been a great a privilege, through my role with the Zero Waste Academy (ZWA) as a staff member of Massey University, to have been given the opportunity to undertake a PhD. This has been a unique learning and professional development challenge and I am extremely grateful for this opportunity. It is astounding to be awakened to the big wide world of science and it has been humbling and exciting to have been able to make a small contribution and enter this conversation.

In this instance the opportunity to have undertaken this research is indistinguishable from the existence and function of the Zero Waste Academy (ZWA), so it is important to acknowledge and sincerely thank Massey University for hosting the ZWA and enabling my role as the coordinator. In this role I have had the opportunity to develop skills and experience as an educator, research supervisor and to have undertaken a number of interesting industry and community R&D and sustainable campus projects. My employment at Massey has meant I have been able to work with many amazing colleagues and have experienced the inspirational scientific leadership of a series of Heads of the School of Agriculture and Environment (SAE). Specifically, Professors Rus Tillman, Peter Kemp, and Paul Kenyon. In this context it is also important to acknowledge the Palmerston North City Council (PNCC), which provide a substantial funding commitment to support the ZWA over a considerable period.

With sincere respect I would like to acknowledge key members of the original Zero Waste Academy (ZWA) Board, whose experience and knowledge enabled both the ZWA and the associated teaching and research programme to be developed. I have a debt of gratitude to Don Riesterer, (ex-Chair) Zero Waste New Zealand (ZWNZ) Trust Warren Snow, Julie Dickinson, and Jo Knight past Mangers Zero Waste New Zealand (ZWNZ) Trust, Chris Pepper and Rob Green of the PNCC. Also during his tenure as HoI of the INR at Massey, Professor Russ Tillman (now retired) made an enormous contribution to the early development of the ZWA.

In particular, I would also like to acknowledge Emeritus Professor Vince Neale for his interest in and support of the zero waste movement and his Chairing of the Zero Waste Academic Advisory Group (ZWAAG) who have provided guidance through all stages of development of the ZWA. Huge thanks to Dr Terry Kelly, Professor Mike Roche, Dr Sue Cassells, Dr Lone Jorgensen, Ewen Cameron, and Eric Lombardi (International) Executive Director, Eco-Cycle International.

The Zero Waste Academy (and with this, ultimately, my opportunity to undertake a PhD) would not have come into being without the foresight and campaign strategy of the Zero Waste New Zealand Trust, which has inspired an incredible community of *zero wasters* in New Zealand. My work as coordinator of the ZWA would have no substance without the extraordinary grassroots community-based work of what is now known and the Zero Waste Network and Pare Kore. It has been my privilege to play a modest role in in this sector and I would like in particular to acknowledge Marty Hoffart, Jackie Forbes, Warren Snow, Julie Dickinson, Dorte Wray, Sue Coutts, Ric Thorpe, Hannah Blumhardt, Liam Prince, Matthew Luxon, and Sheryl Stivens for their inspirational work and longstanding long-standing contributions in scripting New Zealand's zero waste story. I have been particularly fortunate to have been able to work in various capacities with this group and am constantly amazed and inspired by their expertise and commitment.

In addition, the ZWA collaborates internationally, via the Nexus for International Zero Waste Academic Collaboration (NIZAC). Accordingly, I would like to acknowledge the following key supporters: Dr Atiq Zaman, Curtin University, Australia; Rodrigo Sabatini and Lais Vidotto, Instituto Lixo Zero Brazil (ILZB) + Zero Waste Youth + ZWIA; Prof. Dr Armando Borges de Castilhos Junior, Sara Meireles & Fernanda Elisa Demore Palandi, Federal University of Santa Catarina, Brazil; Dr Enzo Favoino, Chair of the Zero Waste Europe Scientific Committee + Scuola Agraria del Parco di Monza, coordinator of the Scientific Committee of the Zero Waste Research Centre in Italy; Gustavo Rittl, University of the State of Santa Catarina, Brazil; and Raphael Rossi, President of the supervision board, ASM Rieti spa, CEO, Formia Rifiuti Zero, Turin, Italy.

Paramount in this group of international experts deserving acknowledgment are the authors of the key selected source documents which provided the authoritative content, which was analysed in this research project. Ultimately this has enabled the proving and explication of the new municipal zero waste methodology (MZWM). I would like to particularly acknowledge the authors of *The End of Waste: Zero Waste by 2020*, Warren Snow Julie Dickinson and authors of *The Community Zero Waste Roadmap*, Eric Lombardi and Kate Bailey and the group of the authors of the GAIA published *On The Road to Zero Waste: Successes and Lessons from around the World*, Cecilia Allen, Virali Gokaldas, Anne Larracas, Leslie Ann Minot, Maeva Morin, Neil Tangri, Burr Tyler, and Bill Walker. Interestingly, these publications all also acknowledge a wider international grouping of expert contributors and practitioners.

My role as coordinator of the ZWA has enabled involvement several groups whose expertise and influences has informed my work:

NZPSC: The New Zealand Product Stewardship Council (https://nzpsc.nz) is an independent voice for effective product stewardship on behalf of the wider community. In this capsity it has been a great privilege to have been able to work alongside the following: Warren Snow, Assoc. Prof Trisia Farrelly, Hannah Blumhardt, Marty Hoffart, Assoc. Prof. Ben Wooliscroft, Brent Aiken, Romilly Cumming, and Sandi Marray.

EXITO: For an intense and interesting period *the Extractives Industry Training Organisation* enabled the development of an NZQA accredited system of vocational training for the *Waste and Resource Recovery* sector. In the capacity of being a member of the RRSAG, I had had the privilege of working alongside and learning from the following industry leaders and experts: Trevor Munro, Chairperson (SMRANZ), Sheryl Stivens (CRN/RONZ), Marty Hoffart and Ric Thorpe (ZWN), Tom Reece, Graham Burt, Susi Batterbury and Peter Fowler (EXITO)t, Paul Bishop, Nigel Clark and Boyne Drummond (WasteMINZ), John Jury (SMRANZ), and Alan Edge (C&D).

PERC: Political Ecology Research Centre provides a platform for engagement, leadership and action in the interdisciplinary field of political ecology research that connects politics, economics and culture to environmental issues. PERC has provided me the opportunity to have learned from and be inspired by the example of: Assoc. Prof. Trisia Farrelly, Dr Sy Taffel, Prof. Glen Banks, Dr Nicolas Holm, Lisa Vonk, Assoc. Prof. Sita Venkateswar, Assoc. Prof. Ingrid Horrocks, Romilly Cumming, Dr Philip Steer, Dr Tom Doig Dr Karen Hytten Alice Beban, and Dr Laura Jean McKay.

ENM, PPC and the Green Bike Trust / Green HUB: The ZWA has provided a framework for a range of local engagement and practical initiatives designed to outwork environmental practice and progress in the city of Palmerston North. Early on this involved supporting the Green Bike Trust as this pioneering local organisation sought to evolve into a bigger mission. This vision included a role as an on-campus recycling service provider and pursuing the dream of establishing a Resource Recovery Centre (RRC) for our city. Most recently, this frame of work has involved the *Palmy* Plastic Pollution Challenge (PPC) which is facilitated by the Environmental Network Manawatu. In various capacities I would like to acknowledge the professional development which occurred through working alongside the following local group of grass-roots greenies doing plenty to support our local community and environment: Lais Vidotto, Dr Heike Schiele, Wiremu Te Awe Awe, Madz Batachel, Siobhan Lunch-Karaitiana, Dr Brian Finch, Dr Heather Knox, Dr Sharon Stevens, and the team of Pip Chrystal, Samantha Bateman, Kian Lee, Natasha Hickmott, Melissa Doyle, Mike Moynihan from the PNCC, Casar Britto, Judy Zho, Yvonne Marsh, John Hornblow, Janice Gordon, Vern Chettleburgh, Marty Bowen, Tina Ryan, Andrew Salisbury, Stewart Davies, Bob O'Driscoll.

Finally, and most importantly, I would not be the person I am, or to do anything much at all without the love and support of my family: Thank you beyond words to my amazing partner Gillian and my beautiful kids Emily, Wilson, and Joshua. You inspire me and make every day worthwhile.

Thank you to my awesome extended family, today led by two gorgeous matriarchs, my mum, Margaret Hannon and my mother in-law, Val Budd. A massive thank you also to – Karen, Ethan and Grace Hellesoe, Pip Hannon and Finn and Honour Simmonds, Nikki, Harry and Jack Clark, Tim and Belinda, Grace and Maggie White, Nick and Leanne, Sam and Ella Tilly.

My family and I want to acknowledge all the practical support, kindness and encouraging words of our network of friends and our church family at CCC. It is not feasible to mention all of you, but the great thing about life is I will get to thank you all in person…

A special acknowledgment and tearful remembrance to some much loved and always missed family who have passed away while I was on this PhD journey: My father, Bruce Hannon, my father in-law, Bill Budd, and my very special brother-in-law, Lino Hellesoe – I hope I have made you proud…

Table of Contents

List of Figures

List of Tables

Introduction:

Based on the global amalgam of scale, crisis, risk, complexity, and tenure, waste is described as a *super-wicked* anthropogenic phenomenon (Krausz, 2012; Levin, Cashore, Bernstein, & Auld, 2012). The environmental degradation and pollution associated with waste is a complex and critical issue, with interrelated social, cultural, economic dimensions (Hannon & Zaman, 2018; Hoornweg, Bhada-Tate, & Anderson, 2012). International waste data indicate that limited progress is being made in holistically addressing this issue and resolving the associated human and environmental health crisis (Hannon & Zaman, 2018; Mavropoulos et al., 2017).

This lack of progress has prompted urgent calls for a comprehensive, internationally coordinated transition from the current extractive, linear, wasteful globalised socio-economic model, to a circular material economy aiming for zero waste (Ellen MacArthur Foundation, 2013a; Ellen MacArthur Foundation & World Economic Forum, 2016). Addressing waste issues presents a key opportunity to reduce environmental exploitation and pollution, as well as to mitigate climate change and to progress the United National Sustainable Development Goals (UNSDGs) (D. C. Wilson, Rodic, et al., 2015a).

Tackling the holistic problem of waste, is a highly interdisciplinary imperative, necessarily drawing on numerous subject areas and vocational spheres. This observation applies doubly to the proposition of zero waste, which requires a managed transition from a so-called *end of pipe* disposal focus, into an holistic re-engineering of all production, products, packaging and consumer responsibility systems (S. Lehmann & Crocker, 2012; Levitzke, 2012). The nature, scope, and scale of aspiration involved in a zero waste approach, requires a genuinely transgressive and transdisciplinary level of change-making (Hannon, 2020).

However, the term "waste management" is not even specifically identified as a formal scientific discipline in common reference documents.[1] A sense of omission and confusion exists around what disciplines are required contributors, in order to generate effective (zero) waste management. Critically, it is also unclear how these contributing spheres of knowledge and practice should engage and hopefully synergise, in order to catalyse progress beyond the apparent inertia and dysfunctional status quo (Hannon, 2020).

It can be recognised that a number of interrelated *post-waste* movements and overlapping intellectual disciplines (WasteMINZ, 2001) exist in a dynamic and aspirational milieu of sustainability ideas, ideals, rhetoric, and activity (Ayres, 1997; Glavic & Lukman, 2007). These movements coincide in rejecting the historically constructed socialisation of consequence free, infinite consumption and disposability, which is commonly understood and referred to as the *throw-away society* (Porritt, 2007; Strasser, 1999). These alternative, future-focused, sustainable waste management movements choose to interpret waste as a resource and opportunity, rather than as just a problem requiring immediate evacuation and disposal (Agudelo-Vera, Leduc, Mels, & Rijnaarts, 2012).

[1] In this instance a compilation and interpretation of sources: 1- the taxonomy of disciplines, based on the National Science Foundation (NSF) longitudinal survey of doctorate recipients; 2- the National Commission for Scientific and Technological Research (CONICYT) / Organisation for Economic Cooperation and Development (OECD) list of disciplines; 3- the open source Wikipedia format; or 4- other indicative frameworks / discussion reported in academic publishing i.e. (Glavic & Lukman, 2007; Repko & Szostak, 2017; D. C. Wilson, Rodic, et al., 2015a).

Even the adherents of traditional disposal-orientated waste management theory, now appear to acknowledge the crisis of waste and also that the associated depletion and pollution of natural resources, is no longer sustainable or justifiable (Boucher & Friot, 2017; CIWM, 2014; D. C. Wilson, Rodic, et al., 2015b). The historical theoretical framing and industry praxis of "linear Integrated Waste Management Systems (IWMSs)", is now cited as being reimagined, evolving and being re-languaged as "circular IWMSs (CIWMSs)" (Cobo, Dominguez-Ramos, & Irabien, 2018, p. 279; Hannon, 2020).

A progressive symmetry exists across the cluster of alternative movements that are responding to the crisis of waste, including, for example, zero waste (ZW), zero emissions (ZE), circular economy (CE), industrial ecology/symbiosis (IES), urban metabolism (UM), bioeconomy (BE), and CIMWSs, These movements identify with the common aspiration that future socio-economic design and associated political management should actualise the *ecosystem metaphor* of infinite-perpetual resource life-cycles, as a design principle (Kuehr, 2007; Loiseau et al., 2016; McDonough, Braungart, Anastas, & Zimmerman, 2003; Pfau, Hagens , Dankbaar, & Smits, 2014; Varga & Kuehr, 2007). This interrelated cluster typically envision that all future production and consumption will be premised on normalised maximum material resource conservation, stewardship/responsibility, efficiency, and circularity (Hannon, Zaman, Rittl, Meireles, & Demore-Palandi, 2018).

This genre of alternative sustainability focused waste management movements can be conceptualised as a transitional spectrum of activity, which can be abbreviated[2] via the encompassing extremities of the *waste → zero waste [and or (zero) waste]* annotations (Hannon, 2020). A consequence of adopting this spectral and interconnected view of the subject of (zero) waste is that the scope of the literature review for this research project became necessarily broad and inclusive. This project conceived (zero) waste holistically and as much a consideration of social sciences, humanities, design and management, as it might otherwise narrowly be considered a strictly STEM[3] based discipline (Hannon et al., 2018).

Framing Statement: At this point, for the purpose of clarity, it is acknowledged that this research project deliberately adopted a limited focus on the theory and practice of the circular economy movement. This thesis also does not distinguish the relationship, or accord status between the zero waste (ZW) and circular economy (CE) movements, ahead of accepting a more inclusive view on the existence and compatibility of a heterogenous genre of alternative, assertive, aspirational waste management brands, disciplines and movements, which all seek more sustainable approaches. The contention that *'Zero Waste has been largely eclipsed in the literature… Zero Waste now tends to be overshadowed by discussions of the circular economy'*, may be true in some jurisdictions (R Crocker et al., 2022). However, throughout the duration of this research this has not been the case, nor dominant policy or practical context in New Zealand.

[2] In the cited article it is noted that this is without prejudice, or exclusion to any of the operatives in this sustainable waste/resource management space as all innovation is important and we do not yet know where key breakthroughs and progress will be generated (Hannon, 2020).
[3] STEM = Science, Technology, Engineering, and Mathematics.

The ascent of the CE movement globally and the adopting of this policy framing, particularly as popularised and promulgated by the Ellen MacArthur Foundation is acknowledged and celebrated. However, in New Zealand this *brand* of policy discourse has only relatively recently registered in the consultation documents for the revision of the NZWS and WMA and on the public facing communication of the New Zealand Ministry for the Environment. The documents associated with this, as yet unresolved consultation process, are equally transfused with the diverse ideals and rhetoric of '*sustainable development - taking responsibility for waste - transforming recycling - transitioning to a low carbon economy – and actualising Te Tiriti*'.

The Zero Waste and Para Kore Networks which is are a deep repository of knowledge and experience in this sphere[4], have consistently done much of the heavy lifting around waste issues in New Zealand, seamlessly bridge the distinctions and overlaps between ZW and CE conceptions and practices. Significantly the ZWN submission into the NZWS and WMF consultation includes both terminologies and offers a comprehensive resolution to what for some is a contested relationship[5]. Pointedly this submission also observes:

> *"a circular economy is still a hazy future vision. Circle Economy uses their data to create global and regional circularity indexes. They calculate the global economy to be 8.6% circular. Sadly, that makes us 91.4% linear, AND we are heading in the wrong direction - we were 9.1% circular a couple of years ago"*.

In simple terms, if driving genuine change is the goal, then the real-world case studies underwriting the globalised theory, practice and people of the zero waste, show that this worldview is still more than relevant and certainly sufficient to justify a PhD research project seeking to examine critical questions around MZWM.

In some jurisdictions, such as South Australia the language, legislation and government institutional branding has been distinctly switched from that of zero waste[6] and Zero Waste South Australia, to new incarnations such as 'Greener Industries SA' and the drive towards a circular economy. At one level, especially when measured on an outcomes basis, this kind of re-branding may be argued as just a superficial and expedient re-languaging and re-packaging of similar and overlapping concepts and practices.

However, it can also be argued that the circular economy is distinct and superior intellectual and practical tradition descendant from the 1960's '*Spaceship Earth*' phenomenon first articulated by the inventor Buckminster Fuller (1969) and then seminally and latterly responded to et. al. by architects (McDonough & Braungart, 2002; Stahel & Reday-Mulvey, 1981), (ecological) economists and industrial ecologists (Frosch & Gallopoulos, 1989b; Pearce & Turner, 1989), leading to popular and policy uptake (R Crocker et al., 2022). The counterfactual to the assertion of the distinction and superiority of the circular economy movement is that the same luminaries are also cited as giving rise and engaging with the core

[4] The extensive depth and detail (143 pages) of the ZW and PK network's submissions and the historical scope, holistic knowledge, intellectualism, indigeneity and environmental ethos, which is articulated, demonstrates the long standing intellectual and practical leadership of these groups in the New Zealand context.

[5] *"Zero Waste is a grandparent of the circular economy and should be recognised in the strategy... We feel strongly that Zero Waste should be a headline part of the vision and the actions in the waste strategy. Zero Waste is a key concept that underpins circular economy thinking..."*

[6] NB: this summary presentation was given by Vaughn Levitxzke as Chief Executive of ZWSA.

ideas, metaphors and exemplars also attributed to the zero waste movement[7]. Whilst the concept and practices of the circular economy movement can and should identified and discussed as a distinctive phenomenon, all such movements in the ‘sustainable waste management’ space, have more in common than sets them apart. The position adopted for this research was that it was largely sematic, antagonistic and counter-productive, to try and unpick this commonality, in order to elevate one ahead of all other contributors to much needed and yet to be achieved progress in addressing waste issues.

In the context of this thesis then, the term zero waste describes a heterogeneous global community of practice that is pioneering alternative new approaches to resolve waste issues across industrial/commercial, municipal, community and individual and family/household contexts (Hannon, 2015a). While now quite significant, zero waste literature does not yet demonstrate consensus in all key concepts, methods, and evaluation tools (Pietzsch, Ribeiro, & Fleith de Medeiros, 2017; Zaman, 2015). Despite a growing international body of evidence indicating that zero waste can be considered a successful approach (Allen et al., 2012; Zaman & Ahsan, 2020), the discourse on zero waste suggests that the movement is poorly understood and sometimes unjustifiably maligned.

Like many progressive movements in the human health, social justice, pollution, and climate change space, zero waste appears to be subject to both systemic barriers and the phenomenon of vested interest industry. Ideologically driven lobbying tactically orchestrates confusion, denial, controversy, and delay (Hannon & Zaman, 2018; Oreskes & Conway, 2010). Recent New Zealand experiences indicate patterns of correlation with both this globalised phenomenon of lobbying and its becoming virialised, supercharged, and anonymised via algorithm-driven social media systems. In this scarcely regulated, opaque domain, people’s vulnerability and reactivity to hot-button issues[8] can be exploited and weaponised, often by a limited number of actors propelling ecologies of mis/dis-information, contrarian science, popularist and polarising rhetoric, in order to superimpose partisan over democratic ends (Edwards, 2020; Hannah, Hattotuwa, & Taylor, 2021). When the commercial vectors and economic strands of this phenomenon are examined independently, much of this effort at dissuasion and disruption is associated with industry sectors whose profitability depends of *externalising* environmental and social costs (T. Anderson & Chapple, 2018; Hannon, 2018).

A key objective of this type of industry lobbying is delaying the introduction – and if that fails, then controlling the design – of market-based economic instruments and regulatory interventions (Clough, 2007; Hoffart, 2012, 2018). The net effect of product stewardship/extended producer responsibility programmes, as an example of this type of policy intervention by government, is to relocate otherwise externalised and unaccounted costs and liabilities from the public purse to the private sector responsible for producing and profiting from them (Hannon, 2018; Zero Waste Europe & FPRCR, 2015). Zero waste promotes

[7] For example, Buckminster Fuller ‘there is no away’ (https://www.bfi.org/challenge/2016/eggplant), design to eliminate waste / pollution (R Crocker & Lehmann, 2012; Ellen MacArthur Foundation, 2013a; Frosch, 1997; Frosch & Gallopoulos, 1989a; S. Lehmann & Crocker, 2012; Levitzke, 2012; McDonough & Braungart, 2002; McDonough et al., 2003)
[8] For example, anti-woke/PC/virtue-signalling, gun control, rural land rights and 1080, Māori sovereignty and water/land rights, faith (Christian evangelical or Pentecostal), abortion, euthanasia, cannabis law reform, families and family structure LGBTQIA+ rights (including conversion therapy), immigration, race and gender, environment, climate change and sustainable development, free-speech, free-markets and of *small* and partisan government.

the most assertive regime of market-based policy instruments, economic incentives, and legislative and regulatory interventions (Hannon & Zaman, 2018), specifically because such measures have proved to be highly effective in addressing waste issues (CCME, 2014; Zero Waste Europe & FPRCR, 2015). Alongside the terminology of zero waste obviating aspiration and assertion in solution-seeking, the zero waste movement also embraces activism and the critical role of dissent in confronting the unintended and harmful consequences of society's wasteful "flame, flush and fling" mentality (Hannon & Zaman, 2018; Seadon, 2010, p. 1649).

This convergence of activism with advocacy for environmental policies which assertively confront industries profiting from pollution, appears to set the zero waste movement on a collision course with the industry sectors most directly invested in *making and managing waste* (R Crocker & Lehmann, 2012). Accordingly, one of the key foci identified within the broader literature review was to explore the critique of zero waste and to explore the underlying clash of ideologies and investments that gives rise to this. At its most extreme, this critique portrayed zero waste as a chronic failure and doomed (Krausz, 2013a; Premalatha, Tauseef, Tasneem Abbasi, & Abbasi, 2013). Similarly, zero waste is cited a being a "supermegaproject" that lacks a credible blueprint, or methodology for implementation (Krausz, 2012, p. iii; Krausz, Hughey, & Montgomery, 2013). Such critique is of concern because, if valid, the concept of zero waste is impossible, fraudulent and a pretend solution, potentially drawing resources away from more legitimate and effective approaches (Clift, 2004, p. 64; Premalatha et al., 2013). If false, then such assertions wrongly undermine the opportunity for zero waste to catalyse new ideas and innovation, and to generate progress in resolving the intractable issue of waste (Hannon & Zaman, 2018).

Zero waste is clearly a polarising concept, with ramifications beyond just the debate between the industries that *make and manage* waste and the environmental movements that confront this. Because waste is cited as both, connecting to "everything: energy, food, pollution, water, health, politics, climate, economics…" (Humes, 2012, p. 6). and causing a public and environmental health emergency (Mavropoulos et al., 2017), arbitrating the legitimacy of proposed solutions has relevance to the entireties of our anthropology and future development. Research into the phenomenon of zero waste offers insight into societal processes of legitimisation vs stigmatisation, participation vs exclusion, empowerment vs undermining within society's conversations about how to generate environmental progress (T. Anderson & Chapple, 2018; Oreskes & Conway, 2010).

However, contrary to the appearances posited in any highly antagonised or overly theoretical discourse, zero waste is predominantly a pragmatic, practitioner-driven movement, grounded in community / business level change-making (Lombardi & Bailey, 2015; Zero Waste Europe, 2017). It can be argued that zero waste is less of a competitor to traditional solid waste theory than it is a synergist, catalysing a shift up into the top, "largely uncharted" priorities of the waste hierarchy (Hannon et al., 2018; Song, Li, & X, 2014, p. 10). Examining the legitimacy of critique and the veracity of claims around the existence and composition of a municipal zero waste methodology presents as a critical research opportunity. Within this broad imperative, the following singular research hypothesis emerged:

A municipal zero waste methodology can be established and explicated.

The following research objectives were selected as providing the staging to address this proposition:

1. To review and analyse the global spectrum of zero waste concepts, theories, and practices (i.e., industrial, activist/NGO and municipal contexts) reported in literature, with the view to establishing a unifying understanding of what zero waste is today and how this relates to other sustainable waste/resource management disciplines and movements. For example, disciplines such as industrial ecology/symbiosis and urban metabolism and movements advocating for a circular-, bio-economy and producer-consumer responsibility.
2. To review and evaluate the critique of zero waste in academic and industry literature, with the view of identifying the value of zero waste in addressing the issues and opportunities associated with waste.
3. To explore the (inter) disciplinarity of (zero) waste management and to better understand how these required disciplines relate to change-making and global progress to date.
4. To explore New Zealand's recent (zero) waste management experiences as a case setting for examining the real-world implications of the debate and contest between waste and zero waste worldviews.
5. To analyse the content of a selection of authoritative municipal zero waste literature and reported practice to, if possible, systematically quantify and qualify what constitutes a municipal zero waste methodology.

The Research Question at the centre of this project challenge is:

Can a scientifically defendable municipal methodology be developed by analysing the content of a selection of key zero waste policy documents?

This challenge requires identifying a robust procedure for determining the content and efficacy of any existing methodology for zero waste in a municipal context. The development process for this specific methodology involved a three-stage review strategy, which examined the analysis of waste management and zero waste policy research and then, specifically where content analysis was utilised in researching (zero) waste management policy and practice. The sequence of findings culminated in an evidence base for designing a model of content analysis specifically for testing and elaborating the proposition of a municipal zero waste methodology (MZWM).

As is more fully detailed in the methodology chapter, the methodology that was implemented in this research was a pragmatic hybrid of hermeneutic content analysis that used concurrent, convergent, embedded mixed methods focussed on the theme of municipal zero waste methodology. This is annotated as MMR HCA-T-MZWM quant + QUAL(quant) (Berg & Lune, 2012; Bergman, 2010; Creswell, 2015; Jick, 2008; D. L. Morgan, 2008; Plano Clark & Ivankova, 2016).

The subject, research hypothesis, and objectives selected for this PhD project ensured it was both a wide-ranging academic research experience and an extension of my professional development and current role. This project has evolved from my role as coordinator of the Zero Waste Academy (ZWA) at Massey University, which enabled and hosted this research.

The research outcomes have provided renewed input into the collaborative interdisciplinary teaching and research and outreach functions of the ZWA. During the course of this research my work with the ZWA has also involved engagement with numerous community, industry and central/local government people and organisations.[9]

Alongside my other research interests, industry engagement (Gertsakis et al., 2011; Hannon, 2000; Hannon & Dickinson, 2009; Hannon & ROU, 2007a, 2007b; Hannon et al., 2019; Schiele et al., 2021; Zaman, Arnott, McIntyre, & Hannon, 2018) and practical experience as a recycling contractor, these networks and experiences have shaped my worldview and informed my intellectual perspectives in undertaking this research. The ZWA was conceived as a service provider to the New Zealand zero waste community. The vision for this PhD was that it would contribute to further developing the shared understandings, concepts, polices, and principles, underwriting the heterogeneous global zero waste community of practice.

The ZWA's explicit embeddedness in and support of the zero movement potentially gives rise to subjectivity and bias, rather than the independence and objectivity that empirical positivist science requires. However, from a social science perspective this background involvement, networks, connections, and depth of experience potentially afford knowledge and insights that can enhance research outcomes (Petticrew & Roberts, 2006; Stember, 1991). Aside from the scrutiny offered through the procedure of research supervision, the decision to implement a publication strategy as part of the research procedure, provided an opportunity to manage these issues by independently testing the quality of work via the multiple peer review processes.

This research adopts the holistic perspective that this subject area can be understood as a transitional waste → zero waste management spectrum of ideas and activity (Hannon, 2020). Within this perspective the diversity of interconnected movements and disciplines responding to the issue of waste are book-ended by the extremities of the *known* conventions of historical waste management practices – counterposed with the *yet to be realised*, future aspiration and innovation proposed by zero waste (Hannon, 2020). It can be accepted that this inclusive and encompassing perspective on (zero) waste management adds further grist to the controversy and contest apparent in this sphere. However, this framing can equally be accorded for the universalism of providing a model to acknowledge both difference and commonality among the movements and disciplines addressing waste issues. This framing acknowledges the stark distinctions that exist, as well as the reciprocal inspiration and innovation sharing among synergetic movements and disciplinary knowledge bases, engaged in the issue-opportunity nexus of waste, climate change, and sustainable development.

Reflecting this holistic, interconnected worldview, an extensive and broad-spectrum original literature review was undertaken. Because of the scope of this work and the extent of the outcome (> 100,000 words) it was not practical to include this original literature in the main body, or even in appendices of the thesis. Instead, an alternative means of inclusion and presentation was adopted. The series of publications derived from the original literature

[9] For example: the ZWN, CRN, ZWNZ Trust, ZWIA, Rekindle, The Rubbish Trip, Pare Kore, All-Heart, the New Zealand Product Stewardship Council, Kiwi Bottle Drive, EXITO/MITO, WasteMINZ, RONZ, SMRANZ, eDay NZ Trust, the PNCC, MDC, DELTA, ENM/PPPC/Rangitaane o Manawatu/NIWA/UCOL. For the sake of brevity these important collaborative engagements remain listed by acronym rather than, as per convention, listed in full at the first usage; however, each is explained in full in the Glossary of Terms.

review phase of the research project are appended as evidence of this work (Appendix 1). Excerpts from these publications have been threaded in as a contribution to the narrative of the following three chapters of the thesis: Literature Review (Hannon, 2015a; Hannon & Zaman, 2018; Hannon et al., 2018); Background/Context (Hannon, 2018, 2020); and Methodology (Hannon, 2022 in submission).

Chapter One: Literature Review

Introduction: This chapter explores the subject area of waste → zero waste management, highlights the issue of waste (and conversely the opportunities inherent in addressing this), explores tensions in the discourse around respective theories and practice and specifically identifies a critical research gap. The narrative content of this chapter includes key points and excerpts cited from three (Hannon, 2015a; Hannon & Zaman, 2018; Hannon et al., 2018) of the group of the publications derived from the early expansive literature review phase of the research process. Key outcomes from reviewing literature are to have clarified the topic and precise focus of the research and to identify and justify the specific research question addressed in this thesis.

This literature review observes quite starkly differentiated pro and contra strands of commentary on zero waste and queries the apparent absence in the development of a convergent, non-polarised middle-ground. Particularly in the case of dynamic change-making movements such as zero waste, well-balanced and critically informed debate should play an important role in refining the learning that emerges in translating theory into practice and seeking to improve future performance. This consideration prompted a focussed examination of the critique of zero waste, which resulted in Table 1.

Table 1: A focussed examination of the critique of the theory and practice of zero waste.

A selection of critique sourced from academic and other literature, which is variously directed at the theory and practice of zero waste.
• Too extreme and expensive (Ragossnig, 2006).
• Unscientific, thermodynamically impossible and captured by NGOs and or marketing hype (Clift, 2004; Premalatha et al., 2013). Particularly questionable in seemingly, ultimately suggesting a perpetual motion machine, which defies the laws of thermodynamics… (Zwier, Blok, Lemmens, & Geerts, 2015).
• Politically and economically untenable (Mauck, 2003).
• Oxymoronic, conflicted and merely rhetorical (Mauck, 2011; Townend, 2010).
• Data compromised (O'Brien, 2011).
• The technical and economic impossibility of 100% recycling (Bartl, 2013).
• An extremist and horrible idea (Campanelli, 2011).
• Seeking to questionably displace the well founded and accepted integrated waste management hierarchy (C. Anderson, 2011; Townend, 2010).
• Grossly overstating the lack of landfill space and unreasonably promoting recycling (Lomborg, 2001).
• Part of a *be less bad*, human-bashing, failure of imagination (McDonough & Braungart, 2002).
• As C&D waste is unavoidable and "zero waste" is not practical (Yuan & Shen, 2011)
• Unjustifiably popularist and potentially undermining what might otherwise be considered positive developments in waste treatment and disposal (Clift, 2004; Ragossnig, 2006).
• Pragmatically too expensive and inappropriate in some developing economies (Shekdar, 2009)
• Wishful thinking, non-existent and confused with *zero waste to landfill* (ZWtL) (Themelis, 2009, acccessed 2013).

- Ultimately, at the local government level, impossible and doomed to failure (Krausz, 2013a; Premalatha et al., 2013).

While all aspects of the original literature review were informative and important, assembling the various strands of direct and indirect critique of zero waste was particularly influential in identifying a research question and motivating the design and implementation of the overall research project.

In some publications points of critique were threaded in alongside discussion of and support for aspects of zero waste approaches and vice versa. These publications evidenced the objectivity, which is necessary for critical debate to perform the review-revision function expected of academic discourse. However, some elements of this critique also appeared to be poorly informed and quite contestable. and to exhibit unexamined bias and or disciplinary chauvinism (Hannon, 2020; Klein, 2014; Stock & Burton, 2011). The apparent lack of balanced and positive perspectives on zero waste, in the sphere of literature canvassed at this junction raised important questions. When examined in the context of the orchestrated global campaigns denying and undermining the science of climate change (Dunlap & McCright, 2010) elements of the critique of zero waste appear to exhibit similar patterns of denial and denigration.

Research by Oreskes and Conway (2010) has exposed the globalised phenomenon of vested interest industry lobbying and explains why specific campaign tactics can be disproportionally effective in displacing scientific guidance and distorting democratic processes. Particular manifestations of this phenomenon are the campaigns that have variously denied the existence of climate change, anthropogenic responsibility, the seriousness of the issue, and the necessity and urgency of response (Dunlap & McCright, 2010). The malign legacy of these campaigns has been to socialise confusion, division, anti-government sentiment, distrust of science, and, at the extremity, pervasive conspiracy theories (McKinnon, 2016). The direct result of climate change denial has been to reduce social cohesion, political resolve, comprehension of, and consensus on necessary action and investment in an orderly and effective transition into a zero carbon economy (McKinnon, 2016). It can now be understood that the consequence has been an acceleration of avoidable and irreversible harms, already caused, and a significant escalation in the risk of reaching future catastrophic tipping points into runaway climate change (MassonDelmotte, 2021).

While specific industries with vested interests can be identified as the primary funder of climate change denial, neo-conservative foundations and ideologically driven think-tanks are the primary agency for propagating misinformation, dubious science and the views contrarian scientists (Dunlap & McCright, 2010). While masked innocuously as freedom of speech and public debate, these campaigns have also involved aggressive dimensions in isolating and attacking individual scientists (Hansen, 2009) and undermining the credibility of even the most high profile and credible political commentators (A. Gore, 2007), economists (Stern, 2006, 2009), and international scientific organisations, such as the IPCC. Aside from obscuring the issue, another tactic patterned by campaigns of climate change denial is to denigrate and dismiss the options and opportunities for resolving the issue. These tactical contingencies appear to work in malign synergy to undermine what might otherwise be genuine opportunities for progress and solution-making, which if left unabated, ultimately expose the misinformation and malfeasance of such campaigns.

Given the reality and consequence of campaigns of climate change denial as a backdrop, it is reasonable to consider whether the critique of zero waste is a subsidiary analogue of this phenomenon, outworked in a different sphere of societal and environmental practice. The assembled critique of zero waste appears to exhibit some of the same patterns of denial of existence, seriousness, cause, responsibility, urgency about issues, and denigration of the necessity and opportunity of response. Over recent decades the zero waste movement has been at the forefront of exposing the systematic failure of trying to *manage* rather than *eliminate* waste issues (Murray, 2002; Palmer, 2004). The zero waste movement has been consistently outspoken in confronting the waste industry over enabling and profiting from, rather than ending the exploitation and pollution inherent to the *take – make – waste/dispose* linear economy (Ellen MacArthur Foundation, 2013a; Jessen, 2003). Zero waste advocates have been assertive in pointing toward and demonstrating an alternative framework of policy and programme options needing further research, investment, and application (Allen et al., 2012; Connett, 2013; Connett & Sheehan, 2001).

Numerous questions arose in assembling and examining the critique of zero waste as part of the extensive original literature review process. For example, what strands of critique are valid, in contrast which strands have no merit? Has embracing activism as an essential part of the heterogenous global zero waste movement ultimately been counterproductive? Does exposing the failures of the linear waste management paradigm just make zero waste a target of extreme opposition and unbalanced critique? Have the reactions to activism actually obscured the real issues and the opportunity that the zero waste movement represents, in catalysing awareness and pioneering environmental progress? This process of reflection and questioning all aspects of the subject of zero waste was influential in shaping the overall research design and in particular the selection of the project's research objectives, which culminate in addressing the research hypothesis. An important feature of this research design was the strategy of developing a group of publications that contribute to this and the subsequent background / context and methodology chapters. This publication strategy provided an opportunity to address what appears as the most errant and extreme critique of zero waste and to road-test some alternative theories and more balanced research perspectives via the peer review process of the respective publication formats.

The publication of review research findings before the thesis allowed peer review processes to confirm and support the literature review, background / context, and methodology chapters of this thesis. Appendix 2 provides a summary of the outcomes of the publication strategy in implementing the research objectives related to addressing some of the most acute misinformation and misunderstanding around zero waste. These research outcomes derived from the original literature review contribute to the knowledge base on zero waste and set an agenda for a less polarised and more legitimate scientific debate. While compiling the review of the critique of zero waste (Table 1) provided a general motivation for the group of publications, which are derived from the research process and support this thesis, the crucial outcome was to prompt the identification of the specific single research question. The titles of the following three sub-sections derive directly from three publications: Hannon (2015a), Hannon and Zaman (2018), and Hannon et al. (2018). The respective content of the following three publication-based sub-sections explores critical aspects of the waste → zero waste challenge and demonstrates the extent and veracity of the original literature review. It is notable, as is illustrated in proliferation of red text in Table 17 (Appendix 2) that key points compound into themes, which reinforce an accumulation of arguments which implement the research objectives of addressing misinformation and misunderstanding around zero waste.

1.1. Waste vs zero waste: The contest for engaging and shaping our ambient 'waste-making' culture

The opportunity to present at the 2015 *Unmaking Waste* conference hosted by the *ZWSA Research Centre for SD+B*, UniSA and having the paper (Hannon, 2015a, p. 402) accepted for publication in the conference proceedings, was an important academic milestone in this research process. The following series of five key points and direct excerpts have been selected as providing a summary of this work.[10] This paper canvasses the findings of multiple authors in curating novel discourse examining the interrelated phenomena of waste and zero waste.

The zero waste movement has arisen in response to the failure of traditional approaches to managing waste:

> Today waste issues present as a global syndrome, with toxic impacts at the level of the nano-sphere (Clift, 2008; Oko-Insitut e.V, CIEL, & ECOS, 2015; Swan & Colino, 2021) as well as across the entire Earth bio-sphere. The issue of waste has negative consequences for all living species and the full spectrum human cultures / ethnicities irrespective of socio-economic development status (Boucher & Friot, 2017; Hoornweg et al., 2012). Zero waste is an alternative and optimistic new paradigm, which challenges the sense of crisis and inertia around global waste issues. Zero waste is a heterogenous global community of practice, emerging in response to waste issue, which are an outcome of failed socio-economic design (McDonough & Braungart, 2002) and traditional waste *management* approaches (ISWA, 2017b; D. C. Wilson, Rodic, et al., 2015b). (Hannon, 2015a).

Zero Waste approaches can be considered strategically confrontational and controversial:

> Waste and zero waste are, for different reasons, both controversial and polarising concerns. Solid waste can be interpreted as a physical artefact of the Anthropocene's accumulating failures of production, products, and packaging, as well as of human ethic around consumption, consumer responsibility and future aspiration (Hawken, Lovins, & Lovins, 1999; Zaman & Lehmann, 2013). The concept of zero waste is both hyper aspirational i.e., is cited as a *2nd – green - industrial revolution* (Murray, 1999, 2002; I. D. Williams, 2013) and is controversial, disruptive and strategically distinguished from conventional theorem (Hannon, 2015a). As well as sometimes not working very well, conventional approaches to

[10] Although largely direct quotes, in places these excerpts have been recompiled in order to form a more coherent thesis narrative. For example, the order of points and arguments made in each publication may not correlate with the best narrative flow for the thesis. Where relevant the excerpts have been edited and or, contemporised on the basis of updated information. In the following sections the formatting choice of 'indentation' has been selected as the most appropriate indicator of the use of excerpts.

> Integrated Solid Waste Management (ISWM) are not implementing key theoretical principles or priorities.
>
> For several decades a widely accepted theoretical convention for addressing the *end-of- life* problem of waste, has existed in the form of the ubiquitous (5R) *waste hierarchy*. This prioritisation model provides guiding principles for integrated solid (sustainable) waste management (ISWM) as a globalised industry (ISWA, 2012; UNEP, 2009). Yet, while there are some signs of progress, for all the investment to date around policy / programmes, technology and infrastructure, data suggests that conventional ISWM is failing to deliver on its principle goals, at either: the bottom (disposal), middle (recycle) or top (reduce) priority levels of the waste hierarchy (Hannon, 2015a, p. 404).

The conventional ISWM industry's own data articulates a history of systematic failure:

> In respect of disposal: approximately half of the global human community does not have access to the most basic sanitary waste management systems (D-Waste, 2013a) and approximately 40% of the total waste generated is estimated to be treated via uncontrolled burning, which exacerbates already chronic pollution and climate concerns (Thompson, 2014; Wiedinmyer, Yokelson, & Gullett, 2014). In respect of recycling: only one quarter of the 3.4 – 4 billion tonnes of municipal and industrial waste produced annually is recycled (Chalmin & Gaillochet, 2009). In respect of reducing waste, the combined effects of population growth, increasing consumption and urbanisation means that, total municipal solid waste (MSW) generation of the world's cities is projected to increase (Hoornweg et al., 2012; Mavropoulos, 2010a). (Hannon, 2015a).

It costs more to not address waste issues than it does to solve this problem. The zero waste movement encompasses a diverse free-market of ideas and solution-seeking activity with a growing track-record of innovation, learning and emerging success and progress:

> Today a clear value proposition exists for addressing the issue of waste (D. C. Wilson, Rodic, et al., 2015a). Conversely, significant risks and an acute prognosis that will only worsen over time (Mavropoulos, Newman, & ISWA, 2015; Rucevska et al., 2015) is attached to not effectively tackling waste issues (Graedel, 2010; Platt, Ciplet, Bailey, & Lombardi, 2008). Zero waste encompasses: industrial, municipal and activist / community spheres of practice, the spectrum from developing to developed socio-economic settings (Allen et al., 2012; J Hill, Hislop, Steel, & Shaw, 2006a) and academic, strategic policy-making and governance worldviews (EC, 2014; IPLA, 2011a, 2012, 2013a; S. Lehmann, 2011a; S. Lehmann & Crocker, 2012). Zero Waste involves the duality of upstream and downstream (so called end of pipe) conceptions and the creative tension of being defined by proprietary definition[11], as well as being described as simply shorthand for better resource management (Levitzke, 2012). As an ideal, in the process formation and actualisation (Schnitzer & Ulgiati, 2007), zero waste is continuing to evolve in the globalised free-market of ideas and participating initiatives (Allen et al., 2012; Brandon, 2012). (Hannon, 2015a).

[11] Zero Waste International Alliance (ZWIA) official definition (http://zwia.org/standards/zw-definition/

In drawing together strands of data and commentary from keynote ISWM authors and institutions, this paper poses a challenging question. If the issue of waste is clear and the solution is known, and it is agreed that addressing the issue is cost effective and popular, why then is environmental progress not happening? Set against the extreme backdrop of assertion of failure and impossibility directed at the zero waste movement, this selection of excerpts highlights the *catch-22* situation confronting the conventional paradigm and practice of waste management. Given that conventional ISWM thinking and institutions have historically dominated the global practice of waste management, these excerpts highlight that this is actually the locus of failure and responsibility from which the globalised waste crisis derives.

Relative to a low baseline resulting from conventional ISWM, the practice of zero waste can in contrast be considered quite successful. This paper offers a re-set to polarising discourse by observing that "overall the *waste vs zero waste* debate informs and challenges both conventional waste and zero waste schools of thought and provides insight and encouragement in efforts to address the, largely, unresolved crisis of waste" (Hannon, 2015a, p. 407). This paper takes up the challenge of addressing misunderstanding about zero waste and initiates a more balanced examination of the contested narratives around the respective theories and practices. It can be observed that, despite the attendant opposition and negative impacts the zero waste movement appears to strategically embrace controversy and activism as, essential attributes necessary for catalysing positive change. This paper argues that it is precisely because the zero waste does not have a vested interest in maintaining convention or the status quo, that the movement can act as a disruptor and "promote the most assertive regime of policy instruments and interventions aiming to conserve and cycle resources, avoid pollution, address climate change and to actualise sustainable development" (Hannon, 2015a, p. 402).

1.2. Exploring the phenomenon of zero waste and future cities

The second publication (Hannon & Zaman, 2018) supporting the development of this thesis draws on green-urbanism and eco-, solar-, smart-city and zero- emission, -energy, -waste city literatures and provides an interdisciplinary perspective on zero waste as a heterogeneous global community of practice in the context of the future sustainability of (zero waste) cities. This article also provided a platform for further exploring the phenomenon of zero waste relative to key elements of the critique. The following nine keynote points and direct excerpts provides a summary of the contribution of this article to the literature review chapter of this thesis:

The conceptual and practical failures of waste and waste management are now manifest on a global scale:

> A cluster of international reports describe the issues associated with waste, as becoming a globalised public and environmental health emergency, necessitating an urgent and comprehensive internationally coordinated response (Mavropoulos et al., 2017;

> Mavropoulos et al., 2015). The environmental and social consequence of humanity's failure to effectively manage waste, has resulted in some of the most polluted and poverty stricken places on Earth (Mavropoulos et al., 2017). While this syndrome is often localised and most concentrated around (mega) cities (Abarca Guerrero, Maas, & Hogland, 2012; Mavropoulos, 2010a; UN-Habitat, 2010), the interrelated aquatic and atmospheric dimensions of impacts of terrestrially generated waste are registering across the entire global biosphere (Hodzic, Wiedinmyer, Salcedo, & Jimenez, 2012; Moore, 2008; Ryan, Moore, van Franeker, & Moloney, 2009; Thompson, 2014; Wiedinmyer et al., 2014). (Hannon & Zaman, 2018).

This problem of waste is not going away and is projected to get much worse under a conventional business-as-usual scenario:

> The World Bank reported that the 2012 baseline of 1.3 billion tonnes of municipal solid waste (MSW) generated, by cities globally is projected to double by 2025 to 2.2 billion tonnes p.a. (Hoornweg et al., 2012). Given current trends in population, urbanisation, and consumer demand (Mavropoulos, 2010a, 2010b; Troschinetz & Mihelcic, 2009) driving this projection, it is questionable whether the key priority and challenge of reducing waste generation (i.e., located as the top priority of the *5R-waste hierarchy*[12]) is, under 'business as usual' conditions, imminently achievable? Concerningly, it has been reported that, unless aggressive sustainability scenarios are successfully implemented, global *peak waste* may not occur until 2100 (Hoornweg, Bhada-Tata, & Kennedy, 2014). (Hannon & Zaman, 2018).

Not only is the scale of the failure of waste management predicted to get worse, in future the complexity of waste issues will multiply exponentially:

> The interrelated dimensions of the waste issue are attracting acute media scrutiny (i.e., ocean plastics, disaster waste management, chemical toxicity and dissipation, food-waste, organised crime, nuclear waste and emerging *NBRIC*[13]) and causing escalating public awareness and alarm. The breadth of waste issues is overlain by systemic causes such as history, geography, infrastructure & technology, vested interests, ideology (i.e., privatisation (Iskandar & Tjell, 2009)), individual and collective cultural and socio-economic imperatives (Gutherlet, 2010; ISWA, 2015; Marshall & Farahbakhsh, 2013; Pongrácz & Pohjola, 2004; D. C. Wilson, 2007), which are compounding a sense of crisis, complexity and intransigence (Hannon & Zaman, 2018, p. 3). (Hannon & Zaman, 2018).

Waste is a manifestation of macro-level socio-economic system design. Unless the responding solution theory encompasses this same macro-level of conception it will fail. A management ethos framed and limited to end-of-pipe disposal, can never succeed:

> While conventional waste management theory, which is distilled into the near universal rubric of the waste hierarchy, clarifies our priorities and can be seen as having catalysed a measure of progress, overall we are yet to globally actualise this principle and we appear to be trapped in the limitations of this paradigm (Bartl, 2014a; Pietzsch et al., 2017; Pollans,

[12] This is the order of priority established in the 5R waste hierarchy which is firstly: reduce, reuse, recycle, recover energy and then lastly residual disposal.

[13] 'NBRIC', i.e., nanotechnologies, biotechnologies, information and communication technologies (eWaste), robotics and cognitive sciences (Graedel & Allenby, 2010)

> 2017; Van Ewijk & Stegemann, 2016). The net result is that most of the resources that flow through the global economy still transit via the destructive and polluting linear model, variously described as *take – make – waste* (Jessen, 2003) – *dispose* (Ellen MacArthur Foundation, 2013a; Pietzsch et al., 2017). Evidencing this, socio-metabolic research assessing the degree of circularity of material flows in the global economy, describes this as only in the early stages (Ghisellini, Cialani, & Ulgiati, 2016; Haas, Krausmann, Wiedenhofer, & Heinz, 2015). Currently, the development of a more circular economy is limited by rapid growth in socio-economic stocks, a focus on recycling rather than reuse / reduction, and an estimated 44% of processed materials that are incinerated to provide energy (Haas et al., 2015; Pietzsch et al., 2017) and hence exit rather than realise economic circularity (Hannon & Zaman, 2018, p. 4).

The zero waste movement encompasses a range of alternative theories and practices seeking to pioneer holistic solutions to the issue of waste:

> The evolving concept and emerging practice of zero waste is a controversial sphere of discussion across urban development, manufacturing and waste management (Silva, Stocker, Mercieca, & Rosano, 2016; Zaman, 2015; Zaman & Swapan, 2016). However, the ideal of zero waste continues to be embraced by individuals, families, communities, business organisations, as well as local municipal and national levels of government responding to the issue of waste (Song et al., 2014; Zaman, 2015, 2016). A significant tranche of popular, industry and academic literature evidences and illustrates how the concept of zero waste is being outworked in practice and is evolving, as strategies, policies and programmes are implemented, *reality checked*, reviewed, and revised in further cycles of innovation seeking (Pietzsch et al., 2017; Song et al., 2014; Zaman, 2015). (Hannon & Zaman, 2018).

Zero waste is part of a diverse, creative, future-focused sustainability-seeking genre of activity:

> The zero waste movement (C. Anderson, 2011) can be viewed as one of a cluster of sustainability actors that both highlight and respond to the nexus of failure, inertia and growing sense of global crisis associated with the conventional waste management paradigm (Hannon, 2015b; Silva, Rosano, Stocker, & Gorissen, 2017; Silva et al., 2016). The zero waste movement encompasses a range of perspectives and approaches (Song et al., 2014; Zaman, 2015) and can be regarded as a neologism, residing in a busy eco-ideas marketplace, alongside interrelated and complementary theses on how sustainable development can be engineered (Glavic & Lukman, 2007; Silva et al., 2017; Silva et al., 2016). While the new, alternative sustainability-focused disciplines responding to the issue of waste (i.e., such as industrial ecology[14] and bioeconomy[15] and the movements for a circular economy[16] and zero waste) each arise out of differing perspectives, personalities and intellectual traditions, commonality appears around subject foci, concern / motivation,

---

[14] For example, see The International Society of Industrial Ecology http://www.is4ie.org
[15] For example, see: https://ec.europa.eu/research/bioeconomy/index.cfm
[16] See the work of the Ellen MacArthur Foundation http://www.ellenmacarthurfoundation.org

aspiration / ideals, cognitive DNA, discourse / literatures and practical outworking (Veleva, Bodkin, & Todorova, 2016). (Hannon & Zaman, 2018).

While commonality exists among the movements and disciplines seeking genuine *sustainable waste management*, zero waste retains a unique and important identity:

> However, in this sphere, zero waste also has a unique identity and assumes distinctive role, articulated in the broadly accepted, peer-reviewed definition[17] offered by the *Zero Waste International Alliance (ZWIA).* In the adoption of provocative terminology, a campaign posture and in advocating for a hyper-aspirational continuum of innovation, zero waste seeks to confront perceptions of normalcy and intractability around waste. The embrace of dissent and activism in the framing of zero waste, alongside the embrace of community / NGO involvement and the economically redistributive aspects, is why the movement is simultaneously controversial and arguably, indispensable (Lombardi & Bailey, 2015; Pollans, 2017). (Hannon & Zaman, 2018).

The concept of zero waste encompasses cognitive tensions, as well as freedoms:

> Zero waste exists in a tension between the ZWIA's genuine attempts to quality assure and preserve the integrity of the concept and the creative freedom required to drive the quantum innovation needed to address the escalating spectrum of waste issues, which demand a continuum of locally appropriate responses (UNEP, UNITAR, Hyman, Turner, & Carpintero, 2013; D. C. Wilson, Rodic, et al., 2015a). Leveraging off the mutability and envisioning function of zero – as a *stylistic* for innovation, zero waste can be seen as an optimistic meme for a future and solutions focused freedom of thinking[18] (Hannon, 2015b). Zero waste can be interpreted as part of a 6th wave of innovation in waste management systems and clearly continues to be debated, contested, and to evolve across its globalised contexts and interpretations (Zaman, 2015; Zaman & Lehmann, 2011a). (Hannon & Zaman, 2018).

Zero Waste embraces activism and deliberately seeks to confront the status quo and to provoke innovation, and progress:

> Encompassed in the prickly opposition to incineration and landfill, zero waste seeks to refute and disrupt the prevailing normalisation of waste and our *throw-away society*, as a relatively recent socio-economic construction, which can and must, be redesigned (Herbert, 1998; Waste Watch UK, 2004; Zaman & Lehmann, 2011a). Zero waste directly confronts the waste management industry's twin bury and burn profit centers, on the basis of perpetuating our *flame, flush or fling* (Seadon, 2010) disposal mentality. Ultimately this binds human society to linear material flows, rather than enables the development of a

[17] *"A goal that is ethical, economical, efficient and visionary, to guide people in changing their lifestyle and practices to emulate sustainable natural cycles, where all discarded materials are designed to become resources for others to use…. Zero waste means designing and managing products and processes to systematically avoid and eliminate the volume and toxicity of waste and materials, conserve and recover all resources and not burn or bury them"* (ZWIA, accessed 2018).

[18] Examples of spheres of acute and far-reaching innovation, which are colonising, re-interpreting, simultaneously manipulating, stretching, and actualising the plausibility of zero waste are: Nanotechnology (B. Gibbs, 2011; Nanotechnology Development Blog, acessed 2013; Tsuzuki, 2010) 3D printing (Cubify, accessed 2014; PS, accessed 2014; Taylor, 2014) and in the context of space travel (ESA, 2013; J. Morgan, 2013), clothing (Electrolux, accessed 2014; Korge, accessed 2014), housing (Wainwright, 2014).

more circular economy (Hannon & Zaman, 2018). Described historically as a dangerous idea, the paradox of zero is cited as inspiring the disruptive *zeronautics* capable of breaking the sustainability barrier (Elkington, 2012; Seife, 2000). The idiosyncratic coinciding of the terms waste and zero is a direct and deliberate confronting of the embedded significance of the non-neutral language of waste (Silva et al., 2016), as well as the deeply vested industrial triumvirate,[19] dominating the core of the global current economic system. The discourse and community of zero waste in the respective theoretical nurture and actual participation in waste activism, denotes a stark rejection and disassociation from the entrenched role of traditional waste management, as an enabler of the economic primacy given to consumption and capitalist growth models (Pollans, 2017; Silva et al., 2016). (Hannon & Zaman, 2018).

This article recompiles diverse perspectives and international experience from the original literature review and articulates a further nine key points examining the theory and practice of zero waste, as a response to the escalating global crisis of waste. This further evidences the systemic failure and consequence of the linear, take–make–waste socio-economic design construct and identifies zero waste among a cluster of disciplines and movements seeking to redesign a sustainable circular economy.

Zero waste can be portrayed as an entirely new and alternative waste management paradigm or interpreted as overlapping, extending and synergetic with a general evolution towards more sustainable waste and resource management practices (Hannon & Zaman, 2018). This article acknowledges the pragmatic and intellectual tensions apparent in the diametric combination of the terms zero and waste and the paradox of inclusion and heterogeneity counterposed with definitional propriety.

1.3. Moving toward zero waste cities: A nexus for international zero waste academic collaboration (NIZAC)

The third publication (Hannon et al., 2018) contributing to this thesis, orientates the existence of zero waste-related academic initiatives, the broader vision and activity of environmental education for sustainable development (ESD), and the historic universal aspiration of universities in addressing problems and fostering innovation. The Zero Waste Academy (ZWA-LL) is discussed as providing an example of the intersection of *Living Labs* and zero waste research theory and practices. The aspiration for partnership between universities and their host cities/communities to enhance the quality and outcome of education for sustainable development (ESD) is situated at the genesis of living labs as a research and development construct (Molinari & Schumacher, 2011). These authors observe that this genre of living labs still plays an important role within the wide thematic gamut of living labs research (Schumacher, 2013). Today, a variety of living labs are exploring opportunities for innovation and progress in the nexus between (zero)waste, public/private sector, city / region ESD

[19] i.e., the collective of industries which TAKE [i.e., extracts raw materials from the obliging duopoly of natural sinks and ecosystem services], then MAKE [i.e., cultivate and feeds hyper-consumerism in excess of sustainable anthropocentric utility and want] and then WASTE [i.e., manages this mostly linear discharge of now discarded resources (and associated chemical toxicity) into constructed and accidental, land, sea and air-fills] (Ellen MacArthur Foundation, 2013a; Jessen, 2003; Pietzsch et al., 2017).

(Hannon & Zaman, 2018; Konsti-Laakso, Hennala, & Uottila, 2008; Nevens, Frantzeskaki, Gorissen, & Loorbach, 2013; Santally, Cooshna-Niak, & Conruyt, 2014).

A core attribute of the model of living lab demonstrated by the ZWA-LL, is illustrated in the seminal quote highlighting the value proposition for all stakeholders:

> ... a win-win situation for the university and the neighbourhood. The university students gain such things as the opportunity to apply problem skills to real problems, the opportunity to learn while performing a real service, and the opportunity to write reports for directly involved individuals. The community gains a new, no-cost resource that offers a neutral forum for conflict resolution and can provide high quality analyses. (Bajgier, Maragah, Saccucci, Verzilli, & Prybutok, 1991). (Hannon et al., 2018).

Decades on, the education, research, campus test-bed, demonstration and outreach (i.e., the typical capacities of a university as living labs) is still being recognised as a powerful opportunity for generating innovation and transformational leadership around sustainable development in the locus of cities (Hua, 2013; Kasemir, 2013; J. Robinson, Berkhout, Cayuela, & Campbell, 2013). This chapter establishes this context as a basis for the early stage reporting on the aspiration of forming a nexus for international zero waste academic collaboration (NIZAC) (Hannon et al., 2018). This initiative seeks to connect like-institutions with a shared interest in exploring the intersecting theory and practice of living labs and zero waste and the opportunity for synergy in co-generating innovation (Beynaghi et al., 2016; Nevens et al., 2013; G. Trencher, Yarime, McCormick, Doll, & Kraines, 2014; G. P. Trencher, Yarime, & Kharrazi, 2013).

Building on the precedent of Sections 1.1 and 1.2, this section draws upon a further six published excerpts to complete the literature review chapter's overview of waste issues and (zero) waste management history, theory and practices so as to arrive at a concise summary *problem statement,* for this PhD research. The crux of this statement is to reiterate that *waste and waste management* is the locus of *issue* and is where the word *failure* should be attributed. As this excerpt illustrates, today even mainstream ISWM industry commentators now use terms like urgency, crisis and emergency in respect of waste:

> Today numerous indicators point to waste being a critical global environmental issue, with interrelated human health and socio-economic implications (Hoornweg et al., 2012; Mavropoulos et al., 2015). The environmental and social consequence of our failure to properly understand and effectively manage waste, is most explicit in the burgeoning open dumps, uncontrolled burn, toxic waste-picking/informal recycling sites, which are amongst the most poverty stricken, dangerous and marginalised places on Earth (Mavropoulos et al., 2017; Mavropoulos et al., 2015). Relative to the scale of crisis and the theoretical convention expressed in the waste hierarchy, globally, conventional waste management has made limited progress across key levels of the described priorities for management practice (D-Waste, 2013a; Hannon, 2015a; Hannon & Zaman, 2018; D. C. Wilson, Rodic, et al., 2015a)... Forecast trends in population, urbanisation, affluence, consumption, and technology, heightened by accelerating climate change impacts, appear set to exacerbate global wastes issues (Mavropoulos, 2010a, 2010b, accessed 2014), elements of which are

already being described as a global health and environmental emergency (ISWA, 2017b). (Hannon & Zaman, 2018).

Zero waste was once considered extreme, now this sense of radical aspiration and response is mainstream and accepted as appropriate relative to scale of risk and harm associated with waste. The zero waste movement increasingly appears to be on the right side of history, science, and democracy in this debate. This prescience and popularity are encouraging further individuals, families, businesses, and communities to adopt zero waste goals and pushing out the thresholds of innovation and solution seeking:

> … Accordingly, the heterogeneous global zero waste community of practice encompasses the parallel necessities of both, activism to confront vested interests perpetuating the disposal paradigm and the most assertive regime of policy instruments, and interventions to conserve and circularise material resources, avoid pollution, address climate change and progress toward more sustainable development (Hannon, 2015a; Hannon & Zaman, 2018). Where once zero waste was considered (and sometimes dismissed) an extreme neologism, in the sustainability ideas marketplace (Glavic & Lukman, 2007), now even the most mainstream conventional waste industry association, now employs a vison[20] to work towards an earth where no waste exists (ISWA, 2015) and 100% based, 'stretch targets'[21] forming part of the *Global Waste Management Outlook* report's confronting and aspirational call to action (D. C. Wilson, Rodic, et al., 2015b)…

> … Beyond arguing for a maximum trajectory in change making policies and programmes, implicitly zero waste seeks a continuum of aspiration that aims to disrupt the current technical and socio-economic barriers to sustainable practice and possibility (Elkington, 2012; UNEP et al., 2013). The simple ideal and singular goal of zero waste continues to be adopted by individuals, families, communities, business organisations, as well as by municipal and national governments, seeking to frame a response to the issue of waste (Song et al., 2014; Zaman, 2015, 2016). An accumulating cohort of popular, industry, and academic literature articulates how the evolving concept, strategies, policies, and programmes of zero waste are being understood and implemented, reality checked, reviewed and revised in practice, resulting in further cycles of innovation (Hannon & Zaman, 2018; Pietzsch et al., 2017; Song et al., 2014; Zaman, 2015). (Hannon & Zaman, 2018).

Sustainability on University Campuses: Learning, Skills Building and Best Practices (Leal Filho & Bardi, 2018) provided the opportunity to continue exploring the notion of *zero waste cities,* which closely interrelates with the subject research focus of municipal zero waste methodology (MZWM). This publication explored the different ways zero waste is interpreted and applied and to reinforce themes of identity and integration, for example:

> …The future zero waste city is a reoccurring feature of zero waste and sustainability literature. Future cities are conceptualised as laboratories for innovation for becoming: smart (i.e., by merging ICT with traditional infrastructure, technologies and services to manage risk and resolve problems), zero-energetic, zero-waste, environmentally sustainable, self-sufficient, (organic) food secure, industrially and environmentally

[20] See: http://www.iswa.org/iswa/organisation/about-iswa/
[21] Such as the goal of 100% collection and controlled disposal for urban populations globally

symbiotic and sustainable, as well as offering a more socially enlightened, democratic, equitable and high quality life experience (Batty et al., 2012; Krzemińska, Zaręba, Dzikowska, & Jarosz, 2017)… The future zero waste city concept can be distinguished from the respective historic and contemporary technical utopianism and technological idealism / quick techno-fix ideologies (Lehmann, 2011b) on the basis of the accumulating case studies reinforcing the scientific (Pietzsch et al., 2017; Zaman, 2015; Zaman & Swapan, 2016), economic (Enkvist & Klevnas, 2018; Zaman, 2016), social/cultural[22] (Hogg & Ballinger, 2015; Living Earth Foundation, accessed 2015; D. C. Wilson, Rodic, et al., 2015a), and practical viability (Allen et al., 2012; Hood & Ministry of Environment British Columbia, 2013; Lombardi & Bailey, 2015; UN-Habitat, 2010; Zero Waste Europe, 2017) of the necessary transition from a linear, waste based, throwaway society towards a zero waste-based, circular economy.

The other key attribute distinguishing zero waste from technocentric ideology is an embedded recognition that waste is primarily a social issue (Lombardi & Bailey, 2015; Murray, 2002). While much of the early proof of concept was provided in formative zero waste industry experience, once this success and aspiration was projected toward the municipal/city construct, the zero waste movement becomes more discernibly grounded in grass roots-community/informal sector based activism, initiative and participation (Allen et al., 2012; Hannon, 2015a; Lombardi & Bailey, 2015; Murray, 2002)… Zero waste is also distinguishable in the insistence of public, ahead of private interest, fully internalising otherwise externalised environmental cost in the market price of products and services and in campaigning for more complete and mandatory instrumentation of extended producer (and consumer) responsibility (S. Lehmann, 2011a; Nicol & Thompson, 2007; Zero Waste Europe & FPRCR, 2015). Arguably, this is why the zero waste movement is simultaneously controversial and indispensable, as a critical driver and grist in the societal debate about how to engineer the transition from unsustainable, into sustainable (zero)waste management (Lombardi & Bailey, 2015; Pollans, 2017). (Hannon & Zaman, 2018).

Importantly, this body of work demonstrates the broad scope of the original literature review that explored innovation seeking per se, living labs specifically, and how this connects to inter- and trans- disciplinarity, which enabled the formation of observations such as:

…The nexus of addressing failure and a consequent requirement for quantum innovation, which typifies the zero waste – future city challenge, resonates strongly with the developmental context, out of which living labs theory and practice has emerged. Living labs are viewed as providing powerful imaginative infrastructure, new modes of knowledge generation and for inspiring the fresh politics required for social and technical transformation (Evans & Karvonen, 2011)…Cited as a new science basis for knowing the real world, living labs approaches are viewed as providing ideas factories, real world approximant test beds for proving the application of those new ideas and as spaces for blueprinting the formation of wider sustainable development and climate change mitigation (Evans, Jones, Karvonen, Millard, & Wendler, 2015; Evans & Karvonen, 2011, 2014). Inclusive of application in place / PSS / people / policy, the typifying resume of living labs, reads as a good fit for the waste → zero waste, issue opportunity polemic (Hannon &

[22] ref. the extensive set of Zero Waste Europe case studies: https://zerowasteeurope.eu/case-studies/

> Zaman, 2018). Reducing polluting emissions and enhancing the symbiotic efficiency and circularity of industrial and urban metabolisms is the coinciding objective of much contemporary waste / resource management and sustainable development thinking (CIWM, 2014; EC, 2014; Ellen MacArthur Foundation, 2013a; J. Morgan, Mitchell, & Green Alliance / WRAP, 2015). (Hannon & Zaman, 2018).

Having contextualised the barrier breaking, change making aspiration of zero waste within the universal imperatives of all innovation and sustainability actors, this publication provided a venue for clarifying affirming the attributes of zero waste:

> The emerging global zero waste community of practice is posited as both an antidote to the presiding dysfunction around making and managing waste (Hannon, 2015a; Zaman, 2015; Zaman & Lehmann, 2011a) and as an important addition to the required biodiversity of ideas and actions for engineering change (Hannon & Zaman, 2018). This shift in paradigm and practice will need to be transacted across spheres where living labs have a track-record of providing an engine (Niitamo, Kulkki, Eriksson, & Hribernik, 2006), environments (Ballon & Delaere, 2005; Schaffers et al., 2007), milieu (Bergvall-Kåreborn, Ihlström Eriksson, Ståhlbröst, & Svensson, 2009) and/or, an ideapolis (Kulkki, 2004) for innovation. Education and research in the transitional waste → zero waste space are identified as having potential to perform a transformative role in generating practical innovation and positive progress (Connett, 2013; Seldman, 2004; Van Vliet, 2014a; Zero Waste Europe, 2012). (Hannon & Zaman, 2018).

The broad scope of the book chapter format of the publication (Hannon et al., 2018) provided an opportunity both to frame the overarching New Zealand *zero waste story* as a case setting for this thesis and to introduce areas of policy and practice canvassed in the original literature review, which interrelate with (zero) waste management. In particular, the utilisation of regulatory policy interventions and market-based economic instruments and incentives, such as product stewardship (PS) and extended producer responsibility (EPR), which are further discussed in the upcoming background/context chapter.

In summary, this literature review chapter presents nineteen key points, each linked to a supporting excerpt drawn from the three contributing publications (Hannon, 2015a; Hannon & Zaman, 2018; Hannon et al., 2018). This demonstrates a broad examination of the subject of waste and the issues associated with the failure of the traditional paradigm and practices of waste management. The literature review chapter also examines the dynamic eco-ideas, disciplines, and movements that respond to the issue of waste. Within this future-focussed alternative cluster seeking a more sustainable approach to waste, the zero waste movement demonstrates some common philosophy, as well as a unique, controversial, and contested identity in pioneering innovation, success, and progress.

Important learnings also emerge from examining the critique of zero waste, which highlights the imperative for research to better understand this phenomenon. The literature review and subsequent chapters of this thesis present numerous perspectives that respond to and provide balance to this critique, which, at its most extreme, asserts that the zero waste movement is a chronic failure and doomed. Another key element of the critique is that the goal of zero waste in a municipal context is impossible because this is a super-mega proposition without a credible *blueprint* or methodology (i.e., which encompasses strategy, program design and implementation, etc.) (Krausz, 2012; Krausz et al., 2013; Premalatha et al., 2013). Having examined and discussed a range of discourse and important concepts around zero waste, this strand of critique ultimately informed the selection of the research question. Namely: Can a scientifically defendable municipal methodology be developed by analysing the content of a selection of key zero waste policy documents? The culmination of the literature review is identifying, and the justification that examining, this research question is the most critical research imperative for this PhD project. From this point forward, the central focus of this research process involves establishing the necessary background / contextual understanding and then designing and implementing the specific research methodology (namely MMR – HCA – T – MZWM) to answer this research question.

1.4. Problem Statement and Concise Statement of the Research Thesis:

This literature review illustrates numerous instances where the theory and practices of the zero waste movement appear poorly understood and misreported. In particular, the implementation of zero waste in a municipal context has been variously labelled as having no blueprint / plan and hence being impossible, doomed, and a chronic failure. If this critique is true, then the zero waste movement is offering a false hope and is in essence, fraudulently diverting scarce resources from legitimate programmes that can address waste issues. However, if the critique against zero waste is incorrect, then the opposite is true and a potential new opportunity to respond to the global waste crisis is being wrongly maligned and undermined.

Within waste management, the municipal context represents a crucial nexus between central and local government policy, programmes and resources, – and the opportunity for private sector industry / commercial innovation and action, – and the general public sphere of individual / family / household activity, where people address waste issues through personal choice and lifestyle change. This makes answering the question "*Can a scientifically defendable municipal zero waste methodology (MZWM) be developed by analysing the content of a selection of key zero waste policy documents?"* such a potent research opportunity.

This research examines and eventually proves the hypothesis that it is possible to develop an explicable and scientifically valid municipal zero waste methodology (MZWM) through mixed methods content analysis. The research also contributes to developing a more balanced, accurate, and deeper interdisciplinary understanding of the phenomenon of zero waste. These research findings will support scientific and public discourse about how communities can best respond to the many evident failures of traditional / conventional waste management theory and practice. This research establishes that a MZWM can be considered both legitimate and amongst the most effective approaches for generating new community engagement, ideas, innovation and change in response to waste issues.

In addition, this thesis fulfils the series of research objectives that are critically relevant to addressing the central, singular research hypothesis. These research objectives derive from the original expansive literature review research phase, in particular from assembling and examining the critique of zero waste (Table 1). This work highlighted the need to establish a more balanced and evidence-based understanding of the concept and practices of zero waste, necessary to address incorrect and unwarranted critique.

These research objectives were implemented through the development of the cited group of publications derived from this original review research phase of this PhD research process. Key points and direct excerpts from these publications have been variously drawn upon in forming the narrative and content for Chapters One, Two, and Three. For example, in respect of the assertion that seeking to implement a MZWM is doomed to futility and failure (Krausz et al., 2013; Premalatha et al., 2013), evidence is offered that pursuing zero waste and can actually be effective and successful approach (Hannon, 2018). The design and arrangement of the research objectives, in relation to the research hypothesis and the strategy of publications contributing content, provides for a more complete, well-grounded, and authoritative thesis. The inclusions from the strategic set of publications supplements, contextualises, and illustrates the importance of answering the central research question of this project.

Chapter Two: Background and Context

Introduction: The Literature Review in Chapter One drew together a series of excerpts of keynote findings from the three cited publications which discuss the policy theories, programmes and practices and discourse around the relative failure vs success of waste vs zero waste management. The literature review culminates in a problem statement that enables the identification and justification of the research question selected for this PhD research. This Background / Context Chapter Two compiles and cites excerpts of keynote findings from a further two publications and one in preparation, which together establish the background and contextual understanding for addressing the research question. Respectively the three sections making up Chapter Two:

- Draw upon a real-world New Zealand case study period to examine the, failure vs success debate driving critique of zero waste, from the converse scenario, whereby the once good outcomes that were being achieved under a zero waste regime, then regress as the political and policy pendulum swung to an anti-zero waste setting.
- Explore the extreme complexity and challenge of waste as an issue, relative to the unresolved (inter) disciplinarity of (zero) waste management in seeking to address these barriers.
- Examine the historical and contemporary understanding and use of the term municipal to establish the theoretical basis for the development of a research methodology, which can test and explicate the hypothesised existence of a municipal zero waste methodology (MZWM).

2.1. (Un)Changing behaviour: (New Zealand's delay and dysfunction in utilising) Economic instruments in the management of waste

A fourth publication (Hannon, 2018) was developed by undertaking a situational analysis of a critical period in New Zealand's recent waste and zero waste management experience (1999 to 2017). This publication provides an appropriate contextual grounding for addressing the selected research question. This body of work was published as a submission to the New Zealand Parliamentary Commission to the Environment (PCE). The submission was developed, and peer reviewed by and published under the auspices of the New Zealand Product Stewardship Council (NZPSC). The submission was entitled *(Un)Changing Behaviour: (New Zealand's delay & dysfunction in utilising) Economic Instruments in the Management of Waste* (Hannon, 2018).

The scope of analysis was structured around two relevant frameworks.[23] The first framework is based on the recommendations of the original *Changing Behaviour: Economic Instruments*

[23] In summary, namely: 1. How well has the government addressed the recommendations of the PCE's 2006, 'changing behaviour: economic instruments and the management of waste' report? 1.1. Under-utilisation of market based economic instruments in addressing waste issues (1.1.1. The national waste levy, 1.1.2. Managing the Waste Minimisation Fund (WMF), 1.1.3. implementing the WMA:2008). 1.2. Continued reliance on 'voluntary only' solutions in waste minimisation and management? 1.3. A lack of transparency and reciprocity with community consultation, which undermines democratic engagement? (1.3.1. Clarity and accountability of the 'Waste Advisory Board' (WAB) processes?). 1.4. Deficiencies in

in the Management of Waste? (PCE, 2006) report. The second framework is based on the analysis of ten more general indicators of New Zealand's political and practical management of waste policy. This NZPSC reporting provided a format for implementing the research objectives of enhancing understanding of the phenomenon of zero waste and addressing any unwarranted critique.

New Zealand was at one point reputed as a global leader in zero waste, exemplifying a nationally coordinated approach (Connett, 2013), which at its zenith resulted in >70% of New Zealand councils signing-on and seeking to implement zero waste programmes (ZWNZ Trust, 2007). However, in 2008, the New Zealand government changed from a centre left, Labour Party-led coalition (1999–2008), to a centre right National Party-led coalition (2008–2017). One result of this political shift was that the prior political endorsement of the zero waste campaign was rejected and in many respects reversed (Hannon, 2018). Examining this nearly two-decade national case study, provides a unique opportunity to examine the outcomes of a pro-contra zero waste policy setting. This background provides a real-world context as a basis for exploring the interrelated assertions of the impossibility and failure of zero waste and the non-existence of a blueprint or methodology by which to implement this transformational goal/strategy project (Krausz, 2012; Krausz et al., 2013; Premalatha et al., 2013).

New Zealand's waste data from the 1999 – 2017 period, reflects the associated pro-contra zero waste policy shift and evidences the outcome through national level key performance indicators (KPIs). The NZPSC reporting systematically examines what occurred in the New Zealand context, when a successful zero waste campaign strategy was opposed, mismanaged, derailed, and ultimately abandoned. In this, a question arises. If a real-world example exists where failure follows the abandonment of a zero waste approach, what does this say about the assertion that failure will automatically follow if a zero waste approach is adopted?

The New Zealand Parliamentary Commissioner for the Environment (PCE) represents an authoritative agency with a legislated mandate for providing accountability[24] in respect of the government's performance in this sphere of environmental policy and practice. The PCE's (2006) report, entitled *Changing behaviour: Economic instruments in the management of waste,* provides a comprehensive, reputable, and importantly independent analysis of New Zealand's waste management policy and performance up to that point. The report's content and recommendations provide a substantive examination of New Zealand's performance, relative to international best waste management practice. Specifically, the PCE (2006) reported on deployment of key economic instruments, market-based incentives, and regulatory interventions, which are known to drive progress in the parameters by which waste

government leadership and policy dysfunction, relative to community expectations? 1.5. Omissions in reliable baseline waste and resource management data? 1.6. New Zealand waste going AWOL? - and... 2. Broad range of other indicators of political mismanagement in New Zealand waste policy? 2.1. Unjustifiable inconsistency in waste policy? 2.2. Rejecting the aspiration and accountability offered by targets? 2.3. Vested industry lobbying trumps consultation and community consensus? 2.4. The 'Minister Knows Best' + 'Voluntary Only' + A Flawed and Risky Approach to PS/EPR? 2.5. The negative impacts of vested industry lobbying? 2.6. Comparing New Zealand against international good practice? 2.7. A crisis in rural waste management? 2.8. Ignoring the proven efficacy of PS/EPR systems? 2.9. New Zealand's reversal of the 'polluter pays' principle? 2.10. Indicators of New Zealand's tarnished international reputation?

[24] Other possible candidates might be the Environmental Protection Authority (EPA) https://www.epa.govt.nz/ or the 'Office of the Prime Minister's Chief Science Advisor' (PMCSA) https://www.pmcsa.ac.nz/.

management performance is measured nationally. This report was notably critical of New Zealand's standard and level of progress in waste management at that point.

The NZPSC's publication of the *(Un)Changing behaviour: (New Zealand's delay & dysfunction in utilising) economic instruments in the management of waste* (Hannon, 2018) encompasses a 12-year timeframe in which to re-examine the issues and opportunities originally raised by the PCE in 2006. The two reports' combined scope of coverage encompasses two quite distinctly different periods of pro-contra zero waste policy and practice. The pre-2006 period covers the *Zero Waste New Zealand (ZWNZ) Trust* campaign phase and the publication and early implementation of the *New Zealand Waste Strategy* (NZWS), which was entitled *Towards zero waste and a sustainable New Zealand,* in 2002. The subsequent 2006–2018 period covers the development and expected implementation of the *Waste Minimisation Act* (WMA:2008), the *Climate Change Response (Emissions Trading) Amendment Act* (ETS:2008) and the next heavily revised NZWS in 2010, entitled *Reducing harm – improving efficiency*.

This period of New Zealand (zero) waste management story is particularly interesting and important because of the introduction of a holistic conception of waste, as integrated with environmental, resource management, climate change, and sustainable development policies. Critically, during this period the WMA:2008, whose functionality had been identified and called for by the PCE, was gazetted by Parliament in order to provide the missing legislative mechanism for addressing waste issues and progressing waste minimisation. In simple terms, the NZPSC submission to the PCE (Hannon, 2018) raised numerous red flags and made the case for the Office of the Commissioner to once again critically examine waste as a key work-area within the broader sphere of environmental management in New Zealand.

With regard to the problem statement and research question of this thesis, the report (Hannon, 2018) offers an extensive examination across numerous lines of analysis, as to what happens when a zero waste-framed national strategy is abandoned and replaced with a significantly less environmentally assertive, free-market, voluntary-only, more conventionally styled business-as-usual approach to waste management. Undertaking this work within the research process and referencing it in this Background / Context chapter, supplements the thesis in examining assertions of zero waste failure/existence from the opposite perspective. New Zealand's real-world experience suggests that rather than zero waste being a failure, in fact regression and failure actually occurred as a result of a zero waste approach being abandoned and replaced by a traditional waste management approach.

The inclusion of the NZPSC reporting in this chapter also speaks to the contested question of the existence of a MZWM, which in the affirmative forms the hypothesis of this research. The described political shift away from a zero waste policy setting, resulted in the more than 70% of New Zealand local councils who had signed up to zero waste goals (ZWNZ Trust, 2007) stranded in the expectation of a supportive policy regime that never eventuated. In the New Zealand context, the influential Zero Waste New Zealand (ZWNZ) Trust campaign had been framed around awareness raising, envisioning and advocacy through a comprehensive suite of plans, programmes and publications, such as, G*etting to... zero waste by 2020* (Snow & Dickinson, 2001, 2003). These ZWNZ Trust publications appear principally consistent with the burgeoning number of other indicative zero waste plans, commentaries, and case studies emerging globally during this era.[25] Interwoven in this uniquely New Zealand conception of a zero waste plan was assertive advocacy for market-based policy instruments, economic incentives, and legislative/regulatory interventions (NZBCSD, 2002, 2007; Snow & Dickinson, 2001, 2003) designed to drive the journey towards zero waste and a sustainable New Zealand (MfE, 2002).

In the sense of documenting the outcomes of New Zealand's political and policy shift away from a zero waste setting, the NZPSC reporting captures the result of the omission of and unmet expectation for, some form of a zero waste plan or methodology. This NZPSC reporting enables the Background/Context chapter to examine the assertion of non-existence of a MZWM from the opposite perspective, specifically the absence of a zero waste plan, relative to a broad anecdotal understanding of and anticipation for a zero waste plan (NZBCSD, 2002; Stone, 2002; WasteMINZ, 2001). As precursor to the next Chapter Three, which identifies a methodology to test the hypothesised existence of a municipal zero waste methodology (MZWM), the NZPSC report backgrounds the consequence of causing a void where once there had been a tacit zero waste *gameplan* in formation.

The outcome for New Zealand of the absence of a planned MZWM was a failure of public policy and a significant waste of public investment. As the NZPSC report notes:

> … since its inception via the WMA:2008, the national waste levy has raised more than "$192 million - which has been distributed to national and local initiatives to reduce waste" (MfE, 2017b, p. 7). However, that singular objective has not been achieved – and in fact, the polar opposite result has occurred. Exemplifying the disconnect between objective and outcome, the net tonnages of waste reported at levied waste disposal facilities, increased by 20.1% in the three years between the 2014 and 2017 review periods (MfE, 2017b)… NB: some publications citing a 35% increase since 2009 (Hoffart, 2018). (Hannon, 2018).

Framing New Zealand's experience as an omission of an expected MZWM, provides a contextual basis for interpreting the multiple characterisations of waste management as New Zealand's *dirty little secret* and the anti-thesis of the national *100% PURE* clean green marketing.[26] The NZPSC report concludes that:

> …the dysfunction and delay evident in the subject period, 1999–2017) in New Zealand's journey towards progressive waste and resource management, involves genuine harm to

[25] For example: (ACT Waste, 1996, 2004; Ainge & McIver, 2011; Allen et al., 2012; Amengual, 2014; Anthony, 2004; AUMA, 2012; Badaracco & Weitzel, 2002; Baird, 2004; Björklund, Bjuggren, Dalemo, & Sonesson, 1999; Bulls, 2009; C40 Cities, accessed 2015; Campbell, 2007; CCC, 2006; Chaudhary, 2013; Chen & Houng, 2004; Clay, Gibson, & Ward, 2007; Colon & Fawcett, 2006; Connett, 2013; Connett & Sheehan, 2001; Crittenden, 2005; CRN Wales, 2009; Curran & Williams, 2012; Dileep, 2007; Dimino & Warren, 2004; Ecocycle, 2008; Edgerly & Borrelli, 2007; Ferry, 2011; Friesen, 1999; Fujita & Child Hill, 2007; Galloway & Metro Vancouver, 2009; Green Alliance UK, 2006; GRRN, 2002; Gulland, 2003; J Hill, Hislop, Steel, & Shaw, 2006b; J. Hill, Shaw, & Hislop, 2006; IPLA, 2012; Jessen, 2003; Kenward, 2013; Lang, 2005; Leroux, 2001; Liss, 1997; Lombardi, 2001, 2006; Lombardi & Bailey, 2015; Moňok, Stoykova, Bendere, Tömöri, & Popelková, 2009; Motavalli, 2001; Murdoch, 2010; Murray, 2002; Naylor, 2012; Oakdane Hollins Ltd, 2011; Oakes, 2008; Pierre, 2001; Platt, 2004; Rajendran, Björk, & Taherzadeh, 2013; RCBC, 2009, accessed 2014; Recology, accessed 2014; Residua et al, 2001; Rosa, 2018; Rosa & Chatel, 2016a, 2016b; Seldman, 2004; Seldman et al., 2000; Simon, 2015a, 2015b, 2015c; Smith; Snyman & Vorster, 2010; Soon-Ching, Shou-Chien, & Ying-Ying, 2007; H. C. Su, Lee, Yu, Huang, & Hwang, 2005; Sustainability Victoria, 2007; Suzuki, 2000; Tartiu & Petrache, 2009; The Scottish Government, 2010; Truini, 1999; Tucker, 2006; Van Vliet, 2014a, 2014b, 2014c; Vision 2020, accessed 2014; I. D. Williams, 2013; Young, Ni, & Fan, 2010; Zero Waste Europe, 2012, 2017; ZWA-UK, accessed 2013; ZWSA, 2005a, 2005b, 2011).

[26] For example see: http://www.stuff.co.nz/environment/90613205/new-zealand-showing-environmental-limits-oecd-says + http://www.stuff.co.nz/dominion-post/comment/67548448/mike-joy-new-zealands-dirty-little-secret + http://www.noted.co.nz/currently/social-issues/a-year-of-living-shamefully-new-zealands-dirty-secrets/ + https://www.huffingtonpost.com/2013/08/06/new-zealand-environment_n_3710859.html

our environmental and human health and incurs significant cost to local communities and our international reputation. In the period between 1999 and 2017, New Zealand's waste management was not working well enough, nor transitioning us fast enough into the huge environmental, social, cultural and economic benefits on offer in a zero waste focussed, circular economy (Hannon, 2018).

The NZPSC reporting provided the opportunity to further the research objectives and publication strategy of documenting points of clarification and discussion providing a more informed and balanced understanding of zero waste (Appendix 1 and 2). As illustrated in the following keynote points and associated excerpts, this also involved rebutting negative perceptions of zero waste based upon distortive impacts of an intense period of waste/packaging industry lobbying/campaigning and unwarranted criticism. For example:

Reframing waste from being a problem, to being a powerful opportunity for social and environmental transformation for addressing climate change and sustainable development:

> … Often the subject of waste is perceived as a distasteful and or polarising topic. Society seems transfixed between the pervasive normalisation of our throw-way society and recoiling from graphic images of environmental crisis and associated the smell, yuck and pollution of dumps and landfills, etc. A more contemporary and constructive perspective on waste management is that this subject is better understood as being about how resources flow through our economy. All the material resources that make up products and packaging accumulate an energy, water, GHG emissions, biodiversity, and pollution footprint.
>
> Aiming for zero waste and a circular economic model, avoids the huge environmental price tag, which is re-incurred when material resources are destroyed via disposal systems and have to be replaced, via further exploitation of natural resource. We all have a stake in ensuring that the products our societies create and we consume are not the cause of environmental damage and valuable resources going to waste. Rather than viewing waste as a problem, requiring immediate disposal, the concept of zero waste reconceptualises all waste materials as both, resources and as an opportunity, which is literally, too good to waste… (Hannon, 2018).

Relocating zero waste out from under the mischaracterisation of failure and correctly positioning the movement as relatively successful and in sync with the circular economy and other popular, optimistic, solution focussed movements:

> … Numerous cases studies and strategies[27] now evidence the success and popularity of zero waste approaches and demonstrate alignment and synergy with the circular economy movement (Hogg & Durrant, 2017). Today, a rapidly growing body of science and real-world experience is providing evidence that a zero waste management approach, is one of the most potent and immediate opportunities to progress towards more sustainable development and to address climate change[28].

[27] See: https://zerowasteeurope.eu/category/circular-economy/ and https://zerowasteeurope.eu/%20case%20studies/ and http://ecocyclesolutionshub.org/about-zero-waste/what-zero-waste-is/

[28] *See the brief overview of contemporary scientific literature supporting zero waste outlined in the subsequent 'Summary – Conclusions' section of this submission.*

> The good news is that the vast majority of New Zealanders love and want to participate in our shared 'kaitiakitanga' of the natural environment[29] – and will embrace cost effective, user-friendly eco-action and environmental progress. In the future, a whole new generation of innovative and exciting green products and service systems will be created, as part of an emerging circular zero waste economy. When we effectively design, coordinate, and implement market-based economic instruments, we empower the critical drivers for this new generation of environmentally sustainable product and service systems. Tomorrow's green products will involve less non-renewable fossil resources, be easier to reuse – recycle, be less toxic, and have a much smaller environmental and social footprint… (Hannon, 2018).

The political shift in New Zealand away from the zero waste policy setting was lobbied for by the vested interest sectors who profit from making and managing waste (Clough, 2007). A key finding within the of the NZPSC reporting is that the associated industry lobby groups have exercised a high degree and tenure of *policy capture* in the sphere of waste management. The net effect of this distortive influence was to displace the primacy of the *public good,* with partisan policies and outcomes curated by vested interest industries (Hannon, 2018).

The NZPSC reporting shows that the simplistic *success vs failure* assertion within the critique of zero waste is actually a dependency of a much wider array of factors interwoven within New Zealand's political ecology and practical experience. It appears reasonable to question whether the label of failure is better applied to the conventional dominant linear waste paradigm that is the origin of the current global waste crisis. As background, the NZPSC publication's contribution to this thesis confirms the selection of primary research question. Namely: can scientifically defendable municipal zero waste methodology (MZWM) be established? The observations arising from examining New Zealand's recent (zero) waste management experience, also encourage research beyond just the questioned existence of a MZWM. For example, into the context of if and how a MZWM is implemented, vs the omission or derailing of any such plan.

2.2. Exploring and illustrating the (inter-)disciplinarity of waste and zero waste management.

In the pattern of the preceding sections, research findings in the form of keynote points, accompanying excerpts and graphic illustrations from a fifth publication derived from this research process are compiled in the content of this background / context chapter. The article *Exploring and illustrating the (inter-)disciplinarity of waste and zero waste management* (Hannon, 2020) situates the subject of (zero) waste management and specifically the research question (testing and explicating municipal zero waste methodology) within the context of interdisciplinary research theory and practice. This research (Hannon, 2020) illustrates a new perspective on the inherent complexity and challenge of addressing waste issues and evidence how this complexity and challenge only increase in tackling the converse opportunity posited in a zero waste approach. These findings relate to the question of what elements make up the

[29] *Ref: https://econation.co.nz/kaitiakitanga/*

hypothesised MZWM, as well as ancillary considerations such as assertions of failure vs success of waste vs zero waste (Hannon, 2020).

A key finding of this publication is that the already significant challenge of waste management, which requires successfully integrating multiple scientific and practical disciplines, increases markedly with the adoption of the more holistic zero waste concept. A zero waste approach encompasses the (re)design of materials, products, packaging, and the function of production, consumption, and markets, as well as the roles and interaction between producer-consumer responsibility and government. These *upstream* dimensions of zero waste add to the already challenging baseline of *downstream* imperatives. The so-called *end of pipe* considerations of managing waste as a valuable resource include collections infrastructure and services to recover and circularise all material flows that are otherwise predominantly linear and largely predestined for burn-bury disposal options, which destroy resource value (Hannon, 2020).

This journal article also progressed the PhD project's research objectives of building a more balanced, authoritative, and evidence-based understanding of zero waste. As the following excerpt illustrates, amongst other things this article explores the challenge and limitations of the waste hierarchy concept. It can be argued that, because of the relatively limited progression into identified environmental priorities, the paradigm of *managing* waste is actually caught in a cycle of self-perpetuation. After decades of a theoretical adherence to the concept of the waste hierarchy, in practice this paradigm and practice remains primarily locked into the lowest levels of priority:

> In reality the notional priorities of the waste hierarchy are seldom reflected in the physical praxis of the waste management industry (Eunomia & Resource Media, 2018; Hoornweg et al., 2012), which remains heavily vested at the bottom of the waste hierarchy and, by activity, to the traditional default toward disposal (Haas et al., 2015; D. C. Wilson, 2007). In a wide review of assessment methods for solid waste management, the comparative analysis of the objects of investigation undertaken by Allesch and Brunner (2014) established that only 4% of studies were focused on the top two priorities of the waste hierarchy, i.e., reduction and reuse. Indications are that the top two practices prioritised in the waste hierarchy, are apparently omitted, misunderstood, difficult, and/or unpopular research practices (Hannon, 2020).
>
> This rhetoric vs reality gap presents as a theoretical tension within policy discourse on waste and points to a dissonance in the comprehension of and relationship between the historic disciplinary foundations of waste management and transformational future requirement in respect of natural resource conservation, sustainable development, and climate change (Curran & Williams, 2012; EC, 2014; Hogg & Ballinger, 2015). The embedded societal default setting towards disposal rather than reduction (i.e., to the bottom, rather than the top priority of the waste hierarchy), indicates the dominance of a traditional disciplinary worldview – aka "disciplinary chauvinism" (Stock & Burton, 2011, p. 1099) within waste management practice (Hannon, 2020).

Another key finding is that waste and zero waste can each be conceptualised as extremities on a transitional waste → zero waste spectrum of change and progress towards more genuinely sustainable options for addressing waste issues (Hannon, 2020). This transitional waste → zero waste (W → ZW) spectrum model offers a conceptual framework for understanding the overlap and synergy between interrelated movements, activity and disciplines variously seeking better management → through to eliminating waste. This proposition deconstructs the false and unhelpful waste vs zero waste dichotomy apparent in both the discourses of critique (Table 1) and advocacy of zero waste. Rather than perpetuating a waste vs zero waste perspective as disengaged and antagonised options, the transitional waste → zero waste spectrum model proposes these options as book-ending a dynamic interrelated sphere of principles, policies and practices, all of which variously translate to a direction and trajectory of progress (Hannon, 2020).

The scope of this article provided a platform to explore related spheres of knowledge and to develop a detailed discussion of (inter) disciplinarity. For example, conceptual alignment of the proposed W → ZW transition spectrum and the combination of both, Stock and Burton's proposition of the "*MIT disciplinarity" spectrum of integration*[30] (2011, p. 1091) and Seadon's discussion of *'spectrum of discipline integration'* (Seadon, 2010, pp. 1640. citing Max-Neef, 2005) is explored. In reflecting these findings, this chapter contextualises this PhD research within the broader relationship between advancements in waste management, including more environmentally and socially sustainable approaches and the necessity of advancing scales of disciplinary integration.

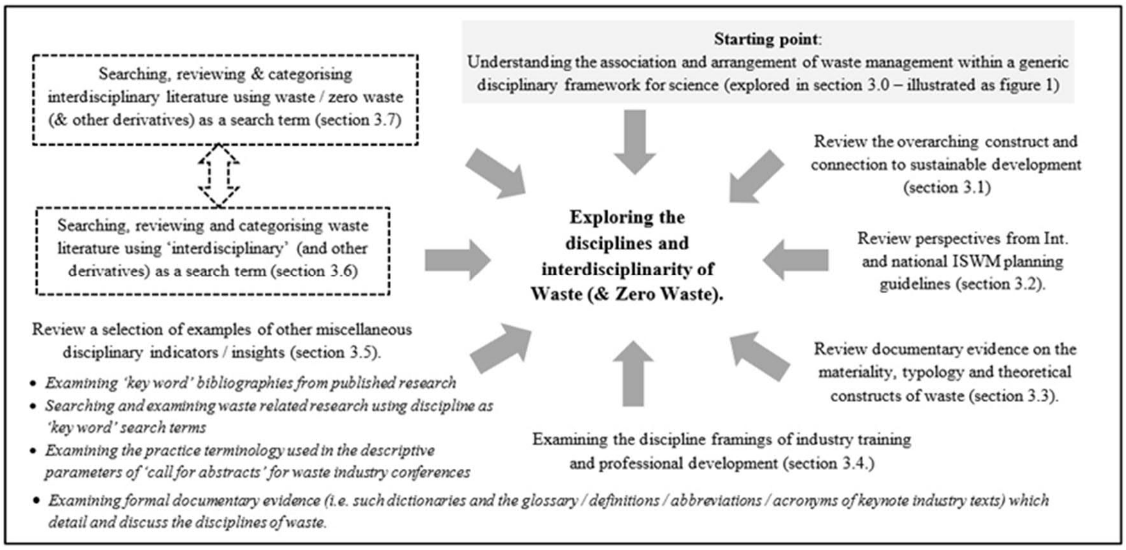


Figure 1: The seven perspectives explored in the review model exploring the (inter)disciplinarity of (zero) waste management.

Figure 1 illustrates the interrelated multiple search and review procedures undertaken as part of the original literature review that aimed to identify and examine sources of indicative terminology, references, and perspectives on the disciplinarity of waste (and zero waste).

The subsequent result (Figure 2) illustrates that this search methodology secured a large body of data that depicts a complex, detailed, and expansive (inter)disciplinary picture in respect of zero waste management. As the following keynote findings and excerpts illustrate, this research highlights a number of important considerations confronting (zero) waste

[30] NB: These authors utilise the term "integrated research" as a "collective noun to refer to all categories of sustainability research involving integrated multiple disciplines" (Stock & Burton, 2011, p. 1091). More broadly, it can be argued that this spectrum should also include other related terminology and discourse for example: *mono, intra, cross, pan and para* – disciplinarity (Stember, 1991).

management's future leaders, irrespective of theoretical / ideological – preconceptions / prejudices:

There appears to be a correlation between failure and environmental crisis associated with the conventional waste management paradigm and indicators of the sector's limited understanding and deployment of interdisciplinary research and practice as an opportunity to improve performance (Hannon, 2020).

> … Interdisciplinarity has been associated with innovation and break-through in addressing real-world problems (Klein, 2008; Metzger & Zare, 1999; Rhoten, 2004). When this assertion is examined alongside the cited under-performance of waste management globally (Hoornweg et al., 2012; D. C. Wilson, Rodic, et al., 2015b) it evokes a succession of questions: How well is interdisciplinary theory and practice understood and outworked within (zero) waste management? What needs to be done to improve this? What might be the result of any improvement?
>
> Within a traditional waste management paradigm, the disciplinary practices of the Social Sciences and Humanities, sometimes appear to be treated as optional and subservient, rather than as an integral priority, contingent with *reduce* being located at the top of the waste hierarchy. For example, community consultation sometimes appears flawed, co-opted, and under-resourced, while education and behaviour change, sometimes appear retrofitted to coerce conformance with rules (i.e., reduce contamination), or repair social engagement after ill-conceived, top-down, technocratic approaches go awry (UN-Habitat, 2010; WasteMINZ, 2009). Possibly, such scenarios exist because, despite supposedly being the least and last priority of the waste hierarchy, residual disposal still dominates the systemic practice and financial calculus of the conventional waste management industry?
>
> A strong value proposition exists around shifting focus, effort, and resources from the bottom to the top priorities of the waste hierarchy. Enhancing interdisciplinary understanding and engagement appears as a key opportunity to advance this via enabling the requisite disciplines/knowledge spheres to coalesce, synergise and, in this to generate innovation and breakthrough progress across the waste → zero waste transition spectrum… (Hannon, 2020).

Subsequently this thesis will provide an in-depth exploration and discussion of the meaning that can be inferred from Figure 2 as a new visualisation of the (inter)disciplinarity of (zero) waste management. However, even a cursory examination of Figure 2 illustrates the expansion and complexity that arise when the conception of zero waste is added to the baseline composition of disciplines required for just managing waste.

Figure 2 was built up via a sequenced literature review that first established a generic bubble model for illustrating the arrangement of all scientific disciplines (which includes the central overlapping bubble demarcating those recognised as within *Interdisciplinary Sciences*). This model was then reformatted based on evidence of what disciplines connect and or contribute to (zero) waste management.[31] Figure 2 was finally derived from both the range of commonly

[31] In the source article, this is referred to as *Figure 1. A compilation and arrangement of scientific disciplines illustrating a commonly recognised connection to (zero) waste management, highlighted in yellow* (Hannon, 2020, p. 72).

recognised, orthodox discipline contributions and an array of new *indicative* discipline and interdisciplinary terminology, references, descriptors, and insights, evidenced via the integrated seven-part search-review exercise (Figure 1). A system of colour coding[32] was utilised to explicate the source, spectrum of disciplines and interconnection and arrangement that form the (inter)disciplinary breadth and complexity of (zero) waste management. This array of subjects and disciplinary indicators, variously connected with (zero) waste management, are dispersed across the generic model of scientific disciplines and also proliferate within the central demarcation of *Interdisciplinary Science* within this model (Hannon, 2020).

[32] Fully explained within the source article itself.

SOCIAL SCIENCES AND HUMANITIES: <u>Social Science</u> • Anthropology, • Business (Admin / Mngt. / Accountancy / Finance / Marketing / HR / Communications, NfP), • Communication / Media, • Criminology, • Demography / Population studies, • Economics / Econometrics, • Education / Teaching, • Government, • International relations, • Political science / Public policy, • Psychology Industrial- / Org- / Social- • Sociology, • Geography (Social /Economic), • Law. + *other Interdisciplinary S.S.* **<u>Humanities:</u>** • History, • Archaeology, • Ethics, • Religion / Theology, • Philosophy / Culture & Progress • Arts.

APPLIED SCIENCES: •Architecture / Design, • Engineering, (Agricultural, Architectural, Chemical, Civil, Construction / Structural , Computer eng. / ICT, Electrical, Enviro, Geotechnics, Industrial, Marine / Ocean, Mechanics, Materials / Metallurgical, Medical, Mining, Nuclear, Operations research, Petroleum, Robotics /Automation, Transport). •Applied mathematics • Applied physics, • Medicine / Public Health (Pharmacology)

INTERDISCIPLINARY SCIENCES: Various Bio-inds. i.e., (-chemistry / -engineering / -physics / -processing / -industrial / -technology (various) / -remediation), • Climate science / Complex systems, • Environmental science / -soc. Sci. / -studies / eng. / -biotechnology, • Traditional knowledge • Food science / -tech, • Agriculture / Horticulture / Forestry / Fisheries, • Military / Network science, • Science studies / Scientific modelling, • Systems science / Systematics, • Technology, • Urban planning / Municipal eng., **• Sustainability / Sustainable Development.**

Waste → Zero Waste indicative disciplinary data identified in association with 'Sustainability / Sustainable Development':

- **Sustainability Practices / Fields inc. + Waste Minimisation and Zero Waste – ref. Section 3.3.** *Part of an 'eco-ideas' marketplace:* C2C (cradle to cradle), CP / CT (clean technology), CSR (corporate social responsibility reporting), DE, EA / (environmental auditing), ED / DfE (design for the environment), EE, EI, EL, EMS /EPI (environmental performance indicators), ER (environmental reporting), ESCM (environmental supply chain management), ET, E2 / (eco-effectiveness), eco-I (eco innovation), F-4 -10 -X, GC / GE (green engineering), GP (green procurement), G-econ (green economy), GM (green marketing), HS / OSH (occupational safety and health), IE, IPPC, LCA / (life cycle approach / thinking), M, MRU, P, PC, PO, PP, PSS, PS / EPR (product stewardship / extended producer responsibility), P2, RC, R, RE, Res-E (resource efficiency), RF, RG, RP, RU, RV, R2, SC, SCM, SD, SP, SR, SRE, TBL (triple bottom line reporting) VEA, WM, ZE, & ZW.
- **Disciplinarity Indicators from International NWMS Planning Guides + Materiality of Waste → ZW - ref. Section 3.4. & 3.5.** NB: This covers solid, liquid and gas and interfaces with every level of governance / management, National & local waste management strategy, policies waste specific legislation, regulation, monitoring and compliance, stakeholder / community communication & consultation processes, international conventions & treaties. + every material type / composition (listed in full in footnote 15) originating from every business type / level of management (listed in footnote 16) + right across the public services / infrastructures sector (ref Table A1 Appendix A) and all funding and ownership models inc. PPPPs + all product design, manufacturing (all goods), packaging, distribution & marketing, export / import + the spectrum of 3R to 16R basis of activity (i.e. transportation, collection, treatment & disposal of waste / resources.
- **Other Disciplinary Indictors from Waste → ZW Literature – ref. Section 3.6. & 3.7.** MSW generation, characterisation, collection (inc. transfer stns.) and management systems, Landfill (conventional + bioreactor) design, operations, closure / aftercare, rehabilitation / mining (inc. leachate, (pre) treatment, heavy metals mngt), anaerobic digestion, composting (inc. bio-mass / -solids), recycling, mechanic al biological treatment (MBT), household hazardous waste, GHG / biogas emissions control / renewable energy programmes, incinerator / 'waste-to-energy' (inc. pyrolysis, fly ash) and 'post-disaster' waste management, environmental evaluation /monitoring, contamination, remediation (inc. degradation, scenario / process modelling, adsorption, kinetics, speciation, soils, (storm) water, policy interventions / instruments.
- **Disciplinary Indicators from Interdisciplinary Waste → ZW Research (IDR) Frameworks – ref. Section 3.8. & 3.9.** WEEE / ewaste, Producer Responsibility /Stewardship Organisations (PRO/PSO), up/down-cycling, education for sustainable development (ESD), problem (orientated project) based learning (PBL), foodwaste, ethnography, solid waste analysis protocol (SWAP), segregation / (inc. optical) sorting, anthropogenic material fluxes, urban / city metabolism, integrated product design (IPD, reuse / repair / recondition / refurbish /remade / remanufactured product design / R&D / market dev., decision support tools (DST), forecasting tools, data collection , performance measurement and benchmarking, sustainability assessment, sensitivity analysis,

NATURAL SCIENCES: <u>Physical</u> •Physics (Molecular, Nuclear, Particle, Plasma, Thermodynamics), • Chemistry (Environmental, Inorganic, Nuclear, Organic, Physical, Solid-state, Supramolecular, Sustainable / *Green*-, Materials science / Nanotechnology), • Earth Sciences (Climatology, Hydrology, Geography (Physical / Human), • Ecology / Biodiversity / Conservation, • Oceanography, • Space science (Atmospheric). <u>Life</u> •Biology (Micro-, Soil-, Socio-, Systematics, Theoretical-, Thermal-, Toxicology), • Zoology (Orthinology, Entomology, Behavioural sci-) , • Human Biology, • Botany / Plant sciences (Agronomy) •Marine science / biology (Freshwater-, Limnology).

FORMAL SCIENCES: •Logic, •Mathematics • Systems theory, •Decision theory, •Statistics.

Figure 2: A schematic illustrating the indicators of associated and contributing discipline connections – and the (inter)disciplinary proposition of (zero) waste management in relation to a background rubric of scientific disciplines.

These findings (Hannon, 2020) evoke a rich new picture of the intense (inter)disciplinarity of (zero) waste management and enables this chapter to establish an evidence based background/context and an unobstructed focus on the central research question of this thesis. A seminal observation in this research was that that despite the tenure and importance of this sphere of activity, the term *waste management* does not appear as a formal designation with the generic orthodoxy of scientific disciplines. Identifying this omission provided an early red flag, which provokes significant questions about the disciplinary status of waste – and by implication, zero waste management.

Despite securing a large amount of new data relevant to this exploration of interdisciplinarity and developing Figure 2 as a new visual arrangement of result, this early research was unable to definitively resolve the (inter)disciplinary status of (zero) waste management. Further research will be required before the current inference that (zero) waste management is an inherently interdisciplinary sphere of science can be considered definitively tested and resolved. Elucidating the absence of a resolved disciplinary status for (zero) waste management has important implications for understanding the seemingly intractable globalised failure of conventional waste management and resulting crisis of waste.

In making the absence of a resolved disciplinary status for (zero) waste management transparent, Chapter Two moves the thesis beyond the shallow relativity of assertions of failure vs success of waste vs zero waste, into a deeper reflection on systemic mechanisms of failure and barriers to success. If the necessary baseline components, arrangement, and overall disciplinary apparatus required for (zero) waste management remains ill-determined, it is unlikely either imperative can succeed. Moreover, if these baselines are absent, it seems unlikely that the more advanced levels of inter- and transdisciplinary composition and dynamic required to generate breakthrough and transformation will be able to be generated (Klein, 2014; Seadon, 2010). Exploring this background and establishing this cognitive dissonance enables this chapter to put the critique of zero waste into a proper context.

Chapter Two contributes centrally to the PhD thesis by offering alternate explanations as to why the most extreme unfounded and malign critiques against MZWM exist (that zero waste is a chronic failure, impossible and doomed) (Krausz, 2012; Krausz et al., 2013; Premalatha et al., 2013). The evidence in this chapter provides a measure of deconstruction of this critique in offering an alternative and confronting insights as to what is really going on in this sphere:

> ...waste is a really complex and difficult problem, which is being approached with a limited, unresolved and outmoded conception of the complete disciplinary requirement for fully encompassing the holistic issue of waste. Further, that what disciplines are understood as contributing, are engaged at less than the advanced level of inter → trans disciplinary synergy necessary to catalyse breakthrough levels of inspiration and innovation required to solve waste issues (Hannon, 2020).

Building on the review findings outlined in Chapter One, the two strands of input from the publications contributing to Chapter Two (Hannon, 2018, 2020) combine to provide critical insights into the barriers facing the zero waste movement in seeking to address the issue of waste. The barriers include pre-existing systemic issues that undermine progress across the transitional waste → zero waste spectrum of activity, as well as misunderstanding of and vexatious opposition to the theory and or practice of zero waste. Such barriers are superimposed over and above the basic practical challenge of realising progress toward a zero waste goal, such as technical impediments, social acceptance and investment cost.

Rather than zero waste being, as it has been wrongly asserted, inherently impossible or chronically flawed, the implication of the publications supporting this chapter are that progress along the waste → zero waste transition spectrum requires socio-economic reforms. For example:

- Creating equitable access to:
  - Policy and programme development which express alterative, for example indigenous vision, values and knowledge and scientific evidence.
  - Supporting processes and opportunities for change-making in response to social and environmental issues.
  - Enabling financial resources, for example publicly generated waste levies, for movements acting for the common-good, intergenerational justice and protection of biodiversity and the natural environment.
- A public commitment to discerning and deconstructing vested interest industry political lobbying that is designed to subvert public interest, distort science, and capture policy.
- A sustained commitment by industry and government to generating much higher levels of (inter)disciplinary comprehension and enabling this across the transitional waste → zero waste spectrum of research and practice.

Collectively, Chapters One and Two introduce the subject, establish the problem statement and confirm the value and validity of the research question and hypothesis of this research. In contrast to the criticism that zero waste[33] is an unacknowledged *super-mega project,* with *no blueprint* or plan (Krausz, 2012), the hypothesis of this research project is that a comprehendible municipal zero waste methodology (MZWM) does exist. In examining a range of systemic background and contextual issues and in further pushing back on the antithesis of zero waste, this chapter sets the necessary foundation for the subsequent development and implementation of a research methodology specifically focussed on proving the hypothesised existence of a MZWM.

2.3. Defining and discussing an emerging municipal convention: Definition, boundaries, historic and contemporary meaning and context:

The hypothesis of this research is that a municipal zero waste methodology (MZWM) can be established and elaborated and explained. Once established, it is envisaged that this MZWM can provide the basis for guiding and implementing (and potentially evaluating) zero waste programmes in a large (city) or small (town / village) municipal context. As the existing and future publications resulting from this research will demonstrate, there is now a strong base of understanding as to what zero waste means as an emerging alternative to the presiding (albeit flawed and failing) theoretical conventions and practices of waste management.

Zero waste can now be understood as an umbrella term that encompasses a heterogeneous global community of practice (Hannon, 2015a) with a differentiated yet interrelated spectrum of worldviews.

[33] In the respective research this is specifically cited in the diminutive, zero waste to landfill aka 'ZWtL'.

An important precursory requirement before addressing this research hypothesis, is to examine the assumption (implied in the term MZWM) that the municipal construct of zero waste theory and practice is identifiable and can be considered as a distinct, within the broader platform of zero waste. For example, that municipal zero waste can be differentiated from industry / business / commercial, or personal / household / family, or NGO / activist / community enterprise spheres, and potentially even from zero waste expressed in a national policy environment.

The complete findings of the research procedure exploring definitions, boundaries, historic perspectives, meanings and contexts of contemporary use of the term municipal are presented as a draft journal article *Exploring the formation of a convention in the use of the term municipal in respect of waste and zero waste management* (Appendix 3). This aspect of research was undertaken in order to define any so-called, *municipal convention* which could be drawn upon in understanding how the term municipal might justifiably combined in the phrasing municipal zero waste methodology (MZWM), which sits at the centre of the research hypothesis examined in this thesis. The intention in delineating out this draft article along with the full text of the five published (ref. Appendix 1) and two other draft (ref. Appendix 3 and 12) articles is to enable the thesis to include content and reflect the holistic scope of the overall PhD research project, but itself remain compact and cohesive as per the goal of a finite wordcount.

This section provides a brief synopsis of the draft article as an output of the research process with implications for this thesis. The article provides a further overview of the zero waste movement, with a particular emphasis on delineating and discussing the municipal sub-sector of the over-all zero waste movement. The origins and applied meanings of the term municipal and the spectrum of ways this term has come to be used in combination with solid waste (MSW) is examined and this background aligned to specifying and legitimising the connection of the term municipal to the emergence of the concept and practices of zero waste management. The question: *After all this history of use, have conventions been established in academic and industry discourse that govern the use of the term municipal in association with (zero) waste management?* – is examined. The corollary of this question is – does any such municipal convention theoretically impinge on, or negate, the MZWM construct, which is instrumental to this research question / hypothesis? The in-depth background research outlined this draft article (Appendix 3), now summarised relativised to this thesis, construct a range of parameters, providing the basis for concluding that this research project is justified in framing the hypothesis of MZWM as it is.

Key conclusions and emerging conventions in respect of combining the terms *municipal and* zero waste methodology:

In respect of the scientific and industry discourse around solid waste, the term municipal emerges as near universal, non-specific, non-exclusive collectivised descriptor encompassing a wide range of geo-spatial scales, socio-economic and institutional / governance contexts and material perspectives. In short, the interpretation and application of the word *municipal* with respect to waste management, is from the local to the international – all but ubiquitous. While examples exist of formal definitions (and with these, an assumed rigor in understanding and communicating what the term municipal does and doesn't mean) this formal clarity appears routinely by-passed in favour of a more unstructured, egalitarian commonality. This definitional laxity permeates industry as well as academic/research discourse, without apparently mattering too much. The term *municipal* in isolation or in conjunction as MSW, functions as a generality whose specific discernment and contextualisation, if required, appears left up to the author and audience.

The question arises: where does this leave this research project in terms of using *municipal* as a boundary term and descriptor for the hypothesis that; a municipal zero waste methodology (MZWM) can be established? In summary, this review of how *municipal* is interpreted in (zero) waste management provides ample precedent for:

- Framing a sub-section of the international zero waste community of practice as, municipal zero waste.
- Associating in this designation, a flexibility of scope ranging from towns to cities to national contexts. The rationale for this is that, globally, the local and the national are functionally integrated in terms of legal responsibility, regulatory jurisdiction, policy, strategy and programme development and implementation, economic, social and environmental realities. As discussed, New Zealand provides a relevant example of this functional integration.
- Accepting that literature's treatment of the term *municipal* is sufficiently plastic to have been stretched over discussion of socio-economic scenarios, materiality/mass flows, geo-physical spaces, governing authority and legislative/regulatory functions, institutional formation, the development and implementation strategy policy and programmes.
- Specifically, given recognition of the ascendence of the city as the focal point of megatrends, issues, and opportunities, the term *municipal* finds utility (as well as apparent convention and disconfirmation) encompassing considerations such as: population/urbanisation, resource and energy use and consumption, industrial ecology/urban metabolism, socio-economic development status, socio-environmental impact, hazards and toxicity, the efficacy and otherwise of institution and government, the built environment/physical and virtual infrastructure, science and technological, social justice/equity, cohesion/resilience and media, corporatisation/globalisation, etc.

Extensive confirmation of a generalised convention in the use of the term *municipal* is evident across waste management literature covering research, theory, and practice. On this basis, municipal zero waste can be accepted as a viable academic / research construct. A pattern exists whereby responsibility is vested with the individual researcher for specifically explaining and justifying any given, specific alignment with municipal convention. This responsibility operates in combination with normative standards and processes of scientific peer review to mediate acceptance (or otherwise) of any given proposition or argument that is put forward. The summary inclusion of this background work as Section 2.3 of this thesis, demonstrate an execution of the required research responsibility for explaining and justifying the parameters by which the term municipal is used within the frame municipal zero waste methodology (MZWM).

Chapter Three: Methodology

Introduction: The Methodology Chapter Three is divided into two parts, namely: 1- methodology design and 2- methodology implementation. Part 1 provides a staged discussion of the review research underwriting the selection of *content analysis* and the examination of *mixed methods* research theory supporting this combination in the design of a specific methodology for testing the hypothesis of MZWM. Following the precedent of chapters one and two of this thesis, this work translated into a draft publication (Hannon, 2022 in submission) which is now cited, via written excerpts and a graphic illustration (Figure 7) now compiled into the narrative of this chapter. Part 2 of this *Methodology* chapter narrates the design evolution and implementation of the concurrent / convergent quant + QUAL embedded hybrid mixed methods hermeneutic – thematic (MZWM) content analysis, annotated as MMR HCA-T-MZWM quant + QUAL(quant). This second element of discussion outlines the pragmatic procedure of this research, including source selection, data coding in NVivo, in process learning and tactical decision-making, quality assurance, data transcription into and out of MS EXCEL into final mixed quant + (QUAL)quant hybrid embedded written and graphic formations. Because this research involves a mix of social and natural science methods and establishes a new mixed methods (MM) model of content analysis for the purpose of policy analysis in the sphere of environmental science, this Methodology Chapter is deliberately extensive and detailed in outlining the relevant research theory, design and implementation of this MMCA.

3.1. Part One – Research informed methodology design: Content analysis for the specific purpose of testing and elaborating municipal zero waste methodology (MZWM)

This *Methodology* chapter draws together a summary of important methods-related elements from the original literature review to establish the theoretical foundations of this research. This foundational work provides the justification identifying the most appropriate type of methodology for answering the research question. The pragmatic decision-making process involved in adapting this research methodology from the original generalised design precedent and commentary provided by Krippendorff (2013), to the research subject and specific question is explored and explained. On this basis, a new and specific *mixed methods hermeneutic – thematic content analysis* (annotated as MMR-HCA-T-MZWM quant + QUAL(quant) methodology was designed and implemented. The chapter concludes with a description of the practical experience and learnings from implementing the research procedure which tested the hypothesis of and then elaborated the resulting proposition of a municipal zero waste methodology (MZWM).

The purpose of this chapter is to illustrate how the methodology of this research aligns with the relevant theories and precedents conveyed in academic literature and to demonstrate that sound research practice has been followed, ensuring the results are robust and replicable. Accordingly, the chapter covers research theory relevant to the selection and adaptive design of the methodology for this specific research setting. This reporting culminates in a capstone graphic summary of the finalised methodology design, which is provided (Figure 7 section 3.5) alongside necessary reflection on the process of implementing the research procedure. With the benefit of hindsight (and summary graphic illustration) the research methodology presents as reasonably synthesised and clear. However, it is important to acknowledge that this clarity emerged through the development and implementation and that this research procedure was to a degree also explorative, iterative, reflexive, and involved in-process decision-making and refinement.

As has been the pattern of the first part of this thesis, where work undertaken as part of the original literature has led to publications, where relevant, these are cited in the form of keynote points and excerpts within Chapters One and Two. While the same approach of referring to and summarising key elements of the article is followed in this chapter, the intended publication is only considered and cited as in the process of submission. The working title of the proposed article is: *Reviewing Policy Analysis in Waste Management Research to Establish a Design Basis for Content Analysis for Testing and Elaborating Municipal Zero Waste Methodology* (Hannon, 2022 in submission).

Key findings from the underlying review research process are included and discussed in Section 3.3. This draft article first discusses the general use of content analysis as a contemporary research methodology and then describes the results of a three-stage systematic review strategy. This review examined how policy analysis was generally undertaken, first in waste management, second in zero waste management research, and finally how content analysis was used in researching (zero) waste management policy and practice (Hannon, 2022 in submission). This Methodology Chapter can be considered the point of transition from the initial three chapters of the thesis, which synthesise input from completed and intended publications from this research - and the subsequent conventional monograph chapters of the thesis which present, discuss, and conclude on the basis of the results from implementing the described methodology.

3.2. Background: Content analysis – a research methodology suitable for analysing (waste) policy

The proposed article *Reviewing policy analysis in waste management research to establish a design basis for content analysis for testing and elaborating municipal zero waste methodology* (Hannon, 2022 in submission) discusses content analysis, from its historical origins to its becoming one of the most important research techniques in social science (Bos & Tarnai, 1999; Krippendorff, 1989). This research identifies with the definition offered by Krippendorff (2013, p. 24), which describes content analysis as: "a research technique for making replicable and valid inferences from text (or other meaningful matter) to the contexts of their use". (Krippendorff, 2013) recognises the importance of the design and procedure of content analysis (and therefore the contribution of the analyst), as well as the context in which meaning arises and is communicated. In this thesis content analysis was used to answer the research question – is there a methodology (alternatively a blueprint or plan) for implementing zero waste in a municipal setting?

As the key focus of the Krippendorff definition, *text* is identified as a suitable source of input for content analysis based on its equation with any other meaning-laden matter (sounds, images, symbols, etc.) that functions to communicate about a phenomenon, beyond its immediate sense, or observation. In specifying *text* as possessing and conveying meaning (that is, providing analysable content) across space and time, Krippendorff assigns *text* with six epistemological features[34] that are critical to its

[34] Namely: 1- text has objective qualities, which are reader independent; 2- text can be read from multiple perspectives; and 3 - text is not limited to a single, or common/shared, accepted/valid meaning; 4- the meaning (content) of text can speak to beyond the given (i.e. invoke

functionality within content analysis. This epistemology correlates with the inherent instrumentalism of policy documents, which are fundamentally all situational, temporal, communicable, functionally orientated, intentional and directional, in seeking to address something (issues) and achieve something (solutions) (Hannon, 2022 in submission; Nisbett, 2013). This research context, which involves testing the hypothesis of a MZWM, draws on this propensity from within the spectrum of types and applications of content analysis, as the field of evidence is primarily the written *text* of zero waste policy/advisory/case-study type documents.

The evolution of content analysis coincides with a period of quantum change in the production of content (Tekin, Aslan, & Yilmaz, 2016). Content analysis has emerged as a recognised, empirically grounded scientific schema for analysing content[35] (Berg & Lune, 2012; Krippendorff, 2013). In this instance the term *schema* is determined as meaning a systemised apprehension ("according to inter-subjectively comprehensible rules for information processing" (Bos & Tarnai, 1999, p. 660)) examination and communication of meaning as understood and provided by the makers and recipients of all forms of content within social constructs (Berg & Lune, 2012; Krippendorff, 2013).

In content analysis, a broad view of what constitutes source data is important. This is particularly relevant in policy research involving content analysis, in that the selected objects of enquiry may, along with written text, also contain images, figures, graphs, and numeric information. All these elements individually and in combination convey meaning in an equivalent and synergetic manner as written text. From this broad conceptual understanding of text, it follows that to form valid inference, content analysts must also look beyond just the physical text, to how people use and receive text, and the conceptions and actions that are encouraged (Hannon, 2022 in submission).

On the basis of the use and justification of inference, Krippendorff (2013) offers a contemporary typology of application[36] regarding content analysis. Within this typology *institutional processes* appears as centrally relevant to the subject research. Strategy, policy, planning, and programme documents commonly both shape institutional functions (including municipal versions) and form a systematic output that presents as a content rich input for content analysis. When a zero waste policy setting or target/goal is adopted, the language, intellectual and philosophical construct of the documents changes and the *content* of these institutional processes manifests as a zero waste version of what are otherwise generic municipal–institutional outputs.

As such, the analysable content of zero waste municipal policy and planning type documents presents as both a window into the respective institutional phenomena (including, for example, the authorship and derivative community), as well as offering a window into the phenomena of zero waste in a municipal setting. It is then the zero waste municipal type of institutional policy planning documents, which are targeted as offering meaning rich content, which is potentially discernible and inferable in terms of the hypothesised MZWM. Encouragingly, regarding this specific *type,* Krippendorff (2013) observes that repetitive, routine documentation of public and institutionalised phenomena provide for easier more reliable inference than other types of content, which can otherwise be quite random and unconventional.

---

feelings, behavioural responses, covey information across time and space, etc.); 5- the meaning of text is relative to context, discourse, and purpose; 6- by nature, text demands specific inference relative to the context which is selected (Krippendorff, 2013).

[35] i.e. all meaningful data, matter/media, images, transcribed sounds, voices, interviews/ personal reflections, forms of cultural expression and especially all written discourse / printed texts (Bos & Tarnai, 1999; Krippendorff, 2013) – including in this context policy documents.

[36] (Krippendorff, 2013, p. 49) suggests that linguistic re-presentations, conversations, extrapolations, standards, indices and symptoms and institutional processes are all amenable to content analysis.

3.3. *'Reviewing policy analysis in waste management research to establish a design basis for testing and elaborating municipal zero waste methodology.'*

This draft publication, reports on the design and implementation of a systematic three-phase review strategy that examined how differing types of policy analysis, and then specifically content analysis, has been utilised in policy-related (zero) waste management research. Table 2 provides an overview of the review strategy and further detail on the coverage and outcomes of the three key word searches targeting the selected literature and requisite insights from (zero) waste management research.

Table 2: An outline of the sequential three-stage systematic review strategy of literature targeting waste and zero waste management policy research literature.

The three phases of the systematic review strategy	Coverage and key outcomes
Phase 1- A general exploration of how policy analysis is undertaken and reported in the broad sphere of waste related research	The key outcome from this work was a tabularised examination and discussion (based upon the 'focus, locus, level and application detail of policy analysis) of a sample of 16 analytic approaches[37] utilised in respect of waste policy. *NB: This indicative cluster should be viewed as only a sub-set of what is likely a broad multiplicity of other approaches to waste policy analysis / evaluation. It is likely there are further examples & variations in approach within each of these identified and examined categories.*
Phases 2- A more focussed examination of how policy analysis is undertaken and reported specifically in zero waste related research.	This next stage in the review exercise sourced a sample of publications in the sphere of zero waste, which enabled further examination of a sample of ten forms of policy analysis[38] specifically identified as being utilised in zero waste policy type related research.
Phase 3- The third and final stage is a detailed examination of how *Content Analysis* has been undertaken and reported in a selected subset of (zero) waste management research.	The third key-word search, which completed the review strategy resulted in identifying and examining a sample of 16 peer reviewed research articles, in which content analysis featured as methodology for policy / programme analysis / evaluation. The tabularised findings from this research are reported in full as Table 4 in the proposed article (Hannon, 2022 in submission) *(ref. Appendix 1 of this thesis)*.

[37] Namely: 1- Meta-regression analysis (MRA) (Bel, Fageda, & Warner, 2010); 2- Cross-sectional multiple regression analysis (Park & Berry, 2013); 3- Scenario modelling analysis (+ sensitivity analysis) (Chang, Davila, Dyson, & Brown, 2005); 4- 'Minimax regret optimization analysis' (MROA) (Chang & Davila, 2007, 2008); 5- 'Dynamic difference -in-differences' (DDD) evaluation (De Jaeger & Eyckmans, 2008); 6- System dynamics (SD) modelling (Eleyan, Al-Khatib, & Garfield, 2013; Sukholthaman & Sharp, 2016; Yuan, Chini, Lu, & Shen, 2012); 7- Life cycle (impact) analysis (LCA/LCIA) (Yoshida, Christensen, & Scheutz, 2013); 8- Correlation analysis (Greene & Tonjes, 2014); 9- Economy-wide material flow analysis (EW-MFA) (Li, Zhang, & Liang, 2013); 10- Data envelopment analysis (DEA) (Rogge & De Jaeger, 2012); 11- Multi-criteria decision-making (MCDM) (J.-P. Su, Hung, Chao, & Ma, 2010); 12- Mixed methods programme evaluation (Wismer & Lopez de Alba Gomez, 2010); 13- Combined physical material and system analysis (Fehr, 2014); 14- Situational / challenge (barrier) policy evaluation (Kasidoni, Moustakas, & Malamis, 2015); 15- Literature review and trend (thematic) analysis (Ezeah, Fazakerley, & Roberts, 2013); 16- Non-methodologically framed observational analysis overview (Chi, Streicher-Porte, Wang, & Reuter, 2011).

[38] Namely: 1- Mixed-methods framework analysis (Wishart, 2015); 2- Case study analysis (Krausz, 2012; Snyman & Vorster, 2010; Zaman, 2012); 3- Comparative (inc. cost-benefit) analysis (Jessen, 2002; Matete & Trois, 2008; Wen, Lin, & Lee, 2009); 4- Energy & Environmental Analysis (Song et al., 2014); 5- LCA + supporting analyses (Hood & Ministry of Environment British Columbia, 2013; S. Lehmann, 2011a; SRMG Inc, 2009); 6- Composition / scenario analysis (Weng, Fujiwara, & Matsuoka, 2009); 7- Input-output analysis (Suzuki, 2000); 8- SWOT analysis (MED-Zero Waste, 2013a; Zotos et al., 2009); 9- Qualitative review (Zaman, 2015); and 10- Content analysis (Kozlowski Russell, 2009).

The sequence of learnings from all three phases (presented as Tables 2, 3, and 4 of the cited article) are each essential components of the systematic review process, which merge to form a consolidated outcome. The first two phases serve to identify content analysis and initiate a body of evidence on how and why this methodology has been applied in the sphere of waste → zero waste management research. The final, culminating phase of the review builds on these findings to complete an in-depth examination of how content analysis has been applied and adapted in researching the policies and consequential practices of (zero) waste management.

Originally, 24 themes were derived (fully reported (Hannon, 2022 in submission. ref. Table 4)) in analysing the cohort of literature, sampled at the convergence of content analysis and (zero) waste management research. The following is a derivative summary of the key attributes of content analysis when employed as a research methodology – including specifically to analyse (zero) waste policy and management practices. Content analysis:

- provides a reputable research methodology, which is *fit for purpose* across multiple forms of analysis.
- is compatible with key overarching research theories within social sciences: notably causal positive, grounded, participatory action, inductive approaches, planned behaviour studies, process of learning.
- can be applied to multiple types of objects of enquiry (large/small amounts of survey/interview / workshop data, various forms of literature).
- can accommodate a broad range of *scopes* of study and sources of documentary evidence (from very large >5000 to very small <10).
- is compatible with the application of input selection and delimitation criteria (which infers the opportunity of undertaking focussed, detailed through to meta-level overview type study).
- can be interpreted and adapted to a variety of types of study, from highly esoteric, theoretical, academic orientation, through to research based on applied practical approaches.
- is able to encompass a range of *foci, locus and levels* of approach to policy analysis, as may be necessitated in the research proposed in respect of MZWM.
- has been demonstrated as appropriate across the spectrum from developed to rapidly transitioning to underdeveloped, socio-economic settings and is able to encompass and unpack socio-economic / geo-demographic influencers, examine hypothesis and as appropriate in respect of quantitative / qualitative mixed methods research.
- can, when implemented, be consistent with computer-assisted qualitative data analysis software (CAQDAS), such as NVivo and appears able to integrate appropriate statistical/empirical measures in support research findings.
- can encompass any and all elements of the *spectrum of materials* associated with waste and recycling.
- can procedurally manage the complex interdisciplinarity associated with the knowledge and practices required across the waste → zero waste transitional spectrum.
- provides a framework for examining a diversity of extraneous but potentially interesting and important factors, such as evolution around periodicity, geographic and other parameters relevant to (zero) waste policy and management practices.
- in terms of the relationship between and the establishment of planning/implementation, as opposed to the monitoring/evaluation of the transitional spectrum of waste → zero waste policy

and management practices, presents as enabling the identification of knowledge gaps and forming future recommendations, i.e., ongoing R&D around policy, practice, technology (Hannon, 2022 in submission).

On this basis it can be substantially concluded that content analysis offers an appropriate research methodology for examining (zero) waste related policy questions. These research findings included examples of research demonstrating methodological procedures which appear specifically relevant to utilising content analysis to address the research question of MZWM (Ashwood, Doick, Atkinson, & Chenoweth, 2014; Lu & Yuan, 2011; Thakur & Ramesh, 2015).

An especially relevant research example is the bibliometric analysis of construction and demolition (C&D) research in waste management literature undertaken by (Lu & Yuan, 2011). In this instance the content analysis involved the application of *NVivo* computer assisted qualitative data analysis software (CAQDAS) in support of coding (categorisation) and affiliation of source data categories, nodes and levels. The researchers discuss the interplay of CADQAS and human judgement in observing iterative cycles of refinement through the preliminary and throughout the overall coding process (Lu & Yuan, 2011). In respect of this project's research objective to examine the hypothesis of MZWM, Lu & Yuan (2011, p. 1254) usefully observe that once coding is completed for all the sources, "the relationship between the key nodes (referring to the two-level nodes in this research) could be constructed by using the 'Model' function of NVivo". This appears functionality relevant to the MZWM research question, involving tasks such as relational interpretation, visualising and connecting requisite contributions, the arrangement of interactive elements, and abstracting this into a systematic whole (methodology), which is currently contested as non-existent and impossible.

This strategically targeted, convergent sequence of literature review is built on the prior general review of book publications by recognised authorities on content analysis (previously summarised in Section 3.2). Together the findings provide an in-depth examination of the background development of content analysis, as an authoritative research methodology and specifically outlines the precedent for how content analysis has been adapted and applied to examine policy and practices across the waste → zero was transition spectrum. This learning justified the selection of content analysis, guided the design (ref. Figure 7, Section 3.5) and subsequent implementation of a specific new model content analysis for addressing this research hypothesis, which involved testing and elaborating the existence of municipal zero waste methodology.

3.4. Quantitative, qualitative, and mixed methods content analysis

Alongside exploring (inter)disciplinarity and reviewing policy analysis of (zero) waste management research, the employment of mixed methods in content analysis was the third area of research theory examined to establish a design basis for using content analysis as a research methodology for examining MZWM. Content analysis is employed both in distinctively quantitative (Bos & Tarnai, 1999; Kondracki, Wellman, & Amundson, 2002; Strijbos, Martens, Prins, & Jochems, 2006) and qualitative research (Elo & Kyngas, 2008; Graneheim & Lundman, 2004; Hsieh & Shannon, 2005). Content analysis is described as having an empirical (quant) orientation, in seeking validity and practical support for knowledge, action and critique, while also seeking to encompass understandings of what content means and does (qual) in shaping people's responses (Krippendorff, 2013). Content analysis is also reported as inherently interdisciplinary in terms of the acceptance of mixing primarily qualitative and quantitative methods (Hsieh & Shannon, 2005; Mayring, 2000).

Accepting that mixed methods research (MMR) is a less well-known and accepted in the natural or physical sciences than in social sciences, this project sought to establish an in-depth theoretical foundation for adopting MMR. A starting point in understanding MMR is to first distinguish and understand the two key components sought to be integrated / mixed into what then becomes a recognisably new and derivative type of research methodology (Plano Clark & Ivankova, 2016).

Quantitative research utilises standardised measuring instruments to collect and analyse numeric data (expressed in numbers / scores), to examine the relationships between variables. Quantitative research seeks to control bias, analyse efficiently, explore relationships within data (such as cause and effect), and conclude based on larger samples. Effective quantitative analysis can produce generalisable statistics reflecting for example, societal trends and a level of causal explanation of phenomena. However, quantitative analysis has recognised limitations in addressing how / why questions. Possibly for this reason, quantitative data are said to be generally drier, more impersonal, less descriptive/textual, and potentially lacking in context (Creswell, 2015).

In contrast, qualitative studies are less numeric and generalisable, but better at capturing context and offering social insights and meaning. The focus of qualitative research is a more open-ended questioning, within the process of collecting and analysing narrative or text data (expressed in words or images), in order to explore the individuals' experiences relative to a phenomenon of interest (Plano Clark & Ivankova, 2016).

In undertaking the broad original and then later specifically targeted aspects of literature review, a variety of examples of quantitative analysis emerged and were examined. This was not unexpected, given the traditional emphasis on empirical / quantitative research approaches (Tashakkori & Teddlie, 2010). Relevant examples of quantitative research which were examined were, respectively: (Eleyan et al., 2013), employing dynamic modelling; (Greene & Tonjes, 2014), correlation analysis; (J.-P. Su et al., 2010), multicriteria decision making; and (Fu, Ho, Sui, & Li, 2010) where quantitative analysis was utilised to support the identification and evaluation of top-rating key- word terms.

Alongside the transparency and validity of assumptions and the experience on which modelling is constructed, empirical analytical research frameworks critically rely on the availability of good quality data (Jick, 2008; Plano Clark & Ivankova, 2016). The review of quantitative approaches to policy analysis showed that empirical modelling appears to correlate more to the more highly developed scenarios, where data are more readily available (ref. Bel et al., 2010; Chang & Davila, 2007, 2008; Chang et al., 2005; De Jaeger & Eyckmans, 2008; Eleyan et al., 2013; Greene & Tonjes, 2014; Kasidoni et al., 2015; Li et al., 2013; Park & Berry, 2013; Rogge & De Jaeger, 2012; J.-P. Su et al., 2010; Yoshida et al., 2013; Yuan et al., 2012). For research seeking a genuine global perspective, this phenomenon presents as a distortive risk associated with exclusive use of a quantitative mono-method.

While quantitative approaches are clearly apparent in the (zero) waste sphere of research, it was also observable that a spectrum of studies differentially reference the respective research theories of both natural/physical and social sciences. The targeted literature review identified studies employing analytic approaches that mix both qualitative and quantitative methods and data (ref. Bel et al., 2010; Greene & Tonjes, 2014; Noel, 2010; J.-P. Su et al., 2010; Thakur & Ramesh, 2015; Wismer & Lopez de Alba Gomez, 2010). (Remenyi & Money, 2004). Multiple authors report combining the mathematical and statistical attributes of quantitative analysis, with the differing processes and characteristics of qualitative research in seeking to broaden and strengthen the basis for forming *objective, valid and generalisable conclusions* (Crotty, 1998).

Quantitative and qualitative approaches are both cited has having a *long history* in research and as a result extensively debated and established doctrines, procedures and proponents (Bergman, 2010). However, over time and across many spheres of research – specifically in respect of content analysis, simplistic demarcations, such as words (qualitative) – numbers (quantitative) were challenged and have broken down (Bergman, 2008; Plano Clark & Ivankova, 2016). For example, it is incorrect to imply that quantitative methods cannot be applied to what has traditionally been thought of or assumed as qualitative data, such as pictures, audio, video, architectural styles, and other symbols (Bergman, 2010). Increasingly, a mixed combination of quantitative and qualitative research methods have been sought to address complex research questions and diverse types and scopes of data.[39] New doctrines, procedures, and proponents have emerged in pioneering the trend toward MMR, which ensure necessary traditions and quality assurance are preserved (Bergman, 2010).

CAQDAS systems, such as NVivo, are cited as helpful in addressing the challenge of integrating analysis and interpretation when mixing qualitative and quantitative data in a singular unified research theory and narrative (Bryman, 2006, 2007). In this context, the use of the term *integration* is clarified as meaning the extent to which "different data elements and various strategies for analysis of those elements are combined throughout a study, in such a way so as to become interdependent in reaching a common theoretical or research goal, thereby producing findings which are greater than the sum of the parts" (Bazeley, 2010; Bazeley & Jackson, 2013, p. 196).

One of the opportunities apparent in *mixing methods* is the enabling of triangulation, in order to obtain more valid conclusions (Jick, 2008) by directly comparing qualitative and quantitative results for convergence and divergence (QSR, 2017). Combining the benefits of both qualitative and quantitative approaches is described as opening up a *third* (actually a number of other) way(s) of undertaking analytical research (QSR, 2017). As is expressed by the concentric dimensions of the various dashed spheres illustrated in Figure 3 (below), mixed methods research can integrate (and by degrees, overlap) greater and lesser levels of quantitative and qualitative research methods.

The degree of mixing and integration of quantitative and qualitative methods in forming a mixed methods approach, is determined by the specific purpose of any given study (Plano Clark & Ivankova, 2016). As a formally recognised methodology, mixed methods is said to be only about 25 years old (Creswell, 2015), with the last 10 years cited as being a period of intense evolution and refinement in MMR procedures (QSR, 2017). Within this short timeframe, mixed-methods research practices have progressed to become a significant global movement with an accommodating range of conferences, journals/literature and funding devoted to promoting, describing and advancing the field (Plano Clark & Creswell, 2008; Tashakkori & Teddlie, 2003).

3.4.1. Defining Mixed Methods Research (MMR)

[39] for example, "health, education/digital learning, accounting, governance/political evaluation, journalism, sociology/psychology, business and consumer research" (Hannon submitted 2021 p. 5).

Initial attempts to define mixed methods research (MMR) began with rudimentary *words-numbers* characterisations (Greene, Caracelli & Graham, 1989). However today, differing disciplinary, philosophical and methodological perspectives give rise to a "wide array of definitions" (Plano Clark & Ivankova, 2016, pp. 64-67). When viewed primarily as a method, Creswell describes mixed methods research as "an approach in the social, behavioural and health sciences in which the investigator gathers both quantitative (closed ended i.e. statistical trends) and qualitative (open ended, i.e. stories and personal experiences) data, integrates the two and then draws interpretations based upon the combined strengths of both sets of data to understand research problems", in ways better than, what insight would be gained by using either form of data in isolation (2015, p. 2).

Usefully, Creswell also variously points out what MMR is not. For example, MMR is not just the gathering without integration, or the adding in without a rationale, of qualitative and quantitative data. MMR is also not a label that can be used outside of adopting a specific scientific technique and is not, simply a (formative + summative) evaluation technique (Creswell, 2015). Creswell identifies four core characteristics[40] as defining of mixed methods research. Alongside the associated description and definition Creswell offers integrated strengths, respective rigour, design specific, theoretical framing as foundational principles for achieving better than mono-method outcomes (2015). Creswell's guidance was instrumental in the selection and design of the specific approach used in mixing the methods employed in this research. The design objective in mixing the methods for this content analysis was; a rigorous and authentic collection, analysis, integration and interpretation of both quantitative and qualitative types of relevant data, necessary to test and elaborate the hypothesis of a MZWM.

A fundamental principle of and rationale for mixed methods research is the concept of combining and complementing the strengths of both qualitative and quantitative (Q&Q) methods, while identifying and mitigating the potential weaknesses of each separate research method. The aim is to exclude or minimise alternative explanations for results, for example by providing information explaining divergent aspects of the phenomena studied (Plano Clark & Ivankova, 2016). This principle is illustrated in Figure 3, in the left to right arrangement of the quantitative and qualitative zones and the centrality of mixed methods between these. This arrangement illustrates that by varying degrees of overlap and integration, quantitative and qualitative spheres can become a genuinely a new mixed methodology which is derivative of and distinguishable from both, mono-methods of research.

---

[40] Namely 1- Acknowledging that qualitative and quantitative research each produce *differing kinds of data*, with respective strengths and weaknesses, MMR involves *collection and analysis of <u>both Q&Q data</u>* in response to research questions. For example, qualitative research provides fewer, but more detailed personal perspectives and caries participant voice and experience in context. As such, qualitative data is said to be softer, more subjective and less generalizable form of data. Whereas, quantitative research seeks to, controls bias, analyse efficiently, explore relationships within data (such as cause and effect) and conclude based on larger samples. However, quantitative data is said to be generally more dry, impersonal, less descriptive / textual and lacking in context (Creswell, 2015). 2- *Utilisation of the <u>respective rigor in both Q&Q methods</u>*, where key elements of *rigor* include considerations such as: types of design, ethical permissions, sampling approach, number of participants, types of and instruments for data collection, organisation and cleaning of analytical database and procedures and sound approaches, which establish validity and reliability (Creswell, 2015). 3- *<u>Combining and integrating of Q&Q data</u>* using a specified mixed methods design and interpretation of this integration. This means specifically selecting appropriate mixed methods designs, such as typically either *convergent, or explanatory sequential, or exploratory sequential designs* (QSR, 2017. citing Creswell, 2014)). Creswell regards these three *basic/foundational* design options as essential, in enabling variously named forms of integration (such as, *merging, explaining, building and embedding*) to emerge through the research process. 4- *<u>Theoretically framing and discussing the mixed methods research design</u>*, within an appropriate philosophical perspective, or conceptual framework. For example, a *behaviour change model*, or *leadership theory*, or *advocacy framework* (which - fall under either, *social or behavioural or transformative* theoretical models) (Creswell, 2015).

Figure 3 also illustrates the acceptance of the methodology design convention that the combination and by degrees an integration of contributing methods and should engineered via three interactive stages, namely:

1. The conceptualisation stage, in which the purpose and <u>question</u> guiding the study are developed
2. The experimental or <u>methods</u> stage, which implements data collection and analysis
3. The <u>inferential</u> stage, in which integrated conclusions from Q&Q results are formulated (Plano Clark & Ivankova, 2016; Tashakkori & Teddlie, 2010).

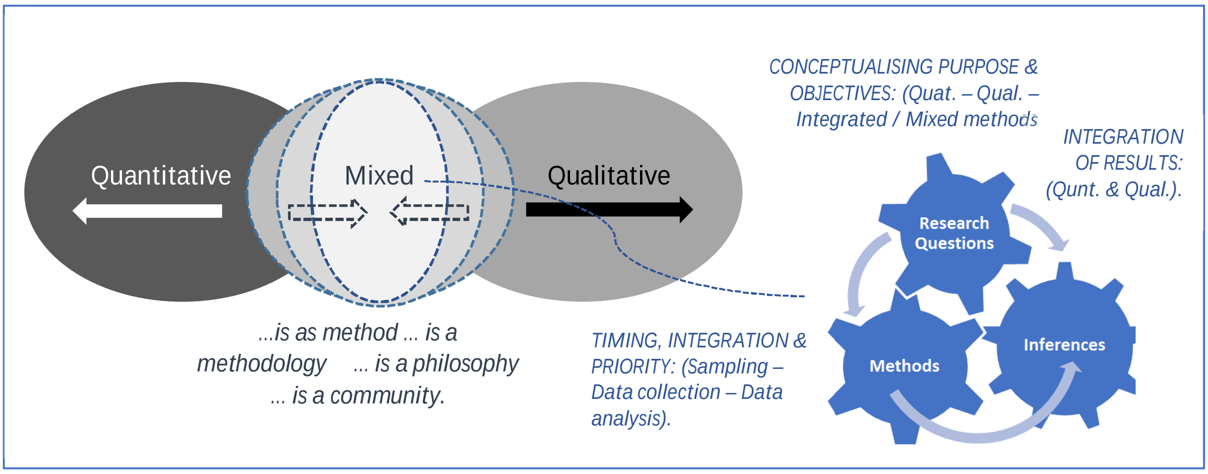


Figure 3: A conceptual illustration of integration and component interactivity within mixed methods research (MMR).

In practice, (as portrayed[41] in Figure 3 and as played out in the implementation of this methodology), these three recognised key stages of MMR can themselves be considered dynamic, interactive, and adaptive within the research process, before reaching a final endpoint in inference, justification, and conclusion (Plano Clark & Ivankova, 2016). As will be subsequently outlined in this research, there was a deep mixing and integration of both qualitative and quantitative data as the research proceeded through the stages of conceptualisation (Hannon, 2020; Hannon & Zaman, 2018) and development and implementation of methods (Hannon, 2022 in submission), and then interferential development of results.

3.4.2. Background – MMR research theory

The development of mixed method research arose in response to the so-called *paradigmatic wars*, which gave way to more pragmatic considerations within academic theory (Tashakkori & Teddlie, 2010). This period of intense paradigmatic debate served to deepen the philosophical foundations of all research theory. Today quantitative, qualitative and mixed methods researchers alike, all benefit from the more resolved basis for designing and defending their approaches (Plano Clark & Creswell, 2008; Tashakkori & Teddlie, 2003).

[41] This illustrates that by various degrees mixed methods research (MMR) seeks to draw in and integrate both qualitative and quantitative research methods, data, and perspectives that might otherwise, in a purist construct, operate entirely independently. Second (in blue) the roles and interactivity of key components of mixed methods research are also illustrated. As such, Figure 1 is a graphic compilation of the orginal *'figure 1.1 - Conceptualisation of mixed methods research' [acknowledged as originally from (Ivankova, N. V, 2015]* and *'figure 3.2 - Different perspective for defining mixed method research'* and *'figure 2.2 - Components of mixed methods research'* (Creswell, 2015, pp. respectively 10, 61 & 36).

In the debate around MMR, metaphysical truth and reality were ultimately deemed not inconsistent with combining and employing multiple research questions, methods, and theoretical perspectives (Tashakkori & Teddlie, 2010). Such rapprochements have enabled the formation of a now relatively common set of beliefs, worldviews, epistemological stances and models / exemplars which undergird the paradigm of pragmatism in mixing methods in social and behavioural research and beyond (D. L. Morgan, 2008; Tashakkori & Teddlie, 2003).

One critical factor negotiated into the *terms of truce* for pragmatic methodological integration is an expressed requirement for precision in understanding and detailed explanation when seeking to establish a methodological position in the taxonomic evolution from mono to mixed method[42] studies (Creswell, 1994; Tashakkori & Teddlie, 2003). In the period following general acceptance of MMR, emerging technology, new methodological tools, and enhanced and reasoned practitioner communication have enabled continued evolution and diversification in mixed methods research (Tashakkori & Teddlie, 2003).

Drawing on an interdisciplinary perspective and with pragmatism as a declared philosophical foundation, Morgan affirms the distinct virtues of both quantitative and qualitative research methods (2008). This author then identifies a number of considerations critical to navigating beyond the limitations of excessively purist approaches to research, into the now recognised benefits of the variously combined, mixed and integrated o*ther* way (D. L. Morgan, 2008). Morgan advocates focussing on the mechanics of answering research questions, acknowledging and encompassing epistemological considerations and the technical implications inherent to each methodology to be combined in generating new knowledge (D. L. Morgan, 2008).

The adoption of mixed methodology for this PhD research draws on the emergence and authentication of pragmatism as an enabling attribute in MMR theory (Tashakkori & Teddlie, 2003, 2010). The extent and detail in this chapter, reflects the necessity of meeting the expectation for explaining and justifying the design basis of the MMR methodology employed in this research (Creswell, 1994; Tashakkori & Teddlie, 2003) as well as adhering to the Morgan's technical guidance on focus, epistemology of MMR design (2008).

3.4.3. MMR design nomenclature

To explain and ratify epistemological security, commentators offer three basic design models for MMR as providing a foundation for the range of advanced MMR designs reported in contemporary research (Creswell, 2015; Plano Clark & Ivankova, 2016; QSR, 2017). Figure 4 exemplifies these three basic models and also illustrates the concurrent / convergent MMR design logic selected for this research project. The design logic of the concurrent / convergent model involves separate collection and analysis (possibly each drawing on differing research theories), before merging and integrating the differing insights and inferences as the basis for forming results. In this instance neither of the

[42] Also referred to a *model* studies NB: each category includes associated sub-categories such as: purists, sequential, parallel/simultaneous, equivalent status designs, dominant-less dominant, multi-level, and multi-phase-multi-application studies.

sequential (i.e., explanative[43] or explorative[44]) MMR design options appeared to fit this research scenario. The strength of the concurrent design model is in the potential for generating different, but complementary data and substantial, well validated findings in a time and cost effective way (Plano Clark & Ivankova, 2016. citing Morse, 1991, pg 122).

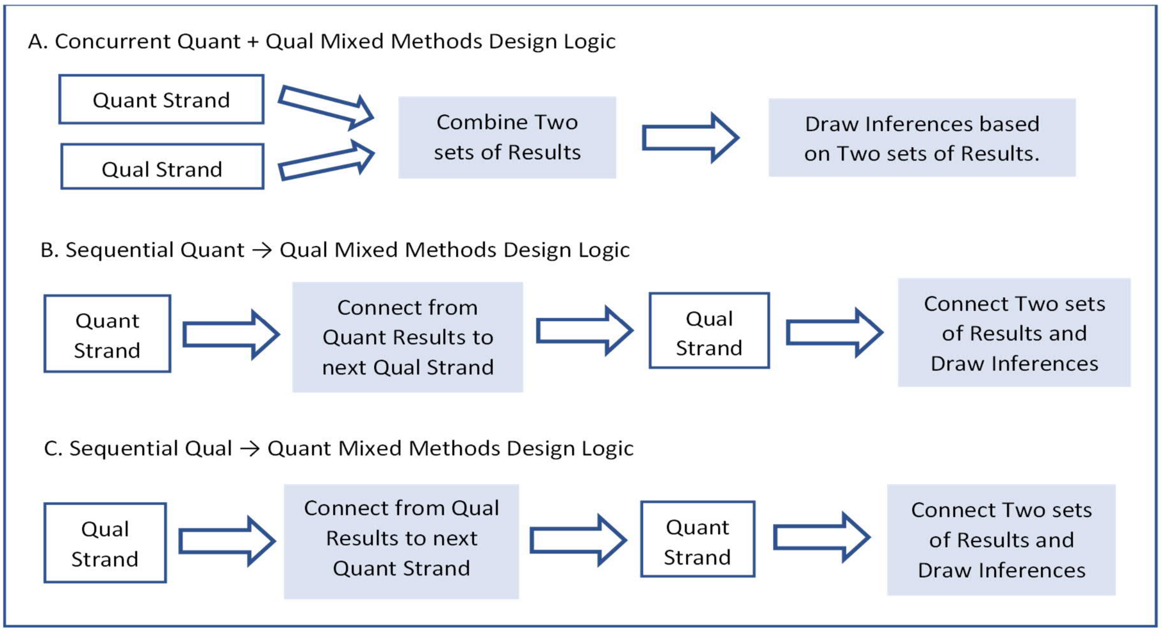


Figure 4: An outline of three basic MMR design models adapted from (Plano Clark & Ivankova, 2016, pp. 118, figure 5.2).

Figure 4 also illustrates the conventions for process diagrams and annotation / nomenclature which have been adopted in this research for communicating the procedural sequencing, relative priorities, component parts and design ethos are described. For example, the use of capitalisation, i.e., QUAN (indicating a priority component) vs quan (lesser priority), is specified for annotating relative priority of either the qualitative or quantitative components in an MMR design. Additionally, the use of the + and → symbols, relative to the naming (and relative priority) of components, indicates respective concurrent (or convergent) vs sequential implementation of the Q&Q parts of a MMR design (Plano Clark & Ivankova, 2016).

The identification of the concurrent/convergent MMR design logic and the adoption of the quant + QUAL as annotations for expressing the relative weighting of data were key early methodological decisions made based on the apparent weighting of data and what the literature review indicated as most appropriate for this research setting. Whilst the selection such typologies provides a framing for understanding and describing this MMR design, Plano Clark and Ivankova (2016) also observe limitations and significant debate circulating around attempts to propose and formalise MMR design

[43] i.e., where the quantitative strand is first and latterly explained by seeking qualitative data. The strength of the explanative sequential MMR design model (i.e., quan/Quan/QUAN → qual/Qual/QUAL) is that the second strand can elaborate, explain or confirm initial quantitative data – especially where unexpected results occur. This model is said to be more straightforward for a single researcher to implement, but can involve a longer duration and introduce complexity, such as having to re-contact and following up with participants again (Plano Clark & Ivankova, 2016).

[44] i.e. where the qualitative strand precedes and explores a problem in order to *develop an instrument or intervention* (Creswell, 2015) and is followed-up with a quantitative strand of analysis (Plano Clark & Ivankova, 2016). The strength of the explorative sequential MMR design model (i.e. qual/Qual/QUAL → quan/Quan/QUAN) is said to be that the follow-up data from a quantitative strand can enable generalisation, testing and verification of initial findings. As with the previous sequential model, additional duration and complexity can result (Plano Clark & Ivankova, 2016).

typologies. Because of the individuality of each research project / context, it is important to recognise that beyond this basic categorisation, a range of alternative[45], additional, multiphase, and advanced MMR designs were considered and might equally have been argued (Creswell, 2015).

3.4.4. The Intersection of MMR and other research approaches

The interest and growth in interdisciplinary (Hannon, 2020) and mixed methods research appear similarly driven by demand for solutions to proliferating real-world problems (Plano Clark & Ivankova, 2016). Within the burgeoning MMR movement this impetus has driven evolution in specific, advanced hybrid MMR designs and applications, such as interfacing and/or the hybridisation of basic MMR with other research design models, methodological approaches, and theoretical frameworks (Plano Clark & Ivankova, 2016).

Figure 5 provides an illustrative overview of how Plano Clark and Ivankova (2016, pp. 141, figure 6.2) argue MMR can appropriately mix (i.e., intersect or be embedded) with other research approaches in forming for example transformative mixed method: experiments, case studies, evaluation and action research. In keeping with this proliferation and evolution in MMR, the conventions for describing and annotating MMR have also expanded to encompass and explain the emerging new arrangements.

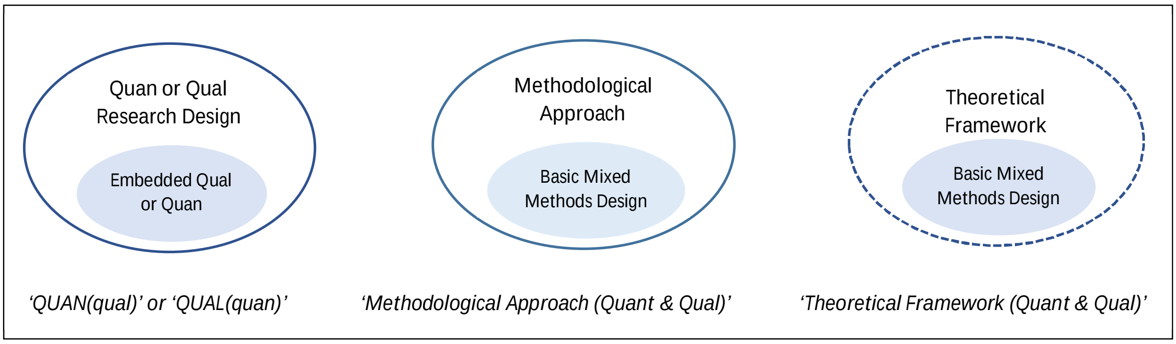


Figure 5: An outline of key perspectives for intersecting MMR with other approaches.

Plano Clark and Ivankova's (2016) figure 5 is framed in the following key perspectives to explain and annotate how MMR can appropriately mix with other research approaches:

- Intersecting by intentionally embedding[46] or joining a secondary method within a primary Q or Q research design – annotated as *'QUAN(qual)' or 'QUAL(quan)'* (Figure 5 left).
- Intersecting by mixing methods within another methodological approach – annotated as '*Methodological Approach (Quan & Qual)'* (Figure 5 middle).
- Intersecting by mixing methods within a theoretical framework – annotated as *'Theoretical Framework (Quan & Qual)'* (Figure 5 right).

The growing plethora of advanced individualised MMR designs challenges researchers to carefully consider the overall design logic of their approach and how this can be orientated within the

[45] For example: Intervention (adding qualitative data to a research experiment, or intervention involving pre and post-test model), Social justice (i.e., a MMR design studying a problem threaded within an overall social justice framework, such as a gender, racial or ethnic lens) and or Multistage evaluation (i.e. where success failure is evaluated overtime by a series of what might otherwise be stand-alone research events in a given setting) as advanced design (Creswell, 2015)
[46] Also known as nesting i.e. incorporating a secondary Q or Q method with a research design traditionally associated with the other Q or Q approach (Plano Clark & Ivankova, 2016).

conventions of relevant and accepted research theory (Plano Clark & Ivankova, 2016). This consideration advances the previous outlined expectation (Creswell, 1994; D. L. Morgan, 2008; Tashakkori & Teddlie, 2003) to explain and justify the technical and epistemological basis of MMR design decisions. The extensive detail offered in this chapter's coverage of the selection content analysis and the project-specific methodology design, as well as orientating the necessary relationship between interdisciplinary, pragmatic and mixed-methods research theories that occurred in this research, is a necessary response to the variously proposed challenge (Creswell, 1994; D. L. Morgan, 2008; Tashakkori & Teddlie, 2003) for rigorous epistemology. The section 3.4.4 provides the context for the subsequent discussion of the pragmatic decision-making (Section 3.4.5) which advanced the intended basic quant + QUAL MMR design logic by intersecting an embedded QUAL(quant) element, as illustrated on the left side of Figures 5 (above).

3.4.5. Theoretical framing for integrating MMR with content analysis – pragmatism

The categorisation process at the heart of content analysis can be inductive, deductive, or potentially a combination of both (Berg & Lune, 2012). Within content analysis discourse the term category appears to be used interchangeably with the terms: themes, indices and codes. However, within this research the preferred and predominantly adopted terminology was codes and coding. The term coding can be simply and functionally understood as a process of organising and labelling, whereas terms code, index, theme, category may be used interchangeably, depending on the conventions applying in the type of qualitative data analysis being undertaken (Lavery, 2016).

An inductive approach to initial category formation is described as proceeding with the researcher immersing themselves[47] in the raw sources / data / documents and forming a sense of the dimensionality and themes, etc., which appear as having manifest and latent patterns of meaning (Bazeley, 2013). An inductive theoretical framework arises internally and is fully and subsequently realised as the outcome of further analysis and explanation of observed patterns in content. In contrast, a deductive approach to content analysis involves researchers beginning this observational organisation process via a categorisation scheme externally derived from an previously recognised theoretical perspective (Berg & Lune, 2012 - citing Abrahamson, 1987). In an inductive process, where category development proceeds into the formation of a theoretical framework, the framework is referred to as being grounded in the derivative data (Berg & Lune, 2012).

In both inductive and deductive approaches, the theoretical framework is designed to explain the *case* being analysed and can be used to generate an hypothesis about the case that can be tested by the data generated by the content analysis (Berg & Lune, 2012). In discussing the relative balance and potential involvement of both inductive and deductive approaches for arriving at the theoretical framework for content analysis (i.e., a combination and interplay of internal derivation and external proposition) Berg and Lune (2012) argue that emphasis should be given to induction, as a way of preserving the sense of voice of the producer of the message/content (2012). Importantly, these authors identify and distinguish the role of researcher experience in underwriting both inductive and deductive reasoning (Berg & Lune, 2012 - citing Glaser & Strauss, 1967). The authors highlight the

[47] The author also refers to this this immersive process of plunging in off the deep end and engaging with sources until observable categories emerge as purposeful play.

opportunity of interplay and blending the respective strengths[48] of inductive and deductive reasoning and researcher experience (Berg & Lune, 2012). In this context researcher experience is described as inclusive of previous relevant personal, scholarly experience and or, actual research into the study phenomena (Berg & Lune, 2012).

In this research, the term *coding framework*, describes the structural framework which was input to NVivo, to support the primary coding function of this content analysis research. In this scenario the initial compilation of the 5-part / 50-point, so called *Zero Waste Methodological consensus* (see Table 20, Appendix 6) and further development of this *coding framework*, via the content analysis of three key sources all involve an expression of researcher experience and reasoning.[49] This initial and latter coding framework development process can also be understood as demonstrating an interplay of both inductive and deductive reasoning. As a contribution to discourse on the interplay of inductive vs deductive vs other theoretical models driving categorisation / coding framework development in content analysis, Morgan proposes Table 3 as outlining the relationship between paradigmatic alternatives in social science research methodology (2008, p. 58, figure 2.2).

Table 3: An overview of pragmatism relative to research theory and data, research process and the forming of inferences.

Parameters of research procedure	Qualitative approach	Quantitative approach	Pragmatic approach
Connection of theory & data	Inductive	Deduction	Abduction
Relationship to research process	Subjectivity	Objectivity	Inter-subjectivity
Inference for data	Context	Generality	Transferability

The critical factor underwriting the acceptance and then application of Morgan's reasoning in the design of this PhD research methodology, was the observation that "pragmatic approaches relies on abductive reasoning moving back and forth between inductive and deductive reasoning to first convert observations into theories and then assessing those theories through action" (D. L. Morgan, 2008, p. 58). The research objective of this project involves turning observation into theory and testing that theory (i.e., proving and elaborating an hypothesised MZWM) and in practice the procedure of content analysis involves dynamic interplay between theory and observation.

As is discussed further in Section 3.5, it is notable that this contention is supported in the graphic illustration of the model of content analysis selected specifically for this research (i.e., Figure 7 Section 3.5). Within this model, *abductive inference* is observed as providing the indirect observational bridge between the analytic construct of the content analysis and answering the research question (Krippendorff, 2013). While Morgan (2008) also observes that from a pragmatic perspective, the only way to test inference is through further action (i.e., predicting the workability of future lines of behaviour), it is important to note that this step exceeded the scope of this research project. That said,

[48] Supporting the authors' advocacy of employing both inductive and deductive reasoning, the following citation caveats and further explains the opportunity of mutualised approaches: "if investigators are attempting to test an hypothesis their theoretic orientation should suggest empirical indictors of concepts (deductive reasoning) If they have begun with specific empirical observations, they should attempt to develop explanation grounded in their data and apply these to other empirical observations (inductive reasoning) (Berg & Lune, 2012, p. 358).

[49] Whilst arguably subjective, in this instance the described *experience and reasoning* is based out of the researcher's 30 years of professional practice, which includes a practical background as recycling contractor and ZWA-LL mode of teaching / research and is evidenced by an emerging body of publications ref. Appendices 1 - 6.

it can be understood that, testing any *inference* of either the existence and or veracity of a MZWM derived as a result of this research process, via the *action* of evaluating implementation of theory put into practice, is envisaged as a distinct possibility. As is discussed in Section 6.1 of the Conclusions chapter, the expectation is that implementation and evaluation are natural and coaxial extensions of this research.

In the context of content analysis, where the focus of analysis is *text* in the form of policy documents, these form fixed historical artefacts representative of a specific time and context (D. L. Morgan, 2008). In this instance, the zero waste policy documents may well have already prompted and directed the further action of implementation, whereby the experience can be formulated into case studies. In this research, one of the subsequently discussed source documents, which was selected as an input for content analysis, records an international series of case studies (Allen et al., 2012). As a source, the outcomes and surrounding events of this compilation of case studies can pragmatically be interpreted as Morgan's *further action* (2008), whereby inference is encompassed in the content analysis, which contributes toward addressing the research question.

Morgan also describes how, when quantitative and qualitative research methods are combined in a sequential fashion, the back and forth abductive process enables "inductive results from qualitative approaches to serve as inputs to deductive goals of quantitative approaches and or vice versa" (2008, p. 59). More broadly, the author argues in favour of pragmatically finding useful points of interplay and connection between different kinds of knowledge (i.e. quant. vs qual.), rather than, as is common, dismissing the other's work, based on wholly incomparable assumptions (D. L. Morgan, 2008). As illustrated in Table 3, Morgan (2008) argues that pragmatically mixed-methods challenges blanket dualities and faux choices between the otherwise extremes of subjectivity vs objectivity and knowledge, which are specifically context dependant, - vs that which is general and universal. In short, instead of getting stuck in abstract theoretic roadblocks, Morgan (2008) emphasises that abduction, inter-subjectivity, and transferability enable the focus to shift pragmatically towards what people can do with knowledge. This creates new opportunities for thinking about and progressing beyond the perception of classic methodological schisms as roadblocks in the progress of social science (D. L. Morgan, 2008).

Referencing the potential relationship between abductive integration of inductive and deductive reasoning in mixed methods content analysis (Berg & Lune, 2012) outlines and proposes this for the context of forming and addressing / testing hypotheses (Hannon, 2022 in submission). In this context, the former is "used as a form of theory development in which the analysis seeks to discover patterns that best explain data", whereas the latter can be considered a "form of theory testing in which ones conceptual framework guides the research in seeking out and testing anticipated patterns and relationships" (Berg & Lune, 2012, p. 358).

It can be argued that this description provides a cognitive bridge linking Morgan's (2008) and Krippendorff's (2013) discourses on the role and positioning of adductive inference in the schema of content analysis, as a methodological branch of social science that can (and arguably should) involve mixed methods. This proposition offers the best alignment between the subject research context, available types of input data, and the objectives of the research project and how potentially the findings can be applied and evaluated as further action (Berg & Lune, 2012; Krippendorff, 2013; D. L. Morgan, 2008).

Examining the disconfirming evidence hypothesis and methodology selection:

Berg and Lune (2012) also assert that a valid hypothesis must be both *provable* as well as nullifiable and that testing procedures must actively seek and examine disconfirming alongside supportive evidence. In terms of this research project's proposed use of a mixed methods content analysis (MMR-CA) methodology to address the hypothesis of MZWM, Berg and Lune's challenge is met in large part by the preceding review of literature involving the critique of zero waste. Elements of this critique extended to asserting that, as a super-mega project with no blueprint (i.e., plan or methodology for implementation), the entire proposition of zero waste was doomed as an inevitable failure and, in effect, impossible (Krausz, 2012; Krausz et al., 2013; Premalatha et al., 2013). Deliberately and specifically reviewing the critique of zero waste represents a structured examination of disconfirming evidence and the most extreme aspect of this critique represents the null hypothesis of MZWM.

This background work provides a pre-examined, balanced starting point for the proposed MMR-CA methodology to now test and explicate the hypothesis of MZWM. Hence, what remains is to sample sufficient representative sources / cases that offer evidence relevant to answering this research question. The proposed MMR – CA provides a methodology for plurally examining (in)consistency in the patterns of data that may (in)validate the hypothesis of MZWM. Additionally, regarding Berg and Lune's methodology design standard, Section 3.10 outlines the rationale for developing and utilising a second coding framework within this research process (i.e., entitles *Exploring waste → zero waste*) to further examine other important peripheral and disconfirming perspectives. This in-process adapting to the analytic construct and examining the original literature and selected sources for disconfirming and other patterns of data is an acknowledgment and response to Berg and Lune's concern for fully examining all outcomes, re the hypothesis and to fully understanding and address the subject and context of the research question (2012).

Berg and Lune's (2012) other key caution around the application of content analysis as a research methodology is based upon the potential for *cherry picking* inputs to influence research outcomes, rather than *selecting* sources / cases in a fair and reasonable manner. In respect of the MMR-CA MZWM proposed for PhD project, this challenge has been managed through the expansive original literature review and the strategy of independently examining this work through the processes of peer-review and publication (ref. Appendices 1–6). This strategy ensured a wide-reaching, thorough, and balanced examination of relevant literature, including a large body of disconfirming evidence, which acts as a robust foundation for selection of sources as inputs for the content analysis.

In this respect, it is critical that the: original literature review, the derivate publication strategy, the coding framework development sequences, the content analysis, and the inferential development and reporting of results, all be conceptualised as a contiguous research procedure designed to meet relevant quality assurance standards proposed for this methodology (Berg & Lune, 2012; Krippendorff, 2013; D. L. Morgan, 2008). In particular, before selecting the representative zero waste literature (Allen et al., 2012; Lombardi & Bailey, 2015; Snow & Dickinson, 2001) as sources for the MMR-CA to process, the full spectrum of this heterogeneous global community of practice (i.e. industry, community, municipal, academic/research, developed/underdeveloped, public/private, waste → zero waste contexts) were systematically considered (ref Table 19 Appendix 5).

3.4.6. Preserving *Quality*, when mixing and integrating qualitative and quantitative methods and data

The academic process and standard for determining the quality assurance of research (that is, the strength and representativeness of the knowledge claims) is largely mediated through process-independent, double-blind peer review. Regarding the imperative for quality assurance in MMR, Plano Clark and Ivankova (2016) outline the following as critical quality parameters. This framework for considering quality assurance was influential in shaping the design process of the research methodology of this project:

- Quality accumulates via the decisions researchers make in deciding how to assess and plan for achieving a mixed methods research process resulting in validity, which is the “extent to which accurate inferences can be made based upon test scores or other measures”.
- Validation is described as “the process of assessing the rigor of the methodological procedures which are selected used in research”.
- Reliability is described as “the extent to which scores produced by a specific measurement procedure are consistent and reproducible”.
- Trustworthiness is described as an umbrella term for quality criteria guiding qualitative research that results in findings being accepted as “persuasive and credible”.
- Similarly, the term credibility denotes the extent to which, in qualitative research, findings are “perceived as accurate in conveying study participants’ experiences”.
- Inference quality denotes “standards for evaluating the quality of conclusions, made on the basis of MMR findings”.
- Inference transferability is the “degree to which MMR conclusion are applicable to other settings contexts and people”.
- Legitimisation is described as, a process of “continuous evaluation of MMR of procedural consistency between research purpose and resulting inferences” (Plano Clark & Ivankova, 2016, pg 62-63).

It is observable that academic literature offers a variety of *conceptual frameworks* for achieving and assessing quality in MMR; however, quality assurance remains a much-contested consideration. Notably, Plano Clark and Ivankova (2016) tabularise five quality framework models, variously synthesised from social, educational, behavioural health sciences research. However, none were reported as arising from a declared interdisciplinary approach, which has been established as being important when researching the subject of (zero) waste (Hannon, 2020). Jick (2008) regards qualitative and quantitative methods as complementary rather than competing and is an advocate of the *multiple*[50] methods tradition in social science, which seeks to bridge the various strengths and mitigate the weaknesses of any given individual methodology and mono-method research generally. Maintaining research quality while mixing multiple methods involves overcoming the technical challenge of effecting multiple collections, combination, convergence (or agreement), and interpretation of data (Jick, 2008).

Triangulation for quality assurance in research:

Regarding quality assurance in MMR, this research also acknowledges the concept of triangulation, which draws on navigational / geometric metaphor, whereby multiple viewpoints enable greater

[50] also variously attributed as: convergent, multi-method, multi-trait, convergent validation or triangulation.

discernment and accuracy. Within MMR, triangulation can be understood, as “combining methodologies in the study of the same phenomena” to validate the objective of ensuring that any variance reflects that of the trait under investigation, rather than, the method of investigation (Jick, 2008, pp. 108, citing (Denzin, 1978)). Jick (2008) identifies triangulation as essentially operating either within method, i.e., cross-checking internally for consistency and reliability or between method, i.e., testing degrees of external validity.

Triangulation can be interpreted as being part of a continuum of design complexity, beginning with the simplest blending and integration of data and method (Jick, 2008). Within this continuum, Jick (2008) identifies s*caling* is as the most primitive triangulation device. Utilising field observations to confirm strengthen statistical results, as an example scaling is defined as the “quantification of qualitative measures” (Jick, 2008, p. 109). Successively more sophisticated triangulation designs involve, for example, adopting a within-method strategy of testing reliability, or conventional / archetypal between-methods approaches designed for convergent validation, or attempts at even more complete holistic / contextual portrayal and description of the unit(s) under study (Jick, 2008 ref. figure 4.1 pg. 109). Responding to Jick’s injunction on designing quality assurance in MMR, this research methodology employed the concept of triangulation in the explorative approach to the qualitative analysis. This involves a sequence of formative analyses in a concurrent / convergent MMR design logic. As is discussed subsequently, the quantitative findings influenced the design of qualitative procedure and ultimately converged to the point of being reported as embedded quant + QUAL(quant) findings.

3.4.7. The convergence of mixed methods and content analysis

Content analysis has been described as a “careful, detailed systematic examination and interpretation” of a selected body of material (typically human communications across various media), undertaken with the objective of “identifying patterns, themes, biases and meanings” (Berg & Lune, 2012, p. 349). In content analysis, the analytic process codes the content as data in a format that addresses a research question or questions. The essential coding operation and data interpretation processes that make up content analysis, can be applied across a range of disciplines, including for example, sociology, business, and political science (Berg & Lune, 2012). A detailed review of relevant literature illustrates a comprehensive spectrum of descriptive attributes on how (and how effectively), where, when, why, in what ways, and with what technical supports, content analyses has been applied as a research methodology in the sphere of waste → zero waste management policy (Hannon, 2022 in submission).

Historically, irrespective of the field of application, commentators are reported as tending to view and report content analyses from variously undeclared perspectives (Berg & Lune, 2012). Because of this disparity, content analysis has somewhat confusingly been regarded as neither inherently quantitative, nor qualitative, and as sometimes dubiously mixing both methods in a variety of debatable research designs (Berg & Lune, 2012). The involvement of counting, in relation to coding frameworks, appears as the nexus of the Q&Q aspect of the debate on content analysis. At one extremity of this debate, it is contended that the involvement and frequency of counting as technique, excludes content analysis from being considered a qualitative research method (Berg & Lune, 2012, citing Burns & Grove, 2005). However, Berg and Lune (citing Sell, Jahoda, Deutsch and Cook, 1959 and Booth, 2000) argue that content analysis, where all non-numeric data are excluded, is self-limiting, because some forms of relevant communication lose meaning if translated numerically. In summation, the authors contend that a polarised, fixed mono-method viewpoint is now moot, as this debate has simply been bypassed by contemporary practice (Berg & Lune, 2012).

Berg and Lune's (2012) acceptance (supported by reference to numerous examples) of quantitative aspects of content analysis is now fundamentally on the basis of ongoing practice. The authors illustrate how quantitative blended with qualitative examination of broad phenomena (i.e. such as ideological mindsets, themes topics and symbols, etc.) advances the objectives and outcomes of content analysis beyond any perceived limitations (Berg & Lune, 2012). The following model (Figure 6) is an adapted, summary illustration of Berg and Lune's discussion on how the quantitative and qualitative elements of mixed methods approaches to content analysis can be engaged to generate new information and how this can be orientated relative to existing knowledge (Berg & Lune, 2012, p. 351).

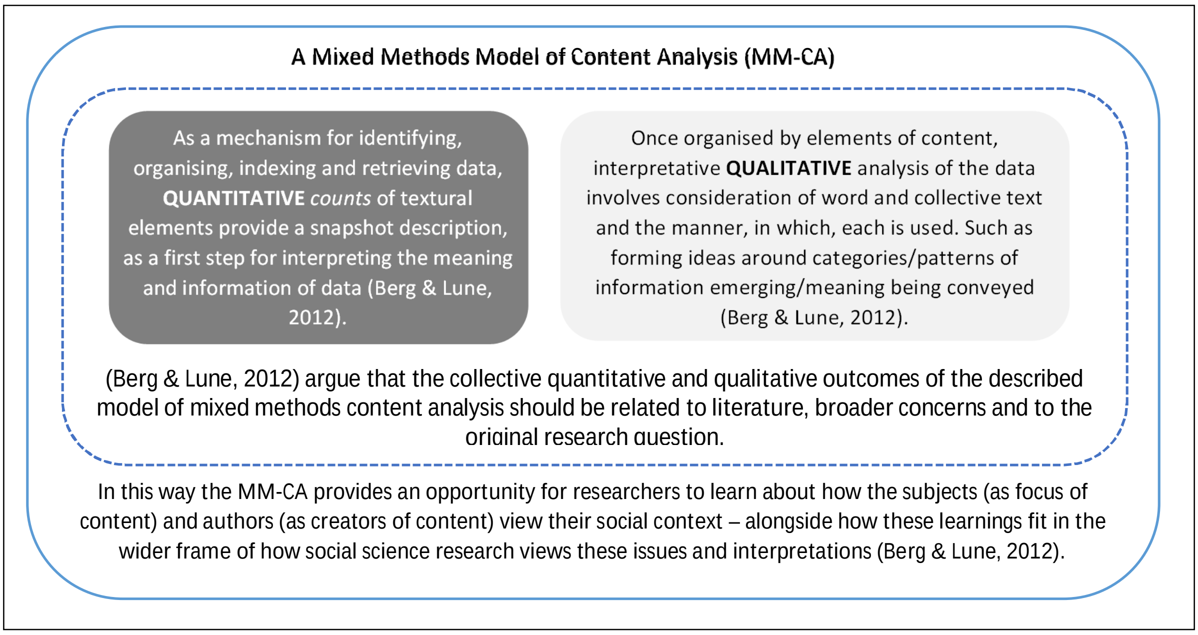


Figure 6: A discursive illustration of a mixed methods approach to content analysis adapted from (Berg & Lune, 2012).

Building on discourse on the employment of Q vs Q vs MM (Q&Q) in content analysis, Berg and Lune (2012) explore the relationship between the manifest (i.e., elements of content which are physically present and countable, *aka surface structure*) vs latent (i.e., interpreted by reading the symbolism underlying physical data, *aka deeply structural*) content being analysed. The authors observe that, "manifest analysis describes the content, while latent analysis seeks to discern its meaning" (Berg & Lune, 2012, p. 355). By extension, this discussion supports the authors' broad advocacy of MMR-CA in that they observe the limitation (while not excluding their use) of descriptive statistics (such as proportions and frequency distributions, etc.), without the accompanying support of complementary analysis, to discern the nature and meaning of the data or variables concerned (Berg & Lune, 2012).

Having acknowledged both forms of analysis and provided a detailed discussion of the background and distinctive practice of qualitative and quantitative content analysis, Bergman (2010, pp. 382-387) outlines thematic and causal analyses as two critical variations in the mixed methods *family* of hermeneutic content analysis (i.e., HCA-T and HCA-C). Within the contemporary context of content analysis, the term hermeneutic has come to be understood as the scientific art of discerning and crafting explanation, which is liberated by mediating a combination of expert researcher knowledge / skills and rule-orientated procedural research design (Bos & Tarnai, 1999). Content analysis is, however, also described as a learnable technique, the results of which should be independent of the researchers' personal / professional authority/bias (Hannon, 2022 in submission).

Appropriately, mixing and applying qualitative and quantitative approaches to content analysis is proposed under the terminology of hermeneutic content analysis (Bergman, 2010). Hermeneutic content analysis is cited as being applicable within constructivist, interpretive, and (post) positivist and pragmatic frameworks, as well as providing a basis for more innovative and interesting combinations of qualitative and quantitative methods, with greater consistency and integration (Bergman, 2008, 2010). The scientific procedure of hermeneutic content analysis is cited as offering interpretive, translative, and explanative functions that enable hitherto obscured and unavailable meaning (manifest and latent), to be rendered more clearly (Bos & Tarnai, 1999).

Hermeneutic content analysis (HCA) is cited as drawing on the ontological and epistemological framework of hermeneutics, whose guiding assumption is that "content and associated meaning of non-numeric can never be identified unequivocally" (Bergman, 2010, p. 388). Underlying this assumption is the fact that content / textural material as a whole, can only studied by examining its parts (i.e., most of us can only read sequences of a few words, as sentences, at a time and accumulate a sense of the whole text as we go). These parts can only be understood in relation to the whole, and the meaning of the parts does not unequivocally equate to the meaning of the whole (Bergman, 2010). Other foundations of the hermeneutic construct are that:

- "All research is bounded by the contextualised researcher and the contextualised research theme or question" (Bergman, 2010, p. 388).
- From conceptualisation to interpretation of the results of analysis, all research activity is linked and must be understood in relation to context (i.e., social, political, cultural, historical, commercial, environmental, institutional, etc.).
- Any given research question/focus must always allow for the reality of multiple *other* content and meaning existing in emerging out of data (Bergman, 2010).

Acknowledging discord and disconfirming around the proposition of MMR and CA:

Before explaining how hermeneutic and thematic finally become the adopted descriptors of this specific design of MM – CA, it is important to acknowledge that at this junction in the formative review of mixed methods and content analysis literatures, a degree of inconsistency and disagreement was encountered. As per Berg and Lune's (2012) injunction, this apparent disconfirmation in the landscape of conceptual, philosophical, and ontological considerations that fed the methodology design process was acknowledged, explored, and eventually resolved.

Morgan (2008) points towards pragmatism and abductive reasoning as a mediation of the supposed impasse between the philosophical, ontological and epistemological conventions around qualitative (inductive) and quantitative (deductive) traditions (ref. Table 3). In contrast, Bergman (2010, p. 390) regards the theory of pragmatism as a "vague formulation" and by implication, lacking in intellectual rigour. This position appears to directly confront the, '*what works in practice'* basis of pragmatism in leveraging off the real-world experience of researchers just pragmatically getting on with mixing methods in their research (Creswell, 2015). Bergman's central accusation about pragmatism as a basis for MMR is that the *'just get on with it'* motive ignores rather than resolves the problem, while the requisite ontological *fancy footwork* (switching between single and multi-reality framings) is seen as inviting an irrevocable inconsistency that undermines the integrity of research design (2010).

In contrast, hermeneutic content analysis (HCA) is proposed as a less problematic, more flexible solution (sic… than pragmatism) that disassociates qualitative and quantitative methods from formal constructivism and (post)positivism (Bergman, 2010). The family of HCA variants are described as a "mild form of constructivism" in which research design adaption pursuant to more objectivistic and (post)positivist perspectives is accepted (Bergman, 2008; 2010, p. 390). Bergman (2010) discusses the opportunity that self-reflective, revisional, and sequenced procedures offered in theoretically legitimising HCA and bridging contention around any perception of excessive or lax pragmatism. Bergman (2010) argues that various combinations of a top down (imposed deductive) or, bottom up (inductive) coding frameworks can be designed to support specific research foci, selected questions, context, and theoretical frameworks.

For the uninitiated, it is hard to discern how the respective perspectives on the ok-ness of ontological and epistemological work-arounds differ significantly enough to offer one perspective (i.e. either Bergman or Creswell's contrasting views) absolute legitimacy over the other. However, in respect of the proposed HCA family of variants (Bergman, 2010), HCA-T thematic analysis appears to have the closest correlation to the intended MMR-CA MZWM research construct of policy/plan discernment, confirmation and elaboration.

Bergman (2010) offers iterative abductive coding processes as providing the necessary inter-subjectivity and transferability to bridge the supposed incompatibility and division asserted about qualitative context-subjectivity vs quantitative objectivity-generalisability (D. L. Morgan, 2008). At this nexus, the theoretical discourse on pragmatism and HCA appears to coincide and helpfully reconcile. Significantly, for this research, Bergman (2010) specifically identifies policy documents among the scope of text / content from which relevant data / themes can be discerned in HCA. The author encourages sequenced, integrated, hermeneutic-based procedures, staged with cycles of reflection, feedback, and revision, within content analysis. In addition, Berman (2010) advocates for measures that make explicit the limitations of inferred findings (i.e., that based on subjectivity and non-representativeness of the sample sources/content).

As this extensive and detailed Methodology Chapter demonstrates, the combination of original literature review and publication strategy demonstrates coverage of a broad range of relevant academic discourse (i.e., historical complexity, challenge, and (inter)disciplinarity of (zero) waste, MMR, and content analysis, theory and practice) in order to underwrite the development of this research design. This background work includes identifying and examining relevant areas of unresolved and inconsistent research theory. However, fully resolved such background scientific disputes is not required in order for ongoing research to proceed.

Table 18 (Appendix 4) *A brief comparative analysis of various commentaries around mixed methods content analysis – utilised as a framework to discuss the design of the mixed methods hermeneutic content analysis – thematic of municipal zero waste methodology (MMR-HCA-T MZWM)*, provides a culminating summary of both the coverage and approach the original literature review and a summary of the key learnings from the following key authors, whose work was examined and correlated in support of the research design:

- A compilation and adaption of (Creswell, 2015) *'Steps in the process of designing mixed methods research (MMR)'*
- *'Table 11.1 - Applying the socio-ecological framework to Collins and O'Cathain' (2009) 'Recommended points to consider for novice researchers implementing a mixed methods research study'* (Plano Clark & Ivankova, 2016).
- The multi-stage, MMR / quantitative compatible model for *'Qualitative Content Analysis (QCA)'* offered by (Berg & Lune, 2012, p. 373) and...
- Bergman's discussion and proposition of iterative abductive coding processes and flexible self-reflective/revising sequencing procedures in the context of HCA as supporting and improving the quality of research process drawing on pragmatic research theory (Bergman, 2008, 2010).

On the combined basis of this background work, it is argued that MMR HCA-T-MZWM quant + QUAL(quant) represents a situationally appropriate research methodology that meets the relevant quality parameters of:

- sophisticated within-method triangulated (scaling – testing) design strategy and for convergence and complementarity between Q&Q elements (Jick, 2008),
- sufficient and effective (rather than excessive reliance) adoption on pragmatism (D. L. Morgan, 2008),
- validation, reliability, trustworthiness, credibility, inference quality / transferability and legitimacy as foundational requirements of all scientific research (Plano Clark & Ivankova, 2016),
- flexible, self-reflective hermeneutic procedures as a framing for quality assurance in abductive inferences within content analysis (Bergman, 2010).

This research was initially conceived as a concurrent / convergent quant + QUAL mixed methods hermeneutic – thematic (MZWM) content analysis, premised on pragmatic design theory for developing abductive inferences. However, in practically navigating the real-world complexities of this subject and data type, the MMR - HCA – T – MZWM pivoted at the point of analysis and write-up to include an embedded hybrid design element, annotated as quant + QUAL(quant). Accordingly, the final design annotation for describing the mixing of quantitative and qualitative methods in this form of content analysis is: *MMR HCA-T-MZWM quant + QUAL(quant)* (Berg & Lune, 2012; Bergman, 2010; Creswell, 2015; Jick, 2008; D. L. Morgan, 2008; Plano Clark & Ivankova, 2016).

3.5. The culminating selection, design, and justifications of mixed methods content analysis specifically for the research context of testing and elaborating MZWM

As covered in Sections 3.1 to 3.4, a review strategy focussed on policy research, MMR theory, and content analysis was undertaken as part of the broader literature review supporting this PhD project. This information base enabled:

1. The identification of the most appropriate policy analysis methodology (content analysis) for examining a selected sample of policy documents, describing municipal zero waste methodology (MZWM).

2. The design of a specific methodology, i.e., MMR HCA-T-MZWM quant + QUAL(quant), based on contemporary research theory and practice, which will implement the research objective of testing and elaborating MZWM.
3. The development[51] and reporting of Figure 7 as an illustration of conclusion from *Reviewing Policy Analysis in Waste Management Research to Establish a Design Basis Testing and Elaborating Municipal Zero Waste Methodology* (Hannon, 2022 in submission, p. 14).

Figure 7 illustrates a methodology design schematic for model of content analysis derived from this review strategy, which is contextually appropriate for both the subject of municipal zero waste methodology (MZWM) and for achieving the research objectives. The model of content analysis methodology, was originally derived from (Krippendorff, 2013, fig. 2.1 pp 36) and was then adapted and annotated for the specific research objective testing and explicating the hypothesis of MZWM (Hannon, 2022 in submission). The expectation in implementing this specific design of content analysis is that abductive inferences would arise both in the facts, observations, givens and reasoning issuing from the *content* of text, and in the human process of coding and analytic procedures of interpretation and the inferential formation of results. In respect of this, the overall enterprise of content analysis can be regarded as a formative and logical augment developed by analytical research that can be expected to underwrite abductive claims (Krippendorff, 2013) and advance the knowledge state in this work area (Hsieh & Shannon, 2005).

While content analysis can be expected to produce convergence and clarification of agreed meaning, this research methodology can and should also be expected to highlight differences in opinion (based, for example, on historical viewpoints and cultural beliefs about the nature of reality) and unresolved issues on how concepts and processes are interpreted and applied in specific fields (Graneheim & Lundman, 2004). This attribute fits the methodological requirement for the highly polarised, dynamic and contested (i.e. archaic – modern, public – private, theoretical – pragmatic) transitional waste → zero waste spectrum of activity (Hannon, 2015a; Hannon & Zaman, 2018).

The methodology design schematic illustrated as Figure 7 (Hannon, 2022 in submission, p. 14), demonstrates the requirement of being systemised, according to “inter-subjectively comprehensible rules for information processing” (Bos & Tarnai, 1999, p. 660). This design model draws on the cited propensity of content analysis for both testing theoretical issues and enhancing understanding of data related to composition and arrangement of policy elements. The specific design of the content analysis offers the reductive / assimilative capacity necessary in seeking the formation of numerous disparate elements of data into a “conceptual systems map” (Elo & Kyngas, 2008, p. 108), which in this instance is hypothesised as a condensed, coherent MZWM. In illustrating the requisite *rule-orientated procedural design* by which this specific content analysis can be implemented (and be replicable), the inclusion qualitative elements in this MMR procedure, can be expected to demonstrate the interpretive, translative, and explanative characteristics attributable as hermeneutic meaning / sense giving, and as such, examine the hypothesis of a comprehendible MZWM (Bos & Tarnai, 1999).

[51] This conceptual formwork/framework is derived from the model offered by Krippendorff (2013, ref. fig 2.1, p. 36), which has been adapted, contextualised, and annotated with discussion about employing this research methodology in the context of the hypothesis of MZWM.

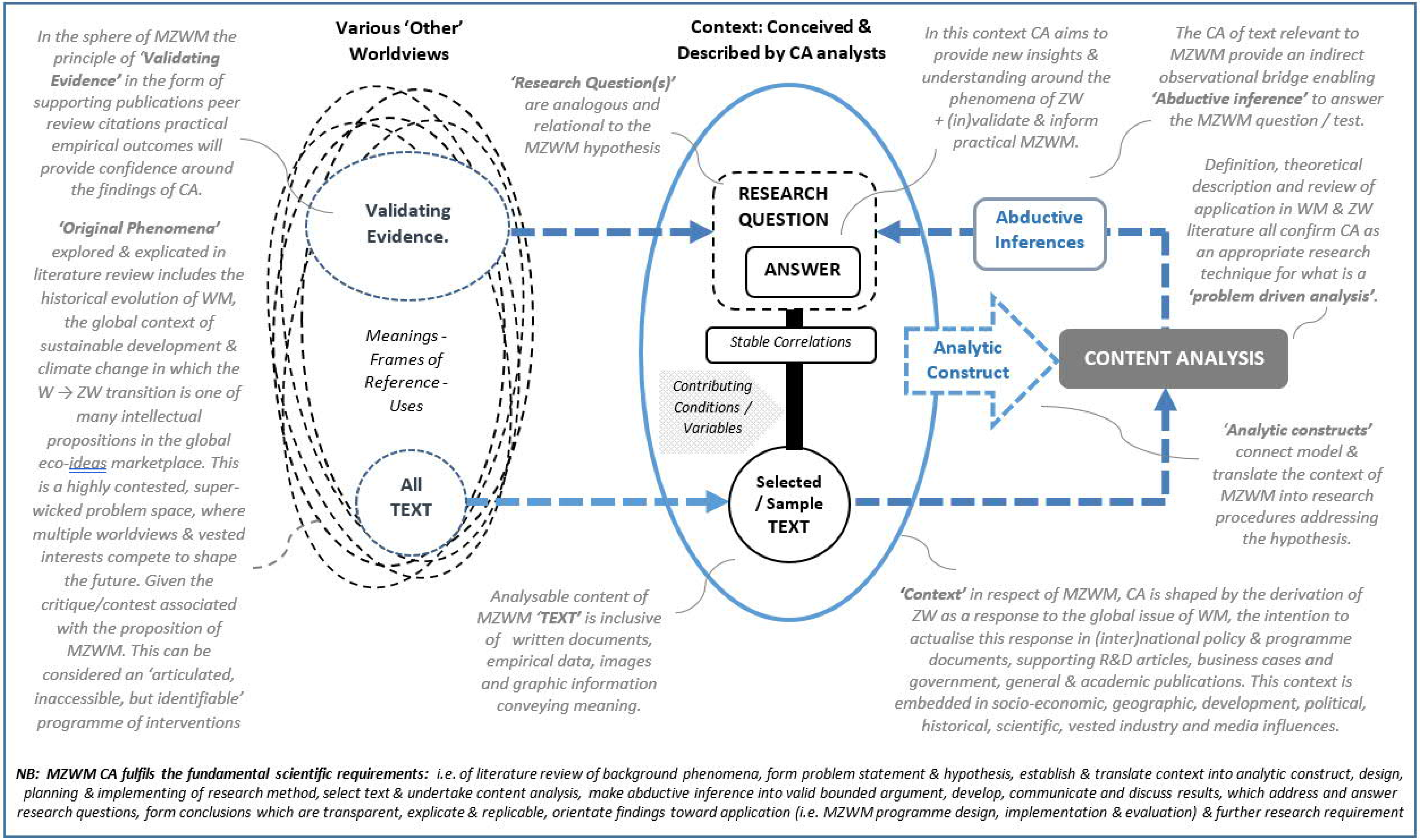


Figure 7: Graphic Illustration & discussion of the design framework proposed for content analysis (CA) examining municipal zero waste methodology (MZWM). Adapted from Krippendorff (2013, fig 2.1, p. 36].

3.6. Part Two – Methodology implementation: Unitising – the starting point of forming an analytic construct and conceptual model for a MZWM

The following section provides an outline of the coding framework development process, the procedure for content analysis, and the transition to the formation and presentation of the scientifically derived MZWM as a result. The stages involved researching and drafting an initial proposed MZWM conceptual model, forming and initial coding framework and iteratively developing this model via ongoing coding framework development processes, implementing the coding phase within NVivo, undertaking the write up and analysis of the coded data, and eventually synthesising a finalised result.

A key task in the process of content analysis (CA) is determining what and how observed phenomena will be recorded and transformed into empirical data. As a form of empirical research,[52] content analysis relies on multiple instances of observation that collectively and often statistically address an hypothesis, develop conclusions, and/or make manifest patterns not otherwise (or singularly) visible (Krippendorff, 2013). The purpose of this process, known as unitising, is to distinguish information-bearing instances (or units) in an observational field. For any subsequent coding and analysis to make sense, each unit must conceptually be whole, logically distinct, independent, and indivisible elements, non-overlapping demarcations of meaning in text (Krippendorff, 2013).

Units should not be considered as a given, but should emerge iteratively and be negotiated through a process of reading and designing the analysis, which therefore implicates the competence and vision of the analyst (Krippendorff, 2013). Berg and Lune (2012, p. 361) define content analysis as being the interaction of two processes: specification of the characteristics of the content being examined into basic elements (also referred to as classes and units); and determining and applying specific guidance (consistent rules) for identifying and recording these character-based elements. Additionally, the authors identify three procedures that support this unitising process:

- Common classes or units which are ubiquitous commonly understood parameters which distinguish members of society, such as gender, social roles.
- Special classes or units such as, labels or jargon associated with for example sub communities, professions (i.e., in-out groups, yes-no registration, chartered status, etc.)
- Theoretical classes or units, which are those terms that emerge in the course of analysis and may not have any meaning or correlating identity outside this analysis (Berg & Lune, 2012, p. 362).

Regarding this research, the unitising procedure determined the design of the framework for coding the information-bearing instances (or units) within the broad observational field of selected cases or sources of zero waste strategy, policy, programmes, and practices. Ultimately, a finalised coding framework provides the basis for the decision-making within the research procedure of coding. The initial proposition of a 50-point model of *Zero Waste Methodological Consensus* (Appendix 6) was framed around five elements, namely: principles and then policy, physical, financial, and social mechanisms. This initial framework was formulated as an inductive finding of the literature review

[52] "Based on, concerned with, or verifiable by observation or experience, rather than theory or pure logic" see https://en.oxforddictionaries.com/definition/empirical

process and then refined via a draft (proof of concept) evaluation exercise[53] and ongoing reflection and discussion within the PhD confirmation procedure.

This *proof of concept* exercise provided the practical basis for confirming the research hypothesis that, based on this indicative starting point, a finalised MZWM can be derived via the scientific methodology of content analysis. As the progression of tables and schematics recorded in Appendices 5 to 8 illustrate, this unitising process produced a sophisticated, detailed, and robust schema of logically distinct, independent, whole, and indivisible, defendable units.[54] Once integrated into NVivo, as the selected mode of CAQDAS, these units evolved into a parent and child node arrangement[55] (see Appendix 7 and 8) that enabled the rule-based organisation and coding of data from the observational field (Berg & Lune, 2012; Krippendorff, 2013). It is also important to note that the exercise of road-testing the initial 5-part, 50-point *Zero Waste Methodological Consensus* (Appendix 6) represents a *further action* (Morgan, (2008) and provides interim verification of the inferred existence, plausibility, applicability, utility, evaluability of the MZWM as a design implementation and evaluation framework.

3.7. Revision and integration to form a coding framework for CAQDAS:

It has been argued that the advent of computers enabled content analysis to come of age and grow to the exponential level, scope, and usefulness of application enjoyed today (Krippendorff, 2013). The development of *Computer Assisted Qualitative Data Analysis Software* (CAQDAS) represents a powerful and potentially symbiotic tool for enabling content analysis, and especially for integrating statistical support for mixed (qual-quant) methods framed research enquiry (QSR, 2017). However, careful consideration needs to be given to "potential issues" and also to which aspects of content analysis are *human critical* and where and how best computers can support and supplement, rather than replace this (Bryman, 2012, p. 592; Krippendorff, 2013; Lavery, 2016).

CAQDAS utilising the NVivo software is cited as, in particular, addressing the challenge of integrating analysis and interpretation of qualitative and quantitative data in a singular unified research theory and narrative (Bryman, 2006, 2007). The use of the term *integration* is clarified in this context as meaning the extent to which different data elements and various strategies for analysing those elements can be combined so as to become interdependent in reaching a common theoretical / research goal and thereby produce findings that are greater than the sum of the parts (Bazeley, 2010; Bazeley & Jackson, 2013).

Literature shows that a variety of mixed methods and CAQDAS and statistical apparatus have been constructed in support of content analysis, undertaken in relevant forms of waste management research, for example, *Partial Least Squares Path Modelling* (PLSPM) (Godfrey, Scott, Difford, & Trois, 2012), statistical software SPSS and chi-squared tests/statistical significance (Díaz et al., 2012, p. 692; Zeiss, 1999), MS Excel spreadsheet-based traditional standard errors regression, variance, sensitivity analysis, and Spearman correlation methods (Bufoni, Oliveira, & Rosa, 2015, p. 498). In particular, the

[53] Proposed initial MZWM model entitled *Zero Waste Methodological Consensus*, see Appendix 6.
[54] Ref the *node descriptions* (Hannon, 2022 in submission. ref. Table 8) and the evolved explanation of the decision making and justification behind the *unitisation* process.
[55] This is framework of language/terminology adopted by the proprietary training offered for NVivo(QSR, 2017).

bibliometric analysis of the C&D research in waste management research literature undertaken by Lu and Yuan (2011) provides a relevant example of the use CAQDAS, specifically NVivo.

In their research, NVivo enabled the coding (categorisation) and affiliation of source data categories, nodes, and levels involved in the content analysis. These authors observe the interplay of CADQAS and human judgement as important for the initial iterative processes of modification and refinement, as well as for the entire coding process (Lu & Yuan, 2011). Specific to this research objective of testing and explicating MZWM, Lu and Yaun usefully demonstrate that, once coding is completed for all the sources, more evolved relational frameworks for key theme nodes (and levels) can be constructed using the "model function of NVivo", which enhances illustration and reconceptualisation (2011, p. 1254).

After proposing the initial *Zero Waste Methodological Consensus* (and also after selecting NVivo and undertaking training in this software system) this unitising model was refined into single child / parent node schematic, suitable for loading as an initial coding framework within NVivo. Within the NVIVO CAQDAS system, on the basis of ongoing reflection, learning, development, revision, and structural integration the earlier (5 part / 50 point) framework was iterated into a 5-parent / 55-child node coding framework (*Analytic Construct for MZWM Content Analysis*, ref. Figure 22, Appendix 7). The iterative process involved writing a summary title and brief descriptive statement for each node, explaining why it existed as a distinct element within the theory and practice of MZWM. For example, creating the combination of node titles and descriptive statements is essential in enabling the succession of interpretations and decisions that make up the coding process to occur in an accurate and consistent manner.

Table 4: A small illustrative excerpt from the *Code Book* which can be printed as an output of NVivo.

Node Name	*Node Description*
A1- Conceptual Foundations & Critical Principles	*Essential foundations and key principles upon which MZWM depends*
A1a- ZW Goal Statement	*Public declaration of a ZW goal often with an associated timeframe*
A1b- Documented Strategic Plan	*Establishing (via wide stakeholder collaboration) and documenting a strategic ZW plan with a programme of implementable actions, where this is framed around holistic multi-stakeholder roles - partnership, involvement and collaboration. A critical consideration is incorporating the grass-roots, bottom-up, real world knowledge and experiences of waste-ZW workers.*

It is important to understand that the development of the coding framework and, ultimately its finalisation as a proposed MZWM (via the completion of content analysis), are entirely iterative. A continued series of revisions in both the node titles and the accompanying descriptive statements are made as the necessity for each becomes apparent throughout the research-led learning process.

For clarity and transparency's sake, it must be noted that this means that coding decisions made at the start of this iterative coding framework development process are made relative to a progressively changing decision-making context, i.e., an evolving coding framework, consisting of node titles and descriptions that iterate from the beginning to the end. This observation does not negate the rigour of the scientific procedure of content analysis; rather it acknowledges an essential feature of content analysis as a research methodology. Within content analysis, objectivity arises in the transparency of developing and explicating a recognised set of systematic rules / procedures for undertaking the analysis.

The design of these procedural rules is based upon the key components of content analysis, namely: unitising, sampling, coding / recording, reducing, inferring (based on an analytical construct) and narrating an answer to a research question (Bryman, 2012; Krippendorff, 2013). The detail and extent of this chapter and the inclusion of such disclosures, provides the required transparency and accountability. Accordingly, this fulfils the responsibility of a content analyst to construct and explicate an interpretive scheme (i.e., the describe initial an evolving coding framework), which is finalised as a proposed MZWM. This framework helps make sense of the innate features of text (in this case three key sources of information about MZWM), encompasses and interprets the spectrum and depth of meaning on offer, and guides the inferences that can be drawn from this data (Bryman, 2012; Krippendorff, 2013).

3.8. Sampling and coding the first source document using the NVivo CADQAS system for the first stage of content analysis for MZWM:

Having established and input the coding framework into NVivo, the next step in the procedure of this content analysis was to start coding elements of data from a selected sample of high quality sources (Berg & Lune, 2012). Berg and Lune (2012, p. 359) describe these elements as being potentially words, themes, characters, paragraphs, items, concepts, and semantics that may occur and be coded in combinations. The actual function of coding occurs within the operation of the NVivo software, where the element selection decision making occurs relative to the coding framework, which at this point is the *Revised v2 Analytic Construct for MZWM Content Analysis* (Figure 22, Appendix 7).

3.8.1. Sampling

Sampling theory seeks to provide for the generalisation of properties in a sample, over the population from which the sample is drawn. As such, sampling theory mediates scientific validity in the space between two extremities: 100% unique individuality (which requires a 100% sample for a complete descriptive inference to be drawn) vs 100% individual alikeness and conformity (where description of a single sample point would represent the entire population). Sampling theory also enables a pathway to be negotiated around practical issues such as data volume, divergence vs symmetry, and estimating and managing bias (Krippendorff, 2013). In content analysis, sample theory interfaces with text matter and encounters unique assumptions and challenges. In contrast to situations where sampling units are entirely individual and indivisible, in content analysis texts can be variously conceptualised and unitised (for example as hierarchies, levels of inclusion, sequences, etc.) and because of this, otherwise natural counting concepts and constructions may therefore not apply (Krippendorff, 2013).

Unlike other spheres of research in which samples are required to represent the distributional properties of the source population, content analysis may forgo accurate representation of the *textual* *universe* in favour of focussing concern on the content of most interest and relevance in giving the research question a fair chance of being answered correctly (Krippendorff, 2013).

It can be acknowledged that depending on the situation, one (or a combination) of several various sampling techniques might be applicable in the selection of source texts in the context of content analysis. In content analysis, rather than forgoing scientific considerations such as avoiding bias, etc., the research questions and context shapes and justifies the specific sampling plan. Depending on the situation, various sampling techniques may be applied to texts in the performance of content analysis. Any one or more in combination of the following sampling techniques, random, systematic, stratified, varying probability, cluster, snowball, relevance, census, convenience sampling, might be applicable (Krippendorff, 2013, p. 116).

However, in the context of this research addressing the hypothesis of MZWM, it was determined that relevance sampling, otherwise known as purposive (Riffe, Lacy & Fico, 1998), was the most appropriate sampling methodology. Relevance-based sampling has been enabled by the development of the *Source Assessment and Prioritisation Schedule* (Appendix 5) for this research. This schedule encompasses a broad range of potential sources, categorised on the basis of: type, location, impact-success, context, and development status. These criteria were selected from the broad range of sampling considerations offered by (Krippendorff, 2013), as being fit for this specific research purpose.

A relevance sample can be inclusive of considerations such as source (personal, institutional, geographic, etc.), situation, time-period, genre, inter-textualities, intended purpose, etc. (Krippendorff, 2013). Relevance sampling can also draw on knowledge that text may be partitioned into clusters and/or snowball into and within networks and accordingly can proceed to examine the texts being analysed in a multi-layered, even iterative selection process. In this way, the *text universe* that is sampled, becomes more and more focussed on that which will fairly and correctly answer research questions. Krippendorff (2013) describes relevance sampling not as probabilistic, but rather as naturalistic in developing through a sequence of exclusion criteria to form a population of texts that are highly relevant to addressing a specific research question. Once exclusion criteria have been exhausted, if a further reduction in the volume of text is required, other sample selection techniques can be applied to achieve this in way that is consistent with scientific principles.

Alongside Krippendorff's guidance, this research sought to apply Bryman's advocacy for quality assurance procedures for content analysis. Bryman's (2012, p. 544; Scott, 1990) four quality assurance criteria for source document selection as input of CA are "authenticity (genuine origin), credibility (evidence free from error and distortion), representativeness (level of typicality) and meaning (clear and comprehensible)". However, as well as the explication of context and the logic of inference, quality assurance of content analysis hangs on the cognisance and literacy of the analyst for the linguistically constituted social realities in which text are rooted and produced (Krippendorff, 2013).

The first source selected from the *Source Assessment and Prioritisation Schedule* (Appendix 5). for this content analysis research was *The End of Waste: Zero Waste by 2020* (Snow & Dickinson, 2001). Given the New Zealand context of this research, this can be considered a relevant and authoritative source (Connett, 2013). At the time this source was written it was regarded as a meaningful reflection of accumulated international best zero waste policy / practice (Connett, 2013; Lombardi & Bailey, 2015). As the coding process began, the expectation was that the initial coding framework would, on the basis of the unfolding evidence, evolve into a final and fully explicated structure and description of MZWM.

This resulting MZWM (Figure 11) is discussed subsequently in Section 4.4. In this sense the coding process is a methodical, detailed, and progressive evidence-gathering, decision-making exercise that becomes self-actuating, in that the coding framework that provides structure to the decision-making process catalyses and evidences the procedure.

3.8.2. Coding / Recording

The term *recording* is sometimes used interchangeably with the term *coding* to mean the creation of a durable record of otherwise transient and unanalysable phenomena. When used interchangeably, *recording and coding* refers to the research process of finding definition within unanalysed text to form separately described, transcribed, and categorised units of code, as comparable data for analysis, reasoning, discussion, and calculation (Krippendorff, 2013). However, more specifically, recording is what occurs when an observer, reader or analyst interprets what they see, read or find and then states that experience in formal terms for analysis. Coding refers to this process when conducted according to observer-independent rules (Krippendorff, 2013).

In this research, the terminology *code / coding* has been adopted. It is used inclusive of when the process is enabled by computer programmes (such as NVivo) providing the mechanical basis for content analysis extracting information from documents in an organised way. In executing the scientific requirements of transparency, rigor, and repeatability, coding relies on two key parameters. These parameters are firstly, the design of the coding framework, which specifies the dimensions of information being identified and secondly, the design of a coding manual, which provides a set of interpretive instructions for the action of coding, including all possible categories of each code dimension and any other factors needing to be taken into account (Krippendorff, 2013).

Open coding is described as an initialising, open, wide enquiry process within which, by necessity "emerging interpretations, questions and possible answers" are held in tentative abeyance (i.e., "believe everything and believe nothing") until the full picture emerges via thorough analysis enabled by the completion of the coding process (Berg & Lune, 2012, p. 365). Content analysis is accomplished in reference to a coding framework, which is used to organise data and identify findings after open coding has been completed. Coding frameworks are built up iteratively, though multiple levels, successive sorting / subdivisions, and types of questioning of criteria, as coding proceeds across several cases (Berg & Lune, 2012). Citing the guidelines offered by Strauss (1987), Berg and Lune encourage that open coding proceed through the simultaneous proposition of four critical questions, namely:

- Asking the data a specific set of study-orientated questions, i.e., any given data might be pertinent to a range of given research questions. So, keeping in mind the original objective of the study, does this relate to and accomplish this, or are alternative other unanticipated questions or goals afforded in the data.
- Analysing the data in miniature, initially using the more-is-better funnel concept, to enable a thorough grounding in the data, before latterly allowing a narrowing down and rationalisation of categories, inclusions, incidents, and interactions, etc.

- Frequently interrupting the coding to draft theoretical notes to capture ideas/responses that are triggered and further ground data in theory formation.[56]
- Never assuming analytic significance to any traditional variable (or common class, i.e., age/gender, etc.) until the data establish their relevance. This ensures every variable earns its way into the grounded theory (Berg & Lune, 2012, p. 366).

Another generalised way of understating the term coding is simply as a labelling function, in which the terms code, index, theme and category may all be used interchangeably depending on the specific conventions in the type of qualitative data analysis being undertaken (Lavery, 2016). Expressed in respect of this broader construct of qualitative data analysis (QDA), the function of coding can also be understood in terms of the encompassing of an iterative exchange and cycling among four elements: exploration; framing; categorisation, and understanding (Lavery, 2016).

First, the exploration stage of coding involves loosely structured reading and reflection, otherwise described as *purposeful play* to access and commence assembling an analytic response (Bazeley, 2013). Second, forming a coding framework solidifies this, often in the form of tabularised lists of labels, names, descriptions, inclusions and exclusions and examples that may involve direct quotes and colloquialisms (Bazeley, 2009a, 2009b, 2010, 2013). Lavery (2016) observes that codes can often emerge from the intuitive and quite abstract, but later can be orientated and described according to three level of code: descriptive (basic), categorisation, and analytic (meaning-full) (G. Gibbs, 2007). Third, reflecting the reality that qualitative data analysis can and should be recognised as, in a sense, a personalised process (Richards, 2015), categorisation can involve a variety of tools and pathways, such as colour coding, mind-mapping and the use of CAQDAS, to iteratively and non-linearly organise, group, (re)visualise, and (re)frame the basis of coding and analysis (Lavery, 2016).

Specifically, Lavery (2016) argues that cycles and interplay between the stages of code framing and categorisation are necessary to finalise the necessary spectrum of functions. For example, questioning the data, identifying keywords and repetitions, indigenous categories, metaphor and analogy, transitions, as well as discerning the role of linguistic features, ideas from literature and missing data in order to form a hierarchy of recorded code (Lavery, 2016). The fourth and final integrated understanding stage moves beyond the raw demarcations of code into the ongoing formations of constant comparison and pattern making, that is explanatory, explanative, thematic, model forming, and creative visualisation processes, all of which involve and benefit from CAQDAS support (Bazeley, 2009a; Lavery, 2016; Saldana, 2012).

However, despite such guidance, others observe that there are “many” and “no single best” way of coding (Berg & Lune, 2012, p. 366). Various typologies and terminologies have been attributed to the formation of coding practice. For example, Morse and Richards (2002, p. 112) distinguish three types of coding: descriptive (storage orientated); topic (focussed on gathering and organising); and analytic coding (for concept development). Further demonstrating the breadth of description, Bogdan and Biklen (2003, p. 161) distinguish “setting / context, definition of the situation, process, activity, event, strategy, relationship and social-structural, narrative and method” codes. A function of the described methodology development process has been to objectively examine the breadth of commentary and to establish a situational and subject appropriate middle path for this research. In this respect this

[56] NB: NVivo which is proposed as the CAQAS software to be utilised in this MMR-CA of MZWM, specifically enables practice, via the *memos function,* which is built into the software system.

research primarily draws on Berg and Lune's (2012) encouragement that the corollary of an initial un-preconceived, open, un-structured, playful coding approach, is a latter balancing, systematic organisation stage, which is cited as making it progressively easier for the "data to talk to you and inform you" in respect of research questions (Berg & Lune, 2012, p. 367)

As it proved in the case of this research, content analysis may involve enormous quantities of data, which are sought to be transformed and narrated as a meaningful output (G. Gibbs, 2007; M. B. Meyers, 2009). It has been variously observed that there is no silver bullet by which research can circumvent the quantum, time, organisation, persistence and problem solving, transparency, accuracy and rigour and overarching cognition, honest reflexivity, and enduring focus on the research question that is required to succeed in this form of research (Bazeley, 2013; Lavery, 2016). However, while recognising that content analysis is still fundamentally a human-derived process (with all this implies), a well-designed and managed coding processes will minimise the idiosyncrasy of human judgement that might otherwise undermine the reliability and explain-ability of analysis relative to findings (Krippendorff, 2013).

Alongside this, coder training, defining the semantics, verbal designation, extensional lists and decisions schemes, magnitudes and scales, simulation of hypothesis, developing constructs for closure and formation, organisation, administrative information completeness and storage of substantive records, all collectively present as a support systems of quality assurance for content analysis (Krippendorff, 2013). The coding process aims to be systematic in applying the macro-level (re. content analysis as a research methodology) and immediate micro-level conventions associated with any given specific content and project design, in a consistent manner so as to reduce the intrusion of personal bias and ensure independently replicable results (Bryman, 2012; Krippendorff, 2013).

Because this research involved a single researcher undertaking coding framework development, implementing the coding procedure, and completing the content analysis, I undertook CAQDAS training to support quality assurance in using the NVivo software. The expectation is that; through the quality assurance of both input data and the design and implementation of a robust, transparent and systemised coding process, relative to an organised coding framework and the imposition of the coder training, a higher and further refined understanding and/or new level of theoretical cognition can be developed for the targeted phenomenon (Bos & Tarnai, 1999).

The culmination of Section 3.8.1 was that, as a result of the described sampling procedure, *The End of Waste: Zero Waste by 2020* (Snow & Dickinson, 2001) was the first source selected for content analysis. On the basis of inputting the 5-part 55-point *Analytic Construct for MZWM Content Analysis* (Appendix 7) into NVivo and the coding procedure outlined in this Section 3.8.2, the first phase coding for this content analysis was implemented. It is anticipated that the outcome of this content analysis will be to definitively answer the primary research question and that within the research procedure this initial coding framework will evolve into a final and fully realised MZWM. The driver for this evolution will be the interplay of inductive and deductive reasoning acting across the mixed qualitative and quantitative data, culminating and consolidating in abductive inference (D. L. Morgan, 2008; Plano Clark & Ivankova, 2016)

3.9. Tactically adapting the scope of the coding framework and content analysis:

As the coding process and ongoing coding framework development proceeded within NVivo, a decision was made to establish a second folder and hence second coding framework to register (rather than ignore) data emerging from the sources. This emerging new data-set appeared to be relevant to the approach that this research adopted in answering the central research question. The other driver of this diversification in the unitisation process, was responding to the assertion that valid hypothesis must be *provable* as well as *nullifiable* and that testing procedures must actively seek and examine disconfirming alongside supporting evidence (Berg & Lune, 2012). Although not initially anticipated in the starting design of the CA, the development of this second coding framework created a mechanism for acknowledging and factoring in disconfirming evidence with the objective that ultimately a more balanced and robust conclusion would be derived. The two folders[57] were named:

- *MZWM:* based upon 5 parent and 55 child nodes and
- *Exploring waste → zero waste:* initially based upon 4 parent, 9 child and 1 grand-child nodes

The decision to establish the second folder, and with this a second coding framework not only supplements the central research focus of exploring consensus as to what is and is not MZWM, but also provides insight to other subsidiary questions such as, how and why the case is argued for and against zero waste. This tactical adaptation in the research methodology follows the evidence and extends the database directed at the primary research question. This new ecosystem of secondary peripheral questioning and reflection enabled a broad holistic understanding of zero waste and broadened and reinforced the basis for developing a defendable answer to the research question.

Diversification and addition in the *unitising design* enable the coding framework to further distinguish information-bearing instances / units from within the broader observational field *(i.e., text universe)* of zero waste. Ultimately, this enables greater dexterity, insight, and rigour as the content analysis culminates in inference formation and hypothesis testing (Berg & Lune, 2012; Krippendorff, 2013). It is argued that, alongside the immediate focus on language, communication, and the exchange of meaning, the focus of content analysis also needs to encompass social reality and cultural context (McTavish & Pirro, 1990). The decision to develop the second coding framework tactically extends the capacity to capture data related to a broader, unblinkered consideration of other secondary/peripheral questions interrelated with the primary research question.

In terms of general waste management policy and practice vs the specific MZWM subject focus of this research, the extension of framing enabled the inclusion of other social, environmental and economic contexts, scientific / academic discourse / debate and the political ecology in which communication takes place (Krippendorff, 2013). This imperative prompted the research to seek to encompass a broader analytical focus, for example including peripheral but important content relevant to the two key interrelated negative assertions in respect of MZWM (i.e., 1- non-existence and 2- absolute failure). Accordingly, while the central research question (i.e., does a MZWM exist?) is addressed in the procedure of the content analysis, this tactical inclusion acknowledges the importance of other relevant and interrelated considerations and questions. For example, why do the negative counterclaims about zero waste exist in the first place?

[57] See Appendix 8 for a subsequent the coding framework outline/project map generated by the *model function* in NVivo.

Although outwardly tangential, addressing interrelated evidence for negative claims, i.e., *1- non-existence* and *2- absolute failure of zero waste,* provides an important converse examination of the central research hypothesis. While it was expected that the central focus of the content analysis would prove this research hypothesis, (i.e., affirm and evidence the case for a MZWM), the opportunity to better understand and disprove the negative claim is an opportunity to strengthen this eventual finding. The combination of:

1. broadening the focus of content analysis (i.e., data accumulated in the second coding framework) *Exploring W → ZW* and
2. the deliberately extensive scope of the original literature review and
3. strategically developing a group of publications as part of the overall PhD research project (Appendices 1–6)

in effect triangulate as an examination of (dis)confirming evidence, which allows both nullifiable and provable hypothesis (Berg & Lune, 2012).

The tactical inclusion of the second coding framework to expand the scope of the content analysis was based on evidencing and responding to the actual (rather than the preconceived) data. This decision is consistent with the approach in both undertaking the original literature review (which included reviewing the critique of zero waste) and the decision to develop a group of publications that evaluate and discussed this critique. However, it is important to note that the original body of critique was externally compiled from a full spectrum of (zero) waste management authorship, whereas the second parallel coding framework (and hence second aspect to this content analysis) examines critique, which is internal to zero waste discourse (i.e., a self-examination of issues, inconsistencies, and tensions within the selected sample of authoritative zero waste sources).

Alongside this decision-making, the opportunity to examine zero waste's internal critique was supplemented by tactically introducing a prominent zero waste review article by a leading academic authority, as a supplementary (4th) source. The article, *A comprehensive review of the development of zero waste management: lesson learned and guidelines* (Zaman, 2015), was also coded into this second parallel element of the overall content analysis as an additional point of reference. The term *supplementary source*, used as the tangential analysis of this review article, was used selectively to explore specific points of interest rather than as an input for answering the primary research question.

3.10. The second source document sampled for content analysis

With the commencement of coding of the second selected source document, *On the road to zero waste: Successes and lessons from around the world* (Allen et al., 2012), the coding frameworks were iterated and simplified, at this point, to two folders:

- *CA MZWM Rubric* (i.e., key elements and arrangement of a hypothetical MZWM) = 5 parent and 61 child nodes and…
- Exploring waste → zero waste (i.e., motive and argument formation exploring the basis for agreement and actioning of zero waste) = 5 parent and 34 child nodes.

Allen et al. (2012) was selected as a source because it encompasses real-world case studies from around the world and includes detailed data and a globalised reflection of zero waste best practice. This source was developed by a reputable international organisation, with the content provided by an international expert group of authors. The relatively recent publication date of 2012 combines being contemporary with enabling enough time to elapse for processes of peer review and critical discourse to refute any aspects that were not considered valid. This document had withstood this critical examination and as such exceeds the requirement for being 'meaningful, authentic, credible and representative' (Bryman, 2012, p. 544; Scott, 1990).

During this phase, observations on the scope and manageability of the content analysis began to materialise (and eventually to firm-up as methodological consideration) as the number of codes, extent of code content and awareness of the complexity of cross code interrelationship began to accumulate. As the large scope became increasingly apparent, the scale of the post-coding analytical processes was beginning to be able to be conceptualised and planned. At this point, an MS Excel spreadsheet was initialised in order to capture and begin arranging the increasing scale of data being coded for content analysis from each successive source. This decision to initiate and test this medium for quantitative analysis usefully prompted a range of other ideas for further forms quantitative analysis suited to the emerging data. In addition, this exercise prompted consideration as to how MS Excel might be utilised more broadly as a medium of the next phases of qualitative analysis. Ultimately, MS Excel was determined as providing the best option as a medium for structuring the conceptualisation, organisation, and translation of the coded data-set into a narrative result.

3.11. Coding the final source document selected for content analysis

The third and final source document selected was *The Community Zero Waste Roadmap* (Lombardi & Bailey, 2015). Published in 2015, this respected policy and practical advisory document can be considered a contemporary distillation of reputable international consensus specifically attuned to the municipal context. The authors have been embedded within the ZWIA nexus of international zero waste best practice and theoretical dialogue and are recognised as experts. The mix of policy and practice based content has been grounded in decades-worth of hands-on experience derived from the organisation Ecocycle, considered a global leader in this sphere. While contributing a critical new experiential dimension as an input for content analysis, importantly this source also exceeds what both Byrman and Scott (2012; 1990) asserted as the standard for quality assurance.

The previously outlined unitising and sampling theory makes provision for the negotiation of methodology design pathways around pragmatic issues, such as data volume / limitation, divergence/symmetry and estimating and managing bias without necessarily forfeiting scientific rigour (Krippendorff, 2013). Unlike some other spheres of research, content analysis does not automatically require all textual sources to be treated equally. For content analysis, sampling theory enables forgoing the accurate representation of the distributional properties of the source population in favour of focussing on text / content of maximum interest and relevance to fairly answering a research question (Krippendorff, 2013).

At the point of completing the coding of the third selected source it was evident from the extensive accumulation of data feeding into the analytical construct to support inference making, that these three selected key sources had provided a rich field of evidence. This posed the question, was this evidence sufficient basis for generating, justifying, and narrating a conclusion in respect of the research question? Throughout this and earlier phases of coding, further iterative changes in the coding framework were be observed. However, the rate of change appears to slow, as a more settled and confirmed framework for MZWM emerges. The declining rate of change as an indicator was subsequently examined in more detail in the quantitative analysis (see Table 11, Section 4.2.5) as a way of verifying the finalisation of the coding framework development process. At the completion of the coding of this third source, the transition from the *Zero Waste Methodological Consensus* as an initial input, to the final iteration of Coding Framework (CF), to the emergent MZWM (i.e., which proceeds into the next phase of content analysis) was considered to have reached an end-point. This final iteration of this Coding Framework is reported as Appendix 9, as an illustration of the iterative evolution and process outcome at this juncture in the research procedure.

3.12. In-process tactical decision making to finalise the methodology design

At this junction, the practicalities of the now increasingly evident large scope and scale of data, and the extent and overall sufficiency of research were discussed. As a proof-of-concept stage, it was proposed to complete full analysis and write-up of the result to date, so as to ensure that it was possible to process the amount of data and to complete the scale of analysis which was becoming apparent. This strategy provided a definitive opportunity to both examine the question of sufficiency in respect of the number of sources and to test the model of analysis that was now being conceptualised for the next phase of the research process.

It was envisaged that provisionally examining the results at this junction would reveal if any further sources and coding of input data was required in order to exceed the scientific threshold of producing robust, reliable, replicable, and defendable results and conclusions (Graneheim & Lundman, 2004; Hsieh & Shannon, 2005). If this standard of proof and sufficiency was not apparent, then further, next priority source(s) would be selected from the *Source Assessment and Prioritisation Schedule* (Appendix 5). This evaluation schedule had been previously developed and utilised to enact sampling appropriate for this design of content analysis.

As outlined, this in-process decision-making also enabled the practical road-testing and finalisation of the next phase of mixed quantitative and qualitative methods analysis, which was proposed be undertaken in MS Excel. As such, this provided to opportunity to reflect on the set-up of NVivo and the interface of coded data with the next stage of content analysis within MS Excel. Importantly, this was also an opportunity to project forward and consider the synthesis of final results and to ensure that the proposed procedure was capable of extracting all the conspicuous, as well as latent, meaning on offer. From this point, unless further sources were required, it was expected that big structural changes in the evolution from Coding Framework (CF) → emergent MZWM would give way to a more incremental mode of smaller finalising iterations.

However, before finalising this tactical variation within the final methodology, a project planning / mapping exercise was undertaken. This exercise sought to anticipate and interpret the consequences of this decision in relation to the overall scientific procedure of the project as a whole. This project planning exercise is illustrated as Figure 8, which illustrates an overarching *schematic model of content* *analysis and methodology for coding framework development → inference re the research hypothesis of MZWM*. As illustrated, the strategic planning exercise outlines how the decision-making pathways were projected forward as a completed methodology and final result for this content analysis. This exercise provided a degree of clarity to and security around the decision to stop coding after the inclusion of just three, albeit significant, sources that had produced an extensive data set.

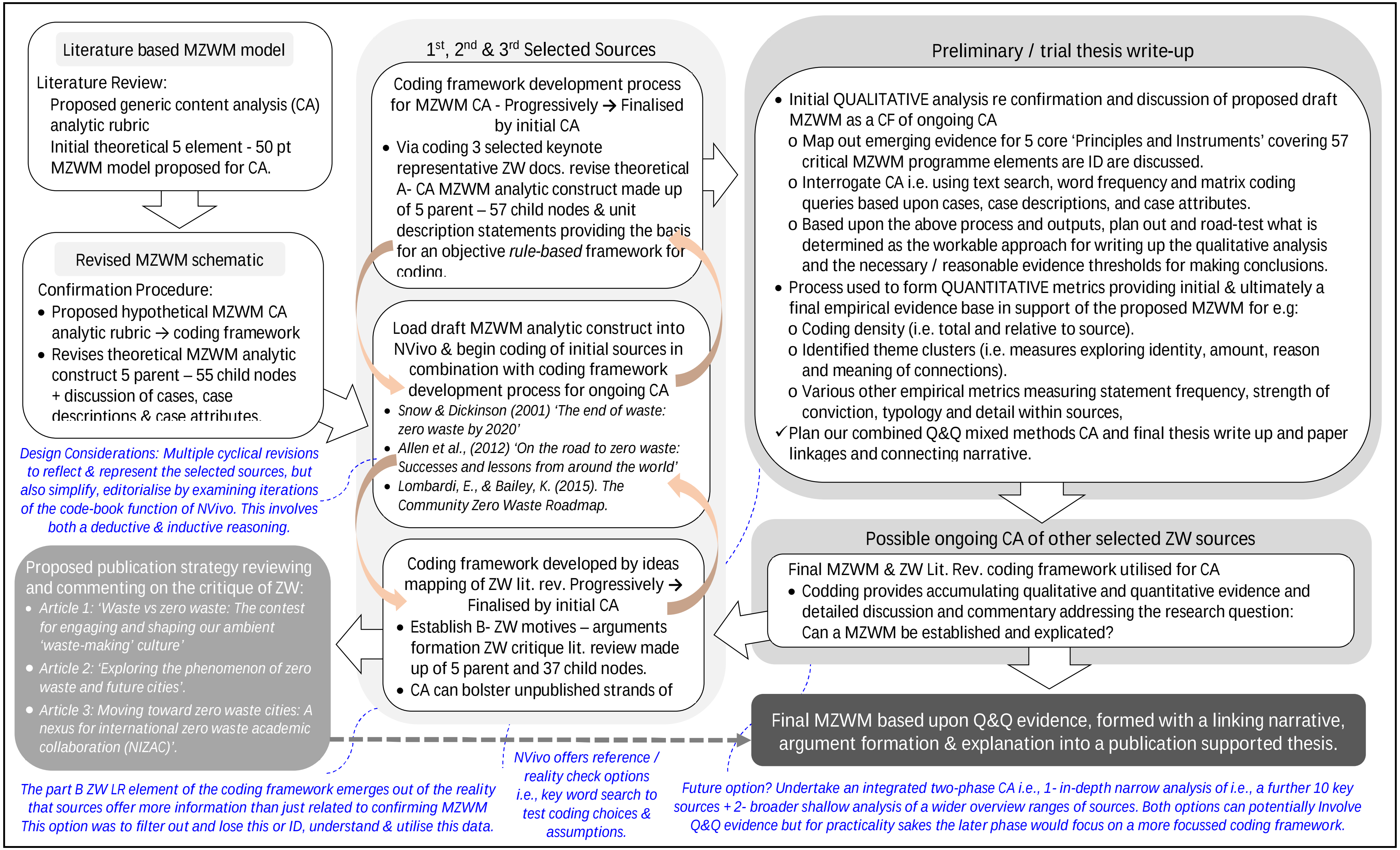


Figure 8: The schematic model of content analysis and methodology for coding framework development → inference re this research hypothesis of MZWM.

3.13. Transcription from NVivo into MS EXCEL for quantitative and qualitative analysis and the formulation of Figure 8 as a graphic overview of the research procedure

As outlined in Figure 8, this stage in the overall process of content analysis involved transcribing the coded data from NVivo, into the respective formats for qualitative, quantitative, and then genuinely integrated mixed methods analysis. Relatively early on in this process it was apparent that the type and weighting of data most suited qualitative analysis. Accordingly, it was anticipated the quantitative analysis would perform more of a support and empirical scrutineering role within the overall content analysis. In this respect, the learning from implementing the methodology and the emerging findings from this model of mixed methods content analysis was confirming the anticipated concurrent quant + QUAL mixed method design logic (Plano Clark & Ivankova, 2016, p. 118. fig. 5.2).

In this design logic the two sets of results are combined as a singular finding before inference is drawn on the basis of having integrated two differing types of data (Plano Clark & Ivankova, 2016). As discussed previously, while the observance of capitalisation reflects prioritisation, and in this instance a sense of the relative volume of data, this does not denote the importance of the differing data sets and resulting finding. It is recognised that the respective quantitative and qualitative data offer critical and unique insights that are not accessible via either mono-method research in isolation. As has been previously noted, the strength of the concurrent design model is in the potential for generating different, but complementary data and more substantial, richly detailed, and validated findings in a time/cost effective way (Plano Clark & Ivankova, 2016. citing Morse, 1991, pg 122).

A key stage in the design of the respective analytical process utilising MS Excel was to conceptualise the organisation of each of the elements of both the qualitative and quantitative analysis. Regarding the design of the qualitative analysis, a schematic illustration was developed as a simple way of conceptualising and capturing the scope and illustrating the evolving organisational arrangement of what emerged as a large body of qualitative data and analysis. For convenience and brevity's sake, only the final endpoint of many iterative versions is reported as Figure 11 within the upcoming results Section 4.4. While the imperative of conceptualising and graphically illustrating the structural organisation of the qualitative analysis occurs and was initialised at this point in the research process, the final iteration was actually not fully realised until later, whereupon it represents and is reported as a final result (Figure 11, Section 4.4).

3.14. Outline of quantitative analysis and the integration in forming a mixed methodology

This research draws on the propensity of pragmatic research theory / philosophy in informing the design and combination of both quantitative and qualitative aspects data collection (Creswell, 2015). The seven sub-sections making up Section 3.4 provide an in-depth explanation and transparency around the philosophical assumptions, scientific precedent, and research theory that underwrite the approach to this specific mixed methods content analysis (Creswell, 2015; Jick, 2008; Krippendorff, 2013; D. L. Morgan, 2008; Plano Clark & Ivankova, 2016). This model is illustrated and summarised in Figure 7 (Section 3.5), which outlines the design of the research methodology for this mixed-methods content analysis.

This design of this research methodology sought to enable qualitative and quantitative research methods to converge and combine in a reflective back-and-forth abductive processes enabling the engagement of qualitative derived inductive results as inputs for the deductive goals of quantitative approaches and or vice versa (D. L. Morgan, 2008, p. 59; Plano Clark & Ivankova, 2016). More broadly, this approach draws on arguments for pragmatically finding useful points of interplay and connection between different kinds of knowledge, generated by complementary rather than by competing quantitative and qualitive methodology (Jick, 2008). The anticipation is that this methodology design will enable multiple angles for integrating answers to the research question(s) (D. L. Morgan, 2008).

As previously outlined in Section 3.4.7, this specific mixed methods content analysis is fully annotated and described as a concurrent MMR – HCA – T- MZWM quant + QUAL(quant) embedded mixed method design logic (Plano Clark & Ivankova, 2016, p. 118. fig. 5.2). In this design logic, the two set of results are combined and conceptualised as a singular integrated finding that ultimately supports inference based on the combination of the two differing types of data (Plano Clark & Ivankova, 2016). In this design annotation, the capitalisation reflects prioritisation and in this instance a sense of the relative volume of qualitative data, but does not denote the relative importance of the differing data sets and resulting finding. This is because it can be accepted that quantitative data offers critical and unique insights that are not accessible via qualitative research alone. The key strength of the concurrent design model is the potential for generating different, but complementary data and more substantial, richly detailed and validated findings, in a timely and cost effective way (Plano Clark & Ivankova, 2016. citing Morse, 1991, pg 122).

Table 5 provides a brief overview of the explorative approach, which was developed in undertaking specifically the quantitative aspect of analysis of the three selected key MZWM sources. This overall model of quantitative analysis was developed progressively as a pragmatic understanding of the sources emerged in the coding process (ref. Sections 3.8. to 3.12.). As coding proceeded, the necessary awareness developed as to what empirical data were contained, and what of these were interesting, pertinent, and might benefit from closer examination to extract further insight.

In-process learning and exploration of what emerged in the data, rather than a preconceived framework, guided the development of this quantitative analysis. This is further discussed in the upcoming results Sections 4.2.1. to 4.3.4. Part of this learning involved pragmatic considerations that emerged and shaped the unfolding sense of what analytical / statistical tools might be applicable in the context of these data. Various quantitative counts of text elements were devised as mechanisms to identify, extract, organise / index, and integrate snapshot descriptions and supporting information to interpret the meaning of the full range of data in the three sources (Berg & Lune, 2012).

On reflection, a variety of quantitative-orientated empirical data existed within the three key selected sources, and wide variety of quantitative approaches exist which, might potentially have been applicable in analysis and inference making from all available data. The overall approach outlined in Table 5 represents an explorative / experiential, as well as pragmatic, determination of the relevant types, combination, interactivity and extent of quantitative analysis that would maximise the mix with qualitative methods in this subject-specific content analysis. Encompassed in the write-up of Section 4.2, is a back-and-forth interplay between all the accumulating, unique, and mutually reinforcing insights, the lines of inductive and deductive reasoning, and the emerging learning that could be integrated with that from the final phase of qualitative analysis.

Table 5: A summary of the design approach for quantitative analysis within the MM CA MZWM.

Discussion & outline of the methodology for Qualitative Analysis for MMR CA MZWM.	Observed Metrics. *NB: the shading highlights the three key relational clusters of quant + analysis namely: (4.2.1 to 4.2.3), (4.2.4 & 4.2.5) and (4.2.7 & 4.2.8).*
Section 4.2.1 Quantitative extraction and examination of baseline information descriptive of the three selected key MZWM sources.	Author, date, context(s) scope of ref data (Developed – Underdeveloped, Publisher, Place published, Status, Pages, References, Supporting website, Acknowledged contributions), Timeline data (Target, Trajectory, Diversion %) Demographic data (Quantitative outcomes, Population, (million), Population density / km^2, MSW kg/pp/dy, MSWM system description, Avoided cost / yr (million), Geographical information)
Section 4.2.2. Analysis of acknowledgments, contributors and people of influence, which may provide indicative evidence on the origins, connections and cross-pollination of ZW ideas, principles and concepts.	Acknowledgments & contributors: TOTAL number of acknowledgments, contributors per source, the number correlations with other sources, # commonality within source & % commonality within source, % correlation to the collective zero waste voice, One on one comparative correlation between common sources.
Section 4.2.3. Analysis of the references, to provide a formal systematic and comprehensive attribution / origin of ideas and evaluation of the relative academic quality assurance.	Formal references
Section 4.2.4. Studying the evolution of consensus within the MMR CA MZWM research process.	• # of refs (codes) + % proportionality
Section 4.2.5. Quantitative mapping of evolution in the type and rate of change in CF v final then MZWM v final.	Tracking evolution in content (Codebook word counts, WC incremental variation, WC incremental % variation, WC variation ref to start, % variation in WC ref to start.) Tracking evolution in organisation of MZWM (Structural overview metric), Incremental change MS review (# of txt changes), Iterative doc to doc comparison (% change, # of copied words).
Section 4.2.6. Characterisation study of MM CA MZWM of quantitative element of data coded to node structures making up the MZWM parameters. NB: 4.2.6. is discontinued but critical quant + analysis discussed Section 5.4.	*Source total (#, yes v no & % affirmative), Score - ID repetition v confirmation, Typology (discussion notes, i.e., WZW hierarchy # Rs, Context materiality, sector)*
Section 4.2.7. Examining secondary related 'Zero Waste Motive - Argument formation' data which has been coded in parallel with the primary MZWM content analysis.	• The 1a, b & c information is collected as part of the MZWM • As per 2a- # of refs (codes) & % proportionality + structural overview + word count
Section 4.2.8. Examining and understanding cross-connecting themes and enablers i.e. nodes which appear interactive and or interrelated within the MZWM.	• Mapping exercise recording connections and the degree of connectivity.

3.15. Translating results out of EXCEL via written synthesis, reflection, revision, overview rationalisation, reorganisation, abbreviation and finalisation of Figure 11 (vfinal).

The final stage of this research methodology involved completing the second stage of qualitative analysis. The first stage had involved transcribing the data from the numerous parent and child node structures of the then coding framework utilised within NVivo into the various worksheets and unitising frameworks that had been developed in MS EXCEL. These second and final stages of qualitative analysis involved processes of further reflection, interpretation, synthesising, and translation of the data from MS Excel into a conventionally expressed written result. While it may not seem entirely logical, in practice these two phases of qualitative analysis were separated by undertaking the quantitative analysis, as outlined in Section 3.14. The positive of this was that this time separation enabled a period of reflection on and reconsideration about these data, and the quantitative analysis provided crucial insights that flowed into and shaped the implementation of the final phase of qualitative analysis and the integrative formation and expression of final results.

My observation, as a researcher, was that the sequence of alternating between qualitative and quantitative perspectives and the reflective space this created, appeared particularly fruitful in terms of the macro- level conceptualisation of how best to present and illustrate results. Mixed- vs mono-methods research can generally be regarded as cognitively demanding. In this instance, the necessary switching between qualitative and quantitative mindsets (and, in this case, back again) did prove challenging. However, this forced the research into a significant level of familiarity and immersion in the data that allowed an opportunity for oversight as well as insight. As Krippendorff (2013, p. 42) observes, this immersive and intimate knowledge of the data enabled the research to proceed across logically distinct domains (i.e., from the content of text to the formation of answers) whereby "particulars can be assembled in particulars of another kind".

In the context and pragmatic procedure of this mixed methods content analysis, abductive inferences can be seen both as arising in the facts, observations, givens, and reasoning evident in the content of text, and also as residing in the human reflective (back and forth) interplay (D. L. Morgan, 2008) of coding, framework development, analytic procedures, and the interpretation of finding (Krippendorff, 2013; Plano Clark & Ivankova, 2016). In this respect, the whole enterprise of content analysis can be regarded as a formative and logical augment developed by analytical research to underwrite abductive claims (Krippendorff, 2013, p. 38). In simple terms, as the subsequent extent and detail of quantitative and qualitative findings illustrate, there was no shortage of results in the form of graphics, tables, and written description. A key challenge in implementing this research methodology has been condensing this enormity of finding and all of the inferred meaning into a concise and meaningful results format.

Chapter Four: Results

Introduction: This *Results* Chapter Four is organised into seven sections. The first Section, 4.1, references Table 17 (Appendix 2) which is a key point mapping exercise, which provides a summary overview of early review research findings from the publications developed within this PhD project. This section correlates with and clarifies how the findings communicated within the Literature Review Chapter One (Hannon, 2015a; Hannon & Zaman, 2018; Hannon et al., 2018), Background / Context Chapter Two (Hannon, 2018, 2020), and Methodology Chapter Three (Hannon, 2022 in submission) relate to and fulfil the research objectives of this PhD project. Table 17 illustrates the strategic approach undertaken in seeking to publish research findings that address critique and provide a more balanced perspective on the theory and practices of zero waste. The zero waste movement is demonstrated as being a part of a spectrum of interrelated activity responding to the complex, interdisciplinary challenge of waste, by provoking new ideas, innovation, change-making and importantly success. The real-world New Zealand zero waste story and the precedents and mechanics of policy research are also examined. The outcome of this of work is to articulate a specific research methodology for, and the reinforce the value proposition of addressing the research hypothesis.

The next Sections 4.2 and 4.3 outline the respective quantitative and qualitative results from implementing the specific *MMR – HCA – T- MZWM quant + QUAL(quant)* research methodology. In simple terms these sections combine with Sections 4.4 – 4.7 in proving the research hypothesis and explicating a new way of understanding and visualising the MZWM. Section, 4.2 (in parts 4.2.1 to 4.2.7 ref. Table 5, Section 3.14), presents a series of tabularised empirical, statistical analyses which explore quantitative insights, for example, developing a metric that indicates the declining rate of changes signalling the end point in the transition from evolving coding framework → to proposed final MZWM model. Section 4.3 presents and explains the qualitative findings via three selected excerpts (sub-sections 4.3.1 to 4.3.4). These three excerpts exemplify the overall qualitative result conveyed, as per this MMR design attribute, in hybrid QUAL(quant) written format. Because the quantum of this result significantly exceeds the word-count capacity of the thesis, the remaining seven of the total nine sections of written QUAL(quant) result are conveyed in Appendix 11.

Section 4.4 presents a schematic (Figure 11) that illustrates the arrangement of all the elements that make up the MZWM. Sections 4.5, 4.6, and 4.7 present a sequence of three new graphic illustrations of final result (respectively Figures 13, 14, and 15) that represent the fully resolved, final outcome of the mixed methods content analysis research methodology (Figure 7). As has been covered in detail in Chapter Three, this specifically designed methodology is a: *concurrent / convergent MMR – HCA – T-MZWM quant + QUAL(quant)* embedded, hybrid, mixed method design logic (Berg & Lune, 2012; Bergman, 2010; Creswell, 2015; Jick, 2008; D. L. Morgan, 2008; Plano Clark & Ivankova, 2016). The novel *16R zero waste hierarchy* presented in Section 4.5 is a derivative graphic illustration that correlates with the full written result of the same name (see excerpt 3, Section 4.3.4). In projecting the (zero) waste hierarchy out to its full cognitively and practically useful extent, this result provokes the next step rationale for the *∞ infinity / continuum model of MZWM* that is presented in both simple (Section 4.6) and elaborated graphic formats (Section 4.7). Rather than the misinterpretation of being a fixed end-point, these concluding and encompassing results from this research evidences zero waste being a progressive continuum and trajectory of change, which is made up of multiple critically interactive elements, that can be operatively assembled depending on factors such as socio-economic context, starting point, available resources, etc. While each individual section of result contains critical learning, all collectivise and culminate in the proposed ∞ infinity / continuum model of the municipal zero waste methodology.

4.1. Key point summary / overview of the publication strategy

The broad set of research objectives, which establish a foundation for answering the central research question of this PhD research, were implemented through the development of the series of publications from the original wide-ranging literature review phase. As pertains to the function of the *Literature Review, Background / Context and Methods Chapters*, excerpts and arguments from these publications are threaded into the respective content of each chapter. Table 17 (Appendix 2) provides an overview and *key point summary* of this group of publications. Because the original Table 17, based in MS EXCEL, exceeds the allowable page width it has been sectioned into a series of page views illustrated variously in either portrait or landscape) and presented as Appendix 2. Although conveyed in the Appendices, Table 17 is presented as a compilation of research findings and is accordingly reported and discussed as a result. Table 17 utilises red text to illustrate the accumulation of deliberately overlapping points and reinforcing strategic themes transecting the group of publications.

The overarching strategic intention expressed within and across this group of publications was to respond to misinformation and error identified in the *review of critique of zero waste* (Table 1, Section 1.0) by offering alternative perspectives, now anchored in academic literature. The red text utilised in Table 17 illustrates how the recurring endorsement of each succeeding point accumulates across the publication strategy and in doing so confers an increasing level of rigour and authority to the collectivised arguments. For example, there is now a multiply peer-reviewed acceptance of zero waste as a *heterogenous global community of practice.* This recognition confronts earlier assumptions, for example that *zero waste industry / commercial* and *zero waste activist / community* perspectives are disengaged and somehow counterposed, conflicted, and self-nullifying (Clift, 2004; Mauck, 2003; Premalatha et al., 2013; Townend, 2010). Challenging unfounded critique and offering a more balanced perspective, grounded in the reality of zero waste theory and practice waste, was an important objective and is now an important outcome of this PhD research project.

Establishing each individual point and the collection of overlapping strands of argument annotated in red text in Table 17, forms a new contribution to the growing body of zero waste literature. This aspect of the result adds to the work of others in deconstructing the sometimes quite unbalanced and incorrect misinformation that has been levelled, in apparent opposition to the zero waste movement. The proliferation of red text in Table 17 provides a simple illustration of how the extent and convergence of these arguments grows to become more comprehensive with each new element of the overall strategy. This result adds to the academic precedent, explaining the relevance and authenticity of zero waste theories and practices as a contemporary movement responding to waste issues. This body of work sets a comprehensive foundation for the project to then focus specifically on answering the central research question and comprehensively prove the research hypothesis of MZWM.

4.2. Quantitative results: explorative design and staged formative analysis

Examining the selected sources, evidences the presence of quantitative, empirical type data, which justifies the use of structured statistical-type analysis in order to the explore the insights on offer from this type of data, as distinct from the learning also on offer in just examining the majority presence of qualitative data. Table 5 (Section 3.14) provides an overview of the types of analysis that were employed to generate the quantitative aspects intended to mix and complement qualitative findings in the expected abductive interplay of different kinds of knowledge in forming the envisaged more integrated and complete MMR result (Jick, 2008; D. L. Morgan, 2008; Plano Clark & Ivankova, 2016).

In keeping with the MMR – HCA – T- MZWM quant + QUAL(quant) design logic, and because the hypothesis involves both testing and explicating MZWM, completing the latter pragmatically commenced from open exploratory (non-exclusionary) view of what quantitative insights might important. Sections, 4.2.1 to 4.2.7 detail the explorative sequence of quantitative analysis undertaken within the concurrent / convergent model outlined by Plano Clark and Ivankova (2016, p. 118, fig 5.2). The expectation associated with this model is that the accumulating quantitative findings would combine with those of the qualitative analysis and provide the basis for inferring a final, genuinely embedded hybrid MMR result.

4.2.1. Baseline descriptive information and insight relevant to the analysable content of the sources.

The first step in the overall process of quantitative analysis was to develop a structured way of examining the information which provides a basic description of the three selected MZWM sources themselves. Table 6 is the result of examining a variety of parameters that appeared to offer interesting insights and relevant understanding. The parameter selection was based on what data was practically evident and might be influential to meaning inferable through content analysis (i.e., the document origin, background to the authorship, i.e., personal professional attributes, worldview, authority, etc., associated with sources and any derivative interrelationships).

Alongside searching and examining key insights about the three sources, the other important purpose of this initial framework for quantitative analysis, was to convey the transparency necessary for anybody seeking to critically examine the sampling and coding procedure and eventual results (Berg & Lune, 2012; Bryman, 2012).

As well as being explorative, the framing of the quantitative analysis was also formative and aspirational in seeking insights and following angles of discovery, some of which did not yield immediately useable information (which might, however, be secured via a supplementary process or from examining other external sources). In order to make this explorative design aspect of the quantitative analysis transparent and be true to this formative process, in some cases the final iteration of each resulting spreadsheet may contain some parameter headings with no associated data.

Table 6: An excerpt of the MS EXCEL worksheet for quantitative extraction and examination of baseline information descriptive of the three selected key MZWM sources.

Source Descriptions CA MZWM:		Scope of Reference (APA) Data										Outcome / Timeleine Data				Background demographics					
Selcted Source - Title	Author	Date	Context(s)	Developed - Underdev.	Publisher	Place Pub.	Org. Status	Pages	Ref.	website	Acknowledged contrb.	Target	Trajectory	Diversion %	Quant. outcomes	Popn. (million)	Popn desnisty / km^2	kg/pp/dy	MSWM System type	Avoided cost / yr ($ m)*	Geo info
1- End of Waste 2020	Snow & Dickinson	2002	NZ for int. ref re ZWIA	Dev.	ZWNZ Trust	Auckland	NGO	16	39	Yes	12	2020	18	50% in 3yrs → 80% in 5yrs							
2- On the Road to Zero Waste	Allen, C. Gokaldas, V. Larracas, A. Minot, L-A. Morin, M. Tangri, N. Tyler, B. Walker, B.	2012	Global - Community	-	GAIA	Quezon City, Philippines	NGO	84	98	Yes	8 + "650 NGOs / Individuals in 90 countries"	-									
	Tangri, N.		Pune, India	Underdev.					5							3.1	4,451	0.3		2.8	
	Gokaldas, V.		SF, US	Dev.					19			90% by 2020		77%		0.8	6,633	1.7			
	Larracas, A.		Alaminos, Philipines	Underdev.					4							0.084	505	0.3			
	Allen, C.		Herani, Spain	Dev.					10					79%		0.019	485	0.86			
	Allen, C.		LaPintana, Chile	Dev.					6							0.21	6928	0.77			
	Gokaldas, V.		Mumbai, India	Dev.					12							12.5	20,696	0.53			
	Allen, C.		Fanders, Belgium	Dev.					25			73%				6.2	456	1.53		$116.33	
	Allen, C.		Taiwan	Dev.					16					48.82		23	642	0.942		$25.40	
	Allen, C.		BAC, Argentina	Dev.					1							2.89	14,307	1.2			
3- Community ZW Roadmap	Lombardi & Bailey	2015	Global - Community	Dev.	Ecocycle-Solutions	Boulder Colorado, US.	NGO	43	0	Yes	45	90% in 10 yrs from start	7 yrs ongoing	3 phases 90% in 10 yrs							

The first and most obvious disclosure within each source is the authorship and date of publication, both of which are relevant to understanding the content within. As has been discussed in Section 3.8.1, re the source selection aspect of the *methodology* all the author(s) are respected experts with associations to reputable international ZWIA / GAIA type organisations. The first source selected was the seminal *End of Waste 2020* (Snow & Dickinson, 2001), an internationalised template (generated and set in a New Zealand context) for implementing zero waste.

Dated at >10 years later than source one, the two other sources offer respectively, a multi-author globalised case study approach (Allen et al., 2012) and an updated genuinely internationalised template for implementing zero waste in the generic community format (Lombardi & Bailey, 2015). Alongside recognising that Authorship might be critical in shaping the source data, which will manifest in the inferable meaning available to the content analyst, the following parameters were also identified and examined:

- *Publication date:* The timing within the continuum of globally developing zero waste theory and practice when this specific data is established by the author. At any given point authors can draw on the accumulated learning of past experience, but can only be predictive of future development and thinking. So, sources capture a retrospective moment in time in the ongoing progression of knowledge and practical development. Overall, the combination and spread of the 2002, 2012, 2015 publication dates presents as a useful *spectrum of capture* that encompasses an informative arc of optimism, pragmatic experience, actualism and future focus. This selected *content* is referrable against ongoing advances in thinking, which are progressively registered in subsequent publications, such as the Zero Waste Europe *'Masterplan'* (Zero Waste Europe, 2017).
- Diversity of *Context*, spanning from national, regional, and city/town/village jurisdictions that exist within whatever is the ascribed development status, encompasses a whole spectrum of local people's historical, cultural, demographic, and socio-economic stories.
- Alongside when and from where, a zero waste story emerges and is told, the *Publisher* and its *Organisational status* (i.e., inc. purpose, funding, governance, and audience/constituency), the place of publication, and existence of website support, all potentially influence how a story is told and therefore what data might emerge from analysing that content.
- The formal annotation of *References* and the *Acknowledgment of contributions* both make it transparent from whom (i.e., which people, their status and affiliation) and which documents (and hence their quality and derivation indicated by the respective references) the content of the respective sources have been drawn. As a grass roots movement, zero waste has drawn on an iterative series of international dialogues in the formation of, for example, the zero waste definition. In such instances, the references and acknowledgments equate to measures of connectedness to what that a community accepts as authentic zero waste discourse and therefore provides a reflection of the quality assurance of the resulting content. Alongside such indicators, recording the number of pages provides a further metric as to the extent, depth, and potentially the substance of the knowledge contained therein.
- The adoption and adherence to the concept of a zero waste *Goal and/or Target*, relative to the actual outcome, which when correlated to the relevant timescale, provides a sense of the trajectory of progress in actualising the targeted goal. This parameter was identified as another important consideration for examination where data were available. Exploring this parameter potentially provides insight to the level of credence that should be accorded to any given author or scenario or methodology that was being documented.
- The final potential insight cluster, that was explored was *Background demographics*, which can have a recognised influence on the generation and treatment of waste. These background factors speak to the norms and assumptions that may carry through into the content documented in the sources generated out of these contexts. For example, the degree of urbanisation as expressed in total population and population density, when combined with the socio-economic development status, predetermines many aspects of the waste management scenario and therefore characterises the potential for implementing zero waste. In this instance, it was observable that only the second case study source (Allen et al., 2012) communicated this depth of contextual insight and covered a spectrum of demographic/geographic scenarios, including those with high development, data-rich status.

The process of forming and undertaking this aspect of the quantitative analysis raises questions for future research of this kind. Should future methodology (particularly in the applied technical sphere) include identifying and examining peri-content to formally establish a contextual framing of parameters that are relevant and important to understanding the findings and interpreting the meaning inferred from content analysis? As Krippendorff (2013) observes that meaningful matter in the form of *text* is produced by somebody to communicate meaning about a phenomenon to somebody else, beyond its immediate sense or observation.

The mandate of communicating meaning about meaning (i.e., embodying a supra-temporal self-awareness of all influences on the meaning contained and conveyed) exceeds Krippendorff's expectation and therefore sits outside what might reasonably be expected of this content analysis. However, as this first explorative aspect of this quantitative analysis illustrates, there are likely to be many meaning-laden parameters within any given unit of text/content that can be examined to provide further insight and context to the meaning inferred via content analysis. This reinforces the cited benefits of appropriately mixing methods to innovate and supplement the scope of hermeneutic information on offer via content analysis (Bergman, 2008, 2010).

While this initial aspect of quantitative analysis does not necessarily define all the various influences shaping the data that will manifest in meaning through content analysis, it does make transparent the existence and potential importance of these influences. This work also flags what is not known and therefore signals a potential limitation to the eventual strength of inference that can result from such data. Additionally, the initial quantitative analysis pointed to follow-on lines of enquiry and also potential relational connections between the next options in this explorative quantitative analysis.

4.2.2. The source of *sources* – examining acknowledgments, contributors, and references.

The following Tables 7 and 8 were formed from examining the sources:

- Acknowledgments, contributors, and people of influence, which may provide indicative evidence on the origins, connections, and cross-pollination of zero waste ideas, principles and concepts
- Formal references, which provide a systematic and comprehensive attribution/origin of ideas and evaluation of the relative academic quality assurance of the same targeted insights (i.e., the origins, connections, and cross-pollination of zero waste ideas, principles, and concepts) which have given rise to the relevant MZWM content to be evaluated and explicated.

Table 7 highlights (in yellow) the specific correlations in the acknowledged contributors of each of the three selected sources. This shows that the first and third sources have the most overlap in the named contributors of the whole amalgam of zero waste thinking (i.e., ideas, principles, and concepts, etc.) and ethos reflected in this writing. The three sources 1- (Snow & Dickinson, 2001), 2- (Allen et al., 2012) and 3- (Lombardi & Bailey, 2015) acknowledge, respectively, 15, 30 ,and 39 contributors. For the first source, four are recognisable as New Zealanders and in the third source only one person (the author of source 1) is a New Zealander. So, from a New Zealand perspective, while all three sources have content relevant to zero waste in New Zealand, between 2001 and the later 2012–15 publication dates there has been an increase in internationalisation, as well as in the size of the network from which the knowledge has been drawn to inspire these sources. This is potentially a really good thing –

alternatively it might indicate a lesser degree of specifically New Zealand relevant context, which might be considered negative.

In each case, of this total cited number of source contributors, the relative *rate of within source commonality* is respectively 50.0%, 6.7%, and 25.6%. Of the group total of 85 acknowledgments, there are a raw total 20 (23.5%) commonalities or double mentions. No individual is mentioned as a contributor for all three publications. In the case of the first source, it appears that a number of key contributors have remained active in the discourse of *zero waste community* and gone on to be further recognised in the third source, which is a similarly framed *'how-to'* guidance document derived from an internationalised perspective. While also framed as compiling an internationalised perspective, the second source draws on a large group of context-specific, expert, local contributors and then projects this local knowledge outward to a global audience. It is therefore not unexpected that this local subset of names is not necessarily reflected in pool of people who might be described as the *total collective global voice* of zero waste.

The difference in the level of acknowledgment correlation between sources 1 and 3, versus source 2, possibly also reflects the differing basis of publication, which in this case is the NGO GAIA network. While not disconnected to the ZWIA network, GAIA approaches this sphere from the converse perspective of campaigning primarily against incineration and secondarily for zero waste, rather than the other way around. Additionally, this GAIA publication draws on a spectrum of case studies, including particularly from lower socio-economic, developing country perspectives, whose keynote practitioners[58] may not have access to the financial resources for the consistent level of international collaboration undertaken by ZWIA.[59]

Finally, it is notable that four of the relatively large pool of eight named authors are not specially involved in authoring the case-study chapters, which are the main body of this source. This indicates that these contributors may have specifically focussed on the overarching internationalised summary of key findings that precedes and introduces the document. Creating Tables 6 and 7 has been helpful in making such potentially important details explicit. The importance (or conversely, unimportance) cannot really be examined until the detail has been exposed in what begins as an aspirational / explorative process of designing, iterating, and extending theses frameworks for quantitative analysis. When compared with this subset of total *collective zero waste voice* of 85 contributors, sources 1, 2, and 3 have respectively 9.4%, 2.4%, and 11.8% correlation. Interestingly, this next stage of analysis reverses what might be the earlier, *many of few* characterisation, applicable to the level of commonality within source 1.

---

[58] NB: Where the accompanying personal bio/affiliation notes of the respective acknowledgments are offered these differing backgrounds is quite apparent.

[59] ... which it should be noted makes a specific effort to locate *'Dialogue'* gatherings in globally representative, including developing country, contexts.

Table 7: An excerpt of the MS EXCEL worksheet for analysis of acknowledgments, contributors and people of influence.

Authors - Acknowledged Contributors.	Three key sources for codng framework development 1- End of Waste 2020	2- On the Road to ZW	3- Community ZW Roadmap	
1	**<u>Snow, Warren</u>**	**<u>Allen, Cecilia</u>**	**<u>Lombardi, Eric</u>**	
2	**<u>Julie Dickinson</u>**	**<u>Gokaldas, Virali</u>**	**<u>Bailey, Kate</u>**	
3	Colquhoun, Cliff	**<u>Larracas, Anne</u>**	Anderson, Peter	
4	Duncan Wilson	**<u>Minot, Leslie Anne</u>**	Best, Ric	
5	Gillespie, Gerrard	**<u>Morin, Maeva</u>**	Calonzo, Manny	
6	Kinsella, Susan	**<u>Tangri, Neil</u>**	Connett, Paul	
7	Knapp, Dan	**<u>Tyler, Burr</u>**	Ercolini, Rossano	
8	Liss, Gary	**<u>Walker, Bill</u>**	Favoino, Enzo	
9	Lombardi, Eric	Drew, Kevin	Franklin, Pat	
10	Malcolm, Jim	Estay Tapia, Exequiel	Gillespie, Gerry	
11	Middleton, Bruce	Fernández, Lucia	Goldstein, Nora	
12	Moore, Andy	Gadgil, Malati	Grate, Froilan	
13	Murray, Robin	Acosta, Gaspar	Grogan, Pete	
14	Sheehan, Bil	Haley, Robert	Gulland, Ian	
15	Williams, Mal	Hsieh, Herlin	Harder, John	
16	Thorne, Peter	Atkin, Michael	Hogg, Dominic	
17		Mhapsekar, Jyoti	Hubbard, Susan	
18		Dias, Sonia Maria	Hurd, David	
19		Dolera, Marnie	Iskandar, Laila	
20		Narayan, Laxmi	Knapp, Dan	
21		Navarrete Benavides, Patricio	Leonard, Annie	
22		Ravarra, Grace	Lindeberg, JD	
23		Shankar, Maitreyi	Liss, Gary	
24		Simon, Joan Marc	Matsch, Marti	
25		Douglas, Rhonda	McDonald, Terry	
26		Thavaraj, Amit	Murray, Robin	
27		Valencia Guzmán, Manuel	Nair, Shibu	
28		Vandeputte, Anne	Platt, Brenda	
29		Wilson, Monica	Powell, Jerry	
30		Zubiria Kamino, Pello	Raymond, Michele	
31			Sanborn, Heidi	
32			Seldman, Neil	
33			Sheehan, Bill	
34			Simon, Joan Marc	
35			Snow, Warren	
36			Van Deventer, Mary Lou	
37			Williams, Mal	
38			Wilson, Monica	
39			Wood, David	OVERALL
TOTAL	15	30	39	84
# commonality within source	8	2	10	20
% commonality within source	53.3%	6.7%	25.6%	23.8%
% correlation to collective ZW voice	9.5%	2.4%	11.9%	

One on one comparative correlation between common sources			*The # of NZ based vs International commentators highlighted in RED*
1 with 2	1 with 3	2 with 3	
0%	100%	100%	*NB: the actual source authors are listed first +centreed +bold + underlined*
2 with 1	3 with 1	3 with 2	
0	80%	20%	

The approximate 2:1 comparative ratio (i.e. 50% to 25%) between sources 1 and 3 flips to the 9.4:11.8% on the basis of the extensive group of additional new contributors, drawn in the intervening years into the total pool, by the latter two publications, i.e., sources 2 and 3. Overall, this evident expansion in the number and make-up of this group of individuals contributing knowledge and experiences into both these subsets (as well as the bigger construct) of a *total collective zero waste voice* is a positive indicator of the breadth and rigor of this movement.

The final analysis in this cluster was a *one on one* comparative correlation between individual sources, i.e., 1 vs 2, 1 vs 3, 2 vs 3, and conversely, 2 vs 1, 3 vs 1, 3 vs 2. This clarifies that the 39 acknowledged contributors of source 3 are an apparent *master-list* within which all (100%) of sources 1 and 2's respective 8 and 2 correlations are located. Conversely, of source 3's 10 correlated acknowledgments, 8 and 2 (80 % and 20%) are found respectively in source 1 and source 2. These results provide insight as to the strength, diversity, and interconnectedness within the collective zero waste knowledge base from which these sources are acknowledged as being derived.

This insight as to the strength and derivation of the sources provides a measure of quality assurance, in that answering the research question relies on content analysis of the selected sources. An absence of understanding and quality assurance of inputs (sources) would cast doubt on the outputs (answering the research question) of the research procedure (MMR – CA). The cumulative quantitative analysis makes an essential contribution to the MMR – CA by providing requisite layers of transparency and quality assurance to the basis by which the research question is eventually answered (Jick, 2008; Plano Clark & Ivankova, 2016).

4.2.3. Examining formal references and the inference of quality assurance.

The next stage of quantitative analysis examined the formal references existing in sources 1 and 2 by utilising a scoring system based on the ranking / type and the level of repetition of each reference *(NB: source 3 did not utilise formal references).* The four-level typology for ranking references was:

- Tier zero: black literature = peer-reviewed literature from high quality academic journals.
- Tier one: 1st level grey literature = books, book chapters, broad-range journals, government reports, and 'think tank' publications.
- Tier two: 2nd level grey lit. = commercial/corporate and NGO publications and annual reports, news & wiki articles, videos, conference presentations
- Tier three: 3rd level grey lit. = blogs, emails, tweets, letters, and catalogues, etc.

In this instance, given that the highest-ranking double-blind peer reviewed academic journal articles are designated as *Tier Zero* and are assigned a score of 0, the highest quality is represented by the lowest total score. The summation of each reference's combined ranking/status metric and the level of repetition provides an indication of the of the overall depth and quality of the cited information, from which each source is derived.

In combination with the earlier analysis (Table 7), which focussed on *quality assurance* based on the *people factor* of acknowledged contributions, this analysis examines *quality* by drawing on the pre-existing concept of ranking the veracity of the literature, which is referenced as a acknowledged source of content, i.e., quotes, ideas etc. The purpose of combining these analyses was to better understand

and evaluate the derivative foundational knowledge on which each source is based. This is an important opportunity to cross-reference and, to a degree, interrogate and quality assure the process of sample selection. These analyses provide a mechanism to evaluate if the three selected sources are the right choice for content analysis to test and explicate the hypothesis of a MZWM. However, in keeping with the concurrent / converging quant + QUAL(quant) mixed methods design logic, this examination is only retrospective and therefore the learnings speak more to future, follow-on work than to this current research.

Table 8 is an excerpt from the large MS EXCEL spreadsheet that separates the top section in order to illustrate the overall analytical framework and content and also recombines this example section with the analytical summary from the bottom of the longest column of the table. Because only sources 1 and 2 utilised formal refencing, this analysis opted, for comparative purposes, to include the references from the article *A comprehensive review of the development of zero waste management: lesson learned and guidelines* (Zaman, 2015). At the time of selection as a supplementary source, this article was the most comprehensive and authoritative review article in this sphere.

As is illustrated in Table 8, in the two bottom rows of analytical summary, sources 1, 3, and for comparison Zaman (2015), each have respectively:

- Source 1: 39 identified individual formal refences, including repeated in-text citations amounts to a total of 59
- Source 2: 98 identified individual formal references, including repeated in-text citations, amounts to a total of 100
- Comparison – Zaman: 136 identified individual formal refences with no repeated duplication of in-text citations, leading to a total of 136.

At face value, these data show that the Zaman (2015) article at 136 references, is drawing on the biggest pool of author referenced work (hence potentially also the biggest pool of authority and knowledge). However, given the differences in document type (the respective rate of referencing in sources 1 and 2 of 59 and 100 respectively), these sources can also be considered to have a substantive basis. Based on the ascribed reference QA scoring system (i.e., ranging from 0 equating to the highest ranking academic references, through to 3 for what are considered the lowest reputation references) plus the factoring in of reference repetition, these three sources each have a total quality score, respectively, of 91, 156, and 50.

It was not unexpected that the Zaman (2015) article would have a low score indicating a higher reference quality assurance (QA) rating; however, it is interesting to further examine this on the basis of the average per reference QA score. This can be undertaken either on the total or repetition adjusted basis, which are for sources 1, 2, and Zaman respectively: 2.33/1.51, 153/1.59, and 0.37/0.37 (in the Zaman article there is no repetition of references).

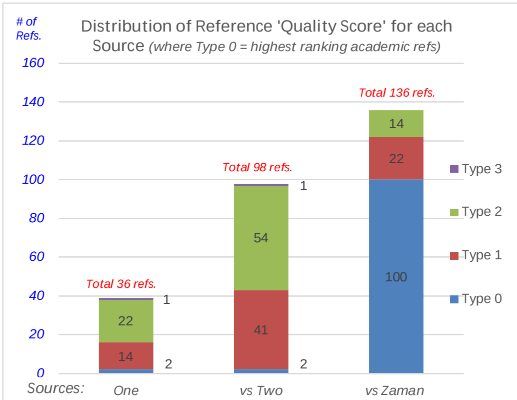
Table 8: An excerpt of the MS EXCEL worksheet for analysis of the references, to provide a formal systematic and comprehensive attribution / origin of ideas and evaluation of the relative academic quality assurance.

Typology and Guidance												
Tier zero: white literature = peer reviewed literature from high quality academic journals. Tier one: 1st level grey literature = books, book chapt. broad range journals, govt. reports 'think tank' pubs. Tier two: 2nd level grey lit. = comm. pubs., annual & NGO rpt, news & wiki artls., videos, conf. pres. Tier three: 3rd level grey lit. = blogs, emails, tweets, letters, catalogue etc. NB1: offical govt.& NGO & commercial company / institutional websites are considered as having the same status as govt. report. *NB2: Interviews / survey responses/ offical-personal comms = 2 - masters thesis = 1 NB3: query university centre / 'think tank' / NGO (int.) = 1 versus NGO (local / national) = 2 NB4: local and national govt both = status i.e. 1*												
Two (of three) key sources for codng framework development									*Example of possible ongoing MM CA MZWM*			
	1- End of Waste 2020	Reps	Type	Score	2- On the road to Zero Waste	Reps	Type	Score	Zaman	Reps	Type	Score
1	ACT government website, accessed 2002. http://www.act.gov.au/nowaste/ (In 1999/2000, Canberra diverted 66% of its waste stream from landfill, after adopting a No Waste by 2010 goal in 1996). (2)	2	1	2	ARCADIS Belgium N.V. & Eunomia, 2008. Optimising markets for recycling - final report. Chapter 7: Case study: Flanders	1	1	1	Abbasi, T., Premalatha, M., Abbasi, S.A., 2012. Masdar City: a zero carbon, zero waste myth. Curr. Sci. 102 (1), 12.	1	0	0
2	ACT Government, 1996. A Waste Management Strategy for Canberra, No Waste by 2010. (3)	3	1	3	Ayuntamiento de Usurbil, A. 2006. Informe de Gastos e ingresos de la recogida de residuos 2006-2010.	1	2	2	Ahmad, Tanweer, Danish, Mohammad, Rafatullah, Mohammad, Ghazali, Amiza, Sulaiman, Othman, Hashim, Rokiah, Mohamad Ibrahim, Mohamad Nasir, 2012. The use of date palm as a potential adsorbent for wastewater treatment: a review. Environ. Sci. Pollut. Res. 19, 1464e1484.	1	0	0
3	Anderson, R. C. 1998. Mid-Course Correction. The Peregrinzilla Press, Atlanta, US. (2)	2	1	2	BART, Accessed 2012. Ad for Compost. http://www.flickr.com/photos/anthonylibrarian/2664296141/in/photostream/	1	3	3	Ahmed, H.M., Viswanathan, N., Bjorkman, B., 2014. Composite pellets e a potential raw material for iron-making. Steel Res. Int. 85 (3), 293e306.	1	0	0
4	Auckland Regional Council & MfE 2002. Cleaner Production. http://www.arc.govt.nz/cp/	1	1	1	Barth, J. et al., 2008. Compost production and use in the EU. Annex 1. ORBIT Association and European Compost Network.	1	2	2	Amaral Filho, J.R., Schneider, I.A.H., Tubino, R.M.C., Miltzarek, G., Sampaio, C.H., Schneider, C.H., 2010. Characterization of a coal tailing deposit for zero waste mine in the Brazilian coal field of Santa Catarina. In: Paper Read at Proceedings of the 2010 International Mine Water Association Symposium: Mine Water and Innovative Thinking.	1	2	2
5	CCC, 2002. Landfill Levies - the RMF - Waste Exchange. Christchurch City Council, ChCh, NZ	1	1	1	Basque Institute of Statistics website accessed 2012. www.eustat.euskadi.net/t35-20689x/eu/t64aVisorWar/t64aCreaFicha.jsp?R01HNoPortal=true&lan=0&code=20040.	1	1	1	Anastas, Paul T., Zimmerman, Julie B., 2003. Peer reviewed: design through the 12 principles of green engineering. Environ. Sci. Technol. 37 (5), 94Ae101A. http://dx.doi.org/10.1021/es032373g.	1	0	0
6	Centre for a New American Dream, accessed 2002, www.newdream.org	1	2	2	Bhada, P. & Nickolas J. Themelis, N. J. 2008. Potential for the First WTE Facility in Mumbai (Bombay) India. 16th Annual North American Waste-to-Energy Conference. May 19-21.	1	2	2	Antrekowitsch, J., Steinlechner, S., 2011. The recycling of heavy-metal-containing wastes: mass balances and economical estimations. JOM 63 (1), 68e72.	1	0	0
7	City of Seattle, 1998. Seattle adopted a zero waste goal in its Solid Waste Plan. http://www.ci.seattle.wa.us/util/solidwaste/SWPlan/default.htm	1	1	1	Bryant, J., Drew, K., Haley, R. & Macy, J. 2011. The Story of Zero Waste. Resource Recycling. August http://www.recologymedia.com/press_room/articles/pdf/2011/Story_of_Zer	1	2	2	Ball, P.D., Evans, S., Levers, A., Ellison, D., 2009. Zero carbon manufacturing facility towards integrating material, energy, and waste process flows. Proc. Instn. Mech. Eng. B: J. Eng. Manuf. 223 (9), 085e1096.	1	0	0
8	Del Norte Solid Waste Mgt. Authority, 2000. Del Norte Zero Waste Plan, Del Norte, USA.	1	1	1	Californians Against Waste website. Accessed 2012. http://www.cawrecycles.org/.	3	2	6	Bartl, A., 2011. Barriers towards achieving a zero waste society. Waste Manag. 31 (12), 2369e2370.	1	0	0
9	Department of Environmental Protection, 2000. Waste 2020 Draft Strategy, Towards zero waste by 2020, Australia. http://www.environ.wa.gov.au/DEP/waste2020/ (2)	2	1	2	Chikarmane and Narayan, 2005. Organising the Unorganised: A Case Study of the Kagad Kach Patra Kashtakari Panchayat (Trade Union of Wastepickers). WIEGO.	1	2	2	Bj€ork, Hans, 2012. Zero Waste Society in Borås City, Sweden e Strategies to Action. University of Borås. Available from: http://www.uncrd.or.jp/content/documents/Hans%20Bjork-Sweden.pdf (cited 12.06.14).	1	1	1
10	Environmental Defence Society, 2002. Description of Design for the Environment. http://www.environmentaldefense.org/programs/PPA/vlc/recyclability.html	1	2	2	Chikarmane et al., 2001. Study Of Scrap Collectors, Scrap Traders And Recycling Enterprises In Pune. International Labour Organisation.	1	1	1	Black, J.T., Phillips, D.T., 2010. The lean to green evolution. Ind. Engr. 42 (6), 46e51.	1	0	0
11	Fisher & Paykel New Zealand, 2002. White-ware disassembly plant which illustrates the 'Design for Disassembly' principle. Auckland, NZ.	1	2	2	City and County of San Francisco, 2010. Press Release http://www5.sfgov.org/sf_news/2010/08/san-francisco-achieves-77-landfilldiversion-rate-the-highest-of-any-us-city.html.	1	1	1	Bochek, A.M., 2008. Prospects for use of polysaccharides of different origin and environmental problems in processing them. Fibre Chem. 40 (3), 192e197.	1	0	0
136									ZWIA, 2004. Zero Waste Definition Adopted by Zero Waste Planning Group. Available from: http://www.zwia.org/main/index.php?option%com_content&view%article&id%49&Itemid%37 (cited 16.07.11).	1	1	1
	TOTAL	59	*1.5128*	91	TOTAL	100	*1.5306*	156	TOTAL	136	*0.3676*	50
	Average Source Reference QA Metric		2.333		Average Source Reference QA Metric		1.59		Average Source Reference QA Metric		0.368	

This shows an even more pronounced differential in reference QA between the academic and general audience documents. This differential not only appears as a function of the number of input authors / knowledge from which *input* is derived and acknowledged, but also reflects the conventions at play in what types of document/literature is selected and how this is treated. In real terms, on a per individual reference basis, there is very little difference between source 1 (i.e., the 2002, NZ / Internationally focused, methodological, *how-to* future projection styled publication) and source 2 (i.e., the genuinely internationalised case study styled publication, with a summary of findings chapter).

When examined on the basis of the *per page reference density* (so as to relativise differing document sizes Figure 9), sources 1 and 2 are significantly lower when compared with the academic journal article, at 10.46 ref. per page. Source 1, at 2.44 registers a slightly higher refenced author/knowledge density than source 2, at 1.17 ref. per page.[60] This, however, is not necessarily a negative reflection, as these are differing types of publications with differing audiences, purposes, and expectations.[61]

Source	Type 0	Type 1	Type 2	Type 3	Individual Ref. Total	# of pages	per pg ref. denisty
One	2	14	22	1	39	16	2.44
vs Two	2	41	54	1	98	84	1.17
vs Zaman	100	22	14	0	136	13	10.46



Figures 9: Tabular and graphic summary illustrating the distribution of quality scores (various 0 to 3 with zero being the highest peer reviewed academic journal articles) attributed to the references of each of the two sources (with refs.) and for comparison (Zaman, 2015).

Rather than just being an inference on referred document QA, the scoring system is as much a designation of the fundamental differences in document audience, expectation, purpose, mode of delivery, convention and style, etc. The above combination of graphics (Figure 9) illustrates the respective distribution of reference QA scores (i.e., the differing document types from which input is drawn and acknowledged) within each source. The proportionality within sources 1 and 2 are relatively similar whereas as is customary the predominate reliance of other academic sources in the academic (Zaman, 2015) article is quite apparent.

A caveat in observing the relative similarity between sources 1 and 2 is that, as a literary / graphic device, the former actually contained a series of high-profile keynote "quotes" for which the authorship is acknowledged in situ and so was not registered in the actual formal reference counts. In contrast, source 2 utilised local people's experiential perspectives/sayings as "quotes" to reinforce and illustrate points. As with source 1, these were not included as including either or both of these manually would have increased not only the complexity, but also the detail and proportionality of the findings.

[60] NB: docs 1 and Zaman both use the double column format, and the academic journal format does not really enable much space for example individualised title, acknowledgements, and table of contents, pages, etc. – so this metric needs to be considered in these contexts and as indicative rather than definitive.

[61] i.e., if using the subject scoring parameters, sources 1 and 3 would only rate as a 2.

Overall, these findings may be considered an interesting and insightful additional perspective on how input contribution translates into and influences analysable content. However, they must only be considered indicative, as there are other unconstrained factors at play in this analysis, for example, repetition, scaling, and in source 3 (Lombardi & Bailey, 2015) the authors' choice not to utilise formal referencing, which precluded this source from this aspect of the quantitative analysis.

The quantitative analysis in this section provides an important next explorative step in learning about the sources and providing further verification of them as inputs for MMR-CA to answer the research question. These sequence of analyses each add vital composition to the mixture of methods that enables the interplay of different kinds of knowledge, observations, and theories that are envisaged as enabling the development of more deeply reasoned and robust answers to research questions (Berg & Lune, 2012; D. L. Morgan, 2008).

4.2.4. Examining the level and pattern of conformation evidence coded in support of each of the derived elements of MZWM.

This next phase of the quantitative analysis examined the level and pattern of conformation evidence coded in support of each of the derived elements of MZWM. The result outlined in Table 9 provides an illustration of the empirical weighting of coded data and locates this relative to all the elements making up the MZWM. As such, this result provides an indicative, compartmentalised, and overall measure of the strength attributable to the answer to the research question (demonstrated in the formation of the MZWM).

The completion of the coding for the three sources enabled the formation of an elemental *MZWM coding framework v final*, which both proceeded into the next qualitative stages of the content analysis and was itself able to be examined via quantitative analysis. Table 9 utilises a numeric and colour coding system to identify how the 1704 total codes were distributed on the basis of 756 to 1- Conceptual Foundations & Critical Principles (44.37%), 203 to 2- Policy Instruments (11.91%), 241 to 3- Financial Mechanisms (14.214%), 250 to 4- Physical Mechanisms (14.67%), and 254 to 5- Social instruments (14.91%).

This distribution shows that the majority of the referred data were coded to the 1- conceptual foundations and critical principles parent node, and that the other four parent nodes were attributed with a fairly even share of the remaining coded data. This distribution indicates the relative importance within a zero waste ethos of projecting a principled alternative and radical conceptual challenge to the traditional concepts and theories of conventional waste management (Hannon & Zaman, 2018; Zaman, 2015).

Table 9: An excerpt of the MS EXCEL exploring the level and pattern of conformational evidence coded in support of the MZWM.

Part 2: Quant MM CA MZWM	# ref	Prorportion
MZWM CF v final	1704	%
1- Conceptual Foundations & Critical Principles	756	44.37%
A1a- ZW Goal Statement	35	2.05%
A1b- Documented Strategic Plan	97	5.69%
A1c- Transparent Monitoring, Compliance & Reporting of ZW Plan	36	2.11%
A1d- Assertive or Alternative WZW Hierarchy	26	1.53%
A1e- ZW Leadership & Agency - Legislation & Regulations	92	5.40%
A1f- Applied Ecological Economics	24	1.41%
A1g- Holistic Societal Commitment (PPPP)	103	6.04%
A1h- Designing an Innovation Continuum	14	0.82%
A1i- Public Ownership vs Privatisation	41	2.41%
A1j- Separation at Source	70	4.11%
A1k- Cyclical Material Flows	26	1.53%
A1l- Precautionary Principle	9	0.53%
A1m- Integrated ZW - SD & CC mitigation	99	5.81%
A1n- Resource Management Focus	35	2.05%
A1o- Targets and Targeting	42	2.46%
A1p- General to Local - Contextualisation, Adaption, Evolution, Flexibility & Prioritisation	7	0.41%
2- Policy Instruments	203	11.91%
A2a- WM to ZW (inc. 3R) Contracts	46	2.70%
A2b- 'Recylate' Markets	13	0.76%
A2c- Systematic PS - EPR	42	2.46%
A2d- CDS Incentives for Packaging	12	0.70%
A2e- Plastics Interventions	9	0.53%
A2f- Backstop Landfill - Incinerator Bans	14	0.82%
A2g- Command & Control - 'Regulations, Bans & Directives'	23	1.35%
A2h- 'Green Procurement'	11	0.65%
A2i- Backstop Recycled Content Minima	4	0.23%
A2j- ZW RoI, Tender & Contract Guides	4	0.23%
A2k- Standards & Accreditation Programmes	9	0.53%
A2m- Disaster ZW Programmes	0	0.00%
A2n- Backstop Product QA	12	0.70%
A2o- Backstop Mixed Multi Material – Unrecyclable Product Bans	2	0.12%
A2p- Multi-partisan - Policy Consistency	2	0.12%
3- Financial Mechanisms	241	14.14%
A3a- Reverse Cheap Disposal & Waste Subsidies - Fund ZW	20	1.17%
A3b- Engage the Polluter 'PAYT' Principle	24	1.41%
A3c- Environmental Taxes – Eco Levies	13	0.76%
A3d- ADFs to Drive Recovery Rates Fees	3	0.18%
A3e- Aligned ZW SD (Tech Infrastr. Service) Investment	17	1.00%
A3f- Fundamental ESD - DfE	44	2.58%
A3g- Transition to Quality Green Jobs	51	2.99%
A3h- Market Based Approaches - Intervene & Employ Economic Instruments	69	4.05%
4- Physical Mechanisms	250	14.67%
A4a- Toxics Reduction - Hazwaste Treatment.	23	1.35%
A4b- Amplified Collection & Sorting Systems	54	3.17%
A4c- MRF Networks	24	1.41%
A4d- Address C&D - C&I i.e. LMRFs (dirty) - MRBT	23	1.35%
A4e- Organic Recycling AD + Compost etc	80	4.69%
A4f- RRC - RRP - RRN - EIP - IE	35	2.05%
A4g- Systematic Public Spaces - Events - Everywhere Recycling	9	0.53%
A4h- Transitional 'Store-fills' - 'Mono-fills' for Mining	2	0.12%
5- Social Instruments	254	14.91%
A5a- Societal ZW-EfS Behaviour Change Programmes.	57	3.35%
A5b- Multi-level ZW 'Enviro-schools' Programmes.	10	0.59%
A5c- ZW-EfS Industry Training - University Education.	25	1.47%
A5d- Internationalised Networking Learning	4	0.23%
A5e- Best Practice ZW-Sustainable Advisory Networks	20	1.17%
A5f- 'Eco-Enviro' Labels & Products	10	0.59%
A5g- Awards Programmes	1	0.06%
A5h- Active International Conventions	0	0.00%
A5i- Enable Public Good – Consumer Advocacy - Protections	19	1.12%
A5j- Enable Participatory Dev. - Ensure Appropriate Technology	108	6.34%
TOTAL	1704	100%
Coding: Red highlight & red text >5%, Blue highlight & blue text equates to 3 - 4.99%, Green highlight & green text equates to 1 to 2.99%		

The next function of this aspect of the quantitative analysis was to individualise this examination of proportionality to each child node within these five parent node groupings. Table 9 lists the number and consequently the percentage of the total number of referenced data coded to each individual child node. For easy identification these were colour coded as: red highlight & red text >5%, blue highlight & blue text equates to 3–4.99%, green highlight & green text equates to 1–2.99%. This means that the highest to lowest ranking groups are easily identifiable. There are five child nodes with > than 5% of the total share of codes.

1. A5j- Enable Participatory Development - Ensure Appropriate Technology: 108–6.34%
2. *A1g- Holistic Societal Commitment (PPPP): 103–6.04%*
3. *A1m- Integrated ZW - SD & CC mitigation: 99–5.81%*
4. *A1b- Documented Strategic Plan: 97–5.69%*
5. *A1e- ZW Leadership & Agency – Legislation & Regulations: 92–5.40%*

Within this grouping, A5j- Enable Participatory Development – Ensure Appropriate Technology, which is part of the *5- Social instruments* parent node, is the highest ranking of all child nodes (at 6.34%). This is an illustration of the commonly cited importance of grassroots involvement and community ownership of the problem of and solutions to waste (Connett, 2013; Lombardi & Bailey, 2015). As might be expected, given the previously mentioned weighting, all the others in this above 5% group were located in the *1- Conceptual Foundations & Critical Principles parent node* (i.e., above italics). The other four parent nodes reinforce the link to the overarching rationale of addressing climate change and sustainable development, as well as developing a strategic plan that envisions, explains, and provokes the necessary leadership, holistic societal commitment to the changemaking frameworks of zero waste (Murray, 2002; Snow & Dickinson, 2003).

Table 10 illustrates the overall distribution of coded data according to the designated percentage bracketing (i.e., red >5% etc). These top five child nodes combine to register 29.28% of the total 1704 recorded codes. The next group of five child nodes in the 3–4.99% bracket highlight the importance of (A5a) pervasive societal zero waste education for sustainable development/behaviour change programmes linked to driving (A1j) separation at source (aka community responsibility of participation and compliance) programmes designed to optimise the cost-effectiveness, process, and outcome quality assurance/safety of the (A4b) amplified universal collection and processing systems for (A4e) organic and general recyclables, all of which are framed in an assertive regime of (A3h) market-based economic instruments, incentives, and regulatory interventions pointed at zero waste and a circular economy.

Table 10: An excerpt of the MZ EXCEL worksheet illustrates the broad distribution according to the designated bracketing.

29.28%	5	Red highlight & red text >5%
19.37%	5	Blue highlight & blue text equates to 3 - 4.99%
41.14%	23	Green highlight & green text equates to 1 to 2.99%
10.21%	24	Black text / no highlight <1%
100.00%	57	TOTAL

Figure 10 was developed to distinguish how the numbers of child nodes attributed to each of the four percentage brackets are distributed for each of the five parent node groupings. When viewed in association with Table 9, Figure 10 portrays where the *bulk and lesser* numbers of referenced data are coded in relation to the key parent nodes clusters. The weighting of reference data being attributed as numbers (and/or as percentages brackets) of codes, evokes a numeric sense of where the weight of consensus lays, i.e., which part of the MZWM framework are most empirically supported by the data.

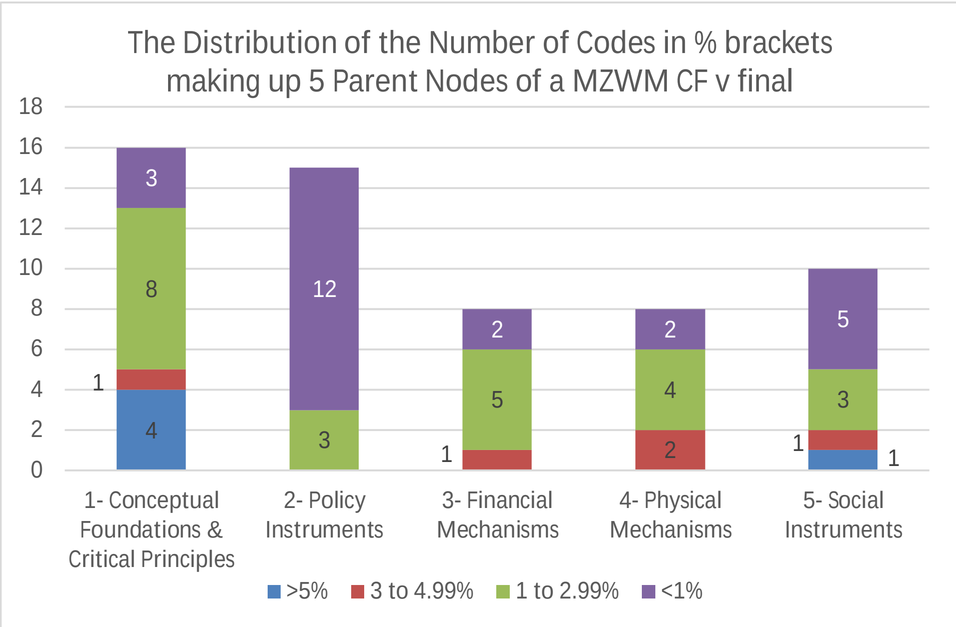


Figure 10: A graphic portraying where the *bulk* and lesser numbers of referenced data has been coded in relation to the key parent node clusters.

While this forms an important marker in the analytical process, further discussion of the meaning that may be inferred from these data, is held over until the main tranche of qualitative results have been derived via the completion of content analysis. However, it is worth noting at this point that this aspect of the quantitative analysis was critical in prompting the initial conceptual framing of the relational matrix design that was ultimately iterated into the combination of Figures 11, 13, 14, and 15 as a finally *Proposed 'Municipal Zero Waste Methodology (MZWM).* Several of the key outcomes of the quantitative analysis derived from Table 9 carry over into and remain part of the design of Figure 11 (Section 4.4), the schematic proposal *Municipal Zero Waste Methodology (MZWM).* For example:

- Embodying empirical data (the number representing the weight of reference data coded to each child node) as a numeric superscript.
- Utilising the same system of text colour coding to denote the percentage brackets of the number of references coded to each child (i.e., RED text equates to > than 5% of and BLUE text equates to between 3 and 4.99%).

- Given that Figure 11 marks the junction where what was an iterative relational matrix shifts from being an evolving coding framework to being a formally proposed MZWM, this graphic, as a way of referencing that change, includes the original groups of five parent nodes, which are annotated separately as well as denoted in the matric via cited colour coded shading.

In simple terms, the results of this aspect of the overall quantitative analysis have made an important contribution in enabling the research question to be answering and addressing the research hypothesis that involves not only establishing the existence of a MZWM, but also explicating its components and design arrangement.

Having made this point, it is important to observe the detail that while the numbers and percentages vary between Table 9 and the derive Figure 11, this does not signify that the initial data is wrong. The changes occurs because as coded data is translated into MS EXCEL from NVivo and then out of MS EXCEL into results as written text, minor iterative change occurs on the basis of re-interpreting how all or parts of source text are coded to various parent / child nodes. An important and related understanding is that, as results Table 9 and Figure 11 have been derived at completely different stages (respectively, early and then near the end) of the content analysis, so differences are expected. Transparently recording them as distinct stages of result is an important for transparency and in staging and annotating the progression of research procedure.

The other notable variation between Table 9 and Figure 11 is in the initial partitioning and structures as a parent / child coding framework. This part of the quantitative analysis was additionally important in that this result catalysed the realisation of the presence of what becomes later confirmed and refined as new clusters / associations illustrated in the finalised structural arrangement of Figure 11.

In illustrating the end point of the iterative restructuring process, which occurs within the subsequent qualitative stages of the content analysis, Figure 11 denotes the transition from the initial 5 parent / 55 child node coding framework (Appendix 6) structure to the final framework of ten thematic clusters, and below this the line connectors that illustrate evidence-based, refined connections and associations. As such, this element of quantitative analysis is one of the key trigger points in this research process which catalysed the development of the composition and arrangement of the MZWM (illustrated as Figure 11) as an entirely new and original research outcome (Krippendorff, 2013).

4.2.5. Quantitative mapping of evolution in the type and rate of change in CF v final then MZWM v final development.

The previous sub-section speaks to both the distribution of supporting evidence across the coding framework v final MZWM and how this evidence catalyses the structural transition into the proposed final *Municipal Zero Waste Methodology (MZWM)* illustrated as Figure 11. Ultimately, Figure 11, combined with Figures 13, 14, and 15 (see the qualitative *Results* Sections 4.5, 4.6, and 4.7), are derived as the final results of the completed content analysis, and these MMR findings collectively answer the research question.

Table 11: An excerpt of an MS EXCEL worksheet which illustrates the quantitative mapping of evolution in the type and rate of change in CF v final then MZWM v final.

		Tracking evolution in content					Tracking evolution in the structural organisation of the coding frameworks	Incremental change MS review	Copy-leaks' D2D comparison	
	Zero Waste Sources	Word Count	WC incremental variation	WC incremental % variation	WC variation ref to start	% variation in WC ref to start	Structural overview	# of new text changes	% Identical with prior iteration of doc.	Number of copied words ref prior doc.
Coding Framework (CF) Development Process	v1 Lit Rev MZWM	1202					1.13 - 2.13 -3.7 - 4.8 - 5.9			
	v2 Initial CF MZWM	445	-757	-63%			1.14 - 2.15 -3.8 - 4.9 - 5.9	95	0.04%	5
	v3 dev. CF MZWM Source 1	2130	1685	379%			1.15 - 2.15 -3.8 - 4.8 - 5.10	125	6.90%	29
	v4 dev. CF MZWM Source 2	2588	458	22%	458	22%	1.15 - 2.15 -3.8 - 4.8 - 5.10	121	90.90%	1962
	v5 dev. CF MZWM Source 3	2769	181	7%	639	8%	1.16 - 2.15 -3.8 - 4.8 - 5.10	58	97.00%	2538
	MZWM CF v final for Content Analysis	2769	0	0%	639	8%	1.16 - 2.15 -3.8 - 4.8 - 5.10	0	100%	2769
Final proposed MZWM - *summary*		1668	-1101	-40%	-462	-52%	1.3/2.2.2/3.1.4.4.4 - 4.4/5.6/6.1.6 - 7.8 - 8.2.3.3/9.3	*na*	*na*	*na*

The findings of this previous element of quantitative analysis (Section 4.2.4) prompted this next analytical exercise (Table 11) that sought to map how the transition from final coding framework to proposed MZWM occurred and to explore what further insights might emerge from better understanding this process of transition. Table 11 illustrates how the word count and structural arrangement of the coding framework incrementally changed and evolved through the coding process towards the point of being proposed as a final, resulting in *Municipal Zero Waste Methodology (MZWM).*

This form of quantitative analysis utilises:

- *Word count* as a parameter and measures incremental changes in word count (as a numeric and percentage variation – and also numeric and percentage variation relative to the first original version; highlighted in yellow) between each of the succeeding versions of coding frameworks as this evolves into the final version, which will be utilised in the next qualitative stages of the content analysis.
- In addition, changes in the structural organisation of the evolving coding frameworks are documented alongside changes in the number of new changes in the text (this parameter utilised the "review – document compare" functions in MS WORD).
- The *percentage to which the current version is identical to an earlier iteration of the document* and also the *number of copied words relative to the prior document* (these parameters were derived via the online 'Copy-leaks D2D' comparison tool.
- The final suite of comparisons are made relative to the summary version of the final proposed MZWM, which emerges as a final result of content analysis.

The set of word-count (WC) parameters, which track evolution in content, initially shows a high degree of change, which then lessens to the point where no further change occurs. For example, between the *v5 dev. CF MZWM Source 3* (i.e., the development stage at the end of coding the third and final source) and the *MZWM CF v final* (which provided the starting input for the next phases of content analysis) no further coding was required.

The adjacent bracket (next right) in Table 11 tracks change in the structural organisation (the number and arrangement of the parent and child nodes) as the coding frameworks evolve through the initial coding phase of the content analysis. Changes in the number and structural arrangement of child and parent nodes in the coding framework are illustrated in red text. For example, between *v1 Lit. Rev. MZWM* and the *v2 initial CF MZWM* the largest structural change occurs as 1, 2, 1 and 1 additional child nodes were generated in respectively parent nodes 1, 2, 3, and 4 (i.e., recorded in Table 11 as "1.13 – 2.13 – 3.7 – 4.8 – 5.9" evolving to "1.14 – 2.15 -3 8 – 4.9 – 5.9".

The word-count and text comparison (change and similarity) parameters for tracking evolution in the type and rate of change in the sequence of coding framework iterations were derived by utilising two software tools (available in *MSWORD* and *Copy-leaks*). The latter two forms of text comparison also serve to illustrate and confirm how the initial high degree of change resolves to smaller and then finally to no further increments of change. The final comparison to the summary version of the *final proposed MZWM* (Figure 11, Section 4.4), illustrates that the final (post-coding) phase of content analysis has yielded a starkly original iterative evolution of a MZWM. Based on word count, this *MZWM CF v final* has been synthesised and refined to the *final proposed MZWM* version, with a word count of 1101. On the basis of word count, this version is 40% different from the most relevant earlier document with which it can be compared.

The comparative structural organisation of the *final proposed MZWM* illustrates an even more pronounced change, to the now nine variously connected aligned themes and various inter-associated clusters of sub-themes illustrated as Figure 11. In the annotation used in Table 11 (above) the '/' symbol indicates *connection* and the blue bold highlight indicates where a cluster has been identified and framed as per the boxes in Figure 11, which illustrate connections and associations. Again, the level of change demonstrated by this parameter demonstrates that the selected research procedure of MMR HCA–T-MZWM quant + QUAL(quant) has resulted in explicating an entirely new framework for understanding the concept, components, arrangement, and interaction of, in this instance elements of a MZWM (Krippendorff, 2013). This aspect (see Section 4.2.5) in the sequence of qualitative analysis supports the overall mixed methodology in answering the research question by providing empirical insight as to the scope of evolutionary change through the research process and the determination to reach an endpoint in forming a final result.

As a side note, for the sake of transparency, while initially adequate, the two selected software tools appeared not to have a level of functionality to enable discerning the differences/similarity between the *MZWM CF v final for CA* and the final MZWM proposed on the basis of the completed content analysis. This is the reason for the '*na*' in this bracket of Table 11. Neither the MS WORD review function nor *Copy-leaks* registered useful data when used for the final comparison at a latter point in the research process. To try to rectify this dysfunction, two alternative options, i.e., https://draftable.com/compare/ and https://www.diffchecker.com/ were also tried to see what reportable insights might be emerge. It appeared that the two documents were now so distinct that no level of similarity or measure of difference was registered, which seems questionable.[62]

However, despite this limitation, overall the pattern of evidence derived from this aspect of quantitative analysis illustrates a sequence of convergence in the wording and structures of the version series of coding frameworks and then a distinct departure from this into an new written description (summary) and graphic arrangement of an original MZWM derived as a result from the mixture methods content analysis MMR HCA-T-MZWM quant + QUAL(quant).

4.2.6. Characterisation study of the emerging MZWM.

The following spreadsheet, Table 12, is noticeably incomplete and was ultimately abandoned as an analytical model. This thawed analysis sought to array the evolving *characteristics (and descriptive statements) of the emerging MZWM* in relationship with the range of prospective ideas and aspiration[63] for types of data and information, which had begun to become evident in the coding process. Table 12 illustrates just the top section (viewable as a single page excerpt) of the original spreadsheet along with listing the full set of *types of data and information*, which was at that point being conceptualised as available and analysable content. The noteworthy aspect of this attempt to structure a framework for qualitative analysis (which is why it warrants its reported as a failed result / flawed analysis) was that the failure and abandonment of this study provided the critical impetus and clear direction to what became successful alternative, *where to from here,* next steps.

Ultimately, the dead-end in this aspect of the explorative quantitative analysis (on the grounds of intangibility and unmanageable scale) catalysed the decision to develop the alternative system of what became a total of nine MS EXCEL spread sheets (which are discussed in Section 3.13; see example provided in Appendix 10). Ultimately, this alternative model for qualitative analysis involved a two-stage transcription of data from NVivo into and back out of MS EXCEL into MS WORD format. This alternative, analytical approach was ultimately able to encompass the diversity and required categorisation of data types, including adopting a system of annotation to merge quantitative perspectives into what becomes a narrative qualitative output from the mixed methods content analysis.

---

[62] Possibly, more sophisticated analytical software may rectify this limitation.

[63] The full initial spectrum of initial analytical aspiration for Table 12 included the full extension of the *'Typology – Notes/Discussion'* column of aspired types of data/information options at the time of writing: *1,2 or all 3. Timelines. Forecasting CBA vs other options. Stakeholder inc. range. Design vs technology vs R&D. Public/private/both. Duration location mechanism enforcement. Exemplar. SD & CC (energy, water, GHG). Total generation v total diversion, organics, ewaste. Criticality. Intervention list/ evidence of outcome. Terminology + typology and detail (i.e. product types, instillation order/priority + voluntary first or only). Product coverage/mechanism. How. Description/ coverage. Product coverage/mechanism/public private/reporting/incentivisation model. ZW branding & paradigm/guidance. Govt. facilitation, support & involvement in standards development & accreditation systems + requirement via contract inclusions. Recorded interventions/actions? Measures of consistency. ID scale of subsidy/ interventions. Framing legislation and strategy and actions + spectrum of terminology. Intervention vs outcome. Legislation + Yes/No hypothecated + detail i.e. terminology, mechanism, reinvestment etc. PS / EPR structures + management detail. Metrics recognising W-ZW in SD CC strategies. Intervention options vs outcomes. Intervention options vs outcomes i.e. job growth potential, associated economic value etc. Interventions vs outcome. 1- curb side, 2- drop-offs, 3- rural remote areas, 4- reverse logistics, 5- other. System description: inc. commercial vs home composting vs vermicomposting. Descriptions. interventions + investment vs outcomes. Interventions, programme investment, monitoring & compliance.*

The deliberate inclusion of Table 12, which is in a sense a non-result, is based on continuing the standard of full and transparent disclosure of process (method) and outcome, which key authors regard as an essential mediation of quality assurance in the formation of MMR CA (Bos & Tarnai, 1999; Bryman, 2012; Krippendorff, 2013; Plano Clark & Ivankova, 2016). In the context of the overall research procedure, this outcome was ultimately neither negative, peripheral nor unimportant. Given the open-ended explorative approach in this sequence of quantitative analysis, this aspect is a turning point that made explicit the limits and stepping off point from the quantitative into a restructured qualitative analysis. This non-result is the junction point in the quant + QUAL(quant) methodology transition and was the catalyst for the revised analytical approach that ultimately resulted in a stronger and more complete answer to the research question.

This turning point in the research process highlights, as Creswell (2015) noted, the limitations of mono method and, relative to this, the strength and opportunity in mixing methods (Plano Clark & Ivankova, 2016), which for this project provided the anticipated *new way forward* (QSR, 2017). As such, this outcome realises the actual, rather than projected, validation and pragmatic bridge into abductive back and forth mixing and interplay of methods, which is reported as the strength MMR brings to content analysis (Berg & Lune, 2012; Krippendorff, 2013; D. L. Morgan, 2008). This process of grappling with and ultimately failing to adequately conceptualise a singular quantitative framework for integrating all the possible / envisioned types of data / information and scope for discussion was a pivotal reality check. This reinforced both the described prioritisation / weighing of this concurrent / convergent *quant + QUAL* mixed methods research design and the inclusion of the embedded hybrid design of *QUAL(quant),* which was applied in the analysis and write-up of the qualitative content analysis.

Table 12: An excerpt from the abandoned MS EXCEL worksheet which unsuccessfully sought to undertake a characterisation study of MM CA MZWM of quantitative element of data coded to node structures making up the MZWM parameters.

Characterisation: MM CA MZWM JH 2018	Discussion	Source total	YES	NO	% Affirmative	Score - ID repetition confirmation	Typology - Notes:	WZW Hierarchy # Rs	Municipal	C&I	C&D	University	Individual / Household
1- Conceptual Foundations & Critical Principles	Essential foundations and key principles upon which MZWM depends	Metrics					Discussion		Context: Materiality - Sector				
A1a- ZW Goal Statement	Public declaration of a ZW goal often with an associated timeframe												
A1b- Documented Strategic Plan	Establishing (via wide stakeholder collaboration) and documenting a strategic ZW plan with a programme of implementable actions, where this is framed around holistic multi-stakeholder roles - partnership, involvement and collaboration. A critical consideration is incorporating the grass-roots, bottom-up, real world knowledge and experiences of waste-ZW workers												
A1c- Transparent Monitoring, Compliance & Reporting of ZW Plan	Transparent programmes for monitoring, compliance & reporting of the implementation of the ZW plan. Emphasis on good data i.e. waste surveys - research to create data sets to enable planning.						1,2 or all 3						
A1d- Assertive or Alternative WZW Hierarchy	Recognition of and assertive commitment to a conventional WM or an alternative ZW hierarchy (i.e. derivative but different to ISWM 5R elements and priorities) where the distinction of both notional exclusion of burn bury disposal options and actualising rather then apparently forgetting, subverting and ignoring the expressed hierarchy of priorities												
A1e- ZW Leadership & Agency - Legislation & Regulations	Accepting and establishing leadership role and agency and developing enabling legislation and regulatory frameworks which support and direct zero waste planning and implementation + Includes govt institutions leading by example i.e. NZ mode GOVT3						Timelines						
A1f- Applied Ecological Economics	Aligned ecological and economics principles applied via life cycle management (LCM, CBA) decision making tools.						forecasting CBA vs other options						
A1g- Holistic Societal Commitment (PPPP) stakeholders	Whole of society engagement involvement and commitment to transitioning to ZW and SD this will manifest in all sector and levels of society having roles as well as in PPPP type arrangements inc. embedded community informal sector engagement in policy planning and service delivery - 'public private people partnerships' (PPPP)						stakeholder inc. range						
A1h- Designing an Innovation Continuum	Investment in generating a design lead continuum of innovation relative to ever-changing nature of the waste problem, future technologies and issues. The concept of continuous innovation connects with the hyper-ambition, challenge and aspirational of the other broad range of 'zeroisms' (i.e. accidents defects, harm, etcs).						design vs technology vs R&D						
A1i- Public Ownership vs Privatisation	The expression of the 'public good' through retaining a balanced influence of public vs privatised waste and resource material flows						public / private / both						
A1j- Separation at Source	Enacting the 'separation at source' principle which requires community participation in and responsibility for maximising recycling and minimising contamination. Sep source especially organics fro other resources is observed as catalyst for improved recycling (collection rates, OSH and profitability).												
A1k- Cyclical Material Flows	Engineer an assertive transition from linear to cyclical material flows through the economy by enhancing resource recovery, reuse and recycling						duration location mechanism enforcement						
A1l- Precautionary Principle	The precautionary principle is accepted in policy and put into practice. Extended disposal operator (landfill and incineration liability (i.e. reflecting and internalising the true aftercare, full life cycle costs). In a general sense this means including all otherwise externalised - overlooked cost into evaluation of environmental impact and where uncertainty exists environmental protection retains priority and the burden of proof of minimal harm resides with the proponent of change						e.g.						

4.2.7. Examining the secondary *Zero Waste Motive – Argument Formation* data that was coded in parallel with the primary MZWM content analysis.

The final aspect of this quantitative analysis followed the analytical procedure developed and outlined in Section 4.2.4, which sought to examine the level and pattern of conformational evidence coded in support of each composition and arrangement of the formative MZWM.

Table 13: An excerpt from an MS EXCEL which examines the secondary related *Zero Waste Motive - Argument Formation* data which has been coded in parallel with the primary MZWM content analysis.

	Overview: 2nd coding exploring W→ZW framework developed In Nvivo to support the collection of additional data.	CF v final			& Zaman 2015		
		# Refs	% proportionality	Structural overview	# Refs	% proportionality	Structural overview
	1- Examining Zero Waste	210	29.01%		225	30.04%	
1	B1a- ZW Characterisations	75	10.36%	1.10 - 2.4 - 3.7 - 4.9 - 5.7	77	10.28%	*1.15* - 2.4 - *3.8* - *4.10* - 5.7
2	B1b- Absolute v Progressive	65	8.98%		66	8.81%	
3	B1c- ZW Call Scope	15	2.07%		15	2.00%	
4	B1d- Circular (nature) vs Linear	24	3.31%		24	3.20%	
5	B1e- Movement v Orthodoxy	19	2.62%		20	2.67%	
6	B1f- ZW Pioneered in C&I Setting	5	0.69%		5	0.67%	
7	B1g- ZW Industry - Sector Spectrum Typology	3	0.41%		4	0.53%	
8	B1h- Organisations ZWIA - Zero Waste Europe	4	0.55%		4	0.53%	
9	B1i- Complexity & IE links	0	0.00%		0	0.00%	
10	B4j- Clarify 7 Spheres - Typology of ZW Lit	0	0.00%		0	0.00%	
11	*Biodiversity & Heterogeneity of ZW*				*3*	*0.40%*	
12	*Catalyst for Sustainable Production & Consumption*				*2*	*0.27%*	
13	*Data - Monitoring & Evaluation of ZW Performance*				*2*	*0.27%*	
14	*Refinement & Evolution of ZW*				*2*	*0.27%*	
15	*Upstream reDesign Paradigm*				*1*	*0.13%*	
	2- Waste Issue Characterisation	91	12.57%		92	12.28%	
1	B2a- WM Policy Approach	40	5.52%		*41*	5.47%	
2	B2b- Waste Issue Descriptors - Causality	38	5.25%		38	5.07%	
3	B2c- Scope of Issue	2	0.28%		2	0.27%	
4	B2d- Toxicity - No Dumps - Informal Sector = Common Ground	11	1.52%		11	1.47%	
	3- ZW Rationale	154	21.27%		155	20.69%	
1	B3a- Precedent & Competitiveness	19	2.62%		19	2.54%	
2	B3b- Citation of Influential Thought Leadership	10	1.38%		10	1.34%	
3	B3c- ID Future Outcome Drivers	24	3.31%		24	3.20%	
4	B3d- Plurality of Multi-format CC Mitigation & SD Benefits	59	8.15%		59	7.88%	
5	B3e- Simple (explanations - paradigm shift) & Progressive	13	1.80%		13	1.74%	
6	B3f- egs of ZW-WM Synergy & Mischaracterisation of ZW	11	1.52%		11	1.47%	
7	B3g - Quantitative Scientific Evidence	18	2.49%		18	2.40%	
8	*Confront Status Quo*				*1*	*0.13%*	
	4- Critique of ZW	172	24%		177	23.63%	
1	B4a- Too Expensive	19	2.62%		19	2.54%	
2	B4b- Inappropriate Tech (i.e. to under developed economies)	4	0.55%		4	0.53%	
3	B4c- Politically untenable - Activist or NGO capture	17	2.35%		17	2.27%	
4	B4d- Extremism	11	1.52%		11	1.47%	
5	B4e- Indistinguishable ZWtL or ISWM	27	3.73%		27	3.60%	
6	B4f- ZW is the Problem - Hampers WM Progress	45	6.22%		*46*	*6.14%*	
7	B4g- Impossible Unrealistic - Perpetuates Fiction	12	1.66%		12	1.60%	
8	B4h- Mixed Methods Q&Q Supports (who, how, where & why ZW)	6	0.83%		6	0.80%	
9	B4i- Contingent Dependencies - Delimitations on Implementation	31	4.28%		31	4.14%	
10	*MZWM - Planning Deficit*				*4*	*0.53%*	
	5- ZW-WM Lit Review Converse & Supporting Debates	97	13.40%		100	13.35%	
1	B5a- Opposition & Social Change Theory	43	5.94%		43	5.74%	
2	B5b- Disciplines and (Inter)disciplinarity & IDR	25	3.45%		25	3.34%	
3	B5c- Evolution & Commonality - History of ZW & WM-ISWM	22	3.04%		*25*	3.34%	
4	B5d- Financial Rigour - Inappropriate Technology	1	0.14%		1	0.13%	
5	B5e- Politics, Power and Control	3	0.41%		3	0.40%	
6	B5f- Origins of ZW Critique	0	0.00%		0	0.00%	
7	B5g- Hierarchies	3	0.41%		3	0.40%	
	TOTAL	724	100%		749	100%	

Coding: Red highlight & red text >5%, Blue highlight & blue text equates to 3 - 4.99%, Green highlight & green text equates to 1 to 2.99%

This next aspect of the quantitative analysis examined the data coded on the basis of the second, parallel coding framework *Exploring waste → zero waste* (see Section 3.9). This second coding framework was developed to record other peripheral, but interesting and important, information when it became apparent that this was present but not being captured from within the three key selected sources. As previously outlined in Section 3.9 and illustrated in Table 13 (above and in Appendix 8), the strategy of developing a second coding framework produced a wide array of new foundational evidence relevant to answering the central research question. Alongside the decision to develop a second coding framework, it was also decided to reference an authoritative point of comparison by including (Zaman, 2015) as a supplementary source in the coding process (see discussions in Sections 3.9, 4.2.3, and 4.2.4).

The data set established through the second coding framework not only enabled deeper understanding and discussion of factors relevant and supplementary to the concept and content of a MZWM, but also created a mechanism for acknowledging and factoring in disconfirming evidence. The objective being that a more balanced and robust conclusion, ultimately be able to be derived in respect of the research hypothesis. As is illustrated in both Appendix 8 and Table 13, this second coding framework was based on 5 parent and 44 child nodes,[64] which represent an extensive body of additional information, the analysis of which enabled examining of (dis)confirmational perspectives as encouraged by (Berg & Lune, 2012).

Table 13 utilises the same system of colour coding, i.e., red highlight/text >5%, blue highlight/text equates to 3–4.99%, green highlight/text equates to 1–2.99% as was applied in Table 9 to distinguish the child nodes with the largest number of references, which is evidence of levels of support. This quantitative analysis provides a simple indicator as to which elements of the coding framework are foremost and/or priorities, based on the content of the selected source. The table annotates the total and grouped distribution of what, within the original parallel MZWM content analysis, became an arrangement of key themes. For example, the top group of red (i.e.>5%) child nodes are: B1a- *Zero waste characterisations* (10.36%); B1b- *Absolute vs progressive perspective of zero waste* (8.98%); B2a- *Waste management policy approach* (5.52%); B2b- *Waste issue descriptors* – causality (5.25%); B3d- *Plurality of multi-format climate change mitigation & sustainable development benefits* (8.15%); B4f- *Zero waste is the problem and hampers waste management progress* (6.22%); and B5a- *Opposition & social change theory (*5.94%), which collectively make up 50.41% of the referred data.

In this framing, the proportionality for the three original key selected sources is distinguished and compared with the additional insight coded from the academic review article (Zaman, 2015). Not unexpectedly, given its purpose in drawing together a comprehensive oversight of this subject, this inclusion produces a total of 25 new codes, 15 of which are coded to an additional seven new child nodes. With the inclusion of the Zaman (2015) data, the five parent/child node structures changes from [1.10 - 2.4 - 3.7 - 4.9 - 5.7] to [1.15 - 2.4 - 3.8 - 4.10 - 5.7]. However, the overall data distribution at both a parent and child node level, does not vary significantly. For example, the five parent node total distributions are: 1- *Examining zero waste* - 29.01% to 30.04%; 2- *Waste 1ssue characterisation* - 12.57% to 12.28%; 3- *Zero waste rationale* - 21.27% to 20.69%; 4- *Critique of zero waste* - 24% to 23.63%; 5- *ZW-WM literature review – converse & supporting debates* - 13.40% to 13.35%.

[64] As illustrated in Table 13, this structure is based on 1- 'Exploring zero waste' (15 child nodes), 2- 'Waste issue characterisation' (4 child nodes), 3- 'Zero waste rationale' (8 child nodes), 4- 'Critique of zero waste' (10 child nodes), and 5- 'Zero waste / waste management literature review, converse and supporting debates' (7 child nodes).

Without completing and reporting a full analysis of the data in this 2nd coding framework, which would involve substantial work, it is not possible to speak definitively to all the meaning behind this structure and content. However, the fact that this variation is low (on average just a gross difference of 0.41%) indicates that relative to the most comprehensive and authoritative academic review article the key selected sources appear to provide a solid coverage of interesting and important key content, which is relevant but peripheral, to the focussed question of MZWM. This insight offers an important confirmation of the sampling and selection of key sources and inputs for this content analysis. The referencing of 724 items of data as new codes, beyond the original 1704 data coded in forming the first original MZWM focussed coding framework, illustrates the relative volume of additional, interesting and important content within the three key sources, which is relevant (but peripheral) to addressing the central question of this research.

By informing alternative and to a degree triangulating points of discussion, the dataset created via the second coding framework *Exploring waste → zero waste*, provides an important contribution in the formation of the MZWM structure as a result. While this work contributed some important insights, the value of undertaking a tactical avenue of qualitative analysis should not be judged solely on the raw substance of the outcome. Sometimes closing off further exploration and setting a necessary delimitation in addressing a research question is a critical outcome of research design. Put simply, ultimately the final MZWM as a result is based on both, what elements were justified for inclusion and also the boundary conditions which established what considerations were warranted for inclusion. This additional dimension of analysis informed a broader discerning and more 360° perspective to the design formation of the finally proposed MZWM. The learnings from this quantitative analysis influenced both the design of the next phase of qualitative analysis and how the subsequent hybrid embedded quant + QUAL(quant) MMR results were reported (Plano Clark & Ivankova, 2016). As the subsequent results demonstrate, ultimately this qualitative aspect of the mixed methods content analysis proved to be substantial in both undertaking and outcome, and no further sources were required in forming a sample sufficient to answer the research question.

4.2.8. Examining cross-connecting and enabling themes

Table 14 is the result of examining cross-connecting and enabling themes, for example, nodes that appear interactive and or interrelated within the framing of the MZWM. The previous Section 4.2.7 signals the end of a singularly quantitative analysis, and Table 14 is the last element of result from the quantitative research phase and is the point of transition point from deriving a mono (quant +) vs hybrid embedded mixed method i.e., QUAL(quant) format of result. As the last instance where the subject data were examined through a singularly empirical lens, the section provided the stepping off point into the next phase of qualitative analysis.

It is observable that the balance of result reported in Table 14 weighted more towards the qualitative (so called words), than the quantitative (numbers) end - as commentators have simplified (Bergman, 2008; Greene & Tonjes, 2014) of the mixed methods spectrum (Plano Clark & Ivankova, 2016). In reporting the final action in the sequence of explorative qualitative analyses undertaken in MS EXCEL (see 4.2.1 to 4.2.7) Table 14 illustrates the accumulating observations and reflections that have emerged through, in particular, the convergent aspect of the quant + QUAL(quant) mixed methodology.

Table 14 is structured around the emerging themes, enablers, interactive functions, feedback loops and connection, synergy & complexity that became apparent in the process of coding and qualitative analysis. This arrangement captures the formative process whereby the data themselves reshape the initial coding framework, into what becomes a final proposed MZWM arrangement. This final proposed MZWM arrangement (see illustration as Figures 12, 13, 14, and 15) embodies the reality of connections, overlaps, theme clusters, interactive groups, dependencies, enablers, and synergy alongside empirical indicators of evidence and priority. The collective emerging picture is one of intense dynamic interdisciplinary complexity and clustering of MZWM, which both greatly exceeds that of traditional / conventional waste management and is poorly understood and catered for in terms of the comprehension and scale of necessary interdisciplinary training / education and research practices (Hannon, 2020).

This result offered in Table 14 carries forward and builds on the analytic procedures (percentage weightings) and the merging of numeric and written data (colour coding) that were established and communicated in the narrative and annotation of Sections 4.2.5. and 4.2.7. That said, this final tranche of data also reflects a preliminary, relatively rudimentary, formative finding that contributes to and later progresses into the final result. In this, the data are true reflections of this quant + QUAL transition point in the research process. As well as expressing the interaction and influence of the second coding framework (content and structure), Table 14 identifies how strands of emerging finding and formation are connected, concurrent, flow into, and shape the impending qualitative analysis.

In practice, Table 14 functioned as a form of *notepad* that captured the series of initial thoughts and observations arising from the later quant + QUAL transition and enabled, as Berg and Lune (2012, p. 367) describe, the initial un-preconceived, open un-structured, playful recording phase that allows the data to speak and inform in respect of the research question. The authors describe this initial phase transitioning into a more systematic, formative, organisational stage, where the accumulating ideas and strands of evidence actualise into a detailed structural arrangement and finalise as a result (Berg & Lune, 2012).

In this instance, the process captured in Table 14 eventuated as the proposed final MZWM (Figure 11). Table 14 functioned as a staging-post to consider and combine all the converging factors, ideas, and questions. For example, what are the components of an effective product stewardship / extended producer responsibility (PS/EPR), as well as details such as, *yes or no* to an advanced recycling / disposal fee (ARF/ADF) as part of this? How can one best enable environmentally sustainable design (ESD) to reduce hazardousness and toxicity when material flows are circularised? Is there a threshold tipping point whereby education for sustainability (EfS) catalyses wholesale social change?

Table 14: An examining and understand cross-connecting, interrelated and interactive themes within the MZWM.

Themes	Emerging Cross-connecting Themes	
	The nature and function of goals and targets:	A1a- ZW Goal Statement and A1o- Targets and Targeting and B1b- Absolute v Progressive(8.98%). The former two are linked but separated aspects of the hypothetic MZWM rubric and the latter captures important textural detail around how goals and target function in motivation a continuum of innovation and the trajectory of progress and change.
	Identifying barriers to progress:	A1b- Documented Strategic Plan and B4j- Contingent Dependencies - Delimitations on Implementation (4.28%) and B5b- Disciplines and (Inter) disciplinarity & IDR (3.45%) are..
	Relationships societal commitment:	A1g- Holistic Societal Commitment (PPPP) was initially connected and then separated out from *[A1b[1] - Documented Strategic Plan]* for which an all of society collaborative approach is essential.
	Relationship to conventional waste management theory: overlap, encompass & extend	*[A1b[2] - Documented Strategic Plan]* and B4f- ZW is the Problem - Hampers WM Progress (6.22%) and B5c- Evolution & commonality - History of ZW & WM-ISWM (3.04%) are…
	Locating zero waste within sustainable development and climate change theory:	A1m- Integrated Sustainability and B3d- Plurality of multi-format CC mitigation and SD benefit (5.15%) are…
	Understanding the relationship between innovation and aspiration	A1h- Designing an Innovation Continuum links *[B1b[1] - Absolute v Progressive]* and the discussion about how the zero goal functions and what it is and isn't - also links to the critique node generally and particularly B4g- Impossible Unrealistic - Perpetuates Fiction (1.66%)
Enablers	Identifying and Exploring Key Enablers	
	Enabler (1): A paradigm shift in the concept and scope of responsibility.	A2c- Systematic PS – EPR and B3g- PS EPR paradigm shifts (4.49%) are….
	Enabler (2): Future (re)design: Cyclical products production and consumption	A3f- Recognise ESD – DfE and A1k- Cyclical Material Flows and B1d- Circular (nature) vs Linear (3.31%) are…
	Enabler (3) Research and targeted development (R&D)	A5c- ZW-EfS Industry Training - University Education + *[A1h[1] - Designing an Innovation Continuum]* + A3e- Aligned ZW SD (Tech Infrastructure . Service) Investment.
	Enabler (4) Employment as an sustainable development outcome	A3g- Transition to Quality Green Jobs + *[A1m[1] - Integrated Sustainability]* and *[B3d[1] - Plurality of multi-format CC mitigation and SD benefit (5.15%)]* are…
	Enabler (5) Transformation and change	B5a- Opposition and social change theory (5.94%) + *[A1g[1] - Holistic Societal Commitment (PPPP)]* + *[A1b[3] - Documented Strategic Plan]* + A5j- Enable Participatory Dev. - Recognise & Support Volunteers.
	Enabler (6) Ownership of the problem / material flows	A1i- Public Ownership vs Privatisation *+ [A1g[2] - Holistic Societal Commitment (PPPP)] + [A5j[2] - Enable Participatory Dev. - Recognise & Support Volunteers]* + A1e- ZW Leadership & Agency - Legislation & Regulations
Functions	Enabler (7) Collection connections	A1j- Separation at source + A2a- WM to ZW (inc. 3R) contracts + [i.e. often as a grouping: A4b- Amplified Collection & Sorting Systems + A4c- MRF Networks + A4d- Address C&D - C&I i.e. LMRFs (dirty) – MRBT + A4e- Organic Recycling AD + Compost etc + A4f- RRC - RRP - RRN - EIP – IE + A4g- Systematic Public Spaces - Events - Everywhere Recycling] + reinforcing policies such as: A3a- Reverse Cheap Disposal & Waste Subsidies - Fund ZW and or A2f- Backstop Landfill - Incinerator Bans and or A5a- Societal ZW-EfS Behaviour Change Programmes.
	NB: The latter theme cluster is quite a big, reoccurring and important one which seems of commonly occur in a spectrum of variations. NB: it seems clear that because of the scope and importance of them clusters this will be a central focus of Q&Q analysis – starting with a more independent less anecdotal more empirical way of establishing and exploring the extend of the cluster effect see the 'Connections and Themes' discussion point.	

	Transition Phase from quantitative into qualitative analysis: observations / formative considerations consolidate around connections and enablers, etc feed into the processes of qualitative analysis.	
Feedback loops	Consideration of feedback loops and or ordering, sequencing, timelines which reinforce latent priorities and or trigger requirements and linked dependencies / co-requisites i.e. things which occurs and then can release other subsequent outcomes.	The concept of program sequencing in relation to the *[A1b[4] - Documented Strategic Plan]* i.e. commitment to total awareness raising & saturation level education to overcome 'waste culture' change thresholds. i.e. creating a high level of recycling systems (services and infrastructure) is a prerequisite for the opportunity for normalising and universalising resource recovery, i.e. preceding backstop regs (unsorted or direct disposal bans, i.e. tyres ewaste etc) and enforcement with higher levels of societal reform through ESD, sources operation, green PPPSS and $ incentives and structural reform through EPR/PS, recyclate market development, green businesses / jobs development platforms. One key overarching prompt for these conceptions is 3rd 'Community Roadmap' source (Lombardi & Bailey, 2015) which is premised on priorities and three phases + 10 yrs. and hence represents linkages, sequencing feedback loops and processes of succession / reinforcement. i.e. the divesting from waste subsidies into re-investment and incentives, for zero waste and a circular economy. for example switching to "collecting trash on a biweekly or monthly basis" as diversion increases resources recovery / recycling flows and empty out flows of waste to disposal. The savings for low waste costs can be used to offset new / increased costs from adding general, organic collection services and or establishing MRBT systems.
	NB: whilst then xR and all 5R concepts accord priority it is interesting that many ZW observations esp. roadmap concepts recognises a different set of ordering than is suggested by the rigid ZW hierarchy concept this seems to be a pragmatic factoring in around meeting current system requirements whilst engineering holistic system change in parallel	
Connection, synergy - complexity	Consideration around connections, relationships and synergy between different elements of the formative MZWM	In transiting from quantitative to the qualitative analysis areas of connection and synergy in for example the structure, content and real world implementation of *[A1b[5] - Documented Strategic Plan]* can be recognised for example the conventional vs 'xR alternative zero' waste hierarchy construct. In this case the xR alternative zero waste hierarchy seemed to fit the data and offered an organisational model that provided insight to the potential for capturing not only connections and themes but latent priorities which enable the MZWM. As this connection and synergy become increasingly apparent the decision to utilise the xR construct was implemented within the iterative structure selected for qualitative analysis, which is illustrated and annotated as a finalised format as table??? In this framing *[A1b[6] - Documented Strategic Plan]* and A1d- Assertive or Alternative WZW Hierarchy are connected and clustered with A1p - 'General to local...' and A5d- 'International shared learning networks', because the ZWIA dialogue series has been instrumental in the formation of gathering and dialogue for the zero waste definition and hierarchy.
	Learning and observation relevant to forming the final CA methodology	The detailed, complex and time consuming task of coding data during qualitative analysis is exacerbated by the confronting reality that often could or needed to be, coded to multiple elements of the coding framework. The realisation prompted the necessity of consolidating and simplifying the coding framework into logical interrelated clusters alongside the accumulating observation of theme connection, enablers and functional groups, pragmatic considerations have appropriately shaped the research procedure and outcomes. In practice in was apparent that overlaps / duplicate locations are not readily visible within the NVivo stage, but unless immediately addressed in the initiation qualitative analysis this issue would have created a lot of duplicated / additional text which would have bogged down the qualitative analysis. In a sense addressing the complexity of interconnection and overlap becomes a driver for developing an efficient consolidated MZWM framework.

NOTES: 1- The annotation is based upon bold being used to designate child nodes from coding framework 1 (i.e. MZWM) all non-bold node titles are from the 2nd coding framwork exlpiring W → ZW. 2- The colour coding of child nodes being discussed carries over from the saytem used in tables??? and ??? Red text >5%, Blue text equates to 3 - 4.99%, Green text equates to 1 to 2.99% this colour coding system applies to the childs nodes form both the 1st (i.e. A # lower case letter) and 2nd (i.e. B # lower case letter) coding frameworks.

3- Where *[brackets, italics and underlining]* is used this indicates where a second or more discussion point references what is obviously a key interconnected child node. A suprescript[1i.e. 1,2 or 3] number is used to indicate how many times this nodes is referenced. At this junction in the research proceedure only the child nodes percentages of the 2nd coding framwork see table??? were finalised - so these are listed for ref. 4- NB: The individual and cluster child node percentages for the 1st coding framework which becomes a proposed final MZWM are not finlaised until much later in the research process. 5- NB: some of the child node titles in the 1st coding framework may be different at this junction in reporting these results, from what are ultimately finalised.

Table 14 represents an outcome of the transition into more fully mixing quant + QUAL analysis. In terms of the research journey, this transition point and result represent a quite distinct cognitive shift away from what had begun to appear as oversimplified models and singular measures into embracing a more complex, nuanced, interactive, and ultimately more realistic and effective interpretation of how all the elements of an MZWM interact and complement each other in an integrated and dynamic way.

As will become evident in the upcoming results of the qualitative analysis, the end point of this transition is the development of the ∞ infinity symbol as the key emblem in the graphic presentation of the overall final result. The ∞ infinity symbol is evocative of the levels of complexity, interactivity, interdisciplinarity and necessary continuum of action and assertion that is required to prosecute the intended shift in paradigm and practice from waste → zero waste within a circular economy.

From this point forward the presentation sequence of the final MZWM results reflects convergence into a quant + QUAL(quant) embedded hybrid mode of result. Both the schematic (Figure 11) and graphic results format (Figures 13, 14, and 15) illustrate and are derivative of empirical annotation – written – visual arrangement of an underlying mix of quant + QUAL(quant) hybrid research process and data. In particular, Figure 11 includes an empirical annotation of quantitative results that reflect the sense of priority communicated via the weight of evidence (% distribution of total codes) supporting the placement in the proposed MZWM arrangement.

The organisational arrangement and annotation of Figure 11 makes themes distinguishable and identifies key elements of the MZWM that can be thought of as elucidating and unlocking the clusters of interoperability apparent within the overall MZWM. For example, the centrally interactive themes of *Participation – Social change – Rationale* are supported by, in total 39.1% of the coded data. Each of these are respectively headed by the three *red >5%* child nodes: *A5j- Enable participatory development / Ensure appropriate technology* (103); *A1g- Holistic societal commitment (PPPP) stakeholders* (103); and *A1m- Integrated ZW - SD & CC mitigation* (99), which are the majority or lead components of the three associated interactive clusters.

Alongside demarcating the origins of this critical cognitive shift into the ∞ infinity symbolism for communicating the MZWM as a result, Table 14 also illustrates and recognises functional aggregation in spheres such as, *'Empowering policy'* and the associated agencies and dimensions of leadership, and *'Services and infrastructure'* and the raft of operations, processes, and technologies that give effect to this critical *practice* orientated theme. While these might, in hindsight be thought to be simply logical, it is important to note that the realisation of child nodes being aggregated into functionally interactive clusters emerges from the data - through content analysis, and was not presupposed beyond the five quite different initial demarcations of *Principles and Policy, Social, Physical and Financial Mechanisms.*

Finally, Table 14 illustrates the combined consideration of data from both the first original and second coding frameworks and marks the point at which only the primary MZWM based coding framework proceeds to the next phase of qualitative analysis. The content and arrangement of data in the second *Exploring waste → zero waste* coding framework functions as an appropriate supplement to describe the engagement of researcher knowledge expertise (Berg & Lune, 2012) in the formation of inductive and deductive inference.

Concluding comments: The suite of quantitative analysis utilised in this research was profiled as explorative. This is because the sequence of quantitative analysis was developed both pragmatically and progressively as understanding of the data in the sources emerged, via the coding progress. Additionally, each next analytical step emerged out of insight as to what empirical data were contained and what of this was interesting, pertinent, and might benefit from closer examination. The narration of the outcomes and learning from this explorative journey includes aspirations and angles of enquiry that were not fulfilled and/or did not correlate with the data (see the data gaps in Tables 5 and 12 of Sections 4.2.1 and 4.2.6.). However, these was also important learning which served to point the enquiry toward more useful direction and forms of quantitative analysis that ultimately culminated in reaching the end-point of a singularly quantitative mode of enquiry. This end-point highlights the necessity for designing and implementing the subsequently described qualitative analysis and signals the transition into a more sophisticated conceptualisation and convergent, embedded-hybrid expression of quant + QUAL(quant) result.

4.3. Fully explicated MZWM written narrative QUAL(quant) result

A significant tranche of qualitative findings that converge with the previously outlined quantitative findings (Sections 4.2.1 to 4.2.8) and validates of the selection, design potential, and implementation of this specific MMR HCA-T-MZWM quant + QUAL(quant) research methodology. Evidently justifying the implied weighting, the raw QUAL(quant) finding, as a written narrative result, was a significant finding totalling 50 pages and a >40,000 word-count. As was anticipated on the basis of the outward appearance of source data, the relative balance of research findings was weighted in favour of the qualitative, which actualised the quant + QUAL(quant) methodology design.

However, the scale of this QUAL(quant) research finding also presents a challenge, in that the quantum doesn't fit the word-count restrictions of a PhD thesis and the amount of detailed reading potentially distracts from the critical meaning on offer. Tactically, it was determined that the best approach in communicating what this element of the research achieved, would be to examine an illustrative subset of this result as detailed reflective excerpt of the overall qualitative result. The remaining result is presented via Appendix 11. This approach also enabled this *Results* chapter (Sections 4.4 to 4.7) to culminate in presenting the four key summary graphics (Figures 11, 13, 14, and 15) which have been derived as a final iterative output of this MMR HCA-T-MZWM convergent / concurrent quant + QUAL(quant) hybrid embedded set of results.

It is important to observe that, although presented subsequently Figure 11 - the final proposed MZWM in a summary schematic format (Section 4.4) provides a useful way of conceptualising the entirety of this fully explicated MZWM written narrative QUAL(quant) result (Section 4.4). So, it is useful for these two elements of result to be considered together. This is because Figure 11 illustrates organisational arrangement of just the fifty-seven primary element titles and therefore provides a useful schematic overview / abbreviation, that acts as roadmap of the full MZWM result. Because the final MZWM relational matrix was not finally derived until both the quantitative and qualitative research phases were completed, it was determined that the presentation of this and other summative results (namely, Figures 13, 14, and 15) would be communicated in the order that they were finally completed.

Three aspects of the total written narrative result were selected as representative excerpts for inclusion in this *Results* section. The first selected excerpt is: *6. Rationale and 6.1. Indicators of integration across environmental sustainability domain (with the imperatives of climate change, circular economy and sustainable development, etc. (CC-CE-SD)* in Section 4.3.2. This expert has been relocated from the sequence reported in Appendix 11. This excerpt was selected because it centrally locates zero waste within the key global imperatives of creating a circular economy, addressing climate change and sustainable development issues. In addition, this selection provides a good example of the system of empirical annotation and colour coding used to capture and convey the full spectrum on meaning of offer in these data.

The second excerpt of the result selected for inclusion here is: *'Vison / Data'* in Section 4.3.3. This was selected as it provides a good example of how the three parts of this cluster, namely 1Aa Goals + A1c Targets + A1o Monitor / Report, have been combined into a single grouping, based on 113 items, i.e., 6.6%, of the total of body of coded data, which is organised and collectively described by seven key brackets of derived information.

The third excerpt selected for inclusion and examination in this section is the follow-on is: *xR Priorities* in Section 4.3.4. This aspect of the result demonstrates the extent and detail of the information that is inferable from this grouping of two separate child nodes and cluster of a further two child nodes, A1b Strategic plan + A1d WZW hierarchy + [A5d Int. networks + A1p General to local], which are based on 143 items, i.e., 8.3% of the total body of coded data.

From this point forward, the remaining elements: *3. Empowering Policy – Leadership to 9. Keys* to *(re)Design*, (NB: numbered as per the original order of the complete results) form Appendix 11. The *xR Priorities* aspect of the overall qualitative result is highlighted and included as an excerpt because in the quantum of (i.e., >10,000) words it both demonstrates the powerful new knowledge generation potential of content analysis and conversely exposes the limits of this.

In similar way as to how this full written narrative result prompted and guided the finalisation of Figure 11 as a simple schematic illustration of the final proposed MZWM, the extent and detail of the *4.3.4. xR Priorities* result, prompted the development of the *16R Zero Waste Hierarchy* graphic (Figure 13, Section 4.5) as a simplified derivative. As a next step iterated summary result, the 16R zero waste hierarchy provided a clear encompassing format for communicating the meaning of this aspect of the overall result, which might otherwise be lost in its quantum. This same principle and precedent prompted the development of both the overarching *∞ Infinity-Continuum Model for Illustrating MZWM* (Figure 14, Section 4.6) and then the further *synthesised / explicated version of the ∞ infinity/continuum model proposed for Illustrating MZWM* (Figure 15, Section 4.7). Collectively e, this group of four graphically formatted *Results* are the final culmination of the process of mixed method abductive inference formation, which is cited as new knowledge generated from the methodical analysis of content (Berg & Lune, 2012; Krippendorff, 2013; D. L. Morgan, 2008).

4.3.1. Decoding the quant + Qual(quant) nomenclature used for reporting results

Both Figure 11, the final proposed MZWM schematic, and the full explicated MZWM written narrative QUAL(quant) results (and to a lesser extent all other results) derived from this research employ forms of empirical annotation and illustrative tools to enhance the communication of the depth of meaning contained in each result. The following information outlines this system of mixed methods annotation, i.e., colour coded text, letters, and numbers and explains the meaning of the communication system merged into the full written narrative MZWM result:

- The *Rate of occurrence/confirmation* is indicted via numerical annotation$^{(+3)}$ illustrated as *super-script* bracketed numbers located in the *to the power of* slot, immediately behind and above the relevant word, phrase or sentence. The numeric annotation system illustrates the exact number of times the point had been coded from the source documents. As such, within this QUAL(quant) write-up, this empirical measure simultaneously provides an unobtrusive quantitative indication of the relative level of strength associated with that point or statement. The strength of the point or statement can be considered to increase through reinforcement provided by repeated confirmation, which can be inferred by repetition in the source documents.
- The *Geographical location* from where the point or statement has been derived is identified by letter system, i.e., *NZ =s New Zealand / F =s Flanders*, which is included in the super-scripted annotation (used either in isolation or in combination with a number indicating the *strength of confirmation*). This geographic identifier is important because, the data coded from source documents are derived from various zero waste case-studies/policy documents, each of which have a distinctive context. The number of location-identifying letters correlates exactly with the number of geographical contexts referenced in the sources. Utilising the letter-number combination allows contextual information to remain explicit within the written narrative result and for any additional insight or meaning that might be inferred from this context to remain transparent. The location identifier letters are located in the *to the power* of slot, immediately above and behind the relevant word, phrase or sentence, for example: *point*$^{(F+3)}$. As discussed previously, where a number is associated with the geographic location letter, the number references the exact number of additional times that point had been coded from that case study location in the source documents. This system of number + letter annotations provides a simultaneous quantitative indication of the relative strength that can be attributed to that point, derived from that geographical case study location, in the QUAL(quant) write-up of results.
- The utilisation of *colour coded words and sections* denotes the theme node from which the information/point has been derived. This changes in each section of the write-up according to what has been ascribed in the associated *legend* at the beginning of each section. This means that in each section the colours have a distinct meaning (i.e., denoting the node/code source listed in the legend at the beginning of that specific section). It is important to note that that this meaning is not transferrable and has no correlation between sections. The purpose of recording this distinction is to track the formation of connections/clusters and to identify from which child nodes the respective elements of written qualitative result have been derived. Having served the intermediate purpose of meaning retention and transparency, these section-specific data are latterly translated into the amalgamated connections and clusters denoted in Figure 11 via bold group borders and line connectors.
- Utilising this model of annotation negated the need for in-text citations, which would otherwise have been an over-bearing presence in the text. This encumbrance would have undermined the readability of the results, without adequately communicating any of the cited quantitative emphasis contained in the original data. So, tactically for the reporting of results, the

demonstrated model of annotation was determined as the best overall option,[65] which fulfilled the research objective of, if possible, forming a singular unified/universal MZWM.

The three selected elements of the complete final MZWM, reported as a written narrative, are as follows:

Please note that the numbering system of the thesis chapters is quite distinct from the numbering system of the section headings of the excerpts and the overall organisation of the written QUAL(quant) narrative MZWM result. Also please note that excerpts have been selected and organised for demonstrative purposes, rather than following the ordering of the overall written QUAL(quant) narrative MZWM result (see remainder in Appendix 11). For example, the overall written narrative result section headings are ordered and numbered as: 1- Vision Data (selected as excerpt TWO - 4.3.3); 2- xR Priorities (selected as excerpt THREE – 4.3.4); 3- Empowering policy; 4- Participation; 5- Social Change; 6- Rationale (selected as excerpt ONE – 4.3.2); 7- Services/Infrastructure; 8-Guidance & Market development; 9- Design / R&D (ref. Figure 11).

4.3.2. QUAL(quant) results – EXCERPT ONE

6. Rationale

Derived from: A1m integrated ZW CE CC SD - A1k cyclical material flows + A1f applied ecol-econ + A1l precautionary principle + A2e plastics interventions - A3g trans to green jobs - A1n Resource mngt focus - ref A3g trans to green jobs – [A2m Disaster WM]

6.1. Indicators of integration across *environmental sustainability* domain, i.e., with the imperatives of climate change, circular economy, and sustainable development etc (CC-CE-SD):

There is a reoccurring conceptual and practical linkage between both the resource/waste management-focused zero waste and circular economy movements and between these and the broader global imperative of climate change and sustainable development.[66] This linking and integration is evident in the numerous subject associations, word choice, connective terminology/ phrasing and the mutually reinforcing rationale which is evident in the selected zero waste literature.[67] For example, zero waste practices are cited as reducing:

- GHG emissions(+17 +9 +3 NZ, P, H, LP, M, F, T), -aka mitigating climate change / impacts(+4),
- municipal solid waste (MSW) disposal costs(+11 +5 +8), which equates to economic benefits for the municipality(+4 +5 +3 P, H, M, F, BA, LP, SF). NB: often while increasing and improving service levels and addressing associated environmental issues, i.e., leachate, etc.),
- waste generation, in a way that is *decoupled* from growth, for example Taiwan (-10%) while GDP (+47%)(+1 F),

[65] It was reasoned that if additional and/or the original information sourcing and empirical contribution are required this can be identified in other ways. i.e., examining the original NVivo files or the derivative analysis of this as it was transcribed into the excel spreadsheets.

[66] Up to this point, this can be tracked across the 2R, 3R, 4R, 8R, 11R, 13 to 16R zero waste hierarchy priorities, the driving motivation for separation at source, the zero waste leadership agency, policy framing and laws / regulations, the instrument and incentives, the collective structures, and the community behaviours change and environmental education sections.

[67] This is saturated with ubiquitous references to the language of circular (+ related words) / ecological economy (i.e., such as a 'precaution, etc.), plastics interventions and natural resource / capital foci.

- unsustainable linear natural resource depletion / ecosystem destruction, by offsetting virgin resource exploitation / extraction(+19 +4 +13 +3 P, M, F),
- pollution / hazardousness / toxicity(+13 +5 +5 P, AI),
- and conserving energy(+11 +5 +4 P, M, F),
- water use(+6 +7 F),
- environmental footprint relative to incineration/W2E on a life cycle management (LCM) basis,
- human health problems,
- loss of biodiversity,
- demand for new landfill/incinerator sites and the associated socio-political tensions)(BA) and imposed replacement reinvestment cost,
- transport demand / cost(+1 +2 F, M, LP) aka *waste miles,*
- the externalisation of environmental cost and more generally, the negative impacts passed on to future generations.

and enhancing:

- the emerging new circular economy(+10 +6 +5 +1 LP, F) and natural/social capital,
- the provision of reusable material flows as a feedstock in large and small industrial systems(+7 BA), i.e., industrial scale ecology / symbiosis models through to small-scale local repair reuse, disassembly recycling, etc., systems(+4), the reuse/second-hand/collaborative/sharing economy(+8 +3), third/informal sector and community enterprise(+3),
- the formalisation and development of the informal (IF) / NGO / community enterprise (CE) sector, which improves this sector's ability to participate in and or facilitate (zero) waste management system functions and related local environmental services and outcomes, but also to leverage off this for
- professional – personal/family health and well-being (6 +9), gender equality/protection (2 +1), social inclusion/justice/security and the amelioration of social (class/caste) economic, cultural, and political exclusion/exploitation(+2 +8 +3 P, M, BA) (inc. the eradication of child labour(+2 H, AI)) among IF/NGO/CE sector members,
- the promotion of corporate social reporting (CSR), *full cost/life-cycle accounting*(+1) and the application of *polluter pays* / PAYT(+2 F) and *precautionary* principles,
- PS/EPR (i.e., for the special/hazardous aka *CHaRM* class of products(+1 +1 +6 F) approaches, which releases all the associated social, environmental and economic benefits of internalising, otherwise externalised and ignored environmental costs(+4 +1 F),
- the framing that promotes *environmentally sustainable design* (ESD) to generate a *green revolution/new product paradigm* (i.e., detoxified, more durable, designed for disassembly, repair and end of life recycling), and involving less & better packaging(+9 +3 +1 F) (i.e. the *ECOLIZER*(F) *– a tool for designers to estimate the environmental impact of products),*
- green procurement to incorporate more recycled material inputs(+2 +1 F),
- the zero waste aim of maximising waste prevention (conversely resource recovery and conservation)/eliminating/re-design out waste and consequently its disposal(+6 +5 +8 H),
- sustainable material management(+5 +1 +1 AI, H, LP, F), production, products and packaging (i.e., in the context whole of lifecycle management (LCM)(+1 +1 F, H),
- sustainable, i.e., reduced and alterative consumption(+12 +10 F, H),
- a business/commercial sector practicing more resource/eco-efficiency(+1 +1), cleaner more sustainable production(+3 +4 +1 F, H), and pollution prevention (PP)(+1 AI, LP) processes,

- green-collar worker OSH and employment benefits and conditions[+1 +26 P, AI, M, BA] and *green* job creation[+6 +3 +16 BA,NZ, H, AI], *NB: see following Section 4.3.6.3 on green jobs for further detail,*
- integrated eco/enviro community-based engagement education/awareness/literacy for zero waste and/or ZW integrated with climate change, circular economy and sustainable development imperatives (ZW-CE-CC-SD)[+5 +1 +5 F] collective education programmes,
- the leveraging back of the ascendency of public good vs private interest[+4 +1 +2], which has declined though privatisation,
- The achievement of targets/ goals[+4 F] that enables advancing both future goal setting, monitoring and reporting (i.e., *rates and dates*) and the level of assertion, i.e., if voluntary efforts don't work, then regulatory backstops, then kick in to mandate the required activity,
- green building/*construction deconstruction and demolition* (CDD) recycling targets and permits[+1+1 F],
- improvement in the upcycling material volume and quality[+1 SF],
- consumer protection/information/guidance, i.e., better uptake of eco-labels/ISO and other standards on around the quality assurance of products and production[F],
- green/progressive and better/good leadership, rather than the right-wing/libertarian reflex to *less government* (which in this sphere appears to feed privatisation and inequity[+2 +1 +2],
- a positive framework for local, national, and internationalisation/globalised knowledge sharing and potential agreements, accords, and collective environmentally affirmative actions, etc.,
- identifying and actioning local priorities, i.e., generally reported as major initial emphasis on general household recyclables and organic recycling[+4] and a *circular bio-economy* i.e. producing and supplying valuable, high-quality compost/nutrients/organic matter/soil amendment/biogas[+2 +2 +2 F, P, M], which encourages organic agriculture[+3 AI, H, LP, M] and soil conservation/protection,
- prompts for new/better community infrastructure and public services[+1 BA],
- cutting-edge environmental research and development (R&D), for example, consideration of the issues and responses to single use plastic bags (SUPB) catalysed a focus on plastics prompted the reported incorporation into concrete pavers[+2 AL]. *NB: this may be a controversial process which may result in the spread of plastic pollution*,
- the provision of innovative models to strengthen governance, for example, rather than just shallow inauthentic consultation, permanently involving community representatives in policy-planning teams, i.e., the inclusion of an environmental attorney and eco-educator[SF],
- comprehensive community engagement and education inherent in zero waste, which in turn provides a platform of community support for directivity/assertion and target achievement by enabling the transition from voluntary to mandatory (and enforced) approaches, i.e., *no separation at source – no collection*[+2 AI, H, T] in three-stream/bin collection systems. *NB: this has the ancillary benefit of improving recyclate quantity, quality and reducing contamination, i.e., less organics/bio-hazards in waste and recycling streams, which improves the OSH status for waste and recycling workers*,
- the implementing of zero waste as a *good news story/virtuous success cycle*, which provides an opportunity for societies to shift their energy and effort from grievance/campaigning on issues into the positive focus of designing solutions and change-making opportunities. For example, *Zero Zabor* evolving from an anti-incineration group to participating in the implementation of a more sustainable zero waste model[H],

- the certainty and assertion provided by zero waste, which both enhances recycling material flows and feeds into a virtuous cycle of recyclate market development and ultimately underwrites better and more resilient and diversified market returns[+2 M],
- support for mandatory container recovery/deposit schemes (CR/DS) and other incentivised PS/EPR *takeback programmes.* Zero waste provides a framework for directly and assertively redistributing and extending responsibility back to the appropriate industry/commercial sector of (in the broadest encompassing sense) *producers* (aka PS/EPR) to shift cost off local/central/state/federal government. For example, in Taiwan, TEPA required supermarkets to prepare plans to reduce plastic packaging (i.e. according to stipulated waste reduction targets of 15%, 25%, and 35% per year 1, 2, and 3 (2011) or accept fines of USD $1 to $5 k) and that convenience stores reduce disposable cups in fast food[T]. Similarly in San Francisco, in 2012 SFE developed a city ordinance requiring all retail stores to provide compostable, recycled, or recyclable bags[SF].

4.3.3. QUAL(quant) results – EXCERPT TWO

1. Vision/Data:

Derived from: 1Aa Goals + A1c Targets + A1o Monitor / report.

1.1. Goal/target relationship

The necessity of a zero waste goal or target is generically asserted[+44] across numerous communities in a global context as being critical for any given zero waste 'community' programme. In addition, key cities (namely, Buenos Aries[+2], San Francisco[+1], the region of Alaminos, Philippines[+1], and the nations of Taiwan[+1] and New Zealand[+8]) specifically used the phrase a zero waste 'goal' and drew on this imperative within the formation of their zero waste programmes. This level of explicit citation represents a large proportion[57] of mentions (i.e., approximately 50% of the 113 references) coded to the relevant vision/data theme nodes. In three contexts[BA, SF & NZ] the construction of a zero waste 'goal' was accompanied by a declared combination of targeted date and objective (i.e., a transparent date by which a percentage of waste reduction/and or other related objective was to be achieved), which, it can be assumed, necessitated and reinforced a requirement for associated monitoring and reporting of the goal.

1.2. Typology, descriptors, compilations, and association with success

The phase zero waste 'goal' appears both as a distinct concept and as interchangeable, with clarifying phrases such as *'vision, target, journey, non-absolute, steps, approach, path, resolution, planning-principle, vision-plan'*, and the term, *'roadmap'*. So in this respect, a zero waste goal the importance of which is clearly identified in all three sources, is voiced as both a quite abstract concept as well as a quantifiable target, which is associated with even more assertive qualifiers, such as *'eliminate, concrete and end to waste'*. Following on from this observation there also appears to be a stark shift (possibly based on accumulating experience with the challenging reality of zero waste management in a municipal setting) between the earlier and latter phrasing of the concept and purpose of a zero waste goal. The rigid and assertive language initially associated with zero waste goal setting later appears to give way to more evocative and motivationally framed language. Within the data coded under the *vision/data theme,* six contexts accompany goal/target statements with measurable empirical parameters for waste diversion.

The following *'date-time-progress'* information was reported for the respective full *'goal-target-monitoring-reporting'* compilations: New Zealand[(+3)] (proposed WtL of: 50% –- 2003, 80% – 2005 & ZW – 2020); San Francisco[(+3)] (cited achievement merging into aspiration for WtL of: 25% – 1995, 50% – 2000, 75% to 90% – 2020); Flanders (cited 150kg residential waste generation target achieved by 2009); Taiwan (cited achievement merging into aspiration for WtL nationally of: 25% – 2007, 40% – 2011 & 75% – 2020 and for the businesses sector: 15% year 1, then 25% year 2, then 35% by 2011); Buenos Aires[(+5)] (cited achievement merging into aspiration WtL of: 30% – 2010, 50% – 2012, 75% – 2017, & ZWtL 2020), the generic global community[(+5)] declared goal and timetable of aspiration for WtL diversion of: phase 1: 50% – phase 2: 80% then 90% in 10 yrs). Four of these six contexts, which demarcate and utilise the concept of a goal/target, specifically adopt the term *'success'* to describe the outcomes prompted by, or the level of progress in relation to the goal (including San Francisco, identifying this as the highest in the US).

1.3. The origins of and reactions/responses triggered by zero waste goals

Zero waste goals are variously described as originating out of the influence of a wide variety of zero waste *'champions',* as well as being enabled by community development processes such as, zero waste/political activism, formalisation of the waste-picker/informal sector (i.e., cooperative formation), collective political action/campaigning. Zero waste *'champions'* are cited as potentially being pretty much anybody, from any sphere of society, i.e., community leaders/organisations, people opposed to incineration/landfills/poverty-scavenging, experienced NGO experts, citizens, students, business owners, as well as public sector staff, working, for example, within city, local or national government.

Having previously noted that the concept of a zero waste goal can be expressed via a variety of interchangeable and clarifying phrases, the actual act of establishing a zero waste goal / target, is cited as being a catalyst for several notable reactions and responses. For example, setting a zero waste is cited as prompting the uptake of more advanced target increments by agencies of and hierarchies within government and as resulting in progressing the jurisdiction further towards a zero waste goal. Another cited reaction to the declaration of a zero waste goal is the establishment of both new programmes (i.e., promoting separation at source, introducing monitoring and reporting, public zero waste education, events and government demonstrations) and new zero waste laws (i.e., mandating waste and recycling collections, reduction in waste to landfill, abolishing incineration, banning certain materials from landfill and incineration, repositioning subsidies from disposal to the 3Rs, aka reduce reuse recycle).

More broadly, paradigm shifts (in citizen mind, habit and culture), further recruitment of new zero waste community 'champions', collaboration, shared learning, and the creation of additional motivation and progress are all regarded as within the range responses prompted by the establishment of zero waste goal and or, target(s) for progress. Establishing a zero waste goal is cited[(40)] by many sources as being specifically integral to the three phase zero waste roadmap, involving: 1- establishing saturation levels of necessary services and infrastructure for *'universal recycling'* (i.e., of all material classes across C&I C&D and organic recycling) (1–5 yr); and 2- growing participation through community education and engagement (6–9 yr); and then, 3- dealing with genuinely residual waste (10 yr +).

1.4. Outcomes resulting from zero waste goals/targets

The following outcomes are identified and attributed to the establishment of a zero waste goal/target(s): quantifiable success in reducing waste (even despite, in Taiwan's case, increases in population and economic growth); cultivating the conditions for adopting further zero waste policy steps/next programme stages; catalysing a more refined understanding of zero waste (i.e., as excluding incineration/W2E; emphasising community engagement and the involvement of the informal/grassroots recycling and 'waste picking' sector); and for enabling the demonstration of innovation/leadership to other cites regionally. Another cited outcome of a zero waste goal is enhancing city/government commitment in terms of employment, service provision, leadership, legislation/regulation and educational programmes. Zero waste goals generally inspire change in the public mind-set and increase support for the new cultural paradigm of zero waste and a circular economy. At the macrolevel, the outcome of declaring a local community zero waste goal is also reported as strengthening the overarching global and national zero waste movement/network.

Each local zero waste goal declaration provides the basis for creating new collective expectations that are critical enablers for any given local community planning collective seeking to drive progress by selecting and implementing next-step policy/programme options. The expectation is that *progress* involves both selecting from 'generic' zero waste concepts, policies, and programme models (i.e., the 'zero waste vision–plan' pro-forma: 3 phase = 21 essential action steps[(SF)]), as well as locally customising and contextualising these options to pioneer new learning. The anticipation that underwrites goal setting is that creating expectation provokes change-making actions, further innovation, and the sharing of the resulting new real-world experience. This progression contributes to further cycles grassroots zero waste goal/target setting, plan/programme envisioning and action, learning and evolution.

1.5. Monitoring and reporting on zero waste goals/targets

For a zero waste goal/target(s) to be effective it needs to be measurable and time bound[(+4)]. Goals/targets require timely and accurate monitoring and reporting to be performed by (or on behalf of) the government, or other relevant authorities, to measure and manage progress transparently and provide accountability. For example:

- In Pune, India, the SWaCH cooperative of informal sector practitioners, is funded for extensive data collection.
- In San Francisco, Recology meet weekly to monitor progress, discuss any outstanding issues and next steps. NB: this involves the financial rate setting in relation to the contract matrix, which is integrated with local and state level targets reviewed in 5-year cycles, i.e., diversion of waste from landfill, etc.
- In a generic global community context, the projected monitoring and reporting requirement is framed in the descriptive anecdote of 'rates & dates'. This approach to monitoring and reporting seeks the examination of benchmarks in respect of zero waste goals and objectives in a way that holds both citizens and the government accountable for the formation and achievement of measurable steps in progressing the zero waste vision plan/path, for example, over the 3-phase 10-year roadmap framework[(+11)].

NB: a suggested overriding principle reported in relation to the anticipation for eventually formalising monitoring and compliance is: *If voluntary efforts don't achieve goals, then use regulation/ordinances to mandate activity' and then backstop monitoring and compliance/enforcement*[(+3)].

1.6. The focus of monitoring and reporting

As illustrated, monitoring and reporting can be undertaken at varying scales and around an extensive spectrum of parameters. The following are examples of what programme attributes are cited as being monitored and reported on, in the variously cited contexts:

- ✓ Varous expresions of, or insight contributing to understanding the level of divserion of waste from from landfill to benficial use. For example: Total residual disposal (reducing average per capita residential waste generation kg/pp/dy)[(+2 F)], waste minimisation, (zero)WtL / incineration diversion rate[(+4 SF, AL, BA) and r]esidential recycling rates[(+2)].
- ✓ Business operator/institutional/vendors groups (i.e. supermarkets plans[(+2)] waste reduction plans, recycling and treatment process compliance, targets and reporting in Taiwan / TEPA[(+3)] rates of recovery recycling and composting[(+2 SF)], business waste plans and progress reports, relative to mandatory business recycling targets[(NZ)].
- ✓ Implementing waste and resource collection[(+1 AI)] and or, separate collection[(FI)] services.
- ✓ Measuring progress[(+2)] towards 'universal' everywhere saturation recycling which encompasses: separate collection of necessary general recycling infrastructure[(+3)] and organic recycling services[(+6)]/commercial and industrial/construction demolition and deconstruction recycling programmes (C&I/ CDD)[(+2)] and mandatory comprehensive PS/EPR[(+1)].
- ✓ Implementing single use/disposable product bans/targeted reductions[(+4)].
- ✓ Reducing plastic packaging from non-renewable resources[(T)].
- ✓ Landfill / incinerator bans[(+1 BA)].
- ✓ PaYT disposal/landfill/incineration taxes/fees/waste levies[(+4)].
- ✓ Per capita (per person)/overall resource usage/sustainable consumption links to climate and sustainable development[(+2)].
- ✓ The implmentation of source separation, i.e., aspects such as pre vs on-site sorting and rates of participation, comprehension of, comliance with, issues raised and enforcement of rules[(+5 AI, BA, F)].
- ✓ Home composting community participation level and organic waste diversion volumes[(+2 F)].
- ✓ Zero waste system/management programme functioning/contamination (feedback on participation responsibility and service provision, i.e., re non-collection positive and negative outcomes)[(+1 AL)].
- ✓ Recycling facilities audited, re recycling volume and regulatory compliance.
- ✓ Local situational analysis, i.e., stakeholder relationship web[(P)] and three asspects in stages: assess waste generation, composition and source[(LP)]
- ✓ Situational waste auditing (i.e., based on kg/pp/dy) + waste characterisation (i.e. by source/type)[(LP)].
- ✓ Engagement levels around national goals, stakeholder relationship web, public levels of support[(+2)], community priorities and timetable/engagement/participation[(+3)].
- ✓ The evolving sequence of municipal and regional policy formation[(SF)], goals (e.g., Flanders where these were met, exceeded and then replaced with more ambitious goals – 4–5 yr review cycles[(+2)], comparative targets [(BA)], i.e.relative to 2004 baselines[(BA)].

- ✓ Community/public education(+2) awareness and critical feedback(T), outreach(SF), system knowledge, education resources, community and stakeholder appreciation, e.g., Alaminos, where at the beginning and the end of the zero waste project was comprehensively evaluated via a survey involving 10% population sample(+3 AL).
- ✓ R&D (i.e., Recology: research into new technologies, best practices, tests runs on services and infrastructure to collect and process trash)(+4 SF).
- ✓ Transition from waste to zero waste framed subsidies/incentives, and other interventions(+1).
- ✓ Collaborative / circular economy metrics.
- ✓ Anti-environmental/vested interest lobbying activity.

1.7. Agency of monitoring and reporting:

The following agencies/actors were identified as being engaged in various forms of monitoring and reporting:

- ✓ Highly visible/transparent national government, regional and/or local council/city-based measuring, monitoring, and reporting systems(+1 NZ, SF).
- ✓ Mandatory corporate environmental reporting.
- ✓ Government-based environmental ministry/agency functions (i.e., SFE zero waste outreach and implementation team(+2SF), OVAM, the Flanders Public Waste Agency, monitors legislation and policies(F); Taiwan EPA (TEPA) community compliance operations including fines (up to $1k–$5k USD)(+2T).
- ✓ Consumer-based reporting system (re TEPA in respect of vendor compliance (with fines $2k–$10 k USD)(T).
- ✓ Residents/'citizens´ committees' which monitor programme implementation.
- ✓ Workers/worker cooperatives involved in system monitoring.
- ✓ Public private people partnerships (PPPP) type service providers, i.e., ‘Recology’ has a symbiotic relationship with SFE in conducting oversight, several successive ordinances that target additional parts of waste stream(SF).

4.3.4. QUAL(quant) results – EXCERPT THREE

2. 16R Priorities:

Derived from: A1b Strategic plan + A1d WZW hierarchy + A5d Int. networks + A1p General to local

2.1. 1R Reframe/re-engage/revitalise

Initial formative commentary: It is important to recognise that these top-level priorities articulate the baseline of affirming the original ‘sanitary motive’ and ‘public service’ centred purpose of waste management (i.e., ensuring communities are hygienic, safe from biohazards and environmental risks associated with pollution), while acknowledging that today this now extrapolates to a globalised context (i.e., re ocean plastics) to humanities commons the biosphere. Recognising the paramount anthropogenic basis of waste as a modern issue phenomenon, it is critical from a zero waste perspective *to ensure this subject is reframed as a human/sociological phenomenon (i.e., individual and collective knowledge, awareness, values, behaviours, etc.) rather than primarily a technical problem (i.e., one which can be fixed by plugging in further 'black box', techno centric, quick fix solutions). The combination of reasserting the centricity of the 'public good', ahead of 'private profit', the reality materials being valuable resources for recovery, not waste for destruction and disposal and the primacy of sociological over the technical basis of waste, provide a strong imperative driving the reshuffling and supplementing process in developing what emerges as a distinctive zero waste hierarchy (NB: it should be acknowledged that there are many other strands of social evolution and political ecology at play, such as the exposure of the co-dependencies of infinite resource extraction, linearity and disposal as being illusory, dysfunctional, and malign negations of the necessity to diagnose and reverse the deliberate social engineering that created the 'throwaway society'. Another apparent driver for the ongoing reworking and actualising of the hierarchy of priorities central to a zero waste methodology, has been the criticality of engaging, via international alliance and collaboration, to share, apply, and grow best practice, relevant to the formation of zero waste methodology. This process appears to offer an infusion of ideas, innovation, and mutual support that enables what would otherwise be isolated clusters of enthusiasm to connect and be energised, be informed, and to evolve through exposure to emerging learning and practice (NB: ZWIA and Zero Waste Europe have respectively been the preeminent early and latter formats for this phenomenon).*

Key high-level factors tath evidence and drive the 'revitalising/reframing/re-engaging' imperatives as the highest level of priority of an emerging zero waste hierarchy are:

- Following on as a confirmation of the prior vision/data theme is the identification of the critical and necessary function of reframing social cognition (i.e., away from a throwaway waste culture, into a future focussed zero waste culture) that occurs when a prominent public zero waste goal statement is coupled to targets and timeline[7 +1 +3] commitments.
- The scientific and public characterisation that 'real' resources exist in the waste stream underwrites the conceptual basis for all waste to be permanently reframed as resources. Zero waste seeks for this conceptual shift to then be actualised in practice via prompting a revitalisation in the design of resource interception and treatment practices and programmes[LP]. This *waste to resource – concept to practice* reframing, is in fact, simply a reversal of the normalised *resource to waste – useful to unwanted* transition that occurs at the point of discard. At this point, normative waste *management* systems kick in and simply confirm and permanentise the conceptual downgrade.
- The foundational principle that shared public good must be reframed and remain elevated ahead of the private rights, perspectives, and benefits of the professional sectors that make and manage waste (NB: it can argued that this has by degrees become inverted through processes such as privatisation and ascendance of vested interest lobbying). However, this principle coincides with the compensating ideal that social and commercial entrepreneurism is an essential driver for realising progress towards zero waste targets[NZ]. In short, at the highest level zero waste embraces the elusive synergy between the private sector and business innovation as a vital driver for actualising the expressed public vision of the community. Zero waste seeks to reframe and re-engage the way private and public sector interest interrelates.
- Engagement and learning through the sharing best practices enables alliance and network formation at local, regional, national and international levels[BA]. The outcome of the re-engaging of people, i.e., non-professional, non-expert, interested, motivated, and responsible communities at the centre of responding to the issue and opportunity of (zero) waste, is:

- An empowered and formative sense that zero waste is becoming a confident, self-actualising global movement, which is on the right side of history (i.e., confirmed in the anecdotes such as, *change making is hard* – zero waste is an aspirational journey, not a final destination).
- The formation of various *'how to'* types, resources *(i.e., Roadmaps, Vision-plans and latterly the Zero Waste Europe Masterplan)* that recognise critical planning principles(+6 +1 +3), key polices, programmes, and an infrastructure that is identifiably zero waste
- Accumulating evidence suggesting that zero waste can be accepted as no longer an exotic and untested anecdote, but rather is increasingly viewed as a proven and cost-effective strategy.

- Coinciding with reinforcing the outcomes of engagement and networking is the accumulation of scientific reporting, which confirms and validate the value proposition (i.e., based on interrelated financial, GHG emission, pollution, and other metrics(+2)) of transitioning from a waste to a zero waste, circular, sustainable mode of economic development
- Accepting the co-axial that raising issues is essential for positively underwriting the opportunity for solution making. The coaxial of issue vs opportunity is activated in the dynamic interplay of media coverage, political focus, and social awareness. The disruptive forces of protest and activism, i.e., the community's fierce anti-incineration campaigns, are an example of this issue vs opportunity interplay, which acts as a catalyst for change, by driving zero waste goal declaration and policy setting(+3 P, H, T).
- Another coaxial that can be constructively revitalised in the dynamic interplay of media coverage, political focus, and social awareness is that success and progress = more success and progress. For example, positive personal and collective indicators of zero waste success and achievability reengage further buy-in and the uptake of responsibility for issue resolution. As an example of this, see the cycle of success associated with OVAM, the 'public' waste agency in Flanders, where the achievement of goals = recognition of 'leadership' status motivated the establishment of more ambitious goals and progressively higher levels of achievement(+2 F).

2.2. 2R Rethink/re-incentivise

Initial formative commentary: The level prioritises a fundamental rethink of the paradigm out of which (zero) waste policies, strategies and plans are derived, for example, this involves replacing the aim of 'managing' by the aim of 'eliminating' waste and, shifting from adequacy to aspiration. A key and well-publicised paradigm rethink involves replacing the default of linear resource (extraction, consumption, and disposal) with new requirement to maximise material circularity within the economy. Enacting such a quantum change requires redirecting all direct (and latent) incentives/subsidies and social engineering away from the existing defaults, such as over-consumption, disposability, designed obsolescence, and the externalisation of environmental costs, toward the polar opposite outcome. These high level aspirations for rethinking and re-incentivising the theoretical framing of waste management into genuine zero waste theory and practice have in large part been defined and articulated by the iterative discussion and publication processes undertaken by the ZWIA collective, latterly supported by the functions of Zero Waste Europe and the recent academic publications.

A key and numerously supported imperative exposed by this high-level, 'rethink/incentivise' requirement, is for a lead zero waste agency to deliver on this high-level strategic role through the development and implementation of recurring city(+1 SF)/regional/national(NZ, F) policy and planning cycles. This lead agency(+2) actually needs to be seen as a trusted and independent (i.e., above polarised debate public private interests) repository of information (i.e., evidence-based R&D/international best practice), yet able to:

- habituate greening change, by lowering the volume[(+8)] of production and consumption[(+2 H, T)] and ensuring this evolves to be more sustainable and collaborative, e.g., the concept of *zero waste purchasing* that is further elaborated in the following levels (i.e., 're-educate', 're-examine/refocus' and ' re-invent/revalue').
- locally facilitate the development of a 'bottom-up', village-level, community-based decentralised approach, as this is the most effective ways of establishing and achieving successful local zero waste goals[(+3 SF, F, T)]. Instrumental to this leadership agency is the process of identifying and engaging essential priority actions from the hundreds of possible options[(+2 +3 +1)].
- articulate the concept and journey of zero waste as being a viable, socially based, comprehensive/systemic change strategy. Zero waste can be recognised as both involving a common internationalised cluster of foundational programme elements (i.e., ref. the ZWIA in forming a definition), and also encouraging customisation and contextualisation of these foundation elements to and within any given local community[(+2+1+3)].
- redirect the agency of government in terms of increasing and redirecting how (transparent and accountable) funding/incentives[(+4)] and subsidies are used to, for example: recognise and enhance informal / community sector services[(BA)] as a key driver for change and to empower resource recovery centres (RRC) as a physical instrument for material circularity[(+2 F)].

2.3. 3R Re-educate

The previously outlined level parameters of the emerging zero waste hierarchy (i.e., 1R: 're-engage/revitalise/reframe'; 2R: 'rethink/re-incentivise') create a quantum requirement for re-education of all facets of society about the necessary individual and collective roles and responsibilities[(+2 NZ)] that need to be fulfilled if we are to transition from the current extractive, linear, *throw-away society* mode into a new zero waste model based on circularising the flow of material resources within the economy.

This tranche of commentary is significant, both because of the level of repetition and reinforcement of the critical importance of re-education/outreach[(+4 SF)] (which is also articulated in various frames, such as awareness raising and engagement for creating participation and culture/system/behaviour change[(+9 +6)]) and because commentators have actually proposed a transparent and escalating financial metric for funding this outreach[(+3 SF)] (NB: ultimately this rises to a suggested $3–4 pp/yr[(+2)]).

Aside from the overarching focus on transitioning social consciousness of fundamental 'roles and responsibilities', other cited foci of re-education are: generating a groundswell of total societal engagement and actual involvement[(+2 NZ)]; creating a *culture of recycling*; and fomenting change in the nature of demand drivers of production and consumption[(H)]. This educational transition also involves new regulatory and economic instruments that support consumers in discerning and choosing green/sustainable procurement and producers in responding to these changing patterns in consumer perception and choice-making.

Another key focus of the necessary societal re-education processes is enabling the requisite evolution from initial voluntary to latter mandatory frameworks. This escalation is reinforced by, for example, escalating zero waste targets for events/public space recycling/sectors of the economy and schools etc(+2). A key knowledge platform in this societal re-education is linking the proposition of zero waste and a circular economy to the broader science, debate, and response curve around addressing climate change and the UN sustainable development goals.

Re-education fundamentally involves accepting, understanding, and reforming past learning, social conditioning, and institutional memory and resetting and renewing the foundations of collective community knowledge. The process of re-educative information and persuasion involves the tools and skill-set of the advertising industry being redeployed from creating the *throw-away society,* to the cause of zero waste and a circular economy.

2.4. 4R Re-examine/refocus

The next level of expressed priority is to re-examine the essential function of *waste management* and to understand this is essentially a problem of how materials and toxins flow through the economy in the form of products and, hence, interface with the lives of people in society. Transitioning to a zero waste model requires moving beyond simply quantifying and qualifying waste destined for disposal. Designing the transition to a zero waste-based, circular economy model requires creating a much bigger, richly detailed, and more accurate and authentic picture of how material resources flow throughout the economy. This process of re-examining the materiality of society moves beyond 'waste and recycling audits'(LP) into the science methodologies typical of industry ecology/urban metabolism studies, such as social material flows analysis (SMFA) and input output analysis (IOA), which can characterise resource flows on local and national scales. Committing to a zero waste journey inherently involves a commitment to overcoming this complexity, accessing and analysing a diversity of new data streams, and collating this into a more complete and effective 'big picture' data-base that can function as a resource management guidance system.

Shifting beyond waste into this holistic materials focus, should include at least all 12 'master' resource categories(NZ). This re-focussing should encompass the entire materials/product supply chain, lifecycle, all relevant stakeholders, and a conception involving an upstream[68], midstream, and downstream(+1) foci and the relevant suite of interventions that can influence and potentially transform the fundamental nature of producer and consumer responsibility, behaviour(H), and resulting material flows.

It can be recognised that the quantum shift from the limited paradigm of auditing and understanding waste into the expansive challenge of characterising the socio-economic and technical attributes of all material resource flows will pragmatically be a progressive journey. This may start with a baseline of, for example, measuring progress in diverting 'traditional recycables' from value destroying disposal pathways(+2), but cannot stop at just that *end-of-pipe* (disposal focused) worldview. A zero waste hierarchy prioritises refocussing not just on the conceptual transition to a *front-end(+1), upstream, top of the pipe* perspective and approach, but also on integrally re-examining how holistic materiality is empirically quantified and qualified, as this is also essential feedstock of information that underwrites the design and implementation of more sustainable resource management across the economy.

---

[68] "Upstream: *Maximising resource efficiency and waste prevention through product redesign, zero waste purchasing (inc. sustainable consumption), producer responsibility and new policies that promote a circular economy. + Midstream: "Maximising resource longevity through reuse, repair, sharing and durable design. + Downstream: Maximising resource recovery through recycling and composting"* (Lombardi & Bailey, 2015 pg. 9).

2.5. 5R Reinvent/revalue

The previous priority of reforming the entire concept and practice of 'measuring' (i.e., what, how, when, where, who and why) to enable managing material resources in a more sustainable, circular, zero waste focussed model, underwrites the possibility of inherently re-inventing the way resource value is understood and ultimately how materials are utilised and conserved(BA). Accumulating scientific and social concern about waste and pollution reinforces the necessity of transitioning from profligate, mostly linear, wasteful, and destructive patterns of material resource exploitation, consumption, and disposal. The stepping off point for this transition is the reframing of the materiality of society from valueless to valued. The challenge of reinventing our conception of value, involves political, policy, technical, infrastructural, managerial (service), and socio-economic dimensions.

A key element of reconfiguring society for circular materiality is at the point of discard, to displace the incumbent expression of *valuelessness* (aka wasting) and replace this option with normalised, self-reinforcing expressions of revaluation. In practical terms, this means deconstructing value-destroying, disposal pathways and replacing these with *universal* recycling. The new normal needs to be an authentic, highly accessible, efficient, user friendly, value preserving, systematic resource recovery pathway that covers all 12 main recyclate (inc. organic resource) streams(+2). The new system needs to be animated by the same level of directive, immersive, and evolving(+2) community education campaigns, which are at least as sophisticated and effective as the ambient levels of persuasion supporting linear, disposable consumerism (aka want – buy – use – chuck waste).

It is widely recognised that the *wastefulness* exhibited today is the direct result of a deliberate socio-economic construction. The antithesis of this requires a similarly deliberate process of social reconstruction of material worth and revaluing of natural capital from zero (i.e. infinite and expendable) to whatever level is necessary to evolve into more sustainable levels of material extraction from and emission to nature. Redesigning the entire system of resource use on the basis the environmental, social, and culture values that are, at the very least, balanced with economic imperatives, represents a revolutionary change in the 'rules of material engagement'. However, the end result of transacting this fundamental culture change is to reverse the current increasingly contaminated/toxic and wasted trajectory and replace it with the opportunity for sustainable prosperity(+1).

A liveable future requires reinventing the design parameters for everything from conception (i.e., including rather disassociate packaging and peripherals), to content (i.e., material derivation, quality, and transitioning into renewable/bio-degradable materials, etc.), to life-cycle (i.e., upgradability/reparability vs obsolesce), to the logistics chain of custody and market-based economic instruments, interventions, and incentives so as to unleash creativity(=3) and reinvention at the nexus of all future production and consumption. This transformational challenge involves creative/artistic and ethical/spiritual dimensions that track to the core of our individual and collective humanity. This reality is reflected in common sayings such as *waste only exists between our ears*. The zero waste ethos asserts that, rather than being an inevitability, waste is fundamentally a failure of imagination and design and hence is an inherently fixable human-centred problem.

2.6. 6R Redesign: Production, Product – Packaging and Service Systems (PPPSS)

Ultimately, unless industrial processes are redesigned[+1 +1] to ensure eco-efficiency and cleaner 'production'[+1 F] are normalised, and unless environmentally sustainable design (ESD) is powerfully engaged to produce a new generation of green product and packaging, services systems (PPSS) and unless toxicity and pollution prevention measures (i.e. such as the RoHS Directive in the EU context) are instigated, the waste/resource stream will always be, by neglect / default, *'designed'* for disposal.

Redesign is an opportunity to get to the root of the issue[F] of waste and to mitigate or eliminate the root cause before it manifests as a problem. Unless the industrial system is required in policy and practice to be redesigned[+2 H, F] to be sustainable[+1 F], the resulting PPPSS will always be, by degrees, unsustainable and problematic. This will mean the previously discussed 5R zero waste hierarchy priority of revaluing the conception and reinventing the actual measurement and management of resource flows risks only ever interfacing with a defective and polluted waste/resource stream that is in essence, pre-destined for, at best 'down', rather than 'upcycling'. The key indicators of zero waste focussed environmentally sustainable (re)design include durable[+1], non-toxic, reusable, and recyclable material flows, etc.

2.7. 7R Redistribute responsibility

A critical fulcrum for generating change and progress towards zero waste is to redistribute the notional and actual *responsibility* for end-of-life product and packaging away from government and to lock it in the 'consumer–producer' transactional context. When government is absent or dysfunctional, then in reality the practice of responsibility gets voided into the amorphous and invariably irresponsible *commons* or abstraction such as the *market.* Neither government, nor ungoverned abstracts such as the *commons* or the *market,* can effectively exercise necessary control over product design or consumer behaviour; *product stewardship* and/or *extended producer responsibility* is the term applied to the mechanism for regulating responsibility within a 'consumer–producer' transactional context.

In reality, there is an internationalised spectrum of terminology and systems covering voluntary to mandatory regulatory, market-based instruments, interventions, and incentives that can be categorised as product stewardship/extended producer responsibility (PS/EPR). However they are designed and described, PS/EPR systems are the critical mechanisms for the corrective redistribution of responsibility for end-of-life product and packaging. When end-of-life responsibility product and packaging (and any assorted issues, such as poor design, toxicity, non-recyclability, etc.) resides with the producers, the cost and consequence resonate back up the supply chain and will positively influence the future design and production functions, potentially transforming the entire life-cycle of future products. To whatever extend that PS/EPR are mandatory, the net effect is to redistribute the financial burden for resource recovery and recycling off government alone and enable it to be more fairly organised and shared with all stakeholders relevant to the producer and consumer transactional context. Ultimately, who and how responsibility is shared will vary according to factors such as industry context, historical background, legislative, technical, and socio-economic development relative to each jurisdiction and for each material class requiring coverage by PS/EPR system design.

Another very pragmatic example of redistributing responsibility that has significant impacts on both the quality and cost-effectiveness of recovery and recycling systems and the social messaging within participating communities is the institution (or otherwise) of *separation at source*. Essentially, a *separation at source* policy means that the core responsibility for correctly identifying, preparing materials for recycling (i.e., washing and sorting), and placing (of resources as well as waste) in the right receptacle for collection, rests with the individual/community/business programme participant, rather than with the recycling programme provider alone. Effective primary *separation at source* can greatly reduce to cost, complexity, and contamination issues at secondary sorting and handling municipal recycling facilities (MRF). Zero waste literature identifies mandatory separation at source[+6 +2], i.e., 'food/organic' waste recovery and recycling[+1 T] are the key mechanisms for decontaminating waste and resource streams and improving the operational (i.e., health and safety for biohazards) and material quality (i.e., resulting marketability and prices).

In practice, separation and source mean the *responsibility* is shared and balanced between the participant and provider of a recycling programme. In a separation-at-source scenario, the recycling programme provider's responsibility is to facilitate the participant's understanding of how the recycling programme works. This knowledge enables the participant's resulting actions to align with and support successful recycling outcome. In this way, both recycling programme provider and participant achieve the shared goal of cost-effective recycling. In a New Zealand municipal context, shared goals are normally defined by the process of local community consultation about forming the *Waste Management and Minimisation Plans* (WMMP) that are a requirement under the Waste Minimisation Act (WMA:2008).

Another option for redistributing and devolving responsibility is for government to require itself (aka the public sector) and the private, industry/commercial sector to develop and be accountable for implementing and reporting on mandatory (zero) waste minimisation plans[NZ]. Such regulatory frameworks might include universal requirement for separate (waste vs resource streams) collection[+1 F]. The redistribution and attribution of environmental responsibility resets socio-economic norms, so the industry and community organisations compete over how they can most efficiently deliver high normalised environmental objectives, rather than over whether they participate or not. This acclimatisation of higher universal environmental expectations and standards serves to reward resource recovery over waste[+4], incentivise R&D and investment focussed on environmental sustainability, as well as generally foster innovation, such as reverse logistics. In this socio-economic regime, commercial parameters such as competitiveness, productivity and profitability are reset and aligned to achieving clean/low toxicity/environmentally sustainable PPPSS (rather than the opposite) and the practice of civic responsibility is enhanced[+2]. Instituting an *all in – level playing field,* guided by a regime of *green drivers*, can then be amplified by further direct market interventions such as, public sector sustainable/ZW procurement polices[+2] and requirements and incentives for construction, deconstruction, and demolition recycling (CDD)[+4]. The various option for redistribution and devolving *responsibility* represent a powerful opportunity to support the development of diverse, growing, resilient, and higher value recyclate markets and hence the financial sustainability of the circular economy per se.

2.8. 8R Recreate

Zero waste is distinguishable as globalised community of practice in its deliberate, sustained, and confrontational opposition to waste and disposal, especially to incineration, which includes the technical offspring, waste to energy (W2E). This assertive activism goes against the prevailing flow of mainstream waste industry idiom and socio-economic momentum and renders zero waste as an outlier. However, while clearly incorporating aspiration and opposition, the theory of zero waste is not, as might be characterised, internally conflicted and self-defeating, as it in fact arises from pragmatism and grass-roots practice, rather than esotericism. As an outlier, the zero waste movement proliferates outside mainstream profitability and investment, which is mostly orientated towards facilitating waste and disposal rather than its antithesis.

Rather than by power and profit, the success and progress of zero waste is actually underwritten by the inherent power substitution that resides in actualising the waste hierarchy, i.e., reducing (top priority) offsets the significant cost and problems inherent to displace disposal (last priority). Much of the opposition and denigration directed at zero waste relates to the fact that, like most *sunset fossil industries*, the waste industry is ultimately only competitive because of an entrenched regime of subsidies and externalities. If the latent subsidisation of waste is exposed and removed, then the top of the waste hierarchy logically and financially outcompetes the bottom.

The zero waste campaign imperative against waste disposal is fundamentally about catalysing substitutional change, i.e., exchanging opportunity at the top of the pipe (aka reduction), for liability at the bottom. The duality inherent in the zero part of zero waste is the re-creative dimension and emphasis towards the largely untapped power of the upper elements of the zero waste hierarchy. The zero waste aspiration for disruption, transformation, and socio-economic paradigm shift, advocacy for regulatory intervention and market–based economic instruments and incentives, the call for investment in *up*- rather than *down-cycling* as the basis of recyclate market development[(2)], the preservation of the public interest in rather than abdication of ownership/control of societal material flows to the private sector and the embrace of the collaborative/sharing economy[(+1)] as an opportunity rather than a threat, are all re-creative manifestations of the power substituting liability for opportunity.

The term *'recreative'* is appropriate because, *today* is an outcome of a creative design process, hence moving beyond *today* to a better *tomorrow* (aka substituting what isn't working for what will work better) is recreative process. The duality, polarity, and tension in the terminology and outworking of zero waste directs a recreative energy at remaking the socio-economic conventions that frame the provision of, for example, regional and nationally coordinated policies and programmes for re-engineering infrastructure and services[(SF)] and financial parameters for circular materials economy (i.e. PAYT fee differentials and higher value and diverse recyclate markets /prices).

2.9. 9R Restore/reform

Initial formative commentary: The context for this zero waste priority is the historically pervasive transfer of responsibility, control, and opportunity over this sphere, from the public to the profit-motivated private sector that has occurred under the influence of neoliberalism/privatisation movement. The net result of this transfer is that in New Zealand most government waste strategy and local councils' WMMP aspirations are scripted in the absence of direct control and hence the ability to execute strategies such as to reshape material flows from linearity to circularity. As a result, most New Zealand WMMPs identify the percentage of material flow controlled by the respective public and private entities are interpreted in the concept of bearing influence, rather than in direct action. In *reality, in New Zealand the type and degree of influence exercised by government (i.e. via legislative, regulatory, policy, and programme interventions and directional funding) are subjected to intensive lobbying, sophisticated media campaigns, and legal challenges that manipulate the outcomes in favour of vested interests. The net result of this policy capture by vested private sector interests has been the subversion of democratic imperative and dysfunction and regression in the key performance indicators describing national waste management performance. The zero wastes response to this scenario is to institutionalise and reform the balance between the public vs private sector's respective 'control over outcome' to ensure the ascendance of public interest (reflected in democratic community consensus) is restored.*

Restoring and re-enabling the essential role of the 'people' (individuals, families, the community, and NGOs) to complement the role of local and national government, is crucial in (zero) waste management. In developing countries this translates as the promotion of the informal sector (i.e. waste pickers) and the projected UNSDG achievements that accrue as this sector evolves into a more formalised *green collar* workforce (D. C. Wilson, Rodic, et al., 2015b). As an internationalised community of practice, zero waste emphasises adding value and formalisation to the informal sector specifically through programmes that increase financial returns, improve service quality, and utilise the sector to improve waste data essential to policy development[(P)].

One of the strands in the development history of the global recycling industry is the transition from informal to formal. In the world's developed economies this has already historically occurred, i.e., London's scavenging community of 'toshers' and 'mudlarks' have evolved into the large cooperate recyclers and scrap metal industry. A referenced zero waste case study that illustrates how this transition can be engineered with a community ethos is San Francisco's 'Recology', which evolved in the 1900s out of informal waste picker federations and finally out of the amalgamation of the 'Scavenger Protection Association' and the 'Sunset Scavenger Company'. Today, San Francisco continues to facilitate a role for the informal sector, via the container deposit/refund system that supplies street-level income to homeless people. Today, Recology is an employee-owned (2,550 employees own 80%) and works symbiotically[(SF)] with the city government through a contractual framework of incentives, based on achieving community derived goals.

In effect, this model represents an established and thriving *public private people partnership* (PPPP)[(4)]. However, while San Francisco is a leading global city, this same zero waste principle of community-based NGO – Govt – informal sector PPPP is also cited as working today in developing country contexts, for example, in the Philippines, where the informal Barangay community have been incorporated in zero waste consultation planning, upskilling, knowledge sharing, and collaborative management business/professional development[(AL)]. These are demonstrations of the zero waste principle of restoring the community/public interest in a positive synergy with (rather than subservience to) the private profit motive. A reformed (zero) waste management service matrix is cited as providing a more innovative, high quality, financially sustainable[(H)] model that promotes worker (green jobs[(+2)]/robust, meaningful and effective community engagement and well-being. The restorative/reformative zero waste PPPP model is articulated as an *inside-outside partnership*[(+1 +1 +1)] that deliberately involves and empowers a *community table* (via citizen advocates)[(+2)] in precedence to the *industry stakeholder table*[(+2 +1)]. Without deliberately structuring in restorative affirmative action in support of *people/community*, where everybody genuinely works together in partnership[(+2)] it is hard to reset and retain the balance of community-inspired, democratic outcomes, ahead of competing private interests. Another way of interpreting these imperatives is to understand that this is a way of re-setting some of the worst excesses of privatisation on what used to be the public good/community service of waste management, i.e., the opposite of *privatisation is publicisation.*

2.10. 10R Reduce – refuse

Reduce normally exists as the top priority of conventional expressions of the concept of a waste hierarchy. In this instance, the location of reduce – refuse at the 10R level does not indicate a deprioritising of the imperative of reducing waste (NB: which still is located above the normal arrangement of reuse recycling recovery and residual disposal). This expansion of the new exceeding (1R to 9R) levels of priority levels is because these are seen establishing the prerequisite environment in which genuine prevention[+9 +1 H, F, T]/minimisation activities that reduce[+7 +5 SF, AI, T, BA] the generation[+2 T] of waste at source can flourish.

For producers, the cluster of necessary (1R to 9R) priorities resets to operating environmental and normalises waste minimisation for all commercial/industrial manufacturing of PPPSS. For consumers, this involves informing and supporting change in individual/household consumption, behaviour, and lifestyle, resulting in less waste generation. This means structurally enabling consumers to refuse[+1 +2] to create waste by normalising the exercising choice about what they pay to allow into their personal sphere (i.e. environmental footprint) and what packaging accompanies these products. Currently, plastic, packaging, and zero waste consumption/lifestyles are the exception, and people have to deviate considerably from the mainstream to realise these choices. The combination of the preceding and the 10R priority enables and shifts reduction from the exception to the rule. This organisational hierarchy recognises the fact that 'reduce' has always been the most cost-effective waste management action that, when realised, entirely resets the subsequent investment parameters for all waste management hardware.

From a municipal perspective, a critical unit and focus of engagement in reduction/prevention is household/residential generation[+3F] and behaviour, as this market signals shaping the future of PPPSS. Zero waste awareness not only reshapes decision making about consumption, resulting in reduced waste generation, but also supports maximised engagement in and compliance with municipal recycling/waste diversion programmes, i.e., correct ID, preparation, placement of recyclables) within whatever the local collection and handling infrastructure and service matrix has provided. Reduction framed in the concept of zero waste aims not only to reduce initial waste generation significantly but also to maximise the diversion of resources from waste disposal (aka circularise socio-economic material flows) and in both respects, minimise the cost of the entire operating system[P].

The potential from reduction exists in a plethora of spaces where purchasing decisions are made, as these are locations where consumers can either refuse to make waste or unconsciously or involuntarily participate in the throwaway society. This means that concept and actual reality of reduction has to colonise the physical locations and operations of, for example, shopping malls and big box stores, etc. In these domains, the social paradigm constructed trough advertising is the polar opposite of thoughtful choice-making and reduction, i.e., unrestricted and conspicuous consumption (*aka don't think – just buy – consume – then quickly dispose and buy more).*

Increasingly, consumption/purchasing decisions and all their attendant implications for waste making are outworked in a virtual shop/online buying space. This means that the challenge of cultivating and normalising reduction also follows this transition from the physical into the virtual domain. The online environment for consumption is a conduit for all the same advertising leveraged, social pressure applied in the *'bricks and mortar'* physical context of purchasing decisions. However, consumption in the online environment obscures the waste-related implications (i.e. packaging) and, because of the involvement of third-party, courier/transport, this mode of consumption may generate even more waste by negating the ability, for example, to decline a packaging bag at the point of sale. Given such permutations, the relative power of retail freedoms of speech and practice and the association of consumption as pseudo-public *good* mean that creating and normalising a future culture of reduction is a significant factor that needs to be outworked in an effective and encompassing way. Direct interventions/restrictions aimed at reducing packaging, as well more general disposability (i.e., single use/products and packaging 'designed for the dump') and disposal(+2) are identified (alongside macro-level product platforms, i.e., requiring deconstruction(+2 +1) in the built environment) as an essential consideration for zero waste.

2.11. 11R Reinvest in return/re-circularise infrastructure

The realisation of a new circular economy(+2) targeting zero waste involves upscaling both the socialised concept and practice of drop-off/return and the corresponding investment in physical collection, drop-off, and processing systems. Progress into a zero waste-based circular economy requires an entirely new level of accessibility, functionality, and efficiency in collection systems in order to receive and process the increasing levels of recovered and recycled material flows, aka *"technical & biological nutrients"* (Ellen MacArthur Foundation, 2013a). The *return* element of this equation can be significantly enhanced through permanently shifting and reinvesting the burden of responsibility for the funding end of pipe recycling systems off local government back on to the industry sectors that produce the various product classes that need to be diverted from waste into recycling streams. The globalised concepts and interrelated practice of *product stewardship (PS)/extended producer responsibility (EPR)* is the key market-based mechanism for driving the return and recovery(+2), and hence circularity(+4), of products and the materials they contain.

A critical feature of PS/EPR systems is the ability to empower and incentivise the function of return/recovery. This effect is maximised where mandatory state/region-wide national framings have been legislated, as this creates an all-inclusive level playing field where all participants in the sector compete on the basis of how cheaply and well (rather than whether they do or don't) they deliver the requirement of producer responsibility/product stewardship. This model of a market-based economic instrument enables rationalisation such as economies of scale to work in favour of, rather than against environmental outcomes. In a market-based economy it can be recognised that ultimately consumers fund all PS/EPR environmental services through pricing mechanisms. This funding process is most clearly apparent where discrete consumer pricing arrangements are transparently identified within the design of mandatory nationalised approaches to PS/EPR. An example is where 'advanced recycling/disposal fees' (ADFs)(+4) are paid by the initial purchaser, at the beginning of the transaction/ownership cycle of the relevant product.

When an ADF is paid at the point of original purchase it generally means that the end of life return/recovery/drop-off is free. As the prepaid end-of-life recycling fee resides with the product, under this model any subsequent owners reusing and extending the life of the product do not have to pay again and can enjoy the privilege of free end of life drop-off. Paying the ADF at the point of original purchase is the logical time to fund the end-of-life treatment as this is where proportionally it is most affordable (relative to the product price) and minimises the overall financial impact. However, for some product classes the concept ADFs funding PS/EPR goes further and actually financially incentivises and rewards the person undertaking the return/drop-off functions of the specific product type. An example of this model is the container deposit/refund systems (CD/RS) for food and beverage packaging that pay the returnee a small per product item refund fee (Allcock, Liefting, Tsuji, & Utley, 2010; Auckland Council & WasteMINZ, 2017; Envision New Zealand, 2015; WasteMINZ TA Forum, 2017).

PS/EPR approaches are particularly useful to drive the return, recovery, and recycling of product/materials classes (i.e., packaging, WEEE, tyres batteries, etc.) that normally fall below the threshold of financial sustainability via free-market forces alone. PS/EPR interventions can be specifically designed to fulfil a wider public good mandate, such as empowering green design, growing the scale, diversity, and returns from recyclate markets, achieving environmental management and occupational health and safety ISO standards, addressing data gaps for waste/resource flows, progressive taxation systems, such as general or specific waste levies (i.e., for single use plastic bags – SUPBs), and general or specific landfill and/or incineration bans. Importantly, the benefits that can be leveraged from instituting PS/EPR, do not necessarily conflict with the closed loop product leasing/renting models that form an important part of the emerging circular economy (Ellen MacArthur Foundation & World Economic Forum, 2016; Fishbein, McGarry, & Dillion, 2000; Geyer, 2004; Mont & Lindhvquist, 2003; PACE & WEF, 2019). PS/EPR systems also align with imperatives or practices of movements that are synergetic with zero waste and a circular economy, i.e., the industrial ecology/symbiosis, urban metabolism and sharing economy, and remaking/remanufacturing (Bernard; Gharfalkar, Ali, & Hillie 2016; King, Burgess, Ijomah, & McMahon, 2006; Watson, 2008). In short, PS/EPR systems represent a powerful opportunity for investing in return, recycling, and re-circularity, while shifting the burden of cost and responsibility from government to where it belongs, which is the product–consumer transaction contest (aka priced into the market).

When PS/EPR is legislated and implement as a now socio-economic fundamental, then the correct platform exists for reinvesting in services and infrastructure to receive and circularise these material flows. Key principles guiding the reinvestment process for establishing infrastructure specifically designed for enabling zero waste and a circular economy are:

- foremost to ensure collateral infrastructure and collections system are designed to structurally avoid mixing/comingling of waste with resource streams[(+2]
- retain the *source separation* of material/product types making up the resource streams
- to build on and redeploy the existing asset base
- rationalise local infrastructure planning within regional & national planning and development frameworks, so as to ensure synergy and cost effectiveness.

Critical baseline functions that are identified for zero waste infrastructure are:

- to support organic recycling (OR)

- municipal recycling / recovery facilities (MRF) with advanced sorting capacity[+5 +1]
- commercial and industrial (C&I), construction\
- deconstruction and demolition (CDD) processing, via MBRT - LF (i.e., dirty MRF)[+4 +1] type models
- centres for hard to recycle materials (CHaRM) types facilities [+4 +1] that are integrated with overarching national PS/EPR systems/strategies.

The endgame of reinvesting in integrated collection/infrastructure for a circular economy targeting zero waste is that, eventually, municipal decision makers (especially in large densely populated cities) can employ mandatory home (and multi-family units – MFUs) and business recycling systems and enforce participation[+2] and compliance to ensure the recovery and recycling of the full spectrum of resource types[H].

2.12. 12R Re-use

The term re-use[+6 +9] encompasses a cluster of aligned and analogous practical activities, including: repurposing, remaking, remanufacturing, reconditioning, refurbishing redeployment, and recovering products/materials)[T] for repair[+2], which may be out-worked via initiatives such as, fix-it clinics[+4 +2], 'tool libraries' to enable do it yourself (DIY) repairs[+1], repair cafes and maker-spaces, etc. One way of enhancing this collection of *re-use* related activity is by programmes and policies that recognise, reward, and grow the local 2nd-hand[+2 F]/so called *third* sector or zero waste non-government organisations (NGO) and networks. Unless this re-use specific infrastructure and service system already exists, the re-use support system is likely to involve making strategic reinvestment into 'resource recovery' centres (RRC)[+1]/parks (RRP)/network(s) (RRN)[+1] and or eco-industrial-ecology/symbiosis park(s) (EIP).

This spectrum of organisations (which may be singular or multi-faceted clusters of operations) operate at varying scales and ways, but are typically involved in outworking variations of the basic 3R framework of:

- reduction (i.e., zero waste and environmental education),
- reuse (i.e., as illustrated above this is actually a diverse cluster of interrelated spheres of activity that enhance product/material exchange to extend the in-use life cycle) and
- recycling (i.e., with the aspiration of moving up the value gradient and this becoming upcycling) across full spectrum of product/material/resource types[H].

As per the 11R discussion point (and for the same reasons) in seeking to enhance re-use as an important platform for circularising material flows, it is important to recognise and align with existing re-use services, infrastructure assets, and networks in the community. While community recycling and zero waste NGOs/networks provide a key element of a re-use service and infrastructure matrix, it is important to recognise that this assets-mix includes: conventional thrift stores, antique shops, pawn shops and online exchanges, green/recycled building material salvage yards and resale stores[+1], and repair shops[+1]. This recognition can be a structural, researched, and deliberately collaborative model of intervention involving gap analysis to identify the current re-use service and infrastructure matrix and hence future programme options that require further investment, and collaborative, and planning support.

2.13. 13R Recycle

The concept of everywhere/universal recycling encompasses three material foci (all conventional materials, organic recycling (composting)[+5 +5], and then everything else) that emerge as a recurring theme in the hierarchy of zero waste priorities. The caveat is that within zero waste recycling is conceptualised as inclusive of *beyond 100% recycling*, i.e., it involves more than just focussing on 100% closing the (re)cycle loop, and instrumentally includes the redesign of our entire conception and system of resource use (Lombardi & Bailey, 2015). In more detail the three material foci of universal recycling are:

- All the mainstream conventional commodity types/material streams (aka in circular economy terminology – technical nutrients) that are recoverable[+1 H] for recycling[+4 +6 F, BA, SF, AI]. In respect of this material foci, two key narratives are: first, transitioning from voluntary to mandatory regime for separation at source and civic/participant responsibility (i.e., removing organic materials to improve recyclate quality, reduce issues, and the cost of handling and sorting both recyclables and waste[LP]); second, the opportunity of collaborative synergy between national level policy frameworks/drivers/initiatives and these being outworked variously by local government, recycling businesses, and residents/the wider community. In the Taiwanese context, this four-way collaboration model, with its shared, singular objective of maximising recycling, is recognised and called the *four in one*[+3 +1] model.
- All organic resources that are recoverable[+1 H] should, as an identified priority[LP, T], be recycled via home[+2 F] and/or commercial[+3 SF] composting/vermiculture and/or anaerobic digestion (AD), which is identified within a zero waste rubric as the only acceptable form of waste to energy (W2E), and/or, in some scenarios, also reprocessed directly into animal food. The acronym applied to the drive within organic recycling for quality assured inputs (that equate directly to quality assured compost outputs) is *source separated organics* (SSO). *Separation at source* for organic recycling involves removing non-biodegradable and hazardous contaminants – such as meat products or acidic citrus fruits, un-shredable bamboo, and flax, and certain types of pernicious weeds that may be unsuitable for some types of organic recycling processes.
- Concurrent with the above, to prioritise all other material resources i.e. striving for all other recoverable and recyclable resources to be captured and diverted from the waste stream. This third grouping includes the full range of PS/EPR class (aka *special and hazardous*) products, all commercial and industrial (C&I) materials, and all construction deconstruction and demolition (CDD) type materials. NB: in respect of C&I and CDD materials, these should, where necessary, be processed via last resort: 'high intensity materials recovery and biological treatment to landfill' MRBT(Hi)-LF, *aka dirty MRFs*).

Under the current technology status and the socio-economic scenario, the combination of the above three recycling process are cited as having the potential to achieve 90% diversion and recycling rate for all discarded[+3+3] material flows, within a concerted 10-year zero waste programme timeframe. Another recycling-related zero waste aspiration (NB: the value of which has been highlighted in both New Zealand and international experience following the change in recycling import policy by China) is for the recycling process to be based on creating a localised circular economy model, with minimal *resource-miles*, a low carbon footprint, and maximal local economic benefit.

2.14. 14R (energy)Recovery

While it is clear that the global zero waste community has been at the forefront of anti-waste/incineration (including W2E) activism (i.e., regarding this as simply resource destruction, which circumvents a circular economy), it is important to recognise the zero waste theory does not support waste to energy (W2E) recovery. What support exists is limited to anaerobic digestion at 'biological temperatures' within a stand-alone operation, or integrated within the cited last resort MRBT(Hi)-LF type recycling, treatment/stabilised disposed systems(+2 +1) before any residual disposal. It is important to recognise that the zero waste understanding of the 'energy recovery' element of a conventional 5R waste hierarchy is quite different from how this is understood within a traditional waste management worldview.

The zero waste perspective on energy recovery links the 14R recovery priority to the precondition of 1R to 13R options being implemented and resulting in effective, comprehensive recycling systems for all resource types. The net result of this model is to maximise the preceding resource/material conservation, efficiency(+1) (production), in-use life-cycle longevity (consumption), and then re-circularity (recycling). After this point, energy recovery is tightly defined and constrained as being a backstop, i.e., implementing advanced MRBT(Hi)-LF sorting technologies. So, in a zero waste hierarchy, the 14R energy recovery[69] is both restricted to just discarded organic resources (i.e. via AD) and is preconditional on all other preceding priorities being actualised, i.e., as opposed to being relegated, as is the norm in the implementation of most conventional 5R/6R waste hierarchy contexts.

This not only represents an authentic interpretation of the (zero) waste hierarchy concept but requires a relatively much greater level of preceding investment. The requisite investment is not just in everything except disposal, but seeks to operationalises a deliberate and assertive practice-led programme designed to liberate every alternative to wasting at every level of the socio-economic functioning of the materials economy.

2.15. 15R Reform (regulate/re-legislate) disposal

The defined and restricted space made for recovering energy from waste provides a precedent for the way a zero waste hierarchy prescribes the succeeding priority of reforming the concept of eventual and transitional management of residual disposal of unrecoverable waste as a last resort, i.e., via landfill or incineration. However, the 15R priority of reforming disposal is coupled with strong commitments to the regulation and re-legislating of this practice to conform with zero waste principles. The two key priorities in reforming a defined and approved (i.e., transitional, significantly de-emphasised/deprioritised) role for disposal technologies (i.e., primarily incineration (burn)(F)/landfill (bury)) in a zero waste rubric are:

- legislating the operating parameters and cost structures of entry to disposal systems (i.e., emissions control/ISO standards and landfill/incineration levies/taxes)

[69] NB: My independent observation, drawn independently of this research process, is that some elements of the zero waste community would argue that there is potentially an ethical pathway to establishing a similarly defined and constrained role for a broader range of W2E, i.e., from high temperature thermal combustion of residual discards/waste as a process engineered fuel (PEF) of feedstock for carbon sequestration as biochar. However, this potential is largely un-explored and/or gets subsumed in the rancour and polarisation of the W2E debate, most of which is dominated by the massive corporate, modified incineration business model, which should rightly be opposed.

- regulating what materials can enter and conversely are banned from entry to disposal systems, i.e., via landfill/clean fill and incineration bans(+3). NB: this may include 'provisional or partial' bans', such as of material flows that have not be subject to prior MRBT(Hi)-LF final sorting and resource capture(+2)and or, of all organics from landfill, or the messaging associated with banning the construction of new incinerator capacity.

A reoccurring zero waste policy tool is waste reduction legislation in the variously cited form of state laws/regulations/ordinances(+3 SF) that may be supported and supplemented by specifically dedicated agencies, for example, OVAM(F), which is cited as developing, monitoring waste management legislation and policies designed to drive the achievement of escalating/phased (per person and collective societal) resource consumption/waste generation/diversion goals/targets(+2). Another example of a waste policy tool designed to reform disposal (which interface with the practice of *separation at source* for residents/households/businesses and/or specific sectors i.e. such as the C&I and or, CDD practitioners) are versions of the *"no sort, no pick-up"* policy (Lombardi & Bailey, 2015). Supporting and incentivising this kind of policy tool is the option of facilitating: for example, the 'Zero Waste International Alliance' (ZWIA) zero waste business accreditation programme, which is designed around independently credentialing progress through waste reduction/diversion targets to achieving a ≤ 10% level of residual disposal.

Beyond just the gatekeeping role of reforming 'end of pipe' disposal, zero waste endorses utilising the capacity for deploying regulation and legislation 'back up the pipe' to re-shape the production and types of waste generated and hence need to be treated via disposal. Zero waste programmes are reported as variously utilising, for example:

- The uptake and widespread operationalisation of backstopped industry accords, ecolabels, and ISO standards, etc.
- Product bans/levies(+2) (i.e., in a New Zealand context this includes microbeads and single-use plastic bags (SUPB), but is posited internationally to include significantly problematic materials (i.e., such as polystyrene (PS) and product types (i.e., straws, etc.).
- Requirements for transparent, fair, and fully costed financial models to be applied to disposal systems, for example, applying 'pay as you throw' (PAYT)(+2 +1)/'polluter pays' and the principle of 'full cost accounting' for disposal pathways, in order to eliminate any externalisation of environmental costs(+3).
- Better data generally, via shifting to include alongside conventional waste data requirements (i.e., New Zealand's WMA:2008 mandated, end of pipe focussed 'waste assessment' (WA) model), more holistic, resource-(and toxins) focussed material flow analysis (MFA)/national input-output type tables/accounting that better reflects and articulates the concept of circular economy reporting.
- Transparent, independent, high-standard litter/fly-tipping and disposal system monitoring/auditing, reporting, and backstop compliance and enforcement(+2) of necessary regulatory frameworks(T) for incineration, and landfill/clean-fill operations.

2.16. 16R Rejecting disposal

While zero waste advocates for a range of measures that reform disposal, it must be recognised that this is premised on maintaining an active policy of opposition to disposal *(aka anti-burn – anti-bury)*.

This is both ethically and scientifically supported (Ciplet, 2009; J. Morris, Favoino, Lombardi, & Bailey, 2012; Platt, 2004; Tangri, 2003) and is retained as a core, essential value of zero waste (illustrated in the ZWIA's accepted definition of zero waste, which has been formed in iterative cycles of international discussion and agreement). This policy positioning manifests in definitive statements such as, "*there no role for waste incineration in our zero waste future"* (Lombardi & Bailey, 2015). It is clear that there have been major improvements in the core technology and hazard mitigation systems that have significantly reformed and, to a degree, legitimised both landfill and incineration by reducing the environmental impacts of these disposal pathways. It is important to recognise that zero waste retains the view that, improved or modified versions of incineration (inc. W2E)[(+1)] and landfill (such as bioreactor landfills) are just that, and that this does not necessarily redeem or change the unalterable fact that these treatments still destroy resource value and exit material flows from what might otherwise be a circular economy. However worthwhile and effective these improvements are, disposal still enables and normalises, rather than disrupts the linear, throwaway society, which zero waste rejects, opposes, and campaigns against.

Broadly speaking, the big picture scientific rationale (i.e., provided via accumulated LCA and ecological economic studies) supports the circular economy/zero waste policy position, which is reflected in this 16R hierarchy of priorities. In simple terms, the long-term, holistic cost and benefits of actioning all the preceding 15R priorities, which reduce the requirement for waste disposal and the associated municipal service and infrastructure costs and attendant enviro issues (i.e., emissions from burning and leachate from landfill, etc.), out-weigh the relative cost and benefits of transitioning away from a linear economy ending in disposal.

That said, it is important to recognise that the interim material resources processing cost structures may not change (and in fact may go up); however, the zero waste conception is that as material flow shifts from linear (ending disposal) to circular (for example, by transitioning to bi-weekly waste collection[(+2)]) as the 'waste' attributed cost savings build, these can be redirected to fund/incentivise the required replacement resource recovery/recycling systems that capture and alternatively process the material flows. Another potential cost increase under a zero waste model occurs when previously ignored and unaccounted externalised environmental costs are required to be made transparent and internalised into market prices. In a zero waste ethos these adjustments are an essential reality check and will actually enable market forces to function for, rather than against, the environment and communities.

A consistent issue that arises out of zero waste experience is that the large and long-tenured investment profiles required for modern landfill/incinerator operations, especially when offered by the profit-focussed private sector, directly compete with, greatly restrict, or close the door entirely on what might otherwise be more positive environmentally oriented zero waste investment. However, it can also be recognised that, in certain instances, once landfill investments have been made, the preservation of space to prolong the life of the landfill (and forestall future investment) can be regarded (and has been reported) as a driver for zero waste. For example, the so-called *waste crisis in the 1980s* is cited as highlighting the issue/opportunity of preserving landfill space. It should also be noted that, within the wider conception of zero waste as an enabler of innovation, interim 'store-fill' technologies and or landfill mining for resource extraction, the opportunity hazard remediation and the re-use of landfill space may also be argued as being included in the purview of zero waste and a circular economy.

However, zero waste has historically maintained a consistent and principled anti-disposal policy stance repeatedly cited as the catalyst for popular local zero waste initiatives, innovations, and case studies, which in small increments propel this grass-roots global movement forward. For example, in both Spain and Taiwan, community-based, anti-incinerator/environmental action is said to have prompted the adoption and implementation of zero waste policies by the government[+1 H, T]. It should be recognised that the anti-waste/disposal policy stance entails going against mainstream public acquiescence in the 'throwaway society' and all the vested interest of commercial influences and policy capture leveraged by the *makers and managers* of waste who are major beneficiaries of that paradigm[+1 T]. Rather than just being a rigid ideological fixation, the zero waste community's determination and tenacity in maintaining the anti-waste/disposal policy setting is based upon tangible outcomes. For example, the result of the Taiwan zero waste policy was that waste decreased, despite population and GDP growth and comments such as, *the results speak for themselves zero waste is a credible alternative to burying – burning our future*[+1 F, SF]. For example, the result of the Taiwan zero waste policy was that waste decreased, despite population and GDP growth.

4.4. Final Proposed MZWM

The next key result presented from this research is Figure 11, which is a schematic illustration of the final proposed *Municipal Zero Waste Methodology* (MZWM). Figure 11 is a distilled schematic framework that summarises and illustrates the key structure of the full written MZWM result in its most compact visual format. Figure 11 is the first of a sequence of four graphic results including the *16R Zero Waste Hierarchy* – Section 4.5, the *∞ Infinity Continuum MZWM Model* – Section 4.6, and the further explicated version of the *∞ Infinity Continuum model proposed for Illustrating MZWM* – Section 4.7. Collectively these four graphics sit alongside the quantitative findings (Sections 4.2 to 4.2.8) and the written qualitative narrative (Section 4.3 and Appendix 11) and represent a complete and integrated body of results which answer the research question.

Figure 11 is a schematic overview of the headings, organisational arrangement, and connections between the interactive clusters that make up the entire final MZWM proposed as a result of this research. As mentioned previously, this simple schematic provides a useful map for conceptualising the full explicated MZWM written narrative result. Both the full explicated MZWM written narrative result (Section 4.3) and this derivative *final proposed MZWM,* illustrated in a graphic summary schematic format as Figure 11, are the endpoint of a logical, pragmatic, evidence-based, back-and-forth abductive inference-making research procedure (Krippendorff, 2013; D. L. Morgan, 2008).

The development sequence for Figure 11 involved: the initial *Zero Waste Methodological Consensus* (Appendix 6; discussed Sections 3.8 to 3.11) as a proposed starting point. Based on further literature review findings and reflection, this starting point evolved to the *Revised v2 Analytic Construct for MZWM Content Analysis* (Appendix 7), which was loaded into NVivo as the initial coding framework. Further iterative development occurred through the coding sequence for the three selected sources (Appendix 8), which resulted in the *Final Coding Framework* (Appendix 9, which includes the full list of finalised parent and child node descriptive statements that support accurate effective, rules-based decision making within the coding process) (Bryman, 2012; Krippendorff, 2013).

This *final coding framework* (CF vfinal) provided the framework for organising all the coded evidence-base in the next stage of qualitative analysis, which involved transcription of the coded data into and then back out of MS Excel, as a final, fully explicated MZWM written narrative result. Both the *CF vfinal* and the data-set of coded content can be considered outputs generated in NVivo, which become inputs for the final phases of content analysis transacted across the sequence of platforms from NVivo to MS Excel to MS Word. Further iteration based on reflection and revision occurring during this latter phase of content analysis enabled the final transition from *CF vfinal* to Figure 11., the final proposition of the *Municipal Zero Waste Methodology* (MZWM) as an answer to the research question at the centre of this project.

This result can be regarded as a formative and logical argument that underwrites abductive claims (Krippendorff, 2013) which developed over the whole enterprise of content analysis through a continuous, interpretive interplay and evolution between the theme clusters depicted in Figure 11 and the row / columns layout and content of the spreadsheets in MS Excel (Tashakkori & Teddlie, 2010). The way this interplay and evolution continued, even through into the planning and final presentation of graphic summaries of result, realised the vision that both Plano Clark & Ivankova (2016) and Morgan (2008) projected for the dynamic of abductive inference formation.

The shared cognitive DNA between the earliest version (initial *Zero Waste Methodological Consensus* (Appendix 6) and what evolves into Figure 11 (the finally *proposed MZWM*) is clear. However, it is equally clear that these two frameworks are also distinctly different. This indicates that the *final proposed MZWM* is a novel, evidence-based research output that has been derived through a transparent, quality assured research procedure, which includes iterative reflection and revision right up until a final conclusion is reached. In this instance, the research involved a mixing of quant + QUAL methodologies to enable the procedure of content analysis to secure meaning, which would not be achievable by either mono-method in isolation (Jick, 2008; Plano Clark & Ivankova, 2016). As a now established approach in social science (Bos & Tarnai, 1999; Krippendorff, 1989) and when conducted in a reputable manner, mixed methods content analysis can be expected to enable meaning making inference to bridge from existing, to new forms of knowledge (D. L. Morgan, 2008; Plano Clark & Ivankova, 2016).

Figure 11 is presented as a final result of this research, which has tested explicated and proved the hypothesis of a *Municipal Zero Waste Methodology (MZWM).* As a relational schematic, Figure 11 illustrates the organisational arrangement of all the fifty-seven distinct elements that have now been established as part of the MZWM. Figure 11 illustrates a combination of both quantitative (for example, colour coding and super-scripted $^{+\#}$ nomenclature) along with qualitative findings. As such, the final proposed MZWM reflects the converging/concurrent quant + QUAL(quant) hybrid embedded design theory and annotation (Plano Clark & Ivankova, 2016) and illustrates a genuinely mixed method result.

The structure of this proposed MZWM is based on a framework of fifty-seven elements[70], each annotated via a letter-number identifier and an abbreviated name (word) and number, which indicate

[70] NB: in the course of the proposition of a coding framework and the content analysis of key sources, two elements were proposed as part of this MZWM framework, but then were not confirmed via coinciding refences in these key sources: A5h Active international conventions (theme: *Empowering leadership and policy*), and A2m Disaster zero waste programmes (theme: *Rationale*). Both are highlighted in the schematic via italics and annotated with zeros in terms of the numbers of codded items of data. Even though the inclusion of these elements was not supported by the coding data, it was decided to continue with the proposed inclusion of these elements in the MZWM (with the transparent identification of their unsupported status) because they appear as critical in a future-focussed globalised perspective and other sources, with a later publication date, might provide confirmation as the impacts of climate change and globalisation advance.

how many times that element was coded. In this system of annotation, the number is minimised in the *to the power of* slot, so as to minimise visual intrusion and any unnecessary confusion. Using the annotation *A1o-Targets*^{42} as an example:

- The letter A signifies that these data come from the first original planned MZWM coding framework, as opposed to the second coding framework *B- Exploring waste → zero waste* coding framework, which was developed with a different secondary purpose.
- The number 1 signifies that these data relate to the *1- Conceptual foundations and critical principles* theme (latterly termed a parent node within NVivo). This number scheme[71] runs from 1 to 5 (signifying orientation to one of the five original key theme/parent node demarcations in the first initially proposed *Zero Waste Methodological Consensus* (Appendix 6).
- The o signifies this element was the 15th in the alphabetical sequences of sub-themes/child nodes (in this instance listed from a to o), recorded within *Final Coding Framework (CF v final)* (Table 21 - Appendix 9 – at the point that coding commenced[72].
- Finally, the name of the element is recoded in what was determined as the most complete yet compact (possibly abbreviated) form that was workable inside the tight the graphic format.

Each of the fifty-seven elements of Figure 11 are illustrated as a text box, colour coded to additionally signify to which of the five original themes the elements originally belonged. The text in each element box is coloured coded to illustrate if that element was in either the top two (i.e., >5% = red and between 3–4.99% = blue) frequency brackets of coded data. Figure 11 also contains two small legends that supplement and outline each of these two, colour-coded references. Each of the fifty-seven elements illustrated as boxes are organised according to nine finalised theme headings (top of the page), which make up the finalised MZWM framework. It is useful to also observe that between the quantitative (only) result (Table 9, Section 4.2.4) and this final quant + QUAL(quant) the empirical data (# and %) change. This is not a negative reflection of either result, but is indicative of the iterative development of result inherent to MMR-CA, which included in this instance in QUAL phase undertaken in MS EXCEL, the re-consideration each coding decision and re-examination of the coded data and sometimes reattribution of this within an evolving coding framework (CF vfinal) → finalised as the proposed MZWM.

Each element of the MZWM is either presented as an individual box, or as part of *relational cluster* of other interrelated element text-boxes, signified with a bold group border. These clusters of element boxes enclosed and signified as a cluster via a bold big box outline are ordered from top to bottom according to the coding frequency (i.e., highest at the top = greatest level of confirmation). Line connectors are also used to signify interrelationship and interactivity between theme headings and individual and relationally clustered elements making up the MZWM. For example, the *Vision/Data, xR Priorities and Empowering Policy* themes appear, on the basis of the meaning inferred from the content analysis, to be interrelated and interactive.

This omission is an indicator of potential incomplete perspective or the existence of a *blind spot* in these three sources and possibly points to the need for the examination of further sources and or future research.

[71] NB: This identifier is supplemented by the numbering and coding annotated in the bottom left-hand legend of Figure 12. This identifier and the finalised descriptive statements are listed in Appendix 9: Final Coding Framework (CF v final).

[72] NB: the progressive development of these frameworks is variously illustrated in the sequence of: Appendix 6 – Table 20, Appendix 7 – Figure 22, and Appendix 8 – Figure 23, which illustrates both coding frameworks and a project map printout from NVivo.

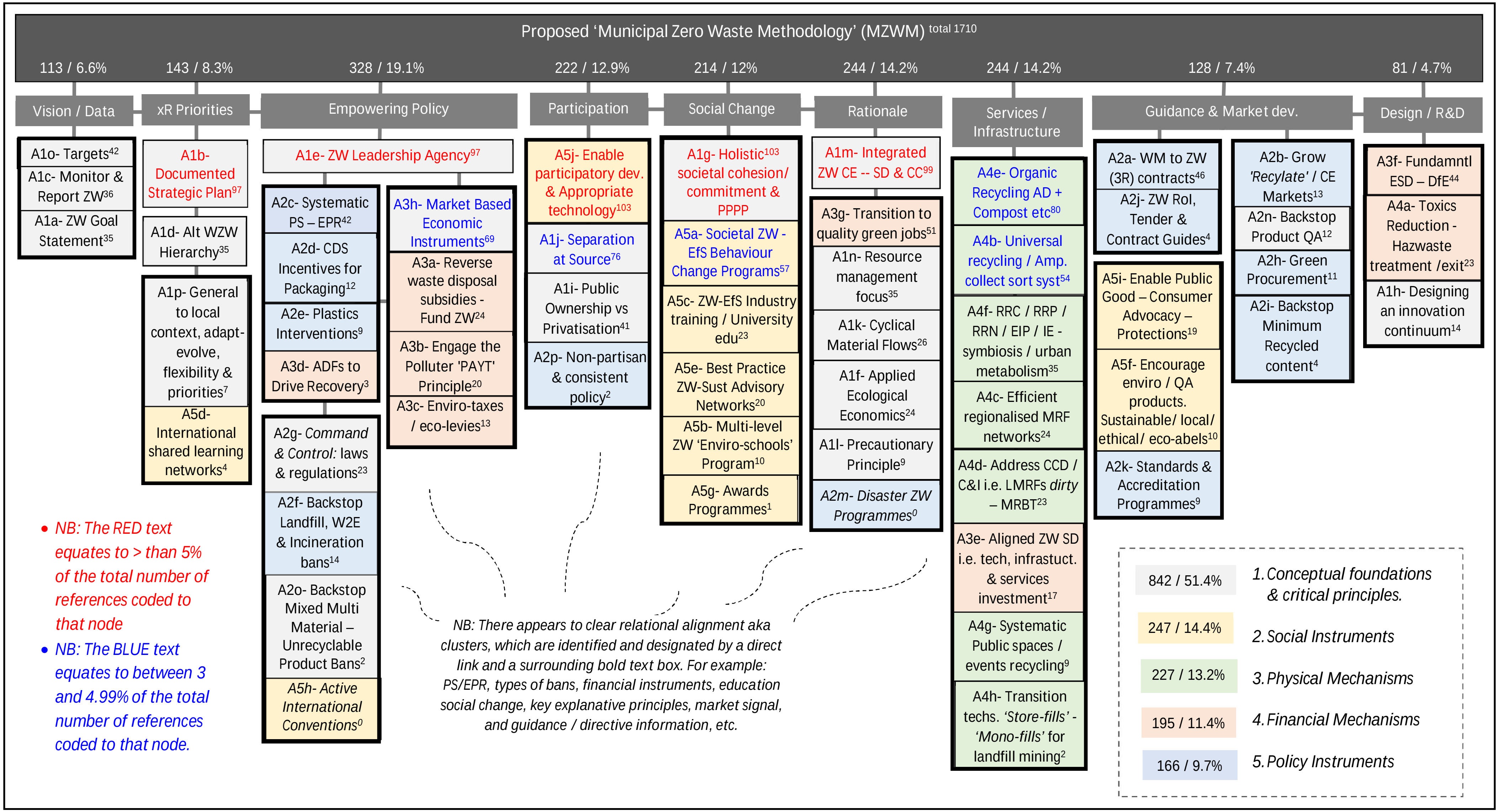


Figure 11: The proposed final MZWM relational matrix.

Along the top banner of the proposed *Municipal Zero Waste methodology* (MZWM), the relative code frequencies for each key theme are communicated as both numbers and relative percentages, which provide an overarching indicator of the relative weighing and strength of confirmation of data supporting this arrangement. The most prominent theme cluster (i.e., *Participation, Social change and Rationale* at respectively 12.9% + 12% + 14.2%, which equals a total of 39.1% of the total 1,710 codes) is arranged centrally, as an indicator of criticality and confirmation. The other themes and theme clusters are arranged outward in an approximate descending order of confirmation. However, it is important to note that, while the top to bottom and left to right arrangement infers prominence and confirmation by the weight of evidence, this is only an indicative and somewhat subjective, aesthetic arrangement formed in finalising the graphic presentation of this MMR result.

The development and presentation of Figure 11 as a final result reflects a balance between seeking to communicate a simple holistic, visual summary impression of the MZWM result, but also to pack in as much important information and relevant detail as the graphic rubric can usefully accommodate. In this sense Figure 11 is (as are the other graphics) a compromise. For example, the act of simplifying, combining and reducing titles and descriptions down to fit in a small box enables all elements to be collectively arranged in a way that imparts meaning visually, but also involves a certain loss of clarity[73].

The tactical decisions about the conduct and reporting of this MMR-CA were based on both the inseparability and mutuality of the word-number data, which exist in the sources, are derived by coding within NVivo and are reinforced in the final systematic translation – interpretation phases of content analysis (Berg & Lune, 2012; Bergman, 2010). The selected mode of presentation best reflects the contained meaning and the research aspiration for an authentic, mature mixing of methods that are meaning-enhancing opportunities afforded by MMR (Creswell, 2015; Plano Clark & Creswell, 2008; Plano Clark & Ivankova, 2016).

The convergence and sense of interactivity and synergy within and between the individual and clusters of elements making up the MZWM, which is sought to be conveyed in the mode of presentation depicted in Figure 11, provides insight into both the inherently interdisciplinarity of this subject (Hannon, 2020) and further confirmation of the growing acceptance of mixed formations of qualitative and quantitative methods in content analysis (Hsieh & Shannon, 2005; Mayring, 2000; QSR, 2017). The final structure of what emerged as the nine interrelated theme clusters summarised and finally depicted in Figure 11 is more fully discussed in Sections 5.5.1 to 5.5.3. However, for purposes of transparency and objectivity (Bryman, 2012; Krippendorff, 2013), the following are examples of kinds of iterative changes made in the sequential formation[74] of the final proposed MZWM:

1. All titles were reconsidered and where appropriate rerevised.
2. Confirm first to last order within the clusters and eliminate the numbering indicating the number of codes attributed to each box. Henceforth, the ordering provides and sufficient

[73] For example, it may not be immediately clear in Figure 11 why A3f- Fundamental ESD-DfE and A4a- Toxic reduction - Hazwaste treatment / exit are colour coded as Financial Mechanisms, until reference is made to the original derivate statements in the Revised v2 Analytical construct for MZWM content analysis (Appendix 7) and or, the more explicated expression of result, Figure 15. Referencing this precursor and further derived result provides additional explanative detail, which is synthesised, distilled and aligned in support of the ∞ infinity / continuum model. This illustrates how awards, competition prizes, R&D grants, tax breaks and financial incentives and supports are linked as drivers of the ESD-DfS design driven solution to the imperatives of reducing toxicity and hazardousness in circularised material flows

[74] As an end result to of the sequence from the: *initial Zero Waste Methodological Consensus* (Appendix 6) to the *Revised v2 Analytic Construct for MZWM Content Analysis* (Appendix 7) through the series of iterations illustrated in the selected *Project Map / Coding Frameworks x2* (Appendix 8) to the *Final Coding Framework (CF vfinal* (ref. Appendix 9) and the inclusion of fata from for example Table 9 (Section 4.2.4) and Table 11 (Section 4.2.5).

indication of prioritisation. Shifting to a % of total as a way of indicating numerical weighting was also considered.

3. The boxed group borders (1Aa Goals, A1c Targets and A1o Monitor / Report, in order to recognise these as formal clusters.
4. The overall connections and arrangement of nodes, as well as code clusters were considered, based on the wording, phrasing and meaning inferred in the original codes:
   - For example, in terms of the three clusters under the A1e- ZW leadership agency, thinking about how the inter-activity between these can be communicated?
   - For example, querying should A2e- Plastics interventions go with a command and control type cluster (i.e., NZ plastic bag bans)? Or does A2p- Non-partisan policy consistency more closely align with A1b- Documented strategic planning, or potentially with the A1i- Public vs private ownership ethos? Also does the A5d- International shared learning networks and A1p- General to local context pairing more logically connect to A5j- Enable participatory development?
5. Numerous other iterative reflection – interpretation – evidence-based – translative revisions which emerge in the full arc of content analysis.

This change process is reflective of what Berg and Lune described as the attribute of "careful, detailed systematic examination and interpretation…" and identification of "patterns, themes, biases and meanings" that characterises content analysis (Berg & Lune, 2012, p. 349).

4.5. A 16R Zero Waste Hierarchy

As an interrelated series, the four graphic results, namely: Figure 11 the *final proposed MZWM* schematic (Section 4.4), Figure 13 the *16R Zero Waste Hierarchy* (Section 4.5), Figure 14 the *∞ Infinity Continuum MZWM Model* (Section 4.6), and Figure 15 the further *explicated version of the ∞ Infinity Continuum model proposed for Illustrating MZWM* (Section 4.7) - combine to complete the reporting of results of this research. These graphic summary results encompass all the critical strands of information generated from the MMR HCA-T-MZWM quant + QUAL(quant) research methodology and carry this meaning forward as full final iterations and expressions of combined completed result.

The third selected excerpt of the full written narrative QUAL(quant) MZWM result provides an example of the extent, detail and organisation of new knowledge (>10,000 words) able to be derived and reconstructed through this content analysis. This 16R zero waste hierarchy excerpt was selected because it both exemplifies attributes of the total result and because it extrapolates the concept of the (zero) waste hierarchy to an entirely new structural extent and level of detail and expression. This specific aspect of the result prompted cycles of creative reflection and ideation (moving beyond just presenting the raw data laden findings) on how advanced graphic formulations might lift the results to a next, equally evidential, but more meaningful level of expression.

Grappling with the extensive written narrative of this result (initially labelled x*R Priorities*) and the associated back and forth, formative reflection-review and abductive inference making provoked the conceptualisations of how best to portray the significant meaning, alongside the extent and detail of the results. Whilst Figure 11 is a directly derivate end-result of a series of coding framework iterations, Figure 13 is the outcome of a process of reflection on result, provoking new conceptualisation of result, which then ultimately inspired the development of Figures 14 and 15 as further expression of result. The compilation of prior quantitative and qualitative data into the composition of Figures 11, 13, 14, and 15 exemplifies and is the endpoint of this concurrent/convergent MMR – HCA – T - MZWM quant + QUAL(quant) methodology. This group of graphic summary results are novel and important new research findings that demonstrate a key attribute of mixed methods content analysis as a research methodology. Namely, enabling a logical, rules-based argument to form bridges from one discrete knowledge format (i.e., a sample of three selected sources) into a complex intermediate assembly of derivative data and analysis and the back out of this staging into new, simple, stand-alone knowledge frameworks (Bos & Tarnai, 1999; Krippendorff, 2013; D. L. Morgan, 2008).

In this instance, the selected quant + QUAL(quant) format for mixing methods not only reflects the data, but justifies the new → old - abductive bridging by transparently providing relevant reporting of the origin of detailed elements of result and an in-situ rolling expression of strength of confirmation. The extent and detail of the information on offer in the *16R Priority* section, as a selected excerpt of the overall written narrative result, self-evidences the necessity of moving into simpler graphic communication formats. The collection of graphic summary results (Figures 11, 13, 14, and 15) as distilled outcome of this research, are anticipated as providing the basis for further publications that will extend and complement the existing publication strategy.

The next proposed publication in draft format (Appendix 12) focuses on the historical, theoretical, and practical development, proliferation and application of examples of the waste hierarchy concept (ref. compilation image as Figure 12 below and in full ref. Appendix 12). The draft article examines how this miscellaneous background relates to the newest research-derived 16R zero waste hierarchy (Figure 13) and the formal establishment of a MZWM, illustrated in the format of the infinity–continuum model (Figures 14 and 15). Building on these foundations, this article will address the question whether a *hierarchy* is still an appropriate theoretical model for expressing (zero) waste management theory, given the implication of implied linearity / singularity and the rhetoric-reality gap associated with theorised, but in practice unrequited priorities.

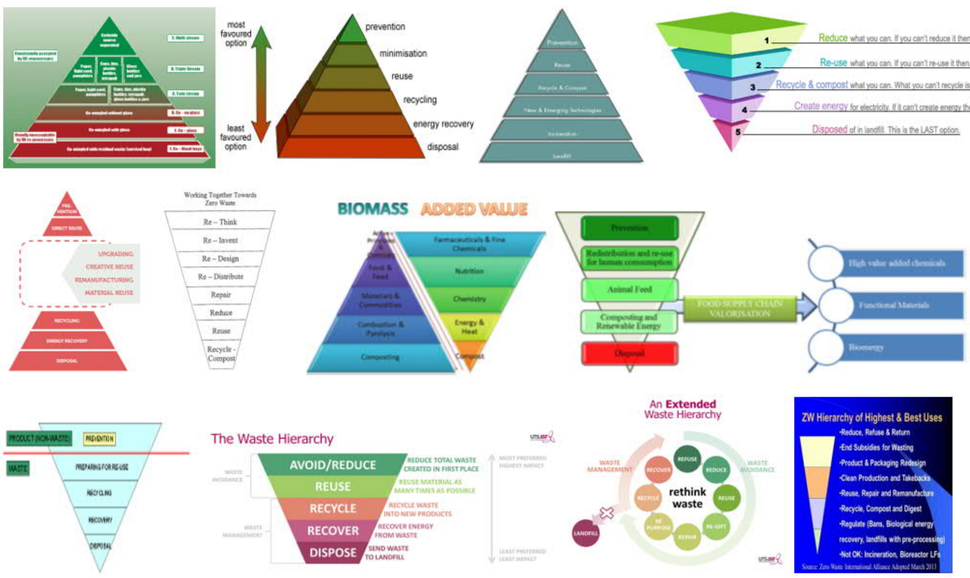


Figure 12: A compilation of various examples of the concept of a waste and or zero waste hierarchy.

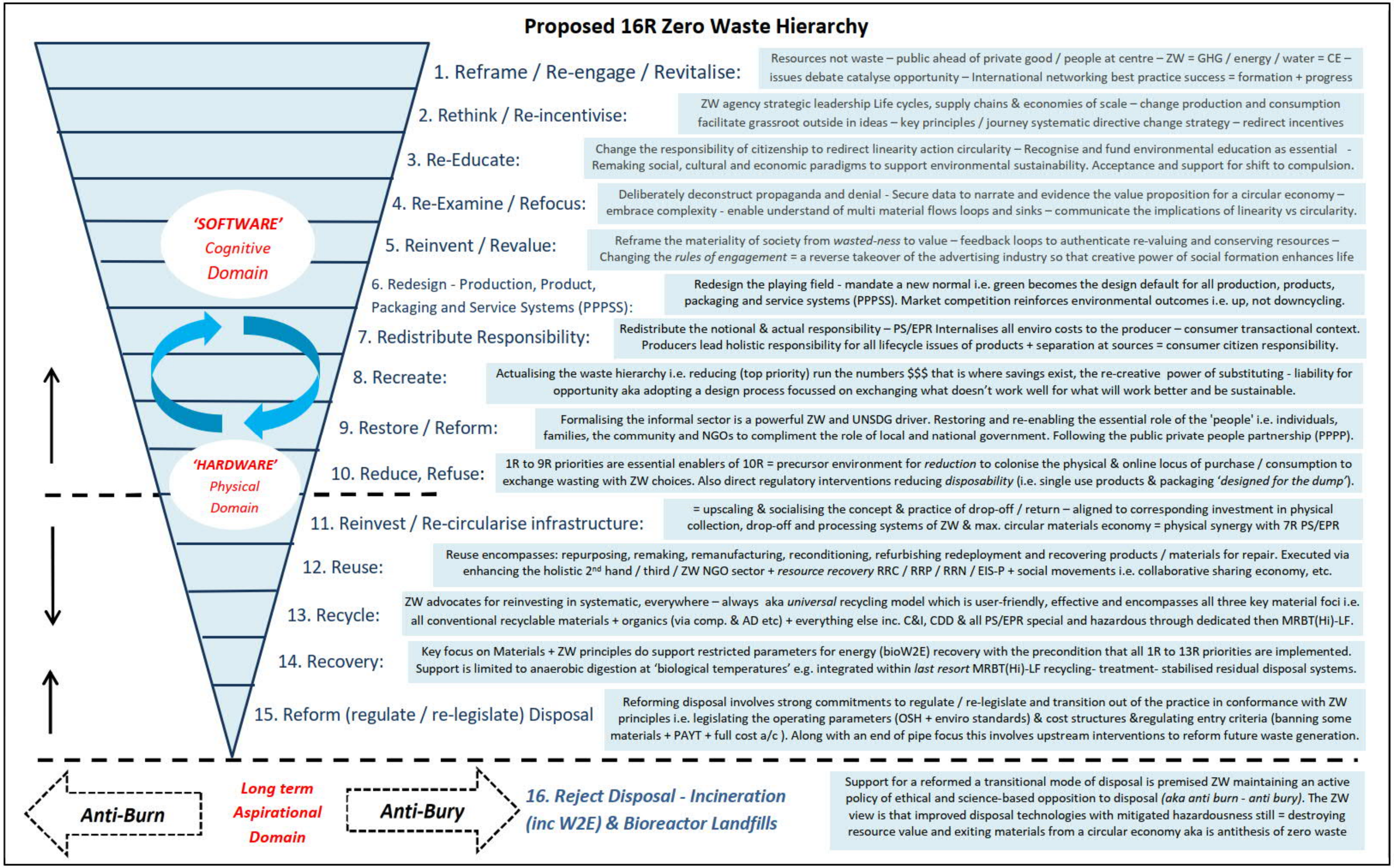


Figure 13: A proposed 16R zero waste hierarchy model based on the findings of the content analysis examining MZWM

4.6. The ∞ Infinity / Continuum Model for Illustrating MZWM.

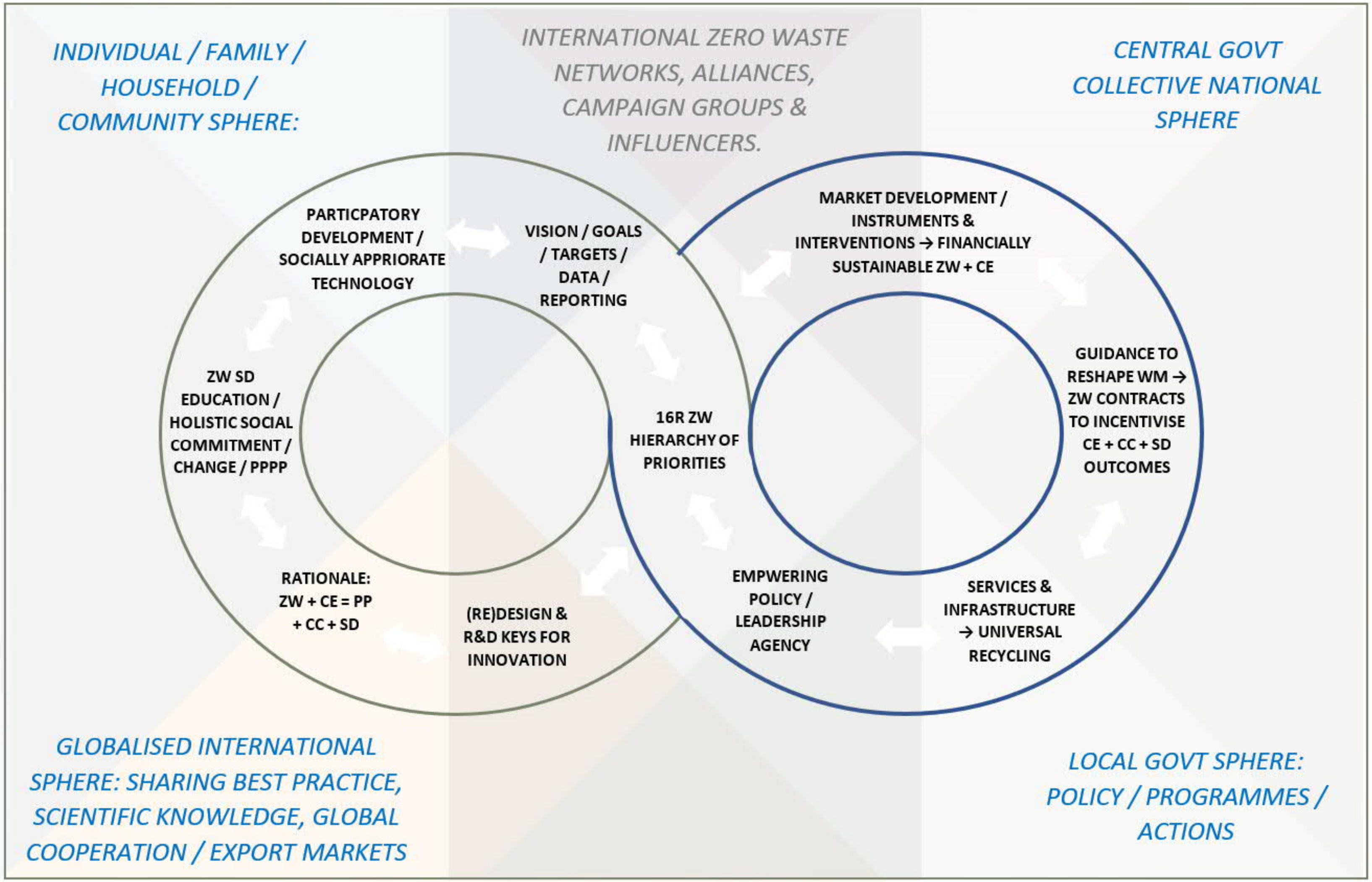


Figure 14: The ∞ infinity / continuum model proposed, alongside the expanded 16R zero waste hierarchy, for Illustrating MZWM.

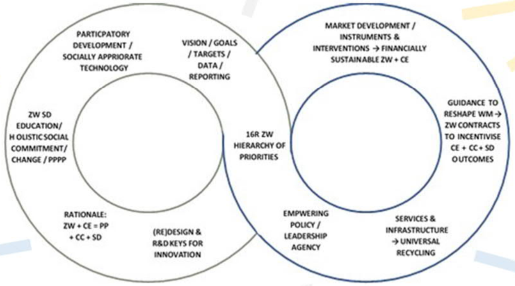
4.7. A further synthesised / explicated version of the **∞** infinity / continuum model proposed for Illustrating MZWM.

- Collectivising shared learning and experience for systemic change.
- Upending conventional power and control structures in order to release fresh energy and experience.
- Bottom-up / top down - public / private - community / commercial inclusion in programme development processes.
- Messaging and terminology around collective input / responsibility / opportunity =s shared community ownership and success. Reinforced by practical case study experience.
- Zero waste case studies present a spectrum of experience in collectivised service and infrastructure models aimed at seeking innovation and advancing best practice.
- Collectivised innovation and knowledge sharing structures and uniform best 3R practices.
- Repurposing and future proofing W → ZW service, technology and infrastructure systems.
- Institutionalised integrated whole of community awareness raising, behaviour change and practical education.
- Properly and permanently funded environmental education, which communicates real world success, progress - recycling good news stories and navigates around issues and program change .
- Community education positively reinforce outsider-in and insider-out participatory development processes and embeds and normalises environmental responsibility.
- Prioritise - start small / immediately and then learn and grow through educational engagement with the community.
- Zero waste vocational training and professional / personal development of zero waste / recycling / informal / waste picking sector workers.

- Participatory community development / Community ownership of responsibility for waste → ZW / The change-making power of community starts with individual choice.
- Community as an appropriate social technology / Socially attuned programme design = beneficial outcomes / Practice confirms and reinforces principle.
- As an innovation space zero waste can catalyse new progress pathway / Debate dissent, myth-busting and reality checking the (zero) waste paradigm.
- Separation at source is an important foundation for ZW and this requires dedicated investment + ID and deconstruct barriers / issues separation at source / Policy synergies can accelerate the benefits of separation at source i.e. Environmental education → separation at source → community acceptance → success and proliferation.
- Deliberate programmed formalisation of the waste picker / informal sector delivers specifically targeted outcomes. / The combination of separation and source and the involvement of the informal sector can increase the reach and specificity of all types of collection services.
- Product stewardship / extended producer responsibility (PS/EPR) are socially appropriate technologies. / Deciphering the opportunity for govt vs private sector opportunities for progress.
- Overarching symmetry and mutuality between zero waste and the key sustainable development platforms of participatory development and appropriate technology.
- Colonising and repurposing waste infrastructure. Centralised design, coordination and collectivisation in sync with de-centralised responsibility.
- ZW has a broad conception of separation at source – i.e. as an appropriate (social) technology integrated with participatory (community) development.

- Goal / Target relationship Typology, descriptors, compilations and association with success
- The origins of and reactions / responses triggered by zero waste goals:
- Outcomes resulting from zero waste goals / targets
- Agency and focus of monitoring and reporting - zero waste goals / targets

- Zero waste an essential community service / public good. So reshape contracts to redirect subsidies / incentives from waste disposal / resource destruction → to the opposite ZW outcome.
- Employing economic and regulatory interventions, instruments & incentives which reverse the impact of waste subsidies.
- Pivoting away from business practices and consumer behaviours which cause harm and endanger human and environmental health.
- Resetting the socio-economic rules of engagement to drive progress → material circularity & ZW.
- Resetting and coordinating societal software with rules-based hardware.
- Design & cultivate multi-factor market development case studies.
- Up / down-stream, hard / soft-ware, voluntary / mandatory, paradigm / practice, inspire / invest, dualities / polarities – systems integration and interactivity.
- People, policies / programmes, operational systems, technology / infrastructure integration & synergy.



- Clear indicators of linkage, integration and synergy across environmental sustainability W → ZW domain / movements - with the imperatives and practicalities of pollution prevention, climate change, circular economy and sustainable development etc (i.e. PP-CC-CE-SD).
- Understanding rather than denying the big picture / holist enviro-economic rationale / reality. / Humanity, values, faith and the virtuous cycle in choosing value over waste.
- Circularity and enhancing the quantity and quality of employment - key social, cultural & environmental rational underpinning ZW and Enhancing the quantity and quality of employment.

- A comprehensive universal everything-everywhere, source separation zero waste collections model
- Maximum recovery and circularity synchronised with the redesign of product and material lifecycles.
- Public / private - profit / not for profit – ownership / operational models / motivations - overcoming barriers zero waste systems.
- Diverse development pathways, ownership / operational scenarios from a spectrum of zero waste contexts.
- Mandatory separation at source / separate collections models - a common denominator in zero waste.
- Localised materials processing to maximise community benefit.
- Integrated zero waste R&D, service, infrastructure, technology, education nexus (R&D SITE).
- A rationale for flexible, scalable and holistic (re)investment for zero waste.
- Pragmatic, future proof strategic planning for (re)investment.
- Symbiotic, multi-stakeholder, multi-faceted, PPPP ownership / operational models: In highly developed and under-developed socio-economic contexts.
- The motivation, justification and outcomes of zero waste collections and material processing model are variously described as an opportunity, i.e. for improved recycling service levels and outright system performance, etc…

- Waste as a failure of socio-economic design.
- Engineering an assertive practice and paradigm shift enabling circularity.
- Redesigning production, products, packaging and service systems (PPPSS).
- Intentional, directional and sustained systems (re)design and leadership:
- Detoxing future and current material flows / upstream – downstream systems (re)design.
- Changing the future - systems (re)design interventions for production – consumption and end of life responsibility.
- Anti-disposal conventions backstop systems (re)design and reinforce upstream - downstream interventions.
- Educating consumers - changing consumption and embracing circular systems.

- Leadership – Agency / Enacting legislation / regulations / Interpreting, mediating and coordinating modes of social change.
- ZW = a phased approach for progressing a regulatory platform / target big early gains / low hanging fruit.
- ZW = Tax waste → incentivise ZW / Directive instruments and incentives for a responsible circular new 'business as usual'.
- Govt. hosting / facilitating ZW leadership agency, policy and planning frameworks & dev. laws / regulations by government.
- *NB: in the absence of government (municipal) leadership, intervention and facilitation / mediation – zero waste progress can be generated.*
- ZW envisions a virtuous interdependence, which combines & optimises the mutual contributions / potentials of both government / community.
- ZW endorses government's potential for authoritative neutral coordination, problem solving and mediating between conflicting interests.
- ZW = Innovation platform for new socio-economic models / change-making = reframing market-based economic instruments and investments which reshape financial flows from negative, to positive environmental outcomes: aka…
  - ✓ Redesign the future through EPR/PS systems, via actioning EPR/PS priorities est. foundation for banning hazardousness / toxicity and design for disposal / dump.
  - ✓ The 'polluter pays principal' / pay as you throw (PAYT) / enacted in conjunctions a disposal levy / tax + mandatory full cost accounting to end to cheap disposal. This cluster of instruments collectively eliminate waste subsidies and the externalisation of environmental costs.
- ZW recognises the criticality of socialising change from community education and advocates for:
  - ✓ Normative public policy support and investment in community education(+6) for reducing and making resource consumption more sustainable through broad cultural and economic systems change.
  - ✓ Mutually reinforcing community education and enforcement: In tandem with education (carrot), enforcement (stick) is designed to backstop the ideal of maximum participation in separation at source.
  - ✓ Meeting reformatted public expectation with transformed infrastructure and services. In synergy with education, zero waste advocates for practical interventions to enable physically redirecting material flows towards circularity of resource flows.
- Beyond focussing on the core 12 master categories of material resource / product types an impt. aspect of ZW & CE circularity is creating, expanding and promoting + reduce, reuse and repair via e.g. resource recovery centres / park / networks, tool libraries and repair cafes etc supporting collaborative economy + hard to recycle (i.e. hazardous and special classes of products) via extended producer responsibility / product stewardship systems (EPR/PS) + CCD + pre-final-disposal (last resort) MRBT infrastructure to intervene redirect resources for recovery and recycling
- Zero waste = EPR/PS integrated everywhere, all the time, easy / user-friendly universal recycling / co-located ZW/RR/Green centres, hubs, parks, zones and networks – aka universal recycling.
- ZW leadership ID & addresses latent inequity between community / public interest and the commercial / private (often vested) interests and seeks to formalise and empower the informal sector / Enabling public, private, people partnership (PPPP) service delivery models / Incentivize community participation and incorporate the interests of waste workers.
- Highly / low & Dev. / underdeveloped socio-econ. / national, regional, city and village level case study contexts illustrate how govt can outwork ZW leadership responsibility via a symbiotic, contractual, working relationship with community enterprise NGO informal sector organisations.

Figure 15: Additional explanative detail synthesised, distilled and aligned in support of the ∞ infinity / continuum model proposed, alongside the expanded 16 zero waste hierarchy, for Illustrating MZWM.

In simple terms, the result of this research has been to establish, explicate and prove the hypothesised MZWM as an extensive and detailed theoretical concept that is accompanied by a diverse and growing practical basis in international case studies, that now evidence a spectrum of real-world innovation, success, and progress.

This results chapter both outlines raw research findings (via excerpts) and examines and expands on their significance via a series of summary graphic representations of the mixed, quantitative / qualitative research results. A notable feature of these results is the significant extent and detail of the findings that have been produced. This outcome is a testament to the interrogative power of mixed methods content analysis as the methodology selected for this research. The finalised design annotation for this specific methodology encompassed a pragmatic problem-solving pivot (beyond the initially envisaged simple converging/concurrent (quant + QUAL) design logic) into the final hybrid embedded qual + QUAL(quant) model, which better enabled the development and graphic expression of the mixed method research findings (Plano Clark & Ivankova, 2016). As final summary results, Figures 11, 13, 14, and 15 seek to appropriately portray a genuine merging of the quantitative / qualitative data, in order to best convey the meaning inferred within these new, hybrid formations of final mixed method result.

The results of the research should be conceptualised as two integrated bodies of work that act in synergy to fulfil the diverse set of research objectives and to comprehensively answer the research question. The first framework of results is overviewed Section 4.1 and illustrated in Table 17 (Appendix 2), which provides a tabular key-point summary of research outcomes expressed within the strategic group of publications cited as the sources of the content of the *Literature review, Background / Context* and *Methodology* chapters. Table 17 maps an evidence base, showing how the overarching publication strategy, in anchoring key points and perspectives in peer reviewed academic literature, has addressed the first four research objectives. This established a foundation for the reminder of the research process to focus solely on the key fifth and final research objective, which integrates with answering the research question regarding the existence of the hypothesised MZWM.

This second framework of results is outlined in Section 4.2, the explorative sequence of quantitative findings, and Section 4.3, the full written narrative QUAL(quant) findings, exemplified by three selected excerpts that the demonstrate the extent, detail, and arrangement of new knowledge generated by the powerful investigative function of MMR CA. This sequence of results finally culminates in sections 4.4 to 4.7, which provide a series of four summary graphics that extract, iterate, and further communicate important aspects of meaning inferable in these results.

Chapter Five: Discussion

Introduction: This *Discussion* Chapter Five is based upon eight sections (5.1 to 5.8) which encompass and discuss what is in effect two integrated frameworks of result. These discussion sections present further detail and offer insights into what the total body of findings, and in particular the MZWM, means for the real-world global imperative of resolving waste issues, circularising the economy, and addressing climate change and the UNSDGs.

This research began with an extensive interdisciplinary literature review that was transcribed into a strategic group of publications whose contents are variously cited and narrated within the respective *Literature Review, Background / Context* and *Methodology* chapters. The literature review chapter provides a compilation of novel perspectives, critical reflections, and points of conceptual synthesis of zero waste theory and practice derived from (Hannon, 2015a; Hannon & Zaman, 2018; Hannon et al., 2018). This chapter provides a foundational understanding of the subject of waste and the failure and issues associated with the traditional paradigm and practices of waste management. A series of excerpts selected from the respective publications achieve research objectives 1 and 2 in demonstrating an understanding of the spectrum of what the zero waste movement encompasses and interrelates with today, as well as responding to themes emerging from examining the critique of zero waste.

The background / context chapter contributes to explaining why dubious and malign claims against MZWM exists. Deconstructing and rebutting erroneous claims conversely supports the central objective of the thesis, which is the counter-claim of proving the research hypothesis and establishing and explicating the MZWM. Vested interest lobbying against the zero waste movement is explored and a case study of the resulting policy capture and negative impact on New Zealand's waste management KPIs is illustrated (Hannon, 2018). Our poor knowledge of the necessary discipline composition of (zero) waste management and consequently insufficient understanding of the complex integrated inter / transdisciplinary requirements for breakthrough and success are examined (Hannon, 2020). The publications respectively encourage a political / policy recalibration and interdisciplinary rethink in (zero) waste industry / community leadership of research and education/training for policy / programme development. The final function of the background / context chapter is to examine and justify the historical origins, definitions, materiality, language, and conventions of the use of the terms municipal / MSW, and to explore and justify a firm theoretical foundation for utilising the term municipal in testing and explicating the hypothetical concept of MZWM.

The three sections making up the background / context chapter combine to achieve the remaining research objectives 3 and 4 and establish a platform for implementing the research methodology focussed on answering the research question and, in doing so, achieving the critical 5th and final research objective. The *Methodology* Chapter Three outlines the development and implementation of a new evidence-based design for a mixed methods content analysis, annotated as the MMR-HCA-T-MZWM quant + QUAL(quant), which is specifically tailored to the research purpose of testing and explicating the hypothesised MZWM. This methodology design process was underwritten by a three-stage review strategy, examining how policy analysis was undertaken in waste management, zero waste research and then, specifically, how content analysis was utilised in researching (zero) waste management policy and practice (Hannon, 2022 in submission).

The combined group of publications go further than just providing a reality-check to misinformation directed at zero waste, whilst contributing to this sphere of academic literature, this body of work performs an important strategic function within this thesis. Table 17 (Appendix 2) provides a visual overview of this strategic function, through the tabularised key-point mapping exercise, which illustrates the progression of key points and new perspectives from the initial phase of the research project, that are now formulated as a contribution to zero waste literature. The overarching purpose of the publication strategy, as a framework of results is, in synergy with addressing the central MZWM research question, to respond to aspects of unwarranted critique of zero waste exposed in the original literature review. This first framework of results (discussed Sections 5.1 - 5.3) seta the foundation for the reminder of the research process to focus solely on the key fifth and final research objective, which answers the research question regarding the existence of the hypothesised MZWM. This primary research procedure generates the second framework of results (discussed Sections 5.4 – 5.8) of this thesis. This second, primary framework of results encompasses the explorative sequence of quantitative findings, the extensive full written narrative QUAL(quant) findings, and the sequence of four summary graphics that illustrate the hypothesised MZWM and explain important aspects of meaning inferred in this result.

5.1. Reviewing existing and new outcomes re zero waste literature

The original literature undertaken for this PhD research project (presented at the point of confirmation) was based on the following sections: the critical and complex issue of waste; the facts and figures of the global waste crisis; waste equals failure; a linear economy equals wasted opportunities; transitioning from waste → zero waste and sustainable development; the background, development, and evolution of a municipal zero waste methodology; and the rationale and importance of the proposed research. Many of the novel perspectives, strands of argument, and content of the original literature review have been translated and, to a degree, are now authenticated through the peer review processes of the publications cited as part of the *Literature Review, Background / Context and Methodology* chapters of this thesis. This work provides a sound basis for identifying knowledge gaps and forming a problem statement and the associated research question and hypothesis addressed in this thesis.

While undertaking a very broad-spectrum original literature review and then implementing a publication strategy as a way of providing the basis for the early chapters of the thesis may be considered an unusual approach, this fits the context of this subject. Ultimately, the broad arc of this research process has achieved the research objectives of:

- Contributing to zero waste literature, in particular by improving understanding of the phenomena of zero waste and by addressing unfounded criticism.
- Underwritten the core functions of literature review, as required by classical scientific process.
- Enabling a professional development opportunity which has threaded research-based learning into the function of the Zero Waste Academy.

Sections 5.1, 5.2, and 5.3 provide a capstone, as well as further illustration of how the body of work undertaken in the original literature review process has been outworked in the publications respectively cited in chapters *1- Literature Review*, *2- Background/Context*, and *3- Methodology* of this thesis.

Another outcome of the original literature review was a broad overview of all types[75] of zero waste literature. This review enabled the definition of the following seven main spheres of zero waste discourse and activity (Table 15). As a collective whole, this spectrum of literature forms and communicates the zero waste story and provides an illustration of intensity and diversity of perspective and response to the critical issue of waste. Together with the growth, proliferation, and popularity of global zero waste movement, this body of literature attests to the practical extent, veracity, and scale of the discussion around the core concepts, theories, and community of practices of zero waste.

Table 15: An overview of the seven main spheres discourse making up zero waste literature.

An overview of the seven main spheres discourse making up zero waste literature	
1	A cohort of book authors identifiable as speaking to this subject. For example, Palmer's pioneering injunction as a chemist eco-entrepreneur (2004), Murray's centrist orientations as an industrial economist (1999, 2002), Connett's community-based environmental activist perspective (Connett, 2013), and the academic/design (S. Lehmann & Crocker, 2012), engineering industry (Khan & Islam, 2012; Nemerow, 1995), community development/innovation focus (Naylor, 2012), household (B. Johnson, 2013; Korst, 2012), and business (O'Connell, 2011) focussed books.
2	The diverse communiqués from identifiable frontline zero waste practitioner, activist/advocate identities and consultants such as Liss (1997, 2001), Lombardi (2001, 2006; 2007; 2008), Snow & Dickenson (2001, 2003) Knapp (1981), Anthony (2001, 2004), Gillespie (2002a, 2002b), Platt et al. (2004; 2008), etc.
3	The consultative position statements and information repositories of zero waste's key associations and interrelated activist collectives (such as, primarily the Zero Waste International Alliance –ZWIA (http://zwia.org/standards/zw-definition/) and Zero Waste Europe (http://www.zerowasteeurope.eu/about/principles-zw-europe/), but also the Global Alliance for Incinerator Alternatives/ Global Anti-Incinerator Alliance –GAIA (http://www.no-burn.org/section.php?id=90), the Grass Roots recycling Network – GRRN (http://www.grrn.org/page/zero-waste) and Zero Waste Alliance (http://www.zwallianceuk.org), etc.
4	The encompassing community of sustainability thinkers and communicators whose perspectives meld into waste's materiality, toxicity, and impact. This grouping includes the more directly related academic and practical spheres such as pollution prevention, cleaner production, industrial ecology, sustainability and circularity in economics, design for the environment, and product stewardship, etc. For example, Hawken and Lovins (1995; 1999), McDonough & Braungart, (2002, 2013) and the Ellen MacArthur Foundation (2013a, 2013b), etc. *NB: the* http://zerowasteinstitute.org/ *website lists a bibliography, which Dr Paul Palmer views as seminal to and influential for zero waste thinking.*
5	The significant tranche of academic and popular publication of industry and community commentary, reaction to and interpretation of zero waste. For example, using *"zero waste"* as a search term in SCOPUS identifies the +400 academic publications and using the same search term in FACTIVA results in an 'all publications' hit of +21,000.
6	Relevant commentary in the established online and physical publication platforms of the mainstream recycling and waste industry media platforms (NB: waste disposal element of this can be seen as evolving spectrum, i.e., landfill → bioreactors and mass incineration → waste to energy - WTE). For example: 'Recycling Today' (http://www.recyclingtoday.com), 'Recycling Waste World' (http://www.recyclingwasteworld.co.uk), 'Resources' (http://www.resource.co), ' Scrap Magazine' (http://www.scrap.org), 'Bio-cycle' (http://www.biocycle.net), 'Waste Management World' (http://www.waste-management-world.com), 'MRW' (http://www.mrw.co.uk), 'MSW Management' (http://www.mswmanagement.com), 'Waste 360'

75 NB: There is a degree of overlap between these demarcations, depending on level and media authors selected for publication. This is overlap is revealed by the extensive reach of search engines. However, these demarcations provide a useful way to bracket literature based on the authors' apparent role and perspective.

	(http://waste360.com), Renewable Energy for Waste' (http://www.rewmag.com), 'Solid Waste and Recycling' (http://www.solidwastemag.com), etc.
7	The growing retinue of 'officialising documentation', generated by cycles of national and municipal zero waste policy planning, strategic governance, and programme implementation, covering early and later developing and developed planning and economic perspectives, as well as, county, city, state, national, and international contexts.

This overview established a platform for following-up some more in-depth lines of enquiry in the literature review and now offers further insights, which complement the discussion results. For example, specifically exploring the balance of industry/commercial vs municipal development drivers, some keynote spheres of intense innovation and success and the implications of rigidly defining zero waste (exclusion / ownership vs heterogeneity / innovation), etc. This extension learning enabled the development of Table 16, which supports Murray's argument about the precedent and importance of the typically pragmatic, interpretive, and evolving industrial / commercial zero waste perspectives / practices (2002).

Based on an indicative review (using Scopus 1973–2010 and the term *zero waste*), Table 16 illustrates the relative volumes of published academic literature. In this timeframe, 168 papers – covering 27 industry/commercial sectors, versus 32 papers – covering 15 national or municipal zero waste contexts reported on their experience in interpreting and implementing the concept of zero waste. This work provides a point of confirmation of Murray's assertion that the initial success of zero waste in an industrial/commercial context provided the critical inspiration and catalyst for seeking to replicate this success in the more complicated, contested and hence more challenging municipal setting (2002).

Table 16: A summary of academic literature identified by using 'zero waste' as a keyword search in SCOPUS 1973–2010.

A summary of academic literature identified by using 'zero waste' as a keyword search	
Industry Sectors	These industry sectors are: Water conservation, wastewater treatment and remediation (8) - Chemical industries (14) - Steel industries (19) - Ag/Hort Industries (4) - Bio-fuels (4) - Textiles/Leather (7) - Green Building (3) – Construction and Demolition (2) - Cement production (10) - Aquaculture (desalination) - Mining / Metallurgy (other than steel, 11) - Recycling (14) - Lubricating and Cooling Fluids (3) - Nuclear industries (6) - Coal power generation (4) - Petroleum industry (16) - Printing/Packaging (7) - Plastics industry (6) - Paint and Dye industries (3) - Transport and infrastructure (2) – Education (7) - Brewing - Electronics (3) - Events (4) - Generic business management/manufacturing 21) - Waste to energy (8) – Nanotechnologies.
National / Municipal Contexts	These are: India (3) – Taiwan (7) – New Zealand – U.S. (4) – Russia – Singapore – Nepal – Australia (2) – Argentina – Abu Dhabi (7) – South Africa – Canada – Greece – Scotland – Austria.
NB: ZWIA reports: Asia (8), Africa (1), Italy (32), UK (4), NZ (30+), Australia (5), South America (1), Canada (9), US (23)] see: http://zwia.org/news/zero-waste-communities/	

This overview work also provided the impetus for drilling down to further examine interesting aspects of specific industry sectors. For example, 19 journal articles specifically reported on zero waste as a driver for alterative thinking, and technical innovation in the steel industry. This industry sector appears to have fostered numerous research projects, for example, examining so-called by-product synergy principles (Rostik, 1999); processes responding to waste disposal and pollution issues (Davené

& Herbertson, 2002; Kondoh, Hamai, Yamaguchi, & Mori, 2001); and exploring zero waste opportunities associated with steel making (Bartels-Von Varnbüler et al., 2003; Fleischanderl, Gennari, Borlee, et al., 2004; Fleischanderl, Gennari, & Daum, 2005; Fleischanderl, Gennari, & Gebert, 2004; P. Fontana & R. Degel, 2004; P Fontana & R Degel, 2004; Gimenez, Bouillon, Ferey, & Sorrentino, 2005; Peters, Schmöle, Korthas, & Rüthe, 2004; M. Sunthankar & Aesf, 1999; M Sunthankar & Joshi, 1998; M. Sunthankar & Joshi, 1999).

Examining this tranche of zero waste industry/commercial literature illustrates that key industry leaders, such as Tata Steel Ltd, Nippon Steel, and ThyssenKrupp Stahl AG, are seeking to exemplify the concept of being an eco-company with eco-products and eco-processes (Kawai, 2000). This leadership appears to have catalysed the entire steel industry to pursue the goal of zero waste (Arora, Rao, & Chakraborthy, 2000; Endemann, Lüngen, & Wuppermann, 2006; Hanagiri et al., 2009; Kawai, 2000; Sen, Roy, Ranjan, & Mukhopadhyay, 2006) to justify the promotion of steel as a 21st century eco-material derived from a zero-emission production system (Kondoh et al., 2001).

While the emergence of this zero waste steel industry reporting offers an encouraging impression of progress and a positive outlook, the more specific drill-down aspects of the original literature review also highlight some of the issues the ZWIA collective seeks to address in demarcating what is and is not acceptable under their definition zero waste.[76] For example, in comparison with the steel industry's apparent success with zero waste, the similar application of this concept and term as a driver for innovation seems far less plausible in industries such as nuclear power (Ciampichetti, Rocco, & Zucchetti, 2002; M. Zucchetti, 2005; M Zucchetti, Cambi, Cepraga, & Ciampichetti, 2007); (M Zucchetti & Bonavigo, 2010), mining [(Nakamura, Mabuchi, Okada, & Uesugi, 2000) (Medeiros & Pinto, 2005); (Tathavadkar, Jha, Fülöp, Török, & Rédey, 2005), or the petrochemical sector (Surface Active Solutions, 2004); (Grishina, Bashkatova, Errera, & Kolesnikov, 2007); (Bammidi, Rao, & Sharma, 2009); (Ive, 2009).

As an example of the extent and detail encompassed in the original literature review, exploring these lines of enquiry provided the groundwork for examining a number of other important considerations. For example, exploring the debate and potential exclusions triggered by the ZWIA's definition, which acts as a demarcation of what activity can and, conversely, cannot be considered legitimate within the ZWIA definition of zero waste. Clearly some industry sectors seem far less plausible than the steel industry in adopting zero waste goals/targets. However, it is the most environmentally damaging industries that face the most profound need for innovation and environmental progress. Limiting the scope of conversation about what is and is not acceptable in zero waste, potentially depowers the possibility of catalysing progress where it is most needed.

The broad scope and depth of the original literature review created a feedstock of information and analysis, elements of which have been (and can in future be) tested via the process of peer review and publication. Another strand of enquiry involved examining the conceptually/vernacularly aligned descriptors/initiatives, which are similar to but not labelled as zero waste. For example, a *world without waste* (A. Johnson, accessed 2013), *life-after-waste* (WasteMINZ, 2001), *beyond waste* (Depertment of Ecology State of Washington, accessed 2013; Launch, accessed 2013), and *no waste* (May & Flannery, 1995), were examined alongside other interconnected academic/scientific disciplines with apparently related theoretical bases of practical focus and aspiration seeking to address waste issues. The following series of quotes illustrate how the strategic architecture of key points were

[76] Ref: https://zwia.org/zero-waste-definition

established in the work undertaken in the literature review phase and then outworked in the narratives of the derivative publications. In this instance, the sequence builds an argument for viewing zero waste as part of a dynamic milieu of creative, aspirational solution-seeking, ideas, and activity responding to waste issues, rather than somehow an extreme and wrongful outlier, the legitimacy of which can be dismissed outright:

> ... preventing, rather than managing waste is allied in synergy with industrial ecology, extended producer responsibility/product stewardship, cleaner production and design for sustainability, etc. (den Boer et al., 2012; S. Lehmann & Crocker, 2012; RCBC, 2009; Spiegelman, 2006). These latter iterations and other interpretive miscellany within the zero waste movement (C. Anderson, 2011) demonstrate the mutability and envisioning function of zero as a catalyst for disruption, innovation and a future/solutions focused freedom of thinking (Hannon, 2015a).
>
> ... whilst disciplines, such as industrial ecology (IE), urban metabolism (UM), and bioeconomy (BE), and the movements for a circular economy (CE) and zero waste each arise out of differing: perspectives, personalities, and intellectual traditions, the appearance of shared cognitive DNA seems clear (Hannon et al., 2018; Veleva et al., 2016). These movements are conceptually aligned and complementary in seeking to confront and re-design and replace the current exploitative, linear economic model with progressively more cyclical and sustainable resource management, where anthropogenic systems *bio-mimic* the modelling of natural systems (Benyus, 1997; Hawkins, 2006; Murray, 2002) (Hannon & Zaman, 2018).
>
> Today a degree of symmetry is discernible across the progressive and poetically allied movements in the sphere of sustainable waste management. This appears in the commonality of 'ideal' and rhetoric around sustainability, as well as in the converging acceptance of issue, causality, consequence and the opportunity in seeking to actualise the ubiquitous conception of naturalistic design (Graedel & Allenby, 2010; Loiseau et al., 2016; McDonough et al., 2003; Pfau et al., 2014). Collectively, the zero waste, circular economy, industrial ecology / symbiosis and bioeconomy movements are all framed in this natural 'ecosystem metaphor' of infinite resource life-cycles. Each, similarly reject the concept of waste and seek radical reform of normative environmental exploitation, routine disposal, externalised pollution costs and the extent of producer–consumer responsibility etc, in favour of regenerative design, dematerialising, detoxing and circularising all resource flows within economy (Ellen MacArthur Foundation, 2013a; McCormick & Kautto, 2013; McDonough & Braungart, 2002, 2013; Mohan, Modestra, Amulya, Butti, & Velvizhi, 2016; Zaman, 2015). (Hannon et al., 2018).

Showing that zero waste is interrelated, analogous, and synergetic with other progressive movements in the aspirational, future-focussed, sustainable waste space, is really important in negating the divide and conquer tactics apparent in the rhetoric of anti-zero lobby groups. In reality, zero waste is one of many movements seeking to respond to the acute globalised crisis of waste and the interrelated challenges of climate and sustainable development (Glavic & Lukman, 2007). It is critical to ensure that evidence-based academic / scientific debate, rather than lobbying and policy capture, is the medium for determining the legitimacy of new ideas and initiatives. New Zealand provides a cases study whereby the anti-zero waste lobbying has caused regression rather than progress in addressing waste issues. The MZWM hypothesis of this research derives in large part from seeking to correct a critical aspect of unbalanced and misinformed critique of zero waste.

This project was based in the Zero Waste Academy (ZWA) at Massey University and implementing the publication strategy as part of this research process enables engaging in the associated peer review processes that provided additional external feedback, learning, and guidance. This external feedback loop provided an additional quality assurance opportunity that benefited both the research process and the teaching function of the ZWA. It is also important to note that while the cited publications provided a venue for peer reviewing zero waste content derived from the research process, the various publications have also had other aligned objectives. For example, publicising the *Living labs* research theory and practice, which is articulated as an attribute of Massey University's sustainability programme.[77]

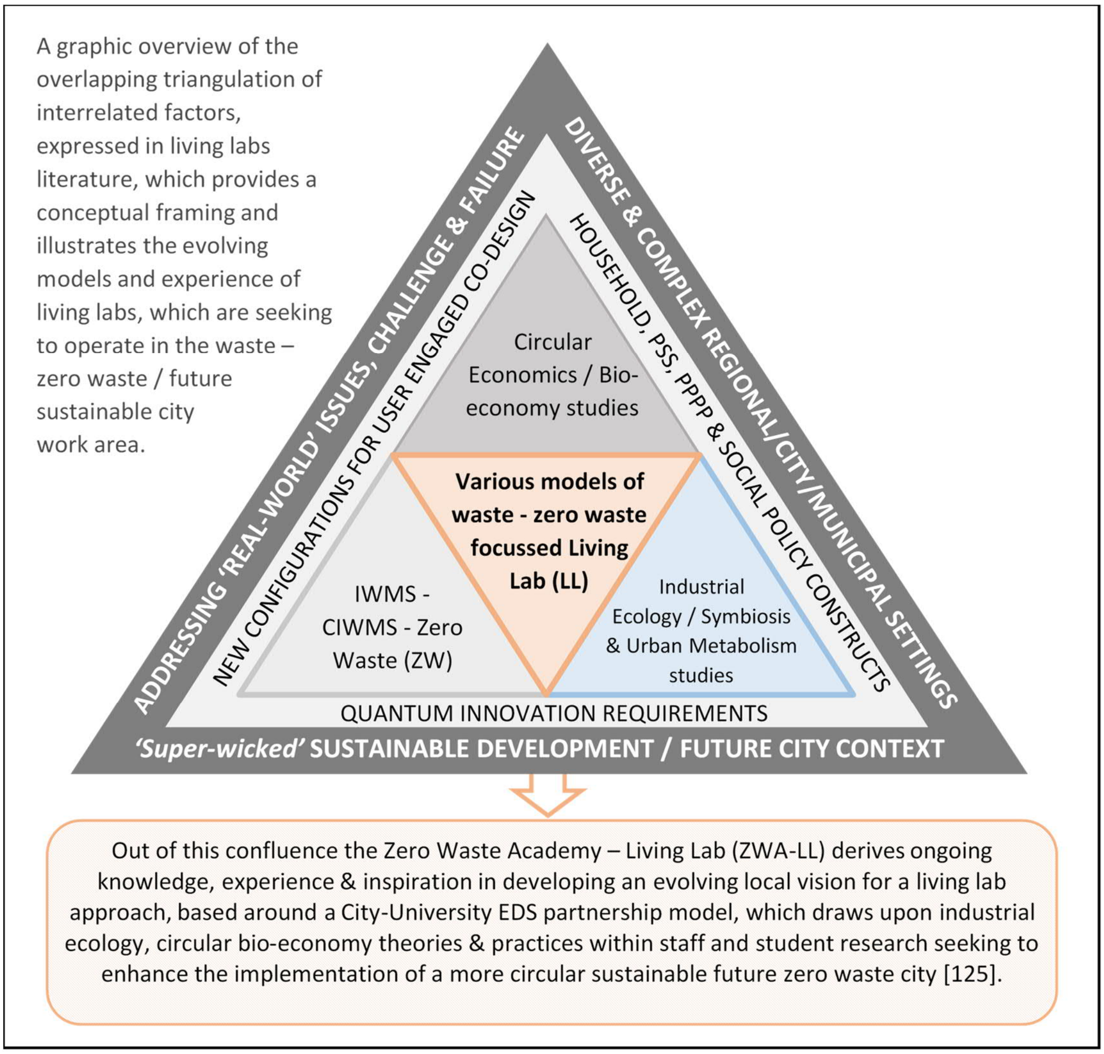


Figure 16: A graphic overview of the living lab – industrial ecology/urban metabolism – circular bio-economy – zero waste, synergy model, which underpins the past and proposed future development model of the New Zealand based, Zero Waste Academy (ZWA-LL) (Hannon & Zaman, 2018; Hannon et al., 2018).

Figure 16, which featured in the *Exploring the Phenomenon of Zero Waste and Future Cities* publication (Hannon & Zaman, 2018), also illustrates the multitasked agenda of the publication strategy. Figure 16 illustrates the model of interdisciplinary alignment that is informing the ongoing development of the Zero Waste Academy (ZWA-LL) in interpreting and outworking an example of living labs research theory – focussing specifically on the concept of future zero waste cities (Hannon & Zaman, 2018; Hannon et al., 2018). However, Figure 16 also provides a real-world, precedent-based example of the previously described argument that the zero waste movement has strong theoretical similarity and

[77] See: https://www.massey.ac.nz/massey/initiatives/sustainability/research/living-labs/living-labs_home.cfm

interrelatedness[78] with other similar progressive sustainability focussed movement seeking to address waste issues. This conception has been translated in the design ethos of the institutional (i.e., Massey / ZWA-LL) teaching, research, and community engagement practices.

As a summary, Table 17 (ref. Appendix 2) illustrates the key-point mapping exercise, showing the interrelated strands of novel zero waste discourse, which through the cited publications have been strategically threaded into and now supplement zero waste literature. The decision to conduct a comprehensive, broad-spectrum, original literature review and then to implement a publication strategy derived from this work as a way of providing the content basis for the early chapters of this thesis represents a thorough and contextually appropriate approach in conducting this research. This approach has enabled this research (and will in future) to contribute to the development of an authoritative, scientific base of zero waste literature. Building the base of zero waste academic/scientific literature presents as both corrective (in respect of unfounded critique) as well as an opportunity to inform and guide the zero waste movement in making a bigger better future contribution in addressing waste issues globally.

5.2. Exploring background/contextual (case study) basis for negating the counterclaim against zero waste

As Table 17 (Appendix 2) indicates, the overall publication strategy was also underwritten by work investigating and interpreting the background issues and the contextual setting of this research. The previously discussed theme of zero waste's interconnectedness (interrelated, analogous, and synergetic) within the sustainable waste management genre is further developed in the publications attributed to the *Background/Context* and subsequent *Methodology* chapters (Hannon, 2018, 2020). The following excerpts from each of the two publications illustrates the expansion and elaboration of key points making up this strand of argument within the overall publication strategy:

> Zero waste, the circular economy, industrial ecology / symbiosis and bioeconomy movements all reject environmental exploitation, pollution, linearity and are all framed in the ecosystem metaphor of infinite circularity…" (Isenmann, 2008; Korhonen, 2004) which recognises that "nature is a zero waste system … Nature recycles everything…" (Snow & Dickinson, 2001; Tobiason, P). In rejecting the concept of waste (Graedel & Allenby, 2010) and seeking to loop the "technosphere back on to itself" (Bourg & Erkman, 2003) industrial ecology can be seen as combining a bio-mimicry of natural systems (Benyus, 1997) and the syntax of recycling, in progressing the "ultimate industrial ecology goal of zero waste" (WMAA & AIEN, 2013)… In the same manner as the theories and practices of zero waste, industrial ecology / symbiosis and a circular economy are reflected national and international policy documents (McCormick & Kautto, 2013), others report a growing legacy of publications, seeking to realise sustainability benefits, spanning environmental economic and social perspectives, on the bioeconomy (Hannon, 2018).

[78] The 'interconnected' design ethos of the ZWA-LL is based on the cited examples of other zero waste framed living labs, namely: *'ZW SA Research Centre for SD + B' / 'Adelaide Living Laboratory' (ALL)* programme in South Australia, the *'ECO LivingLab@Chamusa'* in Portugal and the *'Zero Waste Research Centre'* in Capannori, Italy.

> This emerging cluster of sustainable waste (aka resource) management movements, include several overlapping intellectual disciplines and associated spheres of theory and practice, which can all be variously interpreted responding to waste, as both an acute global environmental crisis (Mavropoulos et al., 2015) and physical emblem of broad systemic failure (Popson, 2002). The milieu of respondents includes: zero waste (ZW), zero emissions (ZE), circular economy (CE), industrial ecology / symbiosis (IES), urban metabolism (UM) and bioeconomy (BE), which all identify in the commonality of seeking to actualise the ecosystem metaphor of infinite-perpetual resource life-cycles and naturalistic design principles (Kuehr, 2007; Loiseau et al., 2016; McDonough et al., 2003; Pfau et al., 2014; Varga & Kuehr, 2007). Aside from fundamentally rejecting the socialisation of waste (Strasser, 1999), this genre of highly aspirational, future-focussed movements, align in seeking to disrupt and replace routine environmental exploitation, disposal and externalised pollution costs, with the polar opposites. Namely, normalised maximum material: resource conservation, stewardship / responsibility, efficiency and circularity (Hannon et al., 2018). (Hannon, 2020).

The contribution of these publications to this thesis is to confront and rebut key elements of the quite negative and misinformed views collated in the review of critique of zero waste (Table 1, Section 1.0) and project a more balanced, in-depth, and evidenced-based perspective within zero waste literature. While this chapter offers an alternative view to some of the most questionable aspects of the critique of zero waste, this is not the main objective. The two publications contributing to the chapter serve two distinct purposes (discussed in the following Sections 5.2.1 and 5.2.2) in the overarching design of this research project:

5.2.1. Contextualising this research in real-world experience.

The first purpose involved examining New Zealand as a specific case study setting, where the real-world outcome allowed a highly negative and misinformed view of zero waste to be constructed by vested interest groups, for this to be promulgated, and to exercise policy capture. The *(Un) Changing Behaviour: (New Zealand's delay & dysfunction in utilising) Economic Instruments in the Management of Waste?* report (Hannon, 2018), details the extensive issues and decline in national KPIs resulting from the orchestrated negation of zero waste to go unchecked. These outcomes evidence the salience of the research objectives. The effect of grounding this research in the real-world New Zealand case setting is to highlight and greatly amplify the value proposition of seeking to test and elaborate the hypothesised existence and efficacy of MZWM. In proving this research hypothesis, the results now disprove the most extreme anti-zero waste assertions (Clough, 2007; Krausz, 2011, 2012, 2013a, 2013b; Krausz et al., 2013) that had previously been influential in the New Zealand context.

The argument and evidence presented in this publication, which covered a two-decade period of New Zealand waste policy and experience, is clear and assertive:

> New Zealand's actual priorities and track-record, currently appear well out of step with international good practice and contemporary science. An inescapable perception is emerging that, New Zealand at the behest of lobby groups representing polluting industries, swapped the initial success and progress of a zero waste approach, for delay and dysfunction in utilising economic

instruments to effectively manage waste. The largely unexamined, true cost of waste eludes the majority of our economic calculus and is still not accurately factored into market pricing. This lack of economic sagacity perversely incentivises the sectors of the economy making and managing waste, at the expense of those emerging sectors, which might otherwise drive an increasingly circular economy (R Crocker & Lehmann, 2012). Enabling the makers and managers of waste, to enjoy profitability untroubled by the accounting of their externalised environmental cost, ensures that society remains unnecessarily shackled to the least priorities at the bottom of the waste hierarchy (Hannon, 2018).

In covering the period between 1999 and 2017, this case study setting encompassed New Zealand waste management policy and resulting performance in two counterposed political cycles of coalition government. The report utilised the framing of the *Changing Behaviour: Economic Instruments and the Management of Waste* (PCE, 2006) published by the Parliamentary Commissioner for the Environment, as a structured opportunity to reflection on the New Zealand (zero) waste story. The report was published under the auspices of the New Zealand Product Stewardship Council (NZPSC), an independent group advocating for the effective design and employment of mandatory product stewardship/extended producer responsibility (PS/EPR) programmes to address waste issues. In the period following the publication of this keynote 2006 PCE report and legislation of the Waste Minimisation Act (2008), the political ideology of government switched from the self-described centre left to centre right, which correlated with a shift from a pro- to an anti-zero waste and sustainability policy setting.

Based on a comprehensive analysis of international experience and best practices, the 2006 PCE report provided a comprehensive examination of the potential to utilise a spectrum of economic instruments (in particular, product stewardship, PS) to address waste management issues. The PCE report discussed these opportunities relative to New Zealand's unique social, cultural, economic, environmental, and political context and examined the barriers to progress which existed at the point. Ultimately, the PCE report called for renewed leadership from central government (PCE, 2006). Helpfully, the PCE report offered a set of recommendations on what needed to be done to overcome the barriers to progress, so that the benefits of resolving waste and other interrelated environmental issues, could be realised by New Zealanders. These same recommendations were utilised as structural framing for re-examining how well in the subsequent >10 years the PCE recommendations had been implemented. Given that the PCE is an authoritative body specifically mandated to hold government to account, this 2006 report provided an ideal basis for framing a case study-styled examination of waste management in New Zealand. Accordingly, (Hannon, 2018) was framed as a NZPSC submission to the PCE and employed a two-part, sixteen-section structural examination based on:

1. Identifiable omissions around the guidance of the 2006 'Changing Behaviour' report
2. Other general questions, issues, and unrealised opportunities inherent in the WMA:2008.

(Hannon, 2018) demonstrates the previously described multi-tasking agenda as pragmatically arising out of the professional practice of the ZWA, which is instrumental in supporting the NZPSC as a critical advocacy group in the New Zealand waste → zero waste scene. A further example of the multitasking and synergy underwriting this research process, was how this publication provided a platform for stating the following summary benefits of zero waste that now supplement the ZWA educational and public communication / advocacy resources:

Zero Waste is:

- Successful (Allen et al., 2012; Ecocycle Solutions, 2017a, 2017b; Rosa, 2018; Rosa & Chatel, 2016a, 2016b; Simon, 2015a, 2015b, 2015c; UN-Habitat, 2010; Van Vliet, 2014a, 2014b, 2014c).
- Scientific (Pietzsch et al., 2017; SRMG Inc, 2009; Zaman, 2012, 2013, 2014, 2015, 2016; Zaman & Lehmann, 2011a, 2011b, 2013; Zaman & Swapan, 2016).
- Learning & evolving (Pietzsch et al., 2017; Song et al., 2014; Zaman, 2015; Zero Waste Europe, 2017).
- Controversial in challenging the status quo (Silva et al., 2016; Zaman, 2015; Zaman & Swapan, 2016).
- Measurable [ref. the 'Zero Waste Index' (ZWI)] (Zaman, 2013, 2014; Zaman & Swapan, 2016).
- Socially and culturally beneficial (Hogg & Ballinger, 2015; ILSR, 2002; S. Kathiravale & Yunus, 2008; S Kathiravale, Yunus, & Abu, 2007; Living Earth Foundation, accessed 2015; D. C. Wilson, Rodic, et al., 2015b).
- A good investment economically (Hood & Ministry of Environment British Columbia, 2013; SRMG Inc, 2009; Zaman, 2016; Zaman & Swapan, 2016). (Hannon, 2018).

The final point of discussion related to the NZPSC leveraged *(Un) Changing Behaviour: (New Zealand's delay & dysfunction in utilising) Economic Instruments in the Management of Waste?* publication, is that this also afforded the opportunity to credibly establish the link between the MZWM research focus and the broader subject of waste management. In this publication, market-based economic instruments, incentives, and regulatory interventions, technology/ services/ infrastructure, policy/programme behaviour change, and political ecology, etc., were all linked and discussed in respect of the immediate history, concept, theory, and practices of zero waste management within which they are instrumental.

5.2.2. Background – the complex and misunderstood interdisciplinarity of waste and zero waste

The second publication contributing to Chapter Two, *Exploring and Illustrating the (Inter-) Disciplinarity of Waste and Zero Waste Management* (Hannon, 2020) also implemented important elements of the publication strategy's research objectives and multitasked purpose. (Hannon, 2020) further links zero waste to general waste management discourse and as illustrated in the logic of the following sequence of excerpts, this publication takes the inter-connectedness theme to its logical conclusion:

Waste = failure / traditional waste management theory and practices are failing – it's a big problem!!

> Waste can be recognised as amongst the most challenging and complex anthropogenic problems being faced globally (Hoornweg et al., 2014; Hoornweg et al., 2012). The International Solid Waste association (ISWA) uses the term "global health emergency" and in response calls for "emergency programmes" to address the most acute aspects of this challenge (Mavropoulos et al., 2015, p. 6). The resource exploitation, linearity, toxicity, leakage, loss of material value inherent to waste disposal, alongside what social and environmental costs are ignored and externalised from this model, combine to make waste issues wickedly complex (Cobo et al., 2018; Velis, Lerpiniere, &

Tsakona, 2017). Contingent with the scale and acuity of these systematic issues, achieving genuinely sustainable management of waste, is both a critically important sphere of human activity and is one which requires a transformational level of breakthrough and progress (Enkvist & Klevnas, 2018). (Hannon, 2020).

Failing conventional waste management theorem is now morphing into the language of circularity/zero

As a derivative issue ocean plastic pollution highlights the failure of terrestrial waste management systems (Boucher & Friot, 2017; Lo et al., 2017; Lohr et al., 2017). The necessity for change appears to be accepted even at the nexus of disposal orientated waste management theory and practice (ISWA, 2017b; Mavropoulos et al., 2017; Velis et al., 2017). Consequently, "linear Integrated Waste Management Systems (IWMSs)" praxis is now cited as being re-conceptualised, reformatted and re-languaged, into "circular IWMSs (CIWMSs)" (Cobo et al., 2018, p. 279). (Hannon, 2020).

Zero waste is part of a broad progressive movement responding to the crisis/failure of waste.

This emerging cluster of sustainable waste (aka resource) management movements (i.e., ref. previously cited excerpt: ZW, ZE, CE, ISE, UM, BE) all respond to waste, as both an acute global environmental crisis (Mavropoulos et al., 2015) and physical emblem of broad systemic failure (Popson, 2002). (Hannon, 2020).

This post-waste movement is anchored in and driven by the overarching science of climate change and sustainable development.

A progressive symmetry and potential synergy is discernible across the spectrum of alterative waste management movements, responding to the crisis of waste (CIWM, 2014; Hannon & Zaman, 2018). All such progressive movements, can be viewed as part of dynamic milieu of sustainability idea s/ ideals, rhetoric, and activity (Ayres, 1997; Glavic & Lukman, 2007), which coincide in interpreting waste as a resource and opportunity, rather than just a problem (Agudelo-Vera et al., 2012). Such post-waste movements (WasteMINZ, 2001) recognise the positive: energy, water, GHG emission, chemical pollution, socio-cultural and economic implications, in respect of conserving and cycling resource flows, mitigating climate change and transitioning into more sustainable development (Enkvist & Klevnas, 2018; Graedel, Buchert, Reck, & Sonnemann, 2011; Pauli, 1997, 1998). (Hannon, 2020).

This movement can be viewed as change-making transitional spectrum, within which zero waste has a unique and extreme identity and progress-making role.

This discussion acknowledges the extremity of zero waste, within the dynamic spectrum of sustainability movements/ disciplines (i.e. ZW, ZE, CE, IES, UM, BE and CIWMs etc.) focussed on deriving new and transformational ways of addressing the issues and opportunities associated with waste. This genre of activity can be conceptualised as a change-making transitional spectrum and abbreviated / annotated via the encompassing extremities of: waste → zero waste, aka (zero) waste management. This abbreviation is used without prejudice, or exclusion to any of the movements / brands operating in the sustainable waste / resource management space. It is recognised that, a multiplicity of efforts are pioneering innovation, research and development, progressive and successful case studies. At this point, it is not yet known what individual, or combination of initiatives may catalyse the requisite transformational breakthroughs, which will usher in the envisioned new era of sustainable waste / resource management. Therefore, there is inherent value in both maintaining a biodiversity of responses, prospecting a range of potential solutions and in cultivating an urgent continuum of experimentation around all opportunities for generating progress (Hannon & Zaman, 2018). (Hannon, 2020).

Conceptualising the waste → zero waste transition spectrum as integral and essential to addressing the challenges of climate change and sustainable development, is the stepping off point for examining the interrelationship between the requisite contributing knowledge bases and scientific disciplines. This recognition challenges us to focus on the efficacy interdisciplinarity comprehension, training and collaboration across the entire transitional of waste → zero waste spectrum of research, education and industry practice?

A question common to this sphere of activity is then: what will reverse perceptions of failure and dysfunction associated with the global crisis of waste and what will enable the envisioned transition from issue to opportunity? The research supporting this article explores how the concept of failure vs success, which is debated in respect of the waste → zero waste transition spectrum, can be interpreted and explored within a wider realisation of the shortcomings of traditional disciplinary thinking and practice. It can be argued that this omission is compounded by inadequate understanding of the complex (inter) disciplinarity of (zero) waste management. Moreover, it can be argued that the cited super-wickedness of the globalised waste crisis, necessitates an urgent advancing of interdisciplinarity comprehension, training and collaboration across the spectrum of waste → zero waste related research, education and industry practice (Hannon, 2020).

This sequence of cognitive bridges arrives at, contextualises and justifies the problem statement, research question and subsequent hypothesis and establishes the value proposition of this research.

Whilst commonality exists amongst the emerging, green / sustainable genre of (zero) waste management movements, so to does debate and controversy (Bartl, 2011). In particular, whilst the zero waste attracts affirmation and support, the movement can also be a lightning rod for criticism (Lee, Pedersen, & Thomsen, 2014). Arguably, within this green / sustainable genre, zero waste is the most extreme and controversial variant (Hannon & Zaman, 2018). Zero waste embraces: activism (i.e. confronting both the fundamental concept of waste and the vested commercial interests, which make, manage and profit from waste) hyper-aspirational terminology, a transgressive ideal and continuum of innovation and elevating the role and responsibility of community, ahead of private sector / professionalised industry control over change-making processes (Lombardi & Bailey, 2015; UNEP et al., 2013; Zero Waste Europe, 2017). Zero waste appears to attract a polarised characterisation, i.e. on one hand, as a chronic failure and doomed on the basis of a non-existent, un-implementable blueprint/methodology (Krausz, 2011; Krausz et al., 2013; Premalatha et al., 2013) and in contrast, as a successful, scientific and popular catalyst of a 2nd – green industrial revolution, (Kopacek & Schadlbauer, 2013; Murray, 2002). (Hannon, 2020).

In contributing to Chapter Two, (Hannon, 2018, 2020) progress key elements of the overarching publication strategy, implement research objectives 3 and 4 and combine to provide important background and context for the development of a MZWM specific research methodology. (Hannon, 2018, 2020) also make a central contribution to this thesis in providing a measure of explanation as to why unfounded and malign counter claims against MZWM exists in the first place (i.e., that zero waste is a doomed/a chronic failure and is a super-mega problem for which there is no plan/blueprint (Clough, 2007; Krausz, 2011, 2013a; Premalatha et al., 2013)). Deconstructing these counter claims provides context for and is a converse way of supporting, the hypothesis of this research.

The diverse themes and interwoven strands of argument projected through the publication strategy go some distance to refuting the anti-zero waste counter claim and establishing a platform for proving the existence of an elaborated MZWM. In particular, (Hannon, 2020) evidences the significant complexity and numerous, extensive, and deeply embedded barriers to progress that exist across the waste → zero waste space transition spectrum. Specifically, (Hannon, 2020) observes that the challenge of generating progress is being approached with a limited, unresolved, and outmoded conception of the complete (inter)disciplinary requirement for fully prosecuting the holistic opportunity encompassed in zero waste. This research finding shows that zero waste research is not just a tangent or beneficiary of the dominant tradition of waste disposal-centric research, but rather an alternative zero waste research perspective that can produce important and genuinely novel insights that benefit (zero) waste management as a whole.

Another key finding is to identify the opportunity of improving inter → trans-disciplinary engagement, as a catalyst for innovation and progress across the transitional waste → zero waste spectrum of activity (Hannon, 2020). The key outcome of the *Background / Context* chapter is, by negating anti-zero waste counterclaims, to strategically underwrite the central research objective, which is testing and elaborating the hypothesis of MZWM. While, at the most basic level, this hypothesis will ultimately be addressed via the simple dichotomy of a yes or no answer, the publication strategy worked out across Chapters One, Two, and Three integrate this simple answer into a bigger, richer, more complex picture. It is clear that, at whatever level zero waste is adopted (i.e., individually, household/family, business/industry/commercial sector, local/regional community, village-megacity municipal, national/global) there is an interesting and important encompassing story on offer.

In simple terms, the background and context for evaluating the subject research hypothesis is to understand that this zero waste story is concentric with the challenges of managing natural, social/human, financial/manufactured capitals (Porritt, 2007), reducing pollution, circularising the flows of material resources in the economy and addressing climate change and the UNSDGs (Hannon & Zaman, 2018). The zero waste story is also actively opposed within the prevailing the highly privatised/commercialised, competitive environment, whereby powerful vested interest groups seek to promulgate a world-view that maintains the pre-eminence of business models and profit pathways based on making and manging waste (Brandon, 2012; R Crocker & Lehmann, 2012).

The final background requirement before preceding to discuss Chapter Three is to examine the use of the term municipal within the phrasing of the MZWM research hypothesis. Examining historical and contemporary scientific and industry discourse points to a ubiquity and universalism in the way the term municipal is used for solid waste/resource management. As a descriptor, municipal can encompass a range of geo-spatial scales, socio-economic, and institutional/governance contexts and material perspectives. While formal definitions and convention can be construed, the onus is equally on the individual researcher to specifically explain and justify their chosen application and or alignment to these precedents. In this instance, the premise of using the term *municipal* in relation to the hypothesis of zero waste, rather than one of many and various versions of solid waste management methodology, is not such a deviation as to require much explanation beyond:

- Recognising municipal zero waste is a pre-existing theoretic and practical construct, within the heterogenous global movement.
- Recognising that the aspiration for working towards a zero waste goal, rather than conventionally managing waste to target any variety of more sustainable outcomes are at one level, not that different.
- Recognising that the aspired spectrum of scopes of application (i.e., towns, (mega)cities national jurisdictions) are notionally the same.
- Acknowledging there is a degree of plasticity in the way the term municipal is stretched over a spectrum of management functions/utilities in respect of waste (i.e., socio-economic scenarios, materiality/mass flows, geo-physical spaces, governing authority, and legislative/regulatory functions, etc. (in full ref. Section 2.3 and Appendix 12), and applies equally to zero waste, that is a differentiated approach, to the same field of management.

In short, the research outcomes expressed and now discussed in Chapter Two established the necessary platform for the *Methodology* Chapter Three to design and implement the specific research procedure to then test and explicate the MZWM hypothesis.

5.3. Methodology exploration, learning journey, theoretical pivot, research design/ annotation and implementation experience

Chapter Three, the *Methodology* chapter, is the junction point in this thesis where the already published research results, cited as content and support for the initial chapters, are supplemented by research results derived from implementing the specific MMR – HCA – T- MZWM quant + QUAL(quant) research methodology. Both frameworks of results are essential and complementary in completing the research objectives and answering the research question that proves the hypothesis and explicates a new way of understanding the MZWM.

The draft article cited in Chapter Three (Hannon, 2022 in submission) builds on the key points and emerging themes articulated within the publication strategy (Appendix 2). The following excerpt illustrates how the previously highlighted theme of interconnectedness (which is just one example of the many themes mapped in Table 17), has for the purposes of discussion, been specifically identified and tracked, having been further iterated and expanded:

> The heterogenous global zero waste community of practice, can be recognised as part of an emerging cluster of sustainability focussed waste management (i.e. including the likes of the circular economy, industrial ecology / symbiosis, urban metabolism, zero emissions and bioeconomy) movements, prospecting the next and new and seeking to drive progress beyond the current known thresholds of achievement (Hannon & Zaman, 2018; Zaman, 2015). This highly aspirational, future focussed cluster propose a starkly alternative worldview, in response to perceptions of crisis and failure attendant to waste management generally, but are particularly energised and popularised by key waste foci, such as plastic waste polluting the oceans. Within in this green grouping, the global zero waste movement, is arguably the most extreme, confrontational, controversial and contested variant, seeking to catalyse revolutionary solutions to the issue of waste. These movements coincide around the ideal and rhetoric of sustainability (Glavic

& Lukman, 2007) and in recognising waste - as actually, resource management (Agudelo-Vera et al., 2012). (Hannon, 2022 in submission).

Alongside such thematic contributions to the thesis (Hannon, 2022 in submission) provided an opportunity to orientate the research project within relevant research theory and explain the design basis of the selected methodology. The draft article first outlines the historical development and employment of content analysis as a generic research methodology. The draft article then describes the results of a three-stage review strategy, which sequentially examined how policy analysis was undertaken in waste and then zero waste management research, before examining how content analysis had been specifically utilised in researching (zero) waste management policy and practice.

The outcome of this body of work was to comprehensively inform and justify the selection of content analysis as the most appropriate research methodology for this research project. The article explains how the findings of the three-stage review strategy guided the design (and actual implementation) of a new model content analysis specifically for testing and elaborating the hypothesis of municipal zero waste methodology (MZWM) (Figure 7, Section 3.5). The combination of this article and the conventionally written sections of the methodology chapter (3.1 to 3.15) provide a strong theoretical foundation and specific research methodology, and describe the actual experience and learning derived from implementing this methodology.

In full, the specifically selected and designed methodology is described as a concurrent/convergent, embedded hybrid mixed methods research – hermeneutic content analysis – thematically focussed on testing and elaborating municipal zero waste methodology, which in full is annotated as *MMR-HCA-T-MZWM quant + QUAL(quant)*. As a whole, the *Methodology*[79] chapter (albeit in a hybrid format) is extensive, detailed, and contains much embedded discussion in reference to numerously cited literatures of policy analysis, content analysis, and mixed methods research. The chapter provides a strong evidence base for justifying that the correct research methodology has been selected (and appropriately adaptively designed) for this research question and also that this methodology has been implemented in a scientifically authentic way that has produced reliable results.

5.4. The importance and meaning of the quantitative findings

Having in Sections 5.1 to 5.3 discussed the first framework of results (which are the published review research findings now interspersed in the narrative and content of the early chapters of the thesis) the following Sections 5.4 to 5.8, discuss (commencing with quantitative) the second framework of results derived from implementing the research methodology.

As demonstrated in the sequence of analysis outlined in Table 5, Section 3.14, and as discussed in Sections 4.2.1 to 4.2.7, the selected research methodology [(*MMR-HCA-T-MZWM quant + QUAL(quant)*] sought an integrated, concurrent/converging analysis, interpretation, and an embedded hybrid communication of both quantitative and qualitative data/findings to be undertaken within a

[79] Because it was the most proximal and pertinent location, a significant amount of what might be considered as *Discussion* is conveyed as part of the in-depth *Methodology* narrative, which covers research theory and methodology design as well as narrating the practice and learnings from implementing this specific methodology. This means that the following sections of *Discussion* should be read in conjunction with the relevant earlier *Methodology* sections.

singular unified research theory (Bryman, 2006, 2007; Plano Clark & Ivankova, 2016). The intention was that this specific design of content analysis would, in parallel with an open-ended questioning of narrative or text data related to the phenomenon of interest (i.e., MZWM), also explore what standardised numeric measures and instruments provided useful insights to relationships between the variables that emerged during the enquiry so that the sources became more fully understood (Creswell, 2015; Plano Clark & Ivankova, 2016).

The importance of what forms of quantitative data were initially evident in scanning the sources became increasingly clear during the detailed coding and later analytical process. The extent and value the quantitative data contribute to the overall results confirmed that the MMR HCA-T-MZWM quant + QUAL(quant) methodology design was a relevant choice for the subject purpose and selected sources. A variety of MS EXCEL spreadsheets were developed based on what analytical formats appeared most appropriate for those quantitative aspects of the dataset that emerged during the coding procedure. As illustrated in Table 5, the overall explorative sequence of quantitative analysis can be usefully grouped for discussion into three relational clusters.

5.4.1. The first relational cluster of *quant* + analysis

The first cluster of related quantitative analyses involved:

a. extracting and examining a full range of the baseline descriptive information available in the three selected MZWM sources (Section 4.2.1) and
b. *Acknowledgments, contributors, and people of influence*, which explored evidence on the origins, connections, and cross-pollination of zero waste ideas, principles, and concepts (Section 4.2.2.) and
c. *Analysis of the references*, to provide a formal systematic and comprehensive attribution / origin of and evaluation of the relative academic quality assurance' (Section 4.2.3.).

In providing an in-depth examination of the sources, this cluster of analyses validated the source selection in terms of transparently encompassing an appropriate globalised spectrum of authoritative authors, acknowledged contributors, referenced primary sources, purpose type and stature of supporting /publishing organisations, scale of municipal context, socio-economic development status, subject population / demographics / culture / geography, financial / material flow/system type parameters, time period, evaluative metrics, and examined knowledge/experience/outcome. This spectrum of examination fulfilled the injunction to convey the transparency necessary for anybody seeking to critically examine the results (Berg & Lune, 2012; Bryman, 2012).

Alongside validating the sample selection, this comprehensive model of analysis also made explicit descriptive data that were not otherwise apparent and thereby enhanced understanding of the sources and the meaning extracted from them. Having established the relevance and broad usage of content analysis as a tool for analysing policy (inc. in the sphere waste → zero waste) (Hannon, 2022 in submission), these findings raise pertinent methodological observations for future design and implementation of content analysis in this type of research. For example, in future, should identifying and examining peri-content (i.e., to formally establish a contextual framing of parameters, relevant and important in fully understanding inferred meaning) become a routine procedure for this type of content analysis research?

This related cluster of analyses provides information on:

- the number of acknowledged contributors to the sources
- the level of correlations/commonality of acknowledged contributors within each source
- the notion of a *'collective zero waste voice'*, represented in the total group of authoritative contributors identified in connection with the three selected sources (Section 4.2.1.).

This aspect of the quantitative analysis provides an empirical basis for understanding the differing personal, organisational basis of publication, which may influence the outcomes of content analysis. Examining this provides the ability to discern the degree to which the information within (hence any inferred meaning) might, for example, be derived from a possibly localised / personality / issue-driven tangent, rather than a possibly more balanced, objective, mutualised, bigger, internationalised perspective.

Following a similar line of enquiry, the formal references of the sources were also examined. Where references are utilised, these provide a formal, systematic, and comprehensive attribution of the origin of key ideas and an evaluation of the relative academic quality assurance (ref. Section 4.2.2). In this instance, only two of the three sources utilised a formal referencing system. A designated quality assurance metric was adopted that enabled a scoring system to be developed. This was based on the number and ranking of each individual reference and provided a measure of the total (and on a page-density basis) number/value attributable to the references associated with each source.

As a point of reference, this analysis also included an examination of the authoritative academic review article: *A comprehensive review of the development of zero waste management: lesson learned and guidelines* (Zaman, 2015). Not unexpectedly, this analysis exposes the difference in the derived content and precept of academic compared with general audience publications that had been selected as sources. The two sources utilising a formal referencing system were the New Zealand based (internationally referenced) how-to methodology (Snow & Dickinson, 2001) and the internationalised case study-styled publication (Allen et al., 2012). These two sources proved on both an outright and per page density basis, a relatively similar quality assurance score (i.e., measuring refenced author, knowledge repute, density). Empirically discerning this similarity (i.e., between the two general audience framed sources) and also where it existed, the differences (i.e., academic vs general source) was not unexpected, as these are respectively similar and dissimilar types of publications with differing audiences, purposes, and expectations.

Together, the two follow-on analyses provided an opportunity to explore:

- the origins and interactivity of information and perspectives and
- a measure of quality assurance of the referenced inputs contained in the sources and to
- then reflect on strength, potential biases/conflicts of interest, etc., which may carry through from the formation of content, into the research findings from analysing that content.

While these empirical measures are interesting and informative, they must only be considered as indicative, not definitive, of the insight that is afforded (i.e., designation of the fundamental differences in document audience, expectation, purpose, mode of delivery, convention, and style, etc.). However, that said, neither did this analysis expose any deficiency in contributors or contributing information making up the sources, which would cast doubt over the legitimacy of the subsequent findings of the content analysis. On balance, the analysis provided further basis for the research to claim to have heeded the injunction and actioned a means of substantiating and conveying disclosure and transparency by which others can critically examine and test the veracity of the results (Berg & Lune, 2012; Bryman, 2012).

5.4.2. The second relational cluster of *quant*+ analysis

The next related cluster of results from quantitative analysis were derived from exploring the level and pattern of conformational evidence coded in support of the MZWM (Tables 9 and 10 and Figure 10, Section 4.2.4.) and mapping of evolution in the type and rate of iterative change in the coding framework as this progressed toward a final version, before ultimately being finalised as a proposed MZWM vfinal (Table 11, Section 4.2.5.).

In identifying the number and relative percentage of data coded across the coding framework and to then bracket and colour code the data into more discernible groupings, Table 9 provides an opportunity to examine where the greatest (and lesser) weightings of coded evidence and support are located. This illustrates the attention given and relative importance accorded within this selection of zero waste literature. For example, *Conceptual foundations & critical principles*, at 44.37% of the total codes, has been accorded the largest percentage of codes.

This indicates a strong emphasis within zero waste of seeking to entirely rethink societal approaches to waste and to create a new and alternative conceptual and principled basis considering and responding to the issues and opportunities of reconceiving waste as a resource. Specific to this theme, these data enable us to understand that this critical reconceptualisation predominantly involves five key factors: the integration of *Zero waste, sustainable development and climate change mitigation imperatives* (5.81%); encouraging the formation of *Documented strategic zero waste plans* (5.69%); which should be developed and implemented through a recognised *Zero waste leadership/agency/legislation & regulations* (5.40%); creating an *Holistic societal commitment/PPPP models* (6.04%); and, relevant to these, promoting the exercise of community responsibility through the principle and practice of *Separation at source* (4.11%).

Noticeable alongside the emphasis on *Conceptual foundations and critical principles* is the relatively even spread of attention and importance (represented in code distribution) accorded to all other four key themes: *Financial* (total 14.14%) *and Physical mechanisms* (total 14.91%) and *Social* (total 14.91%) *and Policy* (total 11.91%) instruments. Examining the other most prominent sub-themes, which are identified across these other dimensions of this emerging MZWM framework, indicates the affirmation within zero waste literature of enabling:

- The pragmatic *Physical mechanisms* of diversion from disposal – circularising material flows via *Amplified collection & sorting systems* (3.17%) and specifically empowering *Organic recycling, via composting and anaerobic digestion* (4.69% - *NB: AD is the only waste to energy (W2E) option which is supported by zero waste*)

- The *Social* transformation and behaviour change offered by mainstreaming *Zero waste-education for sustainability programmes* (3.35%) and enabling the grass-roots community ethos of *Participatory development and appropriate technology* (6.34%)
- The *Financial* acumen of genuinely *free-market* based approaches (i.e., fully pricing and internalising environmental costs and mandated producer/consumer responsibility, etc.) and employing effective *Economic instrumentation of incentive and regulatory interventions* (4.05%).

Interestingly, while *Policy* instruments in total have a similar value/priority weight (based on the percentage of codes) as the above big four, there are no prominent >5% or 3 to 4.99% dominating this theme. *Policy instruments* is instead made up of 15 smaller and more evenly weighted sub-themes (only three in the 1 to 2.99% bracket). These data provide an important insight into how *Policy* is viewed in the composition of MZWM. First, *Policy* is accorded the least code weight priority of all the key themes (arguably conventional ISWM is the opposite and is highly policy focussed and driven), and second, policy appears to be functionally more democratised, i.e., outworked via a more evenly dispersed myriad of interactive sub-themes.

Given the weight and distribution of coded evidence, it can be said that the relative prominence given in the mix of imperatives, provides a high-level characterisation of what zero waste views as, the most essential amongst the essential elements of MZWM. While not an absolute corelation, the priorities quantified in this analysis were evidentially influential in shaping the structural arrangement of MZWM, which included the decision making on the top-down ordering and organisation from left to right. Critically, however, the insights conveyed in these data did prompt the decision to directly correlate both the coding frequency numeric and the colouring system into the Figure 11 rubric. This enables new indicators of value/priority distribution (i.e., accumulated percentages) to be attributed to the final nine key MZWM themes ultimately derived from the completed content analysis.

The perhaps least obvious, but possibly most important consideration, which was exposed and further prompted in this quantitative analysis, was the emerging conceptualisation of association, interrelationship, and interactivity between key priorities and the spectrum of other elements of MZWM. The outcome of this reflective phenomenon are the clusters and links, which have been derived and are communicated in the formation of the previously discussed structural arrangement of boxes, boarded groups, and line connectors in Figure 11. The combination of Tables 9 and 10 and Figure 10 operated as an empirical lens that exposed new perspectives on the composition and concept of MZWM. Ultimately, this leads to the novel depiction of MZWM as being both elementally diverse (where components are important) and having priority clusters that interact in combinations to unlock the operability of the whole MZWM. It seems unlikely that the dynamic interactivity inferred in the quantitative analysis would have emerged from qualitative analysis alone. Communicating the findings of priority and interactivity with the final result necessitated developing new means of graphic expression merging numerics, words, colours, symbols, boxes, links, and arrangement in an embedded hybrid QUAL(quant) format, which ultimately prompts an abductive bridging into entirely new graphic frameworks of result (the ∞ infinity continuum model of MZWM).

The second follow-on quantitative analysis in this relational cluster involved mapping the evolution in the type and rate of iterative change in the coding framework. Change occurs as the coding framework develops (through the sequence of content analysis research undertaken within the NVivo coding procedure and via translation into and out of MSEXCEL) until the point where the empirically measurable variation ceases. At this point, the coding framework can be considered a finalised version and can be proposed as a research derived result, i.e., the MZWM framework. In this analysis, incremental change was measured in the following parameters:

1. word count (as a numeric and percentage variation)
2. a graphic metric conveying the structural organisation of the coding frameworks, i.e., number of themes and the number and arrangement of associated sub-themes clusters
3. the number of *text changes* as measured by the *MSWORD comparative document review* function and *Copyleaks – document-to-document comparison* applied to the so-called *NVivo codebook print-out* function, which produces a tabularised word document (Table 4, Section 3.7, which is a brief excerpt of this function). Each *NVivo code book printout* document offers an analysable snapshot between each of the succeeding versions in the coding framework development sequence. This enables examining the numeric and percentage variation relative to the original version (Table 11, Section 4.2.5) as a measure of finalisation.

This quantitative analysis shows that between version 5 of the developing coding framework, which is examined after having coded the third and final source (i.e., *v5 dev. CF MZWM Source 3*), there was zero variation between this and the next iteration (i.e., *MZWM CF v final for Content Analysis*). This meant this development process could be considered finished and the coding framework could be considered a finalised proposition, suitable for proceeding to the next phases of content analysis, which are outlined and discussed in the respective methodology and results (Sections 3.15 and 4.2).

Table 11 also includes data (albeit latterly backfilled once the research procedure had been completed) from parameters 1 and 2 (above), which enable a comparison between *MZWM CF v final for Content Analysis* and the *final MZWM relational matrix* proposed after the completion of content analysis (see Figure 11). This comparison was not relevant to the question of determining completion, but is interesting in its own right, as it illustrates the outcomes of the processes of reflection, synthesising, and re-organisation that occur within content analysis. The structural organisation of the coding framework→ MZWM framework changes considerably and the written description of this become more succinct and approximately 40% more compact in terms of word count.

Combining these two quantitative analyses provides a window into the evolution of consensus and completion within the MMR CA MZWM research process. The way these findings merge in the expression of Figure 11 as a final *quant + QUAL(quant)* result, reflects the expectation of commentators in advocating for an authentic, mature, and meaning-enhancing mode of *mixing methods,* when undertaking research (Creswell, 2015; Plano Clark & Creswell, 2008; Plano Clark & Ivankova, 2016). The development and presentation of these research findings can be seen as confirming an appropriate alignment of subject, research design and the cited inherent interdisciplinarity and acceptance of mixed formations of qualitative and quantitative methods in content analysis (Hsieh & Shannon, 2005; Mayring, 2000; QSR, 2017). Even at this early stage, the discussed research outcomes provide confirmation of the assertion that quantitative data offers critical and unique insights that are not accessible through qualitative research alone (Plano Clark & Ivankova, 2016). This is a validation of the recognised strength of the concurrent design model and its cited potential for generating different, but complementary data and more substantial, richly detailed and validated findings in a time/cost-effective way (Plano Clark & Ivankova, 2016. citing Morse, 1991, pg 122).

The attempted Characterisation study of the emerging MZWM, Table 12, Section 4.2.6.

Relative to the initial scope of aspiration, this next attempted quantitative analysis (Table 12) turned out to be an unsuccessful, non-aligned effort, whose value to the study was that it exposed the limitation of the initial mono-method *quant+* analysis and triggered a rethink and *where to from here* questions. This research experience is worth capturing in the results and discussion because it reinforced the earlier observations about the strength and interactivity of a mixed methods approach to content analysis.

This attempted analysis sought to characterise quantitative elements of data coded to node structures making up the MZWM parameters (Table 12, Section 4.2.6.). While this analytical approach was ultimately abandoned, the positive was that the exercise culminated in prompting the development of an alternative and much superior analytic model that was successfully implemented. When fully realised, this model utilised nine MS EXCEL spreadsheets that enabled the next, predominantly qualitative phases of the remaining mixed methods content analysis. Having noted that the final outcome was positive, it is worth observing that the lack of data that caused the initial approach to be abandoned (Table 12) is recognised locally and globally as a key issue in waste and resource management (D-Waste, 2013a; Hannon, 2018; OECD, 2012a, 2018; PCE, 2006; D. C. Wilson, Rodic, et al., 2015a).

In hindsight, the conceptual model envisaged for this aspect of this quantitative analysis was not adequate relative to the scale and complexity of the data. This realisation led to the development of a more appropriate analytic model, commensurate with the diversity and scale of what is a mixed methods dataset from a highly interdisciplinary field. The *where to from here*, alternative MS EXCEL-based, analytical approach provided the required larger capacity both to process the complete spectrum of quant + QUAL(quant) data coded from policy/programme descriptions, anecdote/advocacy, and supporting information and to interpret the meaning of the full range of data in the three sources (Berg & Lune, 2012).

5.4.3. The third relational cluster of *quant+* analysis.

The final relational cluster that completed the suite of quantitative analysis undertaken in this MMR HCA-T-MZWM quant + QUAL(quant) project involved: first, examining the second framework of *Zero waste motive - argument formation* data, which has been coded in parallel with the primary MZWM content analysis (Table 13 ref. Section 4.2.7); second, examining and understanding cross-connecting themes and enablers, i.e., nodes that appear interactive and or interrelated within the MZWM (Table 14 ref. Section 4.2.8). The first aspect of this drew on the procedure and learnings of the work described in Section 4.2.4, in mapping the levels and patterns of conformational evidence, coded in support of the elements of this coding framework.

As described in Section 3.9, early in the process of coding the first source, the requirement for recognising peripheral (not centrally identified as a potential part of MZWM), but critically important information, became apparent. Examples of the types of observed information that might contribute to the broader deliberative process of content analysis are *Zero waste characterisations* per se (other non-municipal contexts, interpretations, and programmes / practices) or evidence of *Absolute vs progressive* worldviews. As has been previously noted, in order to extend the basis for authoritative comparison data from the review article (Zaman, 2015) was merged into the *4.2.3. Exploration of formal references for the inference of quality assurance,* as well as into the *4.2.4. Examination of the level and pattern of conformation evidence coded in support of each of the derived elements of MZWM.*

Importantly, the tactical choice to develop and utilise a second coding framework (and to extend the comparative framing by including Zaman (2015) as a supplementary (4th) source within this specific part of the coding process) provided the opportunity for recognising and including disconfirming evidence within the content analysis for testing and elaborating MZWM. Significantly, given that a questionable critique of zero waste was a critical prompt in shaping the selection of research question and the responding research design, this inclusion enabled further *Critique of zero waste* data to be explicitly and transparently factored into the ongoing content analysis – on a comparative and weighted basis. As was previously demonstrated in the related analytical procedures described in Sections 4.2.3 and 2.2.4 and as is now illustrated in Table 13, this form of quantitative analysis makes explicit the relative level and pattern of confirmational evidence, coded in support of the various elements of the coding framework. In this instance, these considerations were outworked in comparison with a selected example of authoritative academic literature (Zaman, 2015), which provides a form of *control* perspective.

The first key point of interest is the actualised content and structural arrangement of the *Zero waste motive/argument formation* coding framework. The iterative formation of this secondary coding framework offers a quite empirical mapping exercise of all the other MZWM relevant information contained in the three sources. The subsequent coding of the fourth selected control source (Zaman, 2015) identified some interesting additional information that was reflected in structural changes in the second coding framework. However, because these can be considered relatively limited, this exercise actually confirmed the utility of this coding framework, which reflects positively on the original sample selection of the content contributed by the three main sources. The fact that a further 724 items of data as new codes were captured in the instigation of the second coding framework (relative to the 1,704 items of data coded in forming the first MZWM focussed coding framework) is a strong validation of the in-process, tactical decision to include this exercise in the research methodology. This quantum of data/content, which is made explicit and more discernible via this aspect of the quantitative analysis, was then able to make a significant contribution to extending the scope of holistic consideration (including disconfirmation) that fed into the content analysis.

Beyond broadening the feedstock information, this aspect of quantitative analysis provided an empirical measure of the weighting of each element's relative importance, which provided a sense of texture, triangulation, and hermeneutic guidance in how this could / should be expertly interpreted. In this context, hermeneutic is understood as the scientific art of discerning and crafting explanation, which is liberated, via mediating a combination of expert researcher knowledge/skills and *rule orientated*-procedural research design (Bos & Tarnai, 1999). This aspect of the overall package of quantitative analysis built successfully on the earlier research procedures and provided further valuable learning. Extending the information horizon, underwrote, as Bergman anticipated, more innovative and interesting combinations in this instance of quant + Qual(quant) sense-making with greater consistency and integration (2008, 2010). As is reflected in later extensive quant + QUAL(quant) findings, these deliberate efforts to extend, underwrite, and validate the scientific procedure of hermeneutic content analysis, empowered the interpretive, translative, and explanative functions that enabled hitherto obscured and unavailable meaning (manifest and latent) to be rendered more clearly (Bos & Tarnai, 1999).

The final reported aspect of the overall package of quantitative analysis is Table 14, which provides an examination of cross-connecting, interrelated, and interactive themes within the emerging MZWM. In being constructed out of observations of apparent and emerging themes, enablers, interactive functions, feedback loops and connection, synergy and complexity, the content and arrangement of Table 14 capture, annotate, and illustrate the beginning of the concurrent / converging formative analysis. This starts with *quant*+ analysis and is finalised by combination in the *QUAL(quant)* analysis, whereby the data itself reshapes initial coding framework into what becomes and is communicated as a final result, i.e., the proposed MZWM. In keeping with the annotation of the subject research methodology, i.e., MMR HCA-T-MZWM quant + QUAL(quant), in this final aspect of quantitative analysis an evident shift occurs in the balance of empirical ↔ narrative spectrum of process and expression (Plano Clark & Ivankova, 2016) whereby the quantitative-numbers combo[80] thereafter plays a subordinate, but still critical role.

As will now be discussed in respect of the three selected excerpts of written QUAL(quant) narrative result (Sections 4.3.2 to 4.3.4) and then more refined final graphic expressions of this (Figures 11, 13, 14, and 15, respectively, in Sections 4.4 to 4.7), this research can reasonably be described as fulfilling the methodological and outcome expectations for mixed-method hermeneutic content analysis as a mature research methodology (Krippendorff, 2013; Plano Clark & Creswell, 2008). Specifically, though, the quality assurance of both input data and the design and implementation of a robust, transparent, systemised recording/observational procedure, a higher and further refined understanding, and a new level of theoretical cognition can be considered to have been developed in respect of the targeted phenomenon (Bos & Tarnai, 1999). The key expression of the final summary result that begins with Figure 11 and continues with the subsequent Figures 13, 14, and 15 (to be subsequently discussed), fulfils the expectation held for this research methodology, which is to advance a new, communicable, and quality-assured theoretical understanding of, in this case MZWM as the targeted phenomenon (Bos & Tarnai, 1999; Krippendorff, 2013).

5.5. The extent and depth of *QUAL(quant)* findings

While the final written QUAL(quant) narrative is, for practical purposes, presented in two parts as three excerpts (Sections 4.4.2 to 4.3.4), with the remainder as Appendix 11, together these form a single, stand-alone research outcome from which the four final summary graphic results (Figures 11, 13, 14, and 15) are then derived. The full extent and detail of the QUAL(quant) findings at 50 pages / +40,000 word count evidences the cited characteristics of the content analysis as a research methodology (Ashwood et al., 2014; Bos & Tarnai, 1999; Krippendorff, 2013). The style and structure choices for this aspect of the results provide an authentic portrayal of the *mixed* reality of these data and indicate the extent of information (i.e., analysable content) latent within the selected sources. The extent and detail of the result provide degrees of confirmation about the general suitability and specific selections of the sources, as well as the compatibility of the sources with content analysis generally and additionally confirms the specific design and implementations of the MMR HCA-T-MZWM quant +

[80] As has been baldly attributed (Bergman, 2008).

QUAL(quant). The quantum and richly textured detail of the result demonstrates, as Ashwood (2014) asserted, the interrogative power of content analysis for discovering and identifying patterns, themes, and core meanings within and between data.

The draft article *Reviewing policy analysis in waste management research to establish a design basis for testing and elaborating municipal zero waste methodology* (Hannon, 2022 in submission) explores how content analysis is utilised as a research methodology for examining waste → zero waste management policy/practice. This work was undertaken to substantiate the design basis of the specified model of content analysis that was selected as the research methodology for this project (Figure 7, Section 3.5).

The extent, detail, and quality of the results from implementing the specified methodology, can be seen as verifying the 14 attributes of content analysis that this article identifies, as well as validating the overall suitability of the specifically selected / designed research methodology. In particular, the results of this research illustrate the methodological attributes of: covering a diversity of social, economic, environmental, cultural, and other factors; identifying and fill knowledge gaps; and forming future research recommendations (Bufoni et al., 2015; Díaz et al., 2012; Heikkilä, Reinikainen, Katajajuuri, Silvennoinen, & Hartikainen, 2016; Noel, 2010).

Other projected attributes of this research methodology that have enabled results to be derived include exploring a range of physically/temporally inaccessible/indirectly observable phenomena and anticipated and yet to be understood factors (i.e., evaluating consensus, adaptive/contextual priority shifts, mapping intellectual origins and tracing critical individual contributions) expressed as content of derivative text. The described research has enabled testing theoretical issues and enhancing understanding, in this instance of data related to composition and arrangement of the policy elements of MZWM (Bovea & Powell, 2016; Elo & Kyngas, 2008; Thakur & Ramesh, 2015; Zeiss, 1999). The results also demonstrate the cited reductive/assimilative capacity of content analysis to include and orientate numerous/disparate and critical/contested elements of the subject policy data and to seek to resolve this in the formation of a condensed proposal (i.e., "conceptual systems map") of a MZWM (Elo & Kyngas, 2008, p. 108). As will be subsequently argued and discussed in respect of Figures 11, 13, 14, and 15, these final graphic summaries are proposed as valid manifestations of the cited attributes of the specific model of content analysis (Berg & Lune, 2012; Bergman, 2010; Creswell, 2015; Jick, 2008; D. L. Morgan, 2008; Plano Clark & Ivankova, 2016), have been an appropriately designed (Hannon, 2022 in submission) and implemented, and are now reported.

Throughout the final written QUAL(quant) narrative result, the written text combines with quantitative supplements in the form of superscripted numeric / letter / symbol combinations [i.e. +3F]. This convergent system, notionally word (QUAL) and numbers (quant) system of annotation (Bergman, 2010) carries forward the weighed expression (Plano Clark & Ivankova, 2016) of rate of occurrence/level of confirmation and geographic location that existed in the originally coded data. The decision to retain this important empirical texture from the original data and to communicate this merged (in what is hopefully a circumspect and unobstructive way) in a written narrative QUAL(quant) format was considered at length. Ultimately, this format was determined as being consistent with the mixed-methods design intention (annotated in full as quant + QUAL(quant) and as being the optimal communication format. This result also establishes a format template that flows into and underwrites the subsequent expression of the set of final summary graphic results.

Colour coding is also utilised in the QUAL(quant) annotation system, in this instance to identify the respective theme node from where the corresponding information/point had been derived. It is important to note that this coding changes between each section of the write-up, according to what had been ascribed in the *legend* at beginning of each section. For example, as outlined in Section 4.3.4 in the formation of *16R Priorities,* the derivative child nodes were identified as: *A1b Strategic plan + A1d WZW hierarchy + A5d Int. networks + A1p General to local* and appropriately colour coded thereafter within that section.

Following the authors' described precedent (albeit in a different but similarly distinct subject and research purpose), this research has "identified, coded and then classified or categorised data according to their significance" and has also designed a QUAL(quant) "classification scheme to fit the emergent findings" (Ashwood et al., 2014, p. 51). For the same reason that it was not possible to include the complete result within the thesis (Sections 4.3.2. to 4.3.4., and the remainder in Appendix 11), beyond the discussion already conveyed relative to the three selected excerpts, it was not practicable to develop a full discussion encompassing the total extent and depth of the full written narrative QUAL(quant) result. This is simply too large and detailed. The positive of this conundrum was that it prompted consideration of how best to overview and present meaningful discussion of this finding as a whole. This prompt, alongside simply following the iterative process of content analysis to its natural completion, resulted in the conception of the four summary graphic result formats, Figures 11, 13, 14, and 15. Collectively, these provide a compact derivative summary result format that is discussed subsequently.

The combination of Figures 11, 13, 14, and 15 provides distinctive overviews and representations of the underlying classification schemes that encompass and communicate the findings wthat emerged from this research. In particular, while representing further evolution in considering of how best to graphically communicate such a large and detailed body of results, Figure 15 provides a culminating schematic that centralises a- the new derivative 16R alternative zero waste hierarchy; b- the new alternative infinity – continuum graphic portrayal of the key themes clusters; and c- the array associated key sub headings of result, namely 1.1-7, 2.1-16, 3.1-19, 4.1-21, 5.1-15, 6.1-6, 7.1-11, 8.1-9, 9.1-8. As is made explicit in the scope of the full original QUAL(quant) results (the combination of Sections 4.3.2 to 4.3.4 and Appendix 11) and the content density of derivative Figure 15 as summary graphic, the key challenge of this work has not been achieving an authentic, novel, and interesting finding, but wrangling the scale of finding into an appropriate graphic format with which to meaningfully communicate this result. As a final outcome of the process of content analysis, the group of summary graphics (Figures 11, 13, 14, and 15) do no replace or negate the full original written narrative QUAL(quant) result, rather, they collectively provide an overview and road-map of the substance of the full written result. It can be anticipated that, in future, having visualised the holistic representations of MZWM, should a practitioner wish to drill down into certain aspects they would be able to refer back to the detailed insight contained in the full written QUAL(quant) narrative result. In this way, the foundational and derivative illustrations of the result can be considered interoperable and indispensable from each other.

5.6. A finalised schematic model of a proposed Municipal Zero Waste Methodology (MZWM).

Figure 11 (Section 4.4) is schematic model of the Municipal Zero Waste Methodology (MZWM) proposed as a final result of this mixed-methods content analysis research. Figure 11 demonstrates the most compact, condensed hybrid embedded style of write-up whereby, as inferred by the quant + QUAL(quant) annotation, both quantitative and qualitative data converge and are mixed. The MZWM represented in Figure 11 represents the ultimate end point of the coding framework development process.

In brief, this process was initiated by the formation of *Zero Waste Municipal Consensus* (Appendix 6 and discussed in Section 3.6), which was then iteratively revised to form the *v2 Analytic Construct for MZWM Content Analysis* (Appendix 7), which provided the basis for beginning the formal coding process within NVivo. The outcome of further reflection and revision was the *Final Coding Framework – CF vfinal* (Appendix 9) as an input for an MS EXCEL-based phase of content analysis. Without wanting to duplicate the discussion on process and outcome already offered in the *Results* Section 4.4, the numerously described links to relevant research theory provide assurance that this final proposed MZWM is a valid result derived from a robust and transparent implementation of a suitable methodology.

Overall, as a mixed-methods result, the MZWM framework arrangement encompasses a significant amount of diverse information that articulates an expansive, detailed, and evidenced-based picture of the composition, internalised influence weighting, and complex clustered interactivity within the overarching proposition of the MZWM. Again, without wanting to duplicate the earlier explanation and discussion in the *Results* Section 4.4., the codified QUAL(quant) expression enables the MZWM to condense and embed 12 distinct items of information in this graphic framework. Namely, this sequence includes 1- capital letter (coding framework ID), 2- numeric 1 to 5 ID original parent node, 3- small letter ID original node order, 4- abbreviated element name, 5- # of times coded, 6- colour code text evidence wight bracket, 7- text box colour code, 8- bold text box board ID relational clusters, 9- bold link bars interrelation groups of clusters, 10- specific explanative legends x2, 11- nine new theme heading names, and 12- each with an acceding percent weight of total code evidence justifying the positioning within the overall MZWM arrangement. This equates to an information-rich, meaning-laden rubric that carries forward unobtrusive indicators of the derivative cognitive structures as well the formative evidence justifying and making the structural progression transparent within the final MZWM framework. This model of presentation was determined as being the best way to prosecute the requirement for objectivity in content analysis that is understood as arising by conveying transparency in developing and explicating a recognised set of systematic rules / procedures for undertaking the analysis (Bryman, 2012; Krippendorff, 2013).

As will be discussed subsequently, a key outcome of visualising this composition and arrangement was that it evoked the conception of shifting beyond just thinking of zero waste through the preconceived lens of a rigid linear hierarchy of elements and priorities for understanding and implementing MZWM. As such, Figure 11 provides the catalyst and rationale for disrupting and transgressing existing condoned theories (Klein, 2014), which after decades of real-world failure have been exposed as shallow and dysfunctional approximations of the level of interdisciplinarity that is actually required (Hannon, 2020). Beginning with Figure 11, the sequence of Figures 13, 14, and 15 are the result of giving permission to reimaging the requisite next, post-waste, post-normal science (Funtowicz & Ravetz, 2003; WasteMINZ, 2001) theoretical formations. The end-point of this abductive back and forth provocation and reconceptualisation was the determination that the infinity-continuum symbol (i.e., ∞) provided a stronger and more realistic conceptual model for encompassing the scale of complexity and interdisciplinary challenge of MZWM.

Importantly, the infinity-continuum model (i.e., symbolised by ∞) can be inclusive of the now much expanded and more detailed alternative zero waste hierarchy, while also providing a much better alignment with the symbolism associated with the most relevant component of the *UN Sustainable Development Goals* (UNSDGs). Notably, UNSDG *12- Responsible Consumption and Production* also utilises the infinity-continuum (i.e., ∞) symbol, so this research has been an opportunity to make and substantiate this connection. The waste aspect of the UNSDG Responsible Consumption and Production Goal 12 is framed on the basis of focussing on chemical, hazardous, solid and radioactive waste, which translates into three key targets.[81]

The best way to understand the importance and novelty of the MZWM schematic as a result is simply to compare it with the pre-existing theoretical illustrations of ISWM / CISMW, and those relating to zero waste methodology. To enable this comparison a range of forty eight different theoretical illustrations of ISWM, CISMW and ZWM have been compiled into a group as Figure 17 (albeit each is cited as per the original publication). This group of forty eight examples of waste / resource related theoretical models variously illustrate: text box labelled components, arranged and connected with arrows, or encompassed in bubbles, diagrams and emblems, colour schemes and pictures / illustrations, evocations of interconnection, flow, circularity vs linearity mechanisation, conception, constitution, schema, origination, evolution, overview - underwriting and principles - pragmatism.

The various model illustrations encompass factors such as: overall context, decisional arenas, stakeholders, system elements / aspects, processing / sustainability finance / legal consideration, data analysis / synthesis, analytical frameworks, methodology / sample procedures, waste characterisation / generation modelling, waste / resource material flow / streams collection, handling and processing systems / cycling / leakage / outflow / export / disposal / environmental sinks, strategic objectives, institutional policies and programmes, community inclusiveness / social interface, identification of who what how actors / actions, the interplay of physical and governance parameters, public and environmental health, centres of environmental, administration and technical responsibility, comprehension of national, regional, city, sector, zone / ward levels of interactivity, transport / (reverse) logistics, supply / value chain, people-environmental-economy paradigms, the evolving interoperability between formal-informal-illegal new alternative waste treatment / disposal and energy / material recovery technologies, toxicity and hazard monitoring, mitigation and reduction, consensus, commonality and overlap as equations of priority and opportunity for progress, capsity building / training, miscellaneous versions of waste / resource hierarchy, programme / phasing of essential infrastructure programmes and services, matrices for parameter and situational analysis, consultation processes for vision statements, target setting, action planning, building buy-in / participation / enhanced compliance and cooperation, conceptualising interdisciplinarity, ethos /

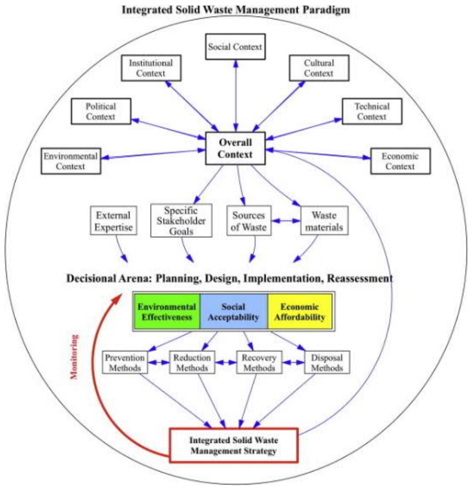
[81] Target 12.3: By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses; Target 12.4: By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water, and soil in order to minimise their adverse impacts on human health and the environment; Target 12.5: By 2030, substantially reduce waste generation through prevention, reduction, recycling, and reuse. Source: https://www.unep.org/explore-topics/sustainable-development-goals

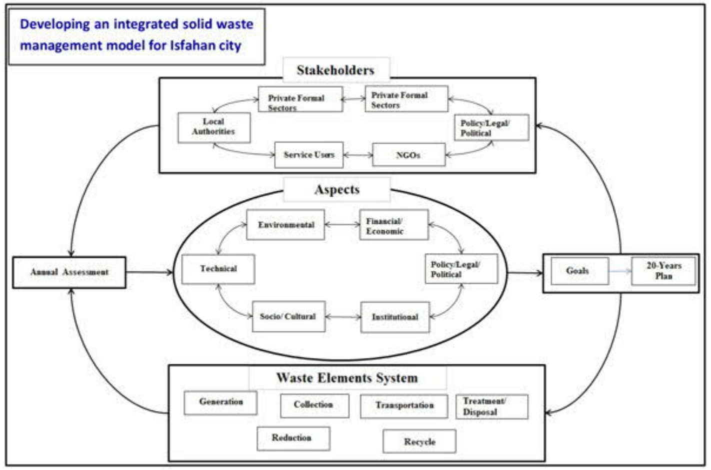
movement alignment and synergy, the interaction of hydrosphere, atmosphere, biosphere, geosphere and anthroposphere, the roles of regulation, legislation, monitoring, reporting and compliance, the ascendance vs subversion of top of the hierarchy *rethink / reduce / reuse* related spheres such as sustainable consumption and behaviours, Industry / community awareness and education, transformative DfE / ESD, etc. It is clear, based on either an immediate visual impression, or deeper cognitive inspection, that the ꝏ infinity-continuum model of MZWM is novel within this genre of theoretical illustration.

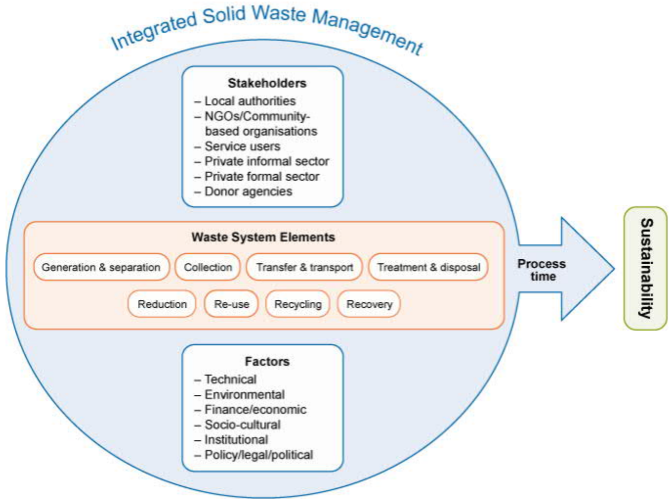
Whilst the origination, research and cognition behind all visual illustrations of various models of waste / resource theory and practices are grappling with essentially the same (albeit evolving appraisal of) real-world factors, agencies, parameters, interrelationships, the new ꝏ infinity-continuum MZWM model derived from this PhD research process presents as a novel outcome. The composition of fifty-seven elements making up the ꝏ infinity-continuum MZWM model is more complete and complex than any other example of theorical model. The arrangement that reflects priorities, interconnection, and interactive clustering framed in nine headline themes appears original. The information density of hybrid (QUAL)quant data that transparently conveys the origins, rationale, and research derivation and progression of the illustrative framework is also unique.

While clearly distinct from any pre-existing ISWM theoretical model, the MZWM is notably also quite different from any theoretical illustrations contained in any of the three selected key sources documents (Allen et al., 2012; Lombardi & Bailey, 2015; Snow & Dickinson, 2001), which were input for content analysis and in fact any of the other examples illustrating zero waste theory/methodology frameworks (Connett, 2013; Zaman, 2015; Zaman & Lehmann, 2013; Zero Waste Europe, 2017; ZeroWIN, accessed 2013). While these attributes are notable, in fact the key observation relative to answering the research question and addressing the critique of zero waste is that the MZWM is not absent or nothing. In fact, the opposite is true, the MZWM offers a comprehensive blueprint on how to plan and implement a zero waste programme to achieve zero waste goals and targets, which are in ambition far in excess of the moderation inherent within ISWM.

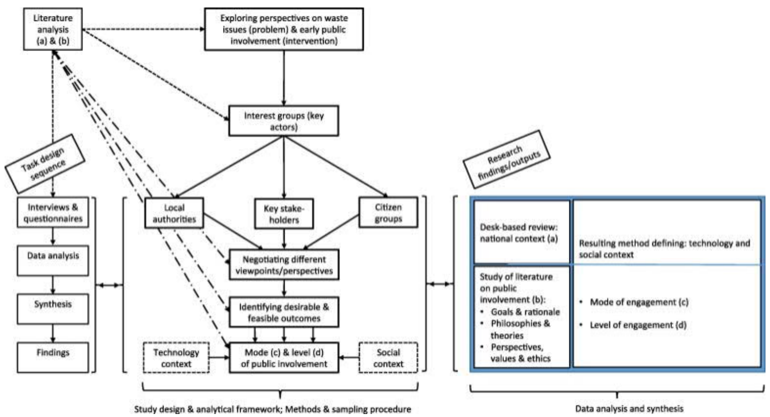
GRAPHIC ILLUSTRATIONS OF INTEGRATED SOLID WASTE MANAGEMENT (ISWM) THEORETICAL MODELS: NB: each individually referenced, but collectively cited as an illustrative grouping as Figure 17

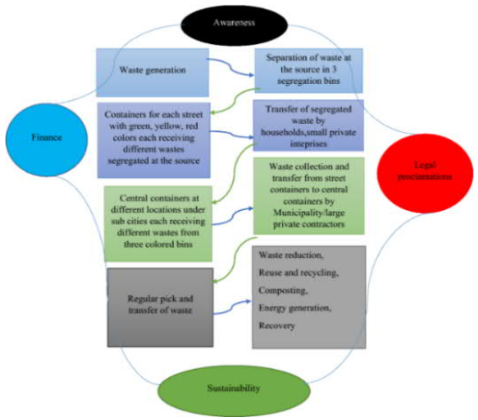


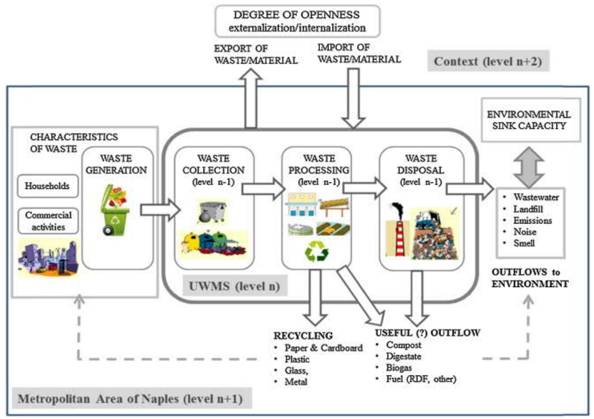


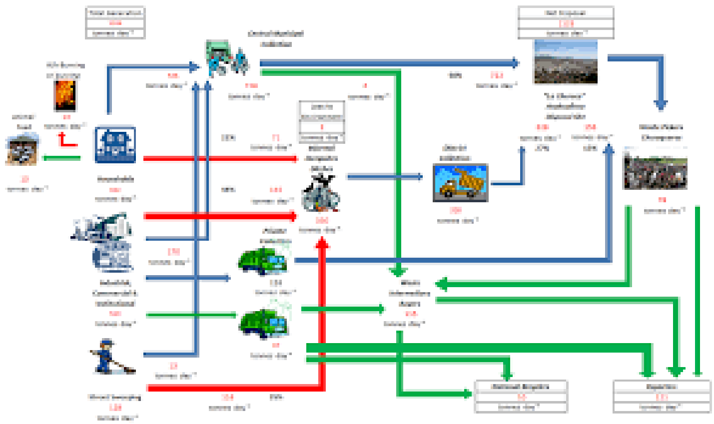


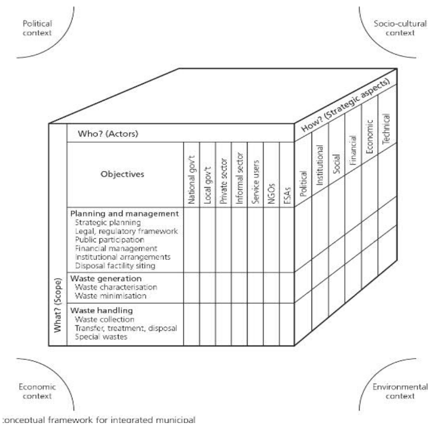
Source Above left: ref. Figure 2 - ISWM (ISWA, 2012; Marshall & Farahbakhsh, 2013, p. 996). Above middle: ref. Figure 3 (Abdoli, Rezaei, & Hasanian, 2016, p. 296). Above right: ref. Figure 11.3 (van de Klundert & Anschütz, 2001). Below left: ref. Figure 1 - Methodology approach (Garnett, Cooper, Longhurst, Jude, & Tyrrel, 2017, p. 213). Below middle: ref. Figure 8 - The proposed new waste management system (Teshome, 2012, p. 28). Below right: ref. Figure 3 - Conceptual semantic framework to characterise the metabolism of urban waste management systems (UWMS) in relation to their context (Chifari, Lo Piano, Bukkens, & Giampietro, 2018, p. 28).

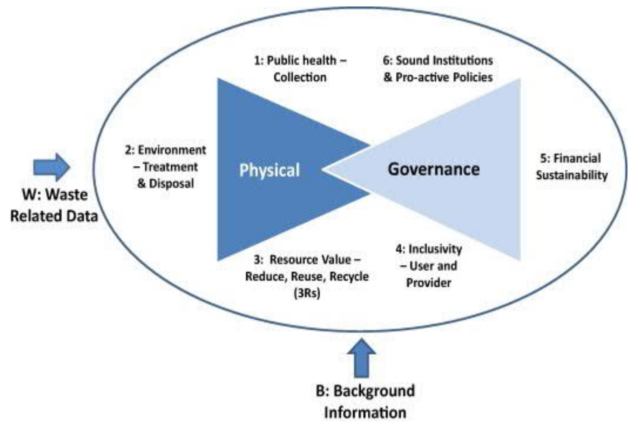




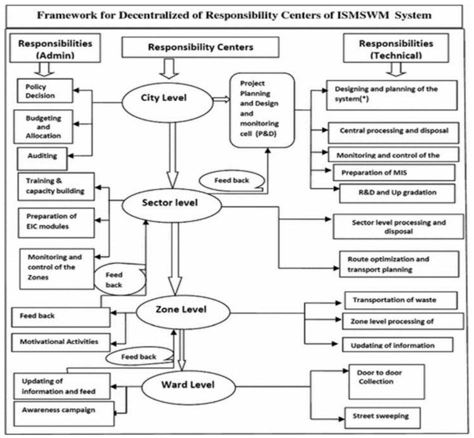


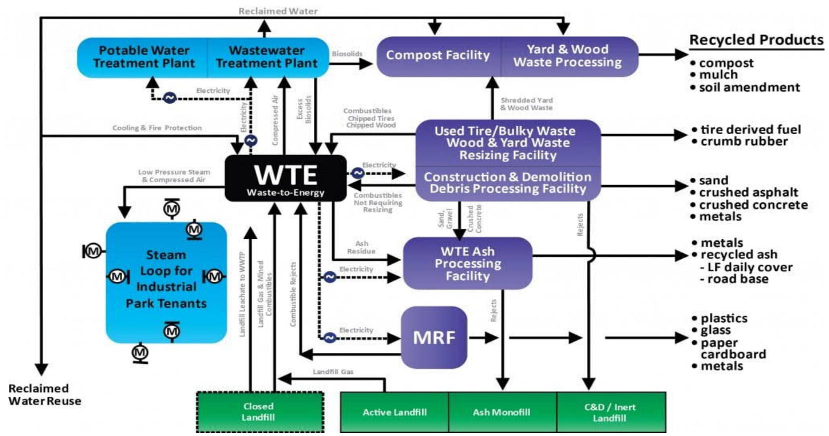


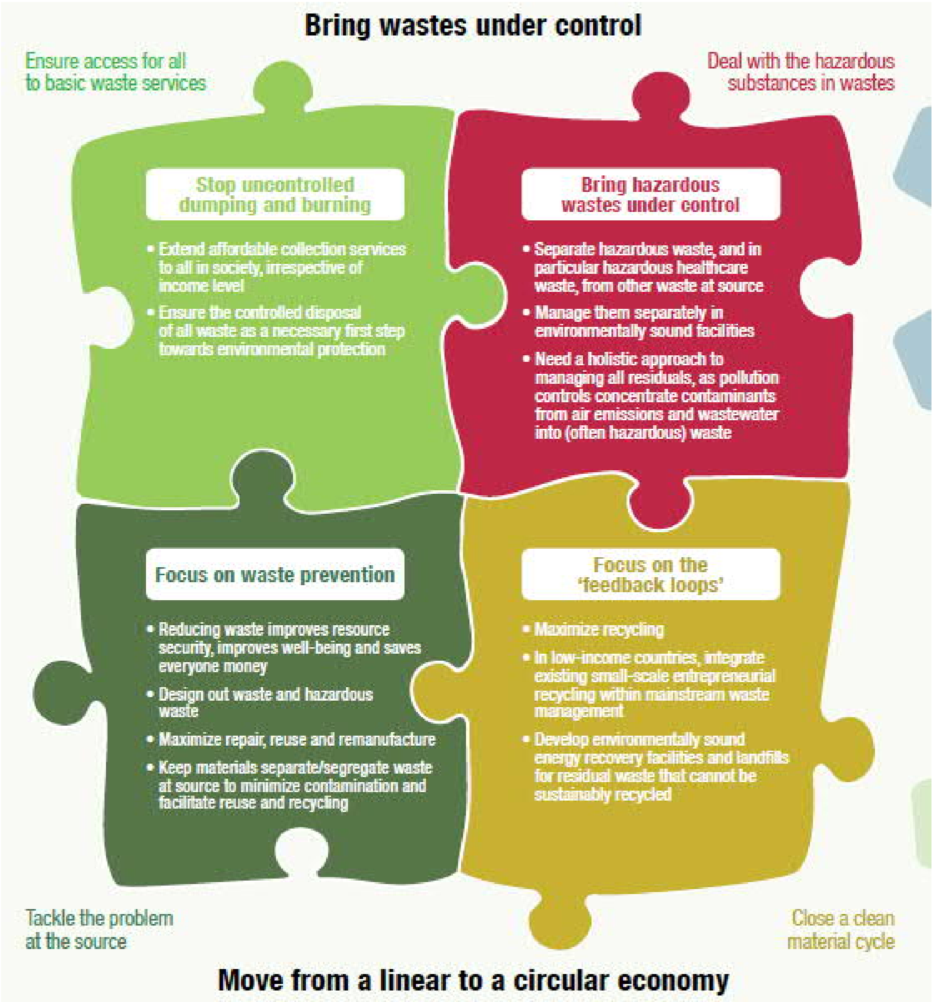


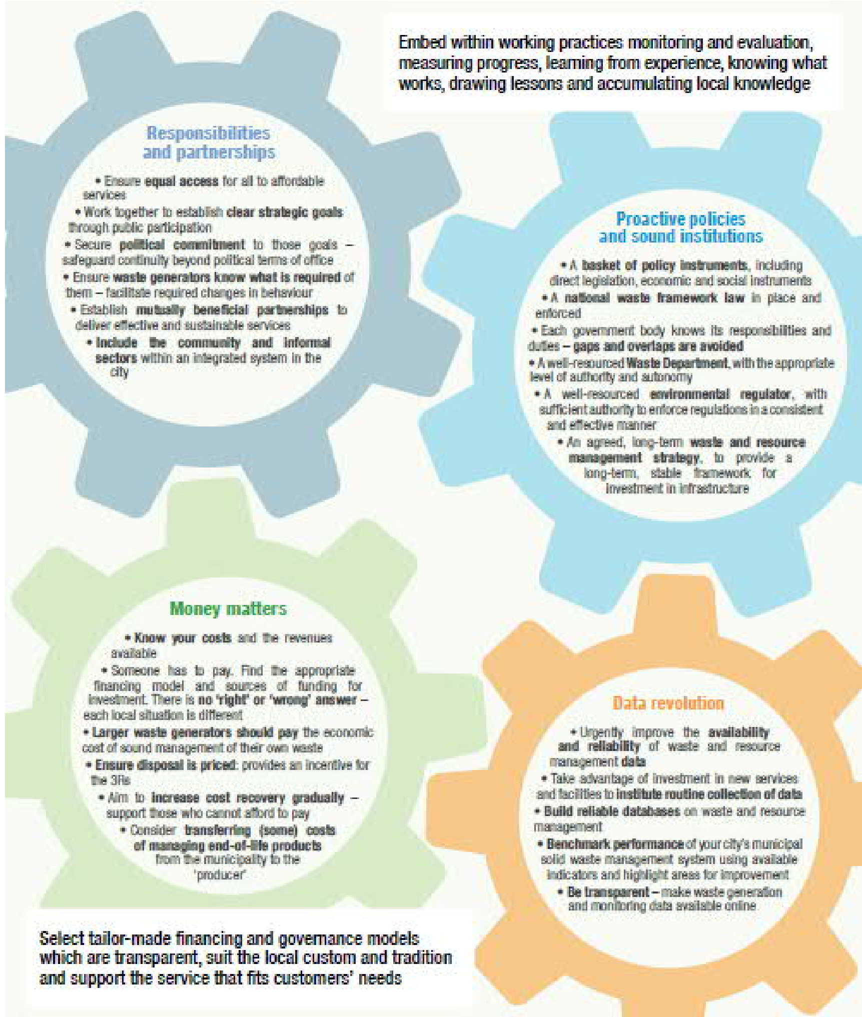


Above left: ref. Figure 4. Process flow diagram – Managua, Nicaragua (D. C. Wilson, Rodic, Scheinberg, Velis, & Alabaster, 2012, p. 246). Above middle: ref. Figure 1. The conceptual framework for integrated municipal solid waste management. Each side of the cube shows one of the three primary dimensions of ISWM, denoted by a question (D. C. Wilson, Velis, & Rodic, 2013, p. 56). Above right: ref. Fig. 1. The Integrated Sustainable Waste Management (ISWM) framework used by the Wasteaware indicator set. This is a simplified version of the original ISWM concept (Schübeler, 1996, Van de Klundert, & Anschütz, 2001; IJgosse et al., 2004). This 'two triangles' analytical framework was first devised for the UN-Habitat methodology (Scheinberg et al., 2010), grouping together the three physical components and the three governance aspects, as represented by the two triangles. This version of the figure was drawn by Darragh Masterson (D. C. Wilson, Rodic, Cowing, et al., 2015, p. 331). Below left: Cited as Graphical Abstract - (Heidari, Yazdanparast, & Jabbarzadeh, 2019). Below middle: ref. Figure 2 - Decentralised responsibility centres for ISMSWM system (Aich & Ghosh, 2019). Below right: ref. Evolution of Integrated Solid Waste Management Systems Enhanced with Municipal Utilities and Green Energy Production for the 21 century Paul L Hauck https://wasteadvantagemag.com/evolution-of-integrated-solid-waste-management-systems-enhanced-with-municipal-utilities-and-green-energy-production/

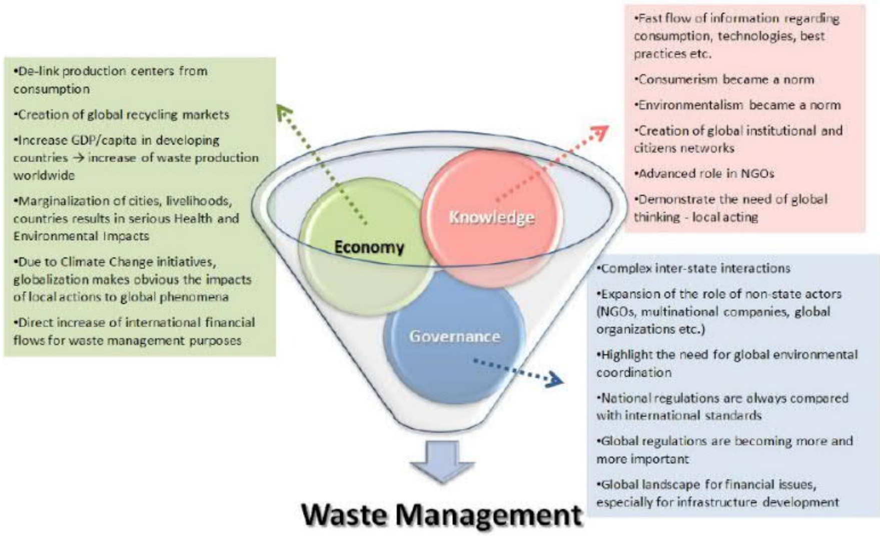


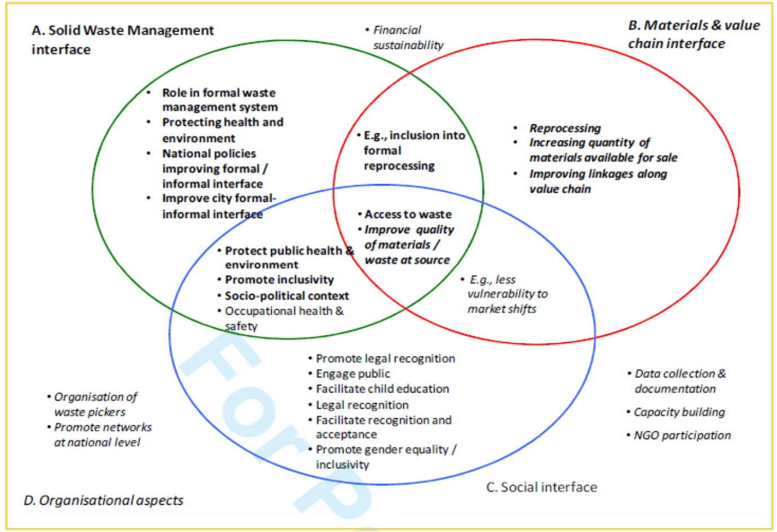




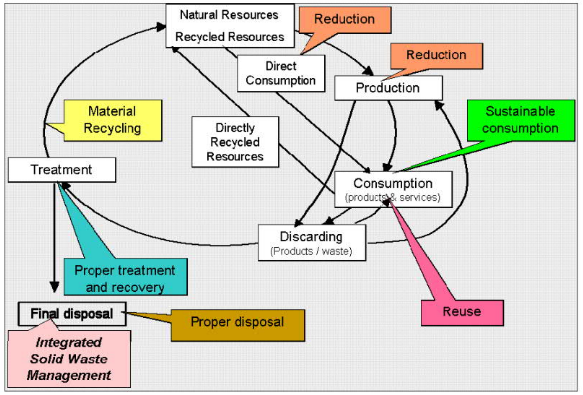


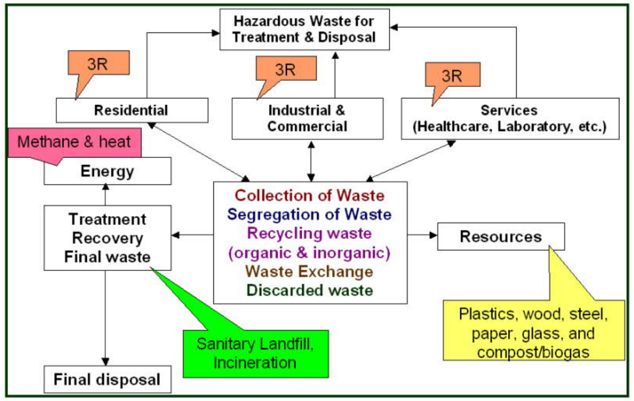
Above left and right: The solutions to the Global Waste Management Outlook (GWMO) assessment and action plan and What needs to be done. (D. C. Wilson, Rodic, et al., 2015b, p. 5 & 6).

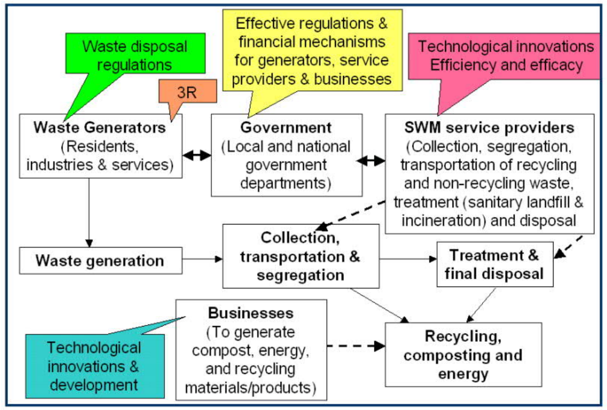


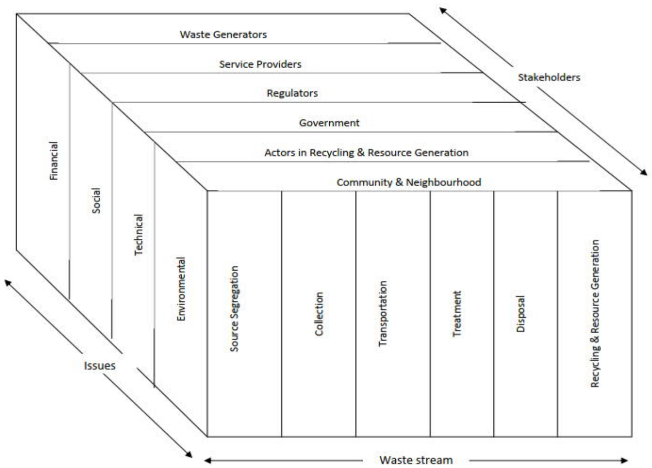


Above left and right: ref. Figure 2: Globalization and waste management linkages (Mavropoulos 2011c) and ref. Figure 12: Overall analytical framework and typology of interventions, showing the interdependencies (Velis et al. 2012) (ISWA, 2012, p. 15 & 28). Below left: ref. Figure 1.1: Lifecycle-based ISWM, Below middle: ref. Figure 1.2: Generation based ISWM, Below right: ref. Figure 1.3: Management-based ISWM (UNEP, 2009, pp. 7, 8 & 9).









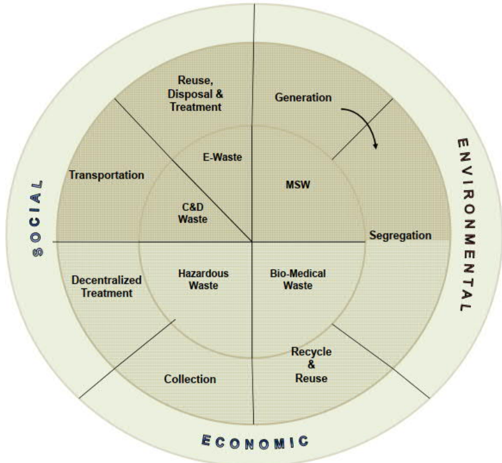
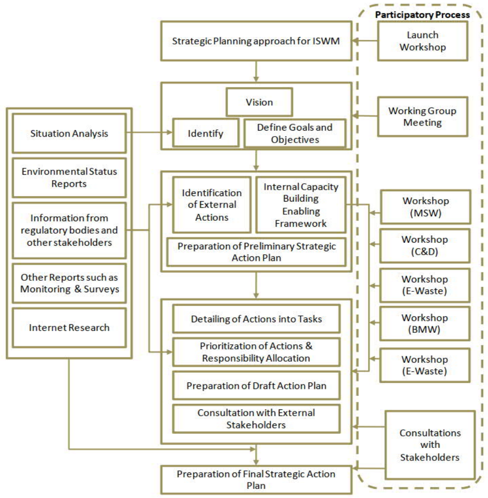
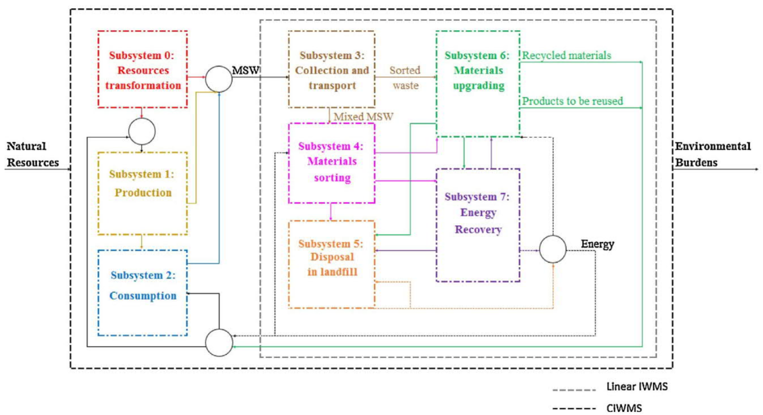


Figure 1.4: Concept of Integrated Solid Waste Management

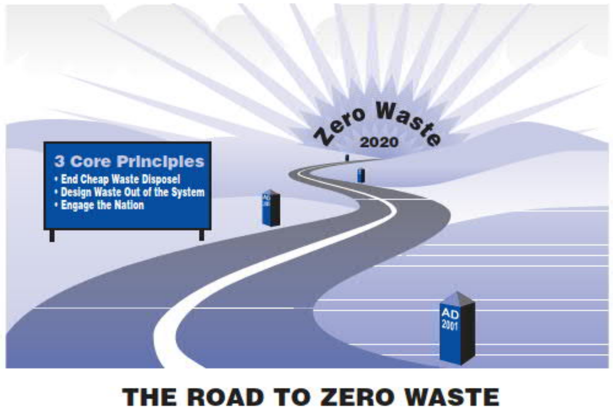


Above left: ref. Figure 2.1 Issues, Stakeholders and components for ISWM (vol. 3), Above middle: ref. Figure 1.4 Concept of integrated solid waste management (vol. 4), Above right: ref. Figure 1.4: Detailed steps in strategy planning for ISWM (vol. 4) (UNEP, 2009, pp. 32, 26 & 52). Below left: Evolution of Integrated Solid Waste Management Systems Enhanced with Municipal Utilities and Green Energy Production for the 21 century Paul L Hauck https://wasteadvantagemag.com/evolution-of-integrated-solid-waste-management-systems-enhanced-with-municipal-utilities-and-green-energy-production/ . Below right: ref. Figure 6: General concepts relates to sound waste management (UNEP et al., 2013, p. 49).

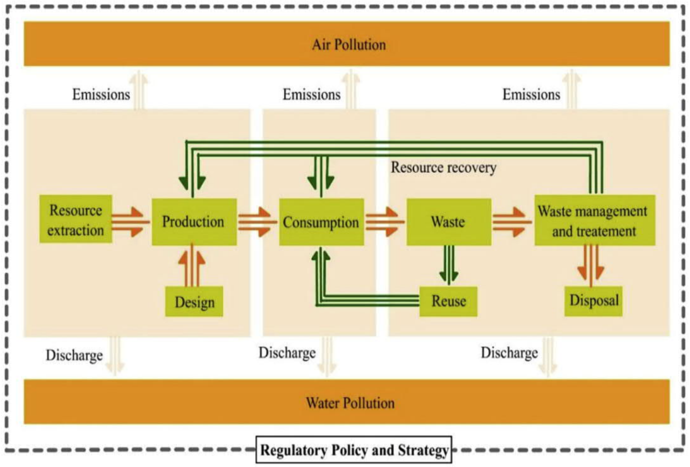


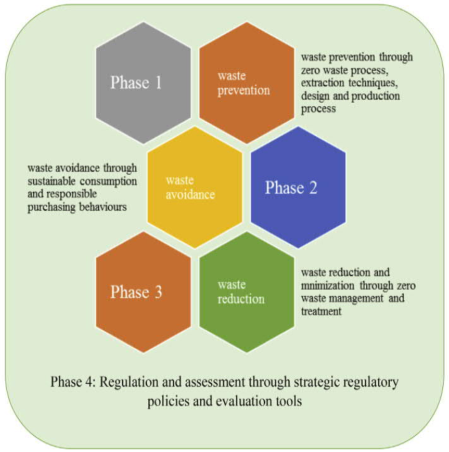
GRAPHIC ILLUSTRATIONS OF ZERO WASTE THEORETICAL MODELS

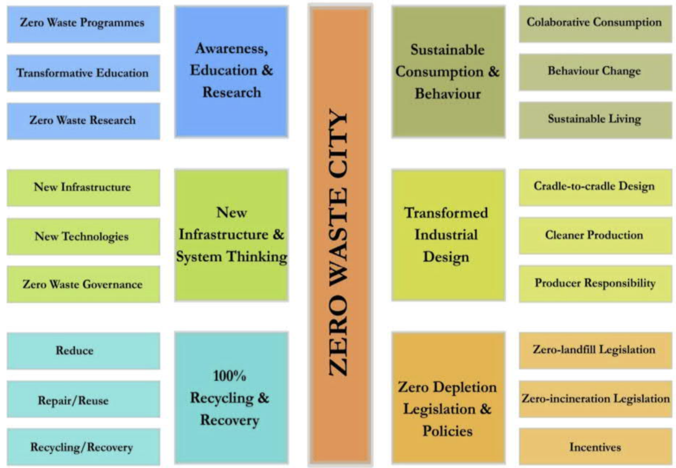
Above left, middle and right: The three phase ten year community zero waste roadmap model, The six key alternative facilities identify as critical to zero waste and the 21 action steps which drive the three phases of the zero waste plan (Lombardi & Bailey, 2015, pp. 13, 14 & 15). Below left: Below middle eco-cycle zero waste economy model https://www.ecocycle.org/ Below right (Snow & Dickinson, 2001).

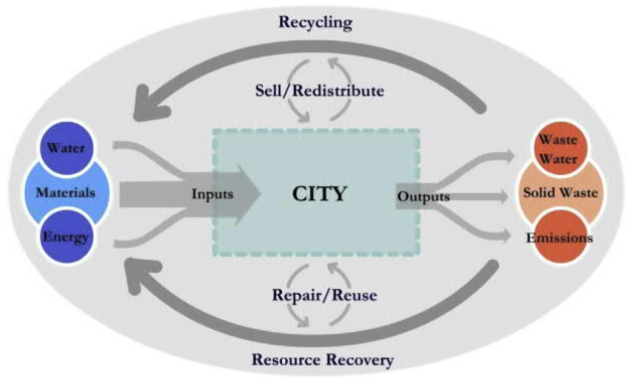


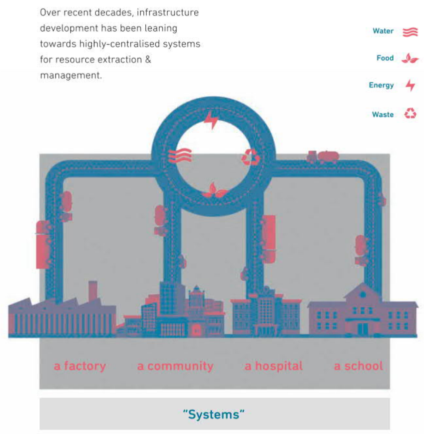
Above left, middle and right (Snow & Dickinson, 2001) and (Snow & Dickinson, 2003, p. 17 & 34). Below left: Figure 5: The life cycle of zero waste management systems ,and Figure 8: Phases in implementing zero waste guidelines (Zaman, 2015, p. 16 & 18). Below right: Figure 1: Drivers for transforming current cities into zero waste cities (Zaman & Lehmann, 2013, p. 125).

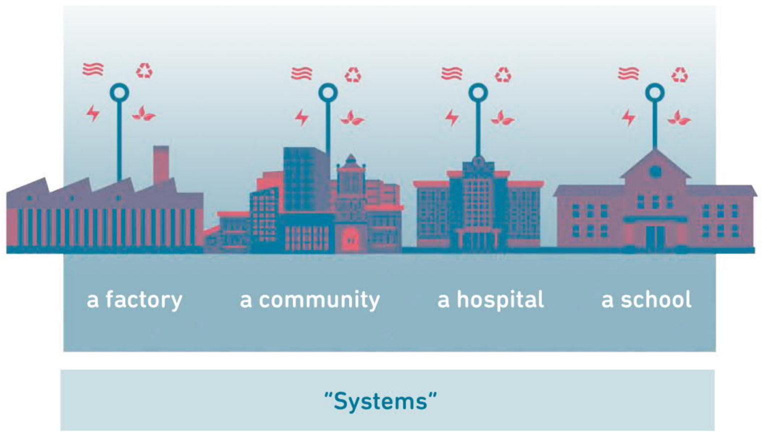




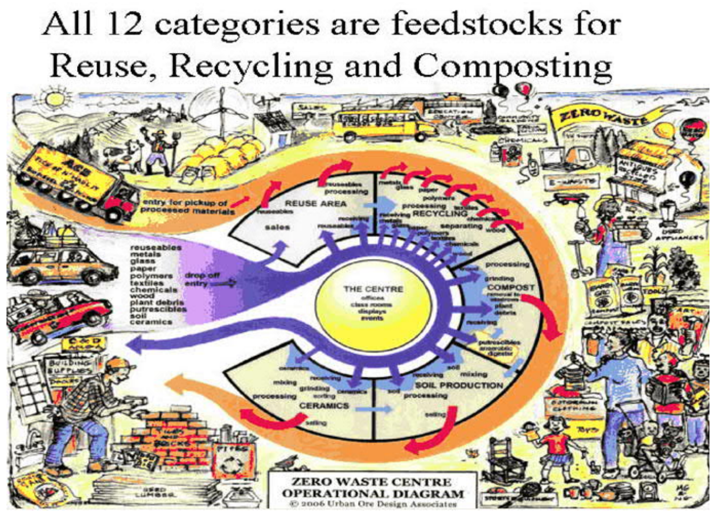


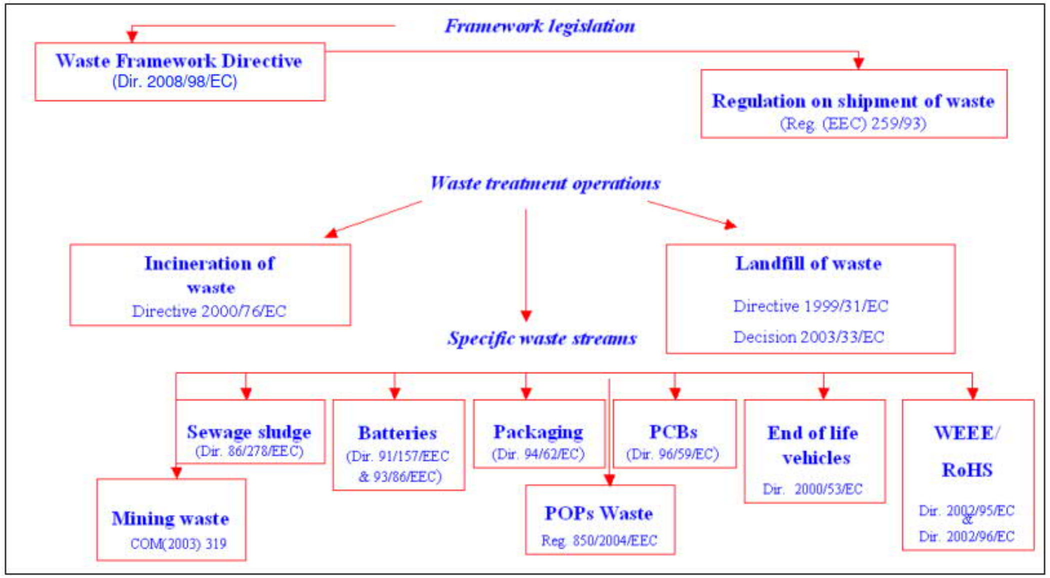


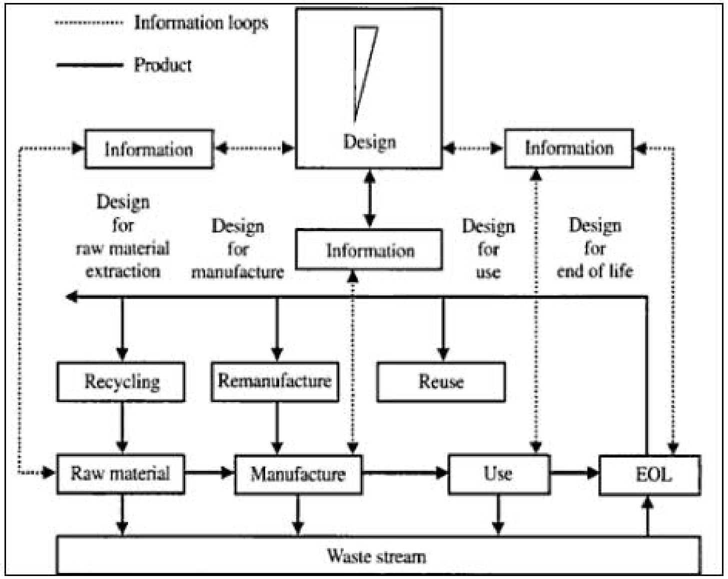




Above left: ref. Figure 2: Material flow in a zero waste city (adapted from Girardet, 1992, 1999) (Zaman & Lehmann, 2013, p. 125). Above middle: The old way of centralised resource management vs (Above right) the now trending distributed resource management model (Zero Waste Europe, 2017, p. 15 & 18). Below left and middle (Connett, 2013). Below right: A well-known Resource Recovery Centre model (source: Dan Knapp).







Above left and right: ref. Figure 2: Summary of legislative drivers for zero waste; and ref. Figure 6: Design for Environment Process Model. (ZeroWIN, accessed 2013, p. 14 & 39).

Figure 17: A compilation of 48 graphic illustrations of various theoretical waste / resource management models for visual comparison with the ꝏ infinity-continuum MZWM model

5.7. A revised, expanded, evidence-based alternative zero waste hierarchy – explained

As discussed in Section 4.5 of the *Results chapter,* Figure 13 illustrates, and annotates a new 16R (i.e., 16 levels of priority) zero waste hierarchy model, based on the findings of the MMR HCA-T-MZWM quant + QUAL(quant) research methodology. This finding provides a good illustration of the cited *interrogative power* of content analysis for discovering and identifying patterns, themes, and core meanings within and between data (Ashwood et al., 2014). As Figure 13 demonstrates, this content analysis research has provided an opportunity to expand on the previously most advanced conception of the *zero waste hierarchy* (ZWIA, accessed 2018) and to expose new levels of detail and understanding within this existing, albeit alternative, rubric for prioritising (zero) waste management policy and practices.

When compared with the numerously debated, iteratively co-developed, and widely accepted 7R *Zero Waste Hierarchy of Highest and Best Use* (ref. https://zwia.org/zwh), this research finding offers a new structural model. This new model is framed in both an upper *human software*-based cognitive domain and a lower, *physical / technical hardware*-based domain. The domain junction is illustrated with a notional partition point between levels *10R reduce/refuse* – personal and socialised choice-making priority level and the *11R the reinvest/re-circularise-infrastructure* level of priority. Both the official ZWIA 7R and this new 16R zero waste hierarchy, highlight the same demarcation around the unacceptability of incineration and waste to energy (W2E). However, the 16R version demarcates a twin *anti-bury/anti-burn* as part of a long-term aspirational domain. This structurally identifies the entire premise of disposal as being antithetical to a circular economy. The 16R version of the zero waste hierarchy includes a greater level of textured discussion around, for example, the phenomenon of bioreactor landfills (similar to the association between incineration and W2E) that have been questionably promoted as greener, more acceptable alternative to conventional landfills.

This 16R result is not proposed as a replacement for, or as in conflict with, the conventional 7R ZWIA zero waste hierarchy, which has been arrived at via series of international ZWIA dialogues[82]. Notably, all of the seven designated levels of priority in the ZWIA version correlate within the re-structured new proposed alternative 16R zero waste hierarchy[83]. However, the proposition of this new 16R structure, which is derived out of the evidence from the analysable content on offer in the three selected sources, shows that there is a legitimate case for substantially expanding on the current ZWIA model. Clearly the case for expansion involves more levels, but equally significantly there is an opportunity to extrapolate more detailed information on the basis for prioritisation from among the plethora of distinct activities required in implementing a zero waste programme.

The total >10,000 wordcount (11 pages) of the *16R zero waste hierarchy* (ref. Section 4.3.4) illustrates extent of the new data and learning on offer in the overall QUAL(quant) result. Grappling with this volume of new data and how best to present the critical meaning the result, prompted the abductive process of reflection - conceptualisation which ultimately gave rise to the more simple, final summary graphic illustrations namely: Figures 11, 13, 14, and 15. The information distilled in these graphics is the result of a high-level, culminating phase of content analysis and the finalised formation of result. These graphically realised results are liberated in the exercise of researcher "judgement and

[82] Ref: https://zwia.org/history-of-zwia/

[83] i.e., 2- Rethink, 6- Redesign, 10- Reduce, 12- Reuse, 13- Recycle (inc. compost), 14- Recovery (Materials inc. AD energy only), 15- Residuals Management, and 16 demarcating the ongoing unacceptability of Disposal.

experience” in substantiating significance (Ashwood et al., 2014, p. 51) and the scientific art of discerning and crafting explanation, mediated by researcher expertise/knowledge/skills and rule-orientated - procedural research design (Bos & Tarnai, 1999).

As discussed in Sections 2.3 and 4.5, further publications are in development (with others planned) which will build on the publication strategy seeking to implement the research objectives set for this PhD research. Two examples illustrating this extension work / purpose, already underway are appended as Appendix 3 (based on the background work undertaken to understand and justify the use of the term *‘municipal’*) and Appendix 12 (based on discussing the background and future implications of proposing the 16R zero waste hierarchy model - Figure 13). Beyond these immediate draft examples, future publications will focus the other two key findings namely: Figures 11, the MZWM rubric and the combination of Figure 14 and 15 which fully explicate the proposed ꝏ infinity/continuum model.

In respect of this section of discussion, the draft 16R zero waste hierarchy article (Appendix 12), whilst still in a draft format, at >8,000 words, >100 references and in encompassing discussion related to 36 distinct illustrations of the waste hierarchy concept, this draft article is a substantive foundation for and illustrates the scope of this future publication. This next draft publication will examine the historical, conceptual, practical development and proliferation of the now many various examples of the waste hierarchy concept, specifically including:

- Both New Zealand background (including the local PNCC context) and international, perspectives and outcomes relative to the waste hierarchy concept.
- Specifically, zero waste and circular economy perspectives on the waste hierarchy concept.
- The relationship between life cycle analysis (LCA) and the waste hierarchy, as contested mechanisms for prioritising waste policy.
- Material type (i.e., organic waste) and sector-based variations (i.e., the informal/waste picking – developing country context) on the theme of the waste hierarchy.
- Discourse on the issues and opportunities attributed to the concept and application of a waste hierarchy.
- The evolution of the various and visually numerous examples of the waste hierarchy concept, including the shape (triangle, pyramid, cone, circularised, ladder models), orientation (i.e. ↑ vs ↓ vs ↗ vs etc), content, order, interactivity, graphic symbolism, annotation/explanation, supporting illustration, origins/derivation/motivation (i.e., commercially developed arguing the merits of the W2E).

Interestingly the new 16R version of a zero waste hierarchy has as a research finding been derived from three selected sources, none of which actually feature an illustrated waste hierarchy as a preconceived, pre-adhered policy-priority model. That said, there is clearly an imbued assumption of the concept of prioritisation, and also a range of graphic arrangements of steps, phases, clusters, touchstones and sequences (which are forms of hierarchies of expressed preference / action) communicated in respect of moving towards zero waste and shifting from linearity to circularity. While clearly derivative of the illustrated wide spectrum of evolution from the original simple 3R, 4R, 5R waste hierarchy variants (ref. the range of examples Appendix 12), this new proposed 16R MZWM hierarchy identifies new content, organisation, levels, and associated explanation. The proposition of the 16R hierarchy not only advances the documented ongoing discourse in respect of the waste hierarchy concept, but also positions this unique new rubric centrally within the confirmation and explanation of the MZWM.

The latest literature review and background work documented in the draft 16R zero waste hierarchy article (Appendix 12) also examines assertions of failure, around the acceptance, implementation and effect of the waste hierarchy at both a national (New Zealand) (Hannon, 2022 in submission; Hannon & Zaman, 2018; Hannon et al., 2018) and international context (Bartl, 2014a; Pietzsch et al., 2017; Pollans, 2017; Van Ewijk & Stegemann, 2016). It is interesting to examine these assertions generally call into question the value and success of waste hierarchies, relative to the background context of similar assertions of failure directed at the dominant majority theory and practice of conventional waste management and more specifically those levelled at zero waste, which gave rise to the subject research question and hypothesis of this PhD research.

The baseline background failure of conventional waste management is now being described as a globalised public and environmental health emergency, necessitating an urgent, comprehensive, and internationally coordinated response (Hannon & Zaman, 2018; Mavropoulos et al., 2017; Mavropoulos et al., 2015; D. C. Wilson, Rodic, et al., 2015a). This thesis argues that in responding to the syndrome of waste and waste management failure, zero waste can be understood as one of many movements / disciplines responding with new ideas, initiatives, and innovation. Arguably, assertions of – and actual – failure typify not only the waste work area, but the entire gamut of what is covered by the UNSDGs, and this is the catalyst for attempts at innovation and solution-seeking and change-making.

Questions of failure and challenges to the concept of a waste hierarchy appear to have given rise to a whole spectrum of variants (ref. Figure 12 and in full Appendix 12), seeking formats better aligned, for example, to perspectives emerging from LCA research, particular material/sector types, and commercial, and other imperatives. It interesting to consider to what degree accusations of failure and *reality checks* have prompted review, revision, and further development in the ethos and communication of (zero) waste management theories and practices, including the interpretation and application various versions of hierarchy (aka policy prioritization).

The new 16R MZWM hierarchy, derived from MMR HCA-T-MZWM quant + QUAL(quant) of three selected sources (none of which feature a zero waste hierarchy), appears as a significant advancement on the previously recognised most advanced ZWIA model. However, in this a critical question arises! Will the evident progress in articulating the 16R MZWM hierarchy's new content and an expanded structure, which equates to greater complexity, actually produce more progress and improved outcomes in terms of zero waste management practice? Conversely, if simpler (zero) waste hierarchies are failing to catalyse break-through change, will a more complex version resolve barriers to progress?

In the course of this research, a growing suspicion arises that the answer to the above question is no. It increasingly appears that it is not deficiencies in understanding (zero) waste hierarchies, theories, and or methodologies that are at the heart of delay and delimitation in addressing waste issues. Therefore, it seems unlikely that research that better defines and builds understanding of MZWM will itself break down barriers to progress. Rather, it appears that other overarching issues / influences are the key limitation on environmental progress. For example, private sector competition for and control of material flows, a clash between profit vs egalitarian environmental motives, deliberate public misinformation (including climate science denial type campaigns funded by vested interest groups), and targeting leadership / governance pressure points with partisan lobbying, all appear as key limiters of progress (Edwards, 2020; Grover, 2000; Hannah et al., 2021; Hannon, 2018). These impediments exist above and beyond the baseline systemic issues and complexity of the global waste crisis (Hoornweg et al., 2012; Mavropoulos, 2010a; UN-Habitat, 2010; Velis et al., 2017; D. C. Wilson, Rodic, et al., 2015a) and or, any questions around the theoretical or practical integrity of any given approach to policy.

This observation does not negate the value of research, which continues to refine and develop the theory and practice of zero waste. Neither does the observation of systemic societal and industry issues and barriers to progress necessarily devalue the proposition of the new 16R hierarchy as a valuable result. This research findings has contributed to addressing this PhD research hypothesis by providing significant confirmation and new understanding of MZWM, via the extensive written result and the integrated series of new high-level graphic reconceptualisation's of this phenomenon. These learnings have the potential to contribute to significantly resolve waste issues, but only if this MZWM is fully and effectively implemented and actualised. Recognising the contingency of other overarching issues / influences (rather than any innate potential vs flawedness) appears to have always been the key limitation on waste management policies and practices, as it is in fact with ISWM theory, which conventionally identifies *reduce* as the top (but unrealised) priority.

In real terms, despite glimpses of potential and actual success, zero waste remains a peripheral, deliberately marginalised, and often denigrated community of practice that, outside of a few notable exceptions, has only infrequently sought to be fully and consistently implemented. The modus operandi of campaigns mobilised by vested interest groups associated with making and managing waste (R Crocker & Lehmann, 2012) appears to be to misinform and discredit the idea of zero waste, in order to prevent its uptake and implementation. Wherever and to whatever degree zero waste programmes /case studies have been implemented, the evidence of success, efficacy, innovation, and progress can be considered strong, especially when compared with the baseline failure of conventional waste management (Hannon, 2018).

The argument emerges that the basic method of zero waste is functional and successful, but the real issue is if and how the method actually gets to be implemented (vs practically obstructed and derailed by misinformation). The same phenomenon appears to apply to the theory and practice of the waste hierarchy concept. In practice, the ideal priority at the top of the waste hierarchy (i.e., reduce) is never actualised, because in reality the waste industry is dominated and preoccupied by disposal (supposedly the least and last priority). In reality, international waste data indicates that, after over four decades of widespread notional acceptance of the waste hierarchy principles, most industry imperative and investment remain stuck at the least, last, and lowest priority - disposal[84] (Allesch & Brunner, 2014). Further, it can be argued that an entrenched bias and disciplinary chauvinism manifests in not accessing the other envisioned modes of thought and action. This omission thwarts opportunity and locks in the ongoing systemic failure of never actually realising the 50% point of the stated, top (reduce), middle (recycle), or lowest (residual disposal) priorities (Hannon, 2015a; Hannon & Zaman, 2018).

[84] Allesch and Brunner (2014, p. 446, fig. 6 a&b) report that the allocation of the reviewed studies to the five steps of the EU waste hierarchy (without considering the categories of waste management system and waste collection) shows that waste prevention is not ranked among the top issues by the waste management assessment community (see Figure 6(b)). In only 4% of the reviewed studies was the main object of the investigations waste prevention or re-use; however, approximately 25% assessed waste recycling systems.

In this sense, even the most basic waste hierarchy can be said to be analogous with and an endorsement of a call for zero waste. In articulating 16R levels, this new proposed MZWM hierarchy exploits this cognitive symmetry to its fullest and takes this development trajectory to its logical extent. However, given that neither lesser, nor more advanced conceptions of the waste hierarchy are the crux of the societal and technical issue of wastes, these serve in lesser and greater degrees to expose what really are the real issues. The 16R MZWM hierarchy acts then, as a catalyst for a high-level *where to from here* strand of reasoning. The 16R MZWM hierarchy provided a critical prompt and staging post in the final procedure of this content analysis, which was to consider what presentation format best reflects and infers the most meaningful inference of the overall big picture results.

5.8. Beyond hierarchies: A zero waste infinity – continuum model

Examining the discourse surrounding the wate hierarchy concept and in particular the debate giving rise to the diaspora of versions now giving effect to the various academic, commercial, and other pragmatic perspectives, provokes numerous questions. For example, are any negative inferences, or unintended consequences inadvertently communicated in the conceptual arrangement of a (zero) waste hierarchy? Conceptually, does the vertical visual arrangement of a (zero) waste hierarchy infer an unconscious assumption of singular step-wise progression and or linear sequencing in programming change? Such questions are important because a preconceived linear step-wise approach to programming change may out of sync with what is actually required in this complex, integrated, and highly interdisciplinary sphere (Hannon, 2020). In practice, the real-world context of local/central government programming typically involves numerous priorities competing for attention within an always limited budget. Given this scenario, despite the inherent issues associated with disposal and the recognised failings of conventional waste management approaches, it appears that the alternative principles of the zero waste and the aspirations expressed in the (zero) waste hierarchy are often subverted by deeply embedded historical default settings. In practice, it appears that risk management and sanitary considerations (i.e., keeping the streets clean and hygienic) routinely subvert environmental ethos and ambition. In short, the bottom priorities of the waste hierarchy in reality normally win out against the supposed top priorities.

It appears that once this deeply socialised priority given to disposal (which is notionally the opposite priority of the waste hierarchy) has been met, a range of funding, technical, infrastructural, knowledge, behavioural, demographic/democratic constraints kick in. In real terms this means, every other option competes for the financial leftovers and whatever political capital remains. The consequence is that the big picture, science-driven ideal of zero waste (or even just progressing up the levels of the waste hierarchy) is normatively subverted in favour of the known expedience of maintaining the status quo. The elephant in the room in the scenario is that the waste hierarchy has become an emblem of rhetoric that is disconnected from reality. This normalised cognitive dissonance perpetuates the status quo, rather than releasing the next and new ideas and innovation that are urgently required. This prevailing hypocrisy and disfunction now appear institutionalised as a benign subterfuge, normalised and compounded by decades of cycles of unrequited pubic consultation (which registers and records communities' environmental aspirations), action planning, and budget setting that drives the delivery of community services and infrastructure (Stone, 2002).

What will break this apparent association between the inferred verticality, linearity, singularity, hierarchal and sequential thinking and the subversive syndrome of reverse priority lock-in that diffuses progress? The negative associations with the waste hierarchy appear as an unspoken cognitive blind spot that has built up of over decades of promoting, while never realising, notional priorities for waste policy and practice. The outcome of this syndrome presents as an entrenched and potentially irreversible loss of veracity, integrity, intentionality, and a stultifying hypocrisy that is now associated with utilising the (zero) waste hierarchy as a pillar of (zero) waste policy. Concerningly, it appears the same undermining effect and loss of traction apply in respect of other aspirational movement seeking to generate the transgressive, trans-disciplinary innovation and change/progress necessary to break perceptions and actual cycles of failure that shroud (zero) waste management (Hannon, 2020; Klein, 2008).

The question that arises in response to this realisation, which accumulated over the duration of this research project, is *where to form here?* If the concept of a waste hierarchy is fatally compromised, what next model/structure/graphic illustration best fits the intensely interdisciplinary, wickedly complex MZWM scenario? In reality, the MZWM presents as not just requiring a shift simply from linear to circular thinking, but beyond this into a transgressive, post-normal science (PNS) mode of multilateral, pluralistic, transdisciplinary approaches that comprehend the interactivity of elements within a MZWM. Implementing the proposed MZWM appears as a multilevel dynamic that simultaneously employs several elements as well as curates interactive clusters/combinations of policy/programme/practices, with necessary timing and effect.

An important interdisciplinary consideration in respect of the learning generated and articulated in the proposed new 16R MZMW hierarchy is to avoid discarding or trampling over any preceding discipline basis and assumed knowledge foundation in seeking to generate future knowledge (Repko & Szostak, 2017). A guiding interdisciplinary consideration was to build-on the existing (zero) waste knowledge/policy foundations by discerning what new data means relative to existing data. This involved interpreting how best to synthesise what has been said with what is now being said in this sphere, in a way that is consistent, constructive, and coherent.

As discussed in the draft article in Appendix 12, in the official context the New Zealand Waste Strategy (NZWS) the waste hierarchy, zero waste and circular economy policy motifs have been used interchangeably (MfE, 2002, 2010), albeit arguably without sufficient explanation and consistency and unfortunately without achieving the targeted outcomes (Hannon, 2018; MfE, 2017a, 2017b). Relative to the exorbitant value propositions claimed for a circular economy in New Zealand [85] (Blick & Comendant, 2018; Griffin et al., 2017) no corresponding cost benefit analysis was ever commissioned for *Moving towards zero waste and a sustainable New Zealand (MfE, 2002).* Had this research occurred it might have countered the campaign of misinformation, denigration, and scare tactics of that period (Clough, 2007; Hannon, 2018; New Zealand Packaging Council, accessed 2009). New Zealand's most recent national waste policy rhetoric now reflects the concept of a circular economy[86] and appears cognisant of the big picture potential that (zero) waste management offers for reducing pollution,

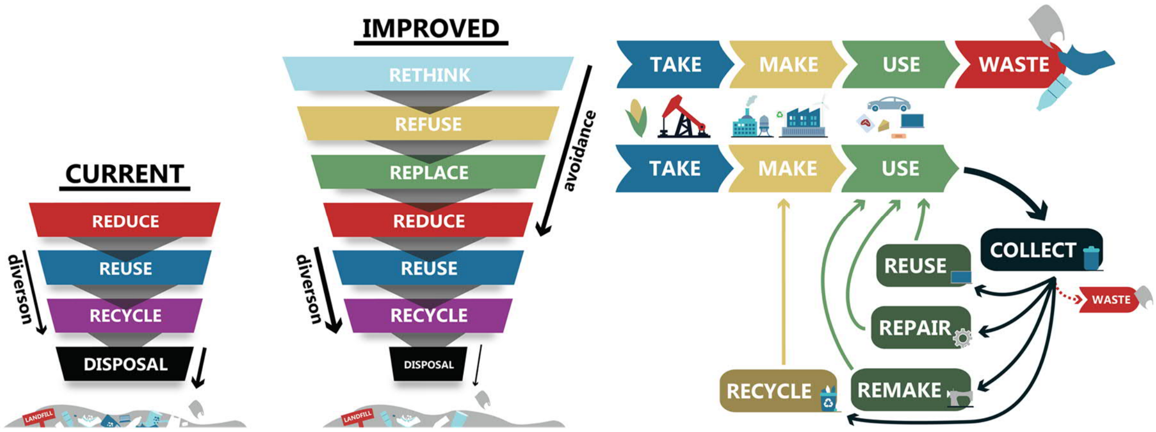
[85] "The circular economy opportunity for Auckland' report cites liberating an $8.8 billion in additional economic activity within Auckland and globally an estimated USD$4.5 trillion economic opportunity by 2030." https://sustainable.org.nz/the-circular-economy-opportunity-for-auckland/

[86] https://www.mfe.govt.nz/waste/circular-economy

addressing climate change, and progressing into more environmentally sustainable forms of development.[87]

Taken as a whole, these emerging indicators[88] suggest that New Zealand is now seeking to address past lapses in waste management performance, is catching-up with international good practice, scientific guidance (PCE, 2006) and is re-evaluating the role of aspirational social movements (i.e. for circular economy and or zero waste) in driving progress (Hannon, 2018). The fact is that it has largely been the zero waste movement that has generated New Zealand's recent keynote international success stories during an otherwise regressive period (Hannon, 2018; Hannon & Zaman, 2018). Despite this, it seems likely that the next NZWS will be reshaped around the language and empowerment of the circular economy concept, rather than the pre-established and proven concept of zero waste.[89]

One possible indicator of the future direction that may be taken by the government in crafting the next NZWS lies in the work of the Office of the Prime Ministers Chief Science Advisor and the *Rethinking plastics in Aotearoa New Zealand* project report,[90] which contains a number of graphic illustrations (compiled below as Figure 18) of proposed policy perspective and priority actions (Chiaroni-Clarke & Gerrard, 2019). As these illustrate, this work includes an expansion of the *avoidance* dimension of a conventional waste hierarchy concept to include *rethinking, refusing, and replacing* at higher priority levels than the normal 3Rs, which in turn sit above the visibly de-emphasised option of disposal. Aside from this relatively conventional rubric, all the other graphic formats that have been selected by the authors to illustrate the results and directives of this project draw on, align with, revise, and replicate the key emblems of the circular economy movement.

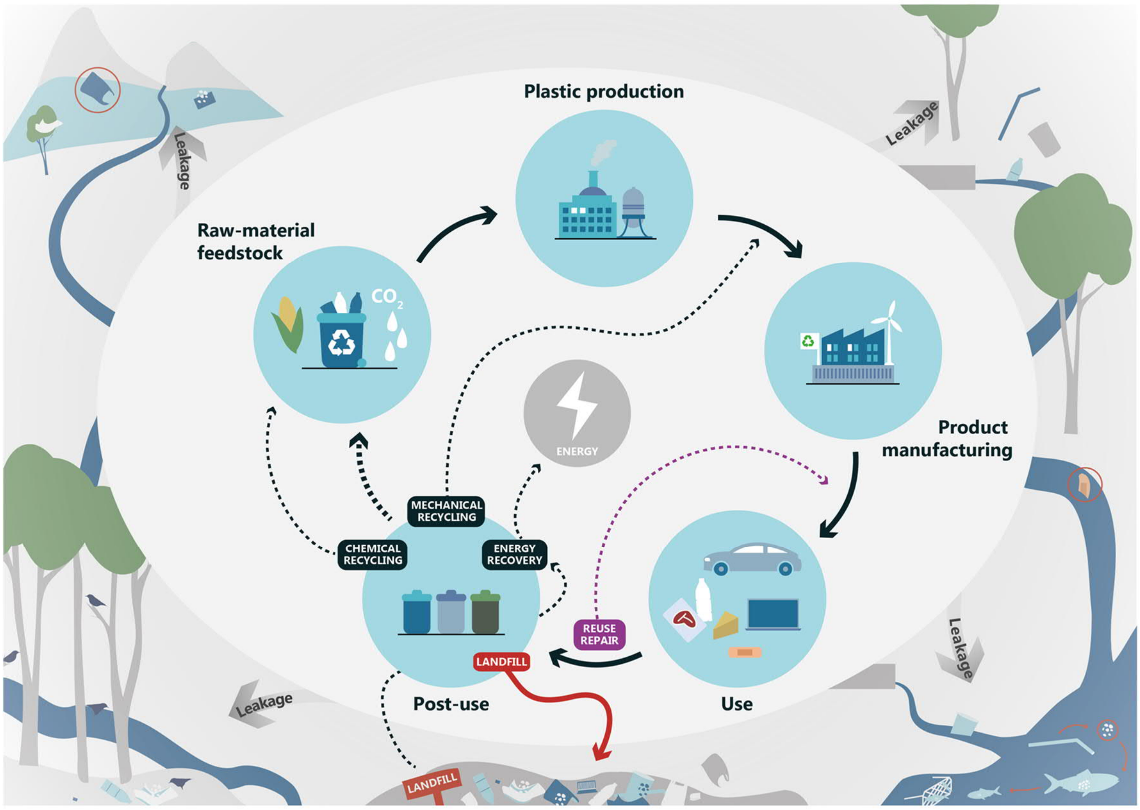


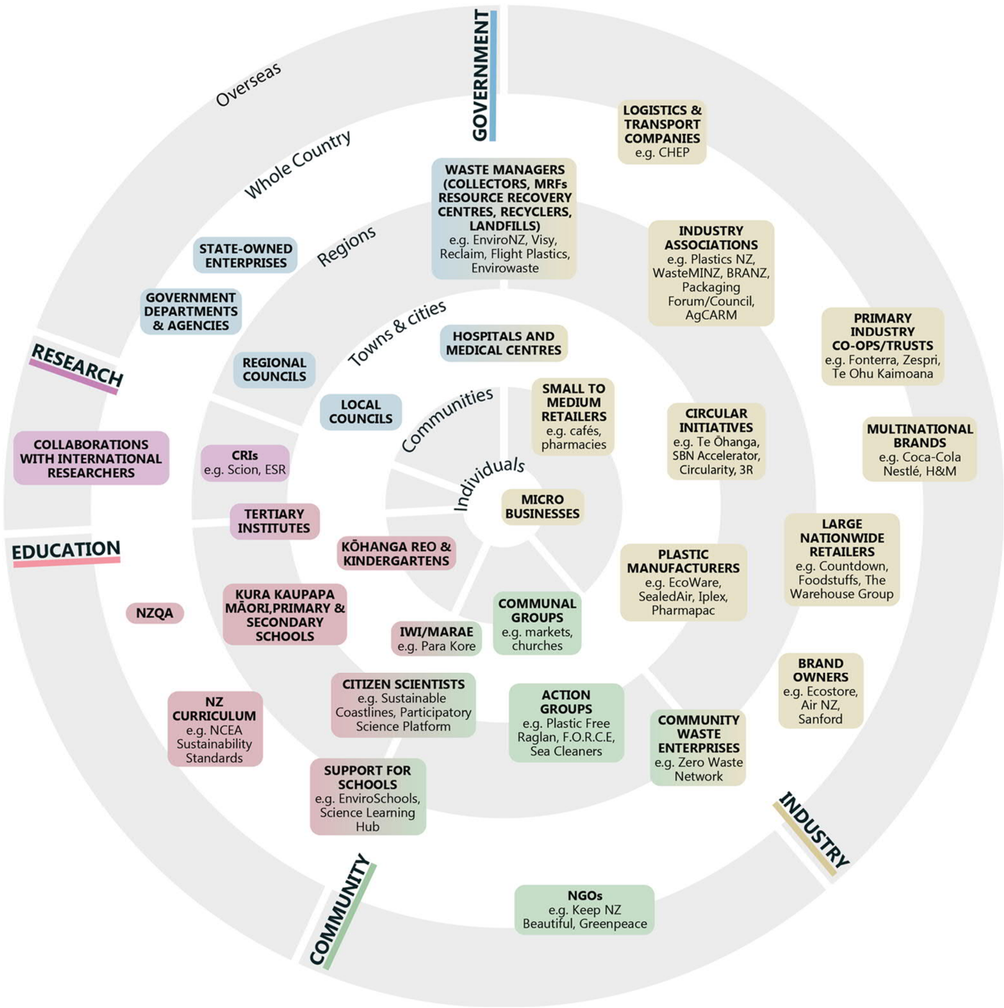
[87] https://www.mfe.govt.nz/climate-change/zero-carbon-amendment-act.

[88] For example, the article (Hannon, 2021 in submission) examines *"New Zealand's response to plastic pollution, which commenced under the National coalition government (2008–2017), with the instigation of a ban on microbeads (ref: https://www.mfe.govt.nz/waste/waste-strategy-and-legislation/plastic-microbeads-ban). This initiative has been followed up in close succession, by a series of plastics-related regulatory interventions by the current Labour led coalition government (2017–ongoing). These involve: a ban on single-use shopping bags (ref: https://www.mfe.govt.nz/waste/single-use-plastic-shopping-bags-banned-new-zealand), announcing a suite of proposed and then formally notified Ministerial priority products declarations to establish mandatory Product Stewardship schemes (ref: https://www.mfe.govt.nz/publications/waste/proposed-priority-products-and-priority-product-stewardship-scheme-guidelines), initiating public consultation and subsequently notifying the intention to increases in scope of coverage and amount of the landfill levy (ref: https://www.beehive.govt.nz/release/government-steps-action-waste-funds-recycling-infrastructure-and-expands-levy-scheme . which equates to future increases in waste minimisation funding), as well as signalling future phase-outs and bans of problem waste types (ref: https://www.beehive.govt.nz/release/government-announces-plan-tackle-problem-plastics-and-seven-single-use-plastic-items). This package of government action around waste (and quite explicitly plastic pollution) appear well aligned to the guidance emerging from relevant institutional reporting, community imperative and research / science related investment".*

[89] Ref. https://environment.govt.nz/what-government-is-doing/areas-of-work/waste/waste-legislation-review/#:~:text=New%20Aotearoa%20New%20Zealand%20Waste%20Strategy&text=The%20strategy%20sets%20out%20course,making%20better%20use%20of%20resources.

[90] Ref. https://www.pmcsa.ac.nz/topics/rethinking-plastics/


Plastic production
Raw-material feedstock
CO_2
Product manufacturing
ENERGY
MECHANICAL RECYCLING
CHEMICAL RECYCLING
ENERGY RECOVERY
REUSE REPAIR
LANDFILL
Post-use
Use
Leakage
Leakage
Leakage
Leakage
LANDFILL



Figures 18: A cluster of illustrations form the *Rethinking plastics in Aotearoa New Zealand* project report by the Office of the Prime Ministers Chief Science Advisor (Chiaroni-Clarke & Gerrard, 2019).

The critical visual metaphor reoccurring throughout this reporting, albeit animated and annotated with various graphic and literary devices, is of circles, cycles, and circularity (ref. Figure 18). The material focus of the above reporting is on plastics, which represents a sub-set of the bigger (zero) waste picture. Similarly, other high-profile international initiatives working in the sphere of food waste and organic recycling have adapted, re-visualised and recrafted material/sector specific hierarchies as a subset of the broader imperative, concept and frameworks of (zero) waste (Caldeira, De Laurentiis, & Sala, 2019; Downes, 2018; Garcia-Herrero et al., 2018; Leao, Cesarino, Narine, & Sain, 2017; Lewis, Downes, Verghese, & Young, 2017; Matharu, de Melo, & Houghton, 2016; Teigiserova, Hamelin, & Thomsen, 2020). The other basis from which these New Zealand materially focussed circular economy emblems are derived is the now ubiquitous global circular economy model (see Figure 19), incorporating the *cradle to cradle* (re)design ethos of (McDonough & Braungart, 2002, 2013; McDonough et al., 2003), which is more recently presented and promoted by the Ellen MacArthur Foundation (Ellen MacArthur Foundation, 2012, 2013a, 2013b; Ellen MacArthur Foundation & World Economic Forum, 2016).

This original depiction of a circular economy model is holistic in envisaging restoration by design and in encompassing the entire industrial system. This model embodies both the implied levels and priorities of a hierarchy, as well as dividing this into two sequentially layered, circularised material pathways, namely of technical and biological nutrients. This model includes the annotated staging of extraction–production–retail–consumption, etc., process details and feedback loops to soil and the biosphere and is reflective of the necessity of extended producer responsibility/product stewardship (EPR/PS) theory and practices. As such, the original circular economy model (Figure 19) seeks to extend into and convey a bigger information load by merging into the biosphere-level interactivities evoked in industrial ecology/symbiosis/urban metabolism depictions of ecosystems theory (Manahan, 1999).

There has been a global uptake and recognition of this model in numerous international circular economy policy/programme guides and white papers (CIWM, 2014; EC, 2014; Enkvist & Klevnas, 2018; Friends of the Earth, 2014). There are numerous local indicators (Blick & Comendant, 2018; Griffin et al., 2017; MfE, accessed 2019; Modal, 2017; SBN-NZ, 2015; Zero Waste Europe, 2015; Zero Waste Europe & FPRCR, 2015) of the likely future inclusion of this theorem into the revision of the New Zealand Waste Strategy (NZWS:2010) and Waste Minimisation Act (WMA:2008). This documentation provides a strong pointer not just to trends in waste policy, but also how key industry community government stakeholders are currently seeking to portray and receive critical, next-steps information in the scientific discourse driving reflection and progress in the waste → zero waste space.

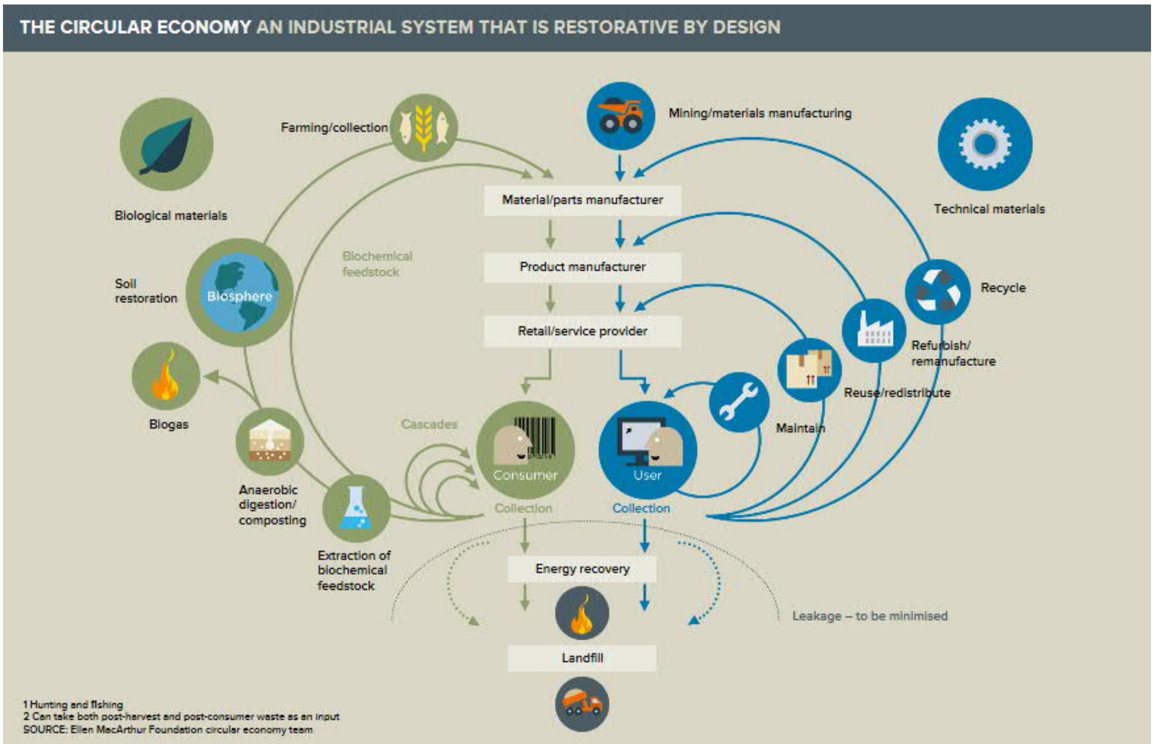


Figure 19: The now ubiquitous global circular economy emblem / model derived from the (re)design ethos of (McDonough & Braungart, 2002, 2013; McDonough et al., 2003) presented and promoted by the Ellen MacArthur Foundation (Ellen MacArthur Foundation, 2012, 2013a, 2013b; Ellen MacArthur Foundation & World Economic Forum, 2016).

At this point in the research journey, three strands of discourse converged to prompt a reconceptualisation of how the MZWM should be considered and presented:

1. First, the work documented in Sections 4.5, 5.7 and Appendix 12 considers the interpretation and evolution of the waste hierarchy concept alongside how the circular economy concept is being illustrated and communicated. This highlights that in both a New Zealand and international context, the theory, practice, and emblems of zero waste and a circular economy have many

shared cognitive foundations and have been utilised on an intertwined and/or interchangeable basis.

2. The second connective strand involves a key finding woven into the foundation chapters of this thesis (from the group publications discussed in Sections 5.1 to 5.3), namely the argument of commonality among all sustainable waste management movements in the waste → zero waste transition spectrum (Hannon, 2020). However, this concept is discussed and described (variously as: a milieu of respondents, a dynamic eco-ideas marketplace, future focussed, a sustainable waste management cluster, etc.), it is clear there are a wide range of movements /disciplines /brands of activity that are urgently seeking to address the manifest sense of failure and crisis around waste and the tradition/conventional paradigm of waste management. This thesis identified zero waste (ZW), zero emissions (ZE), circular economy (CE), industrial ecology/symbiosis (IES), urban metabolism (UM), and bioeconomy (BE) as also sharing in the commonality of seeking to actualise the ecosystem metaphor of infinite-perpetual resource life-cycles and naturalistic design principles (Hannon, 2020; Kuehr, 2007; Loiseau et al., 2016; McDonough et al., 2003; Pfau et al., 2014; Varga & Kuehr, 2007). As such, these movements are disruptors and competitors with conventional waste management. However, they are also allied to each other as synergists that catalyse the innovation required to move up levels and actualise the key principles and priorities of the waste hierarchy. Viewed through the lens of the academy's semantic tribalism, this may be a contested viewpoint, it is now, however, strongly anchored in scientific discourse.

3. The third strand of discourse triangulated within the formulation of deciding how the proposed new research derived MZWM would ultimately be illustrated and presented, was provided by the UNEP. The *Guidelines for National Waste Management Strategies - Moving from Challenges to Opportunities* (UNEP et al., 2013) can be considered as offering a truly international and authoritative future-focussed view[91] on the transition from a conventional waste management based paradigm into the assertive extremity of zero waste (Hannon, 2020; Hannon & Zaman, 2018). The most notable aspect of the UNEP's guidance is that fundamentally it includes an informed and balanced recognition of the contribution the zero waste movement can make in addressing waste issues. This balance stands in quite stark contrast to much of the waste industry misunderstanding and denigration of zero waste (ref. Table 1). Importantly, this guidance articulates a number of critical attributes about zero waste[92] that, because of the independence and authority of the UNEP, can be considered quite influential and non-partisan. The key attributes identified by the UNEP are: grounded pragmatism, a continuum of targeted aspiration

[91] This publication was developed in the IOMC context. The Inter-Organisation Programme for the Sound Management of Chemicals (IOMC) was established in 1995 following recommendations made by the 1992 UN Conference on Environment and Development. The Participating Organisations are FAO, ILO, UNDP, UNEP, UNIDO, UNITAR, WHO, World Bank and OECD (UNEP et al., 2013).

[92] *"Many countries have identified 'zero waste' by a particular date as a national (or sometimes regional or local) target. No country or even city has yet reached that target; but no country or city has ever been satisfied that its waste minimisation efforts have gone far enough. Every success breeds an ambition to do even better. This ambition is the driver of continuous improvement in waste management. The adoption of zero waste as a national target is a recognition that incremental improvements in rates of waste generation or recycling are not enough in themselves, and that a goal that aims to eliminate waste is needed. A zero waste target is a reflection of the never-ending nature of waste management tasks – a recognition that there will always be a need for improvement, and that once one target has been achieved, others, more demanding and difficult, will still remain to be tackled. Zero waste is a target that can be useful as a reminder of the need to look beyond short-term improvements and focus on radical and long-term change. It needs to be supported by clear, measurable goals or subsidiary targets to provide a metric of progress towards the long-term aim of eliminating waste in its entirety"* (UNEP et al., 2013).

striving for improvement and ultimately excellence in aiming to eliminate, rather than just perpetuate the management of waste (UNEP et al., 2013).

The outcome of this triangulated foundation setting and reconceptualisation exercise was that the final determination of MMR HCA-T-MZWM quant + QUAL(quant) procedure was to adopt the infinity continuum symbol ꝏ, as the illustrative rubric for the newly proposed MZWM (see Figures 14 and 15, Sections 4.6 and 4.7). The incorporation of the revised, updated 16R zero waste hierarchy version means that this result maintains connection to and continuity with the past origins of the waste hierarchy, as an existing pillar of waste management theory. In this proposed new graphic arrangement, the 16R zero waste hierarchy is positioned at the central junction point of the ꝏ infinity–continuum model. The other 10 key MZWM elements are arranged in a way that carries forward some of the empirical priority/proximity logic from the arrangement of the result expressed as Figure 11 (Section 4.4). However, as a result, this new ꝏ graphic arrangement can also be considered the culmination of researcher reflection, iterative analysis, and abductive reasoning on how best to finally and fully express the inferred meaning of the research data.

For example, a final iterative decision was to divide and express the *Guidance and Market development* theme as two sperate elements in the ꝏ infinity–continuum MZWM model (i.e., a- *Market development / instruments & interventions → financially sustainable ZW + CE* and b- *Guidance to reshape WM → ZW contracts to incentivise CE + CC + SD outcomes*). This is an example of final refinement based on high-level researcher reflection, culminating analysis, and abductive reasoning. Another similar finalisation is the rationalisation of the order and flow of the elements around the ꝏ infinity–continuum model. The ordering and visual arrangement reflects both the empirical emphasises, clustering and connectivity (illustrated in Figure 11) and an association with the respective 1- individual / family / household, 2- local government policy / programme / action, 3- collective central / federal / national government, and 4- globalised international sphere and 5- international zero waste networks / alliances / campaign/activist spheres of influence, operation, and responsibility. The decision to interconnect all elements around the ꝏ infinity–continuum model via ↔ arrows depicts the sense of interdependence and interactivity, which again emerges in the culmination of earlier results and ongoing meta-level reflection and conceptualisation.

The final depiction of result in Figure 15 involves positioning the MZWM ꝏ infinity–continuum model within a schematic that outlines all the keynote sub-theme headings and therefore offers an indicative overview of the substantial MZWM written narrative knowledge-base, generated by the content analysis. Once again, the wording and aspects of the arrangement of these illustrative sub-theme text boxes has been editorialised from the perspective of seeking how best to communicate this final summary result. Any such final narrative-aesthetic revision at this point was based on simplifying, clarifying, and enhancing illustration and impact of the communication.

These final iterative changes do not negate any of the rigour and definition of the results, which are presented as an holistic, mutually reinforcing and embedded hybrid MMR quant + QUAL(quant) package (i.e., Sections 4.1–4.7, and Appendix 11 and explicitly Figures 11, 13, 14, and 15). It is important to note and distinguish that while in Figure 11 and the numeric hierarchy of Figure 13, where a definite and discussed meaning is attached to the merged empirical/QUAL(quant) system of annotation and narrative, in Figures 14 and 15 there no meaning is attached or sought to be communicated through colour coding, empirical superscripts, text weightings and/or interactive links/clusters. In presenting Figures 14 and 15 as two final summary results, the balance shifts from arcuately and transparently depicting the technical QUAL(quant) MMR detail (i.e., which resides in other parts of the overall package of results) to how best to fully and germanely communicate the inferable meaning (Krippendorff, 2013) from these detailed data.

The MZWM ꝏ infinity–continuum model in a- a summary format (as Figure 14) and b- as a synthesised, expanded and explicated format (as Figure 15) represents the novel research outcome anticipated in the use of content analysis as a research methodology (Bos & Tarnai, 1999; Krippendorff, 2013). As discussed previously, the illustrative arrangements have been selected / designed based on a triangulation of current policy and figurative / stylistic trends and as best reflecting and projecting the attributes of MZWM. In the foundation chapters of the thesis excerpts from the publications derived from this PhD research have provided academic content and background / context, and underwritten the development of the problem statement, research objectives and the identification of research questions, hypothesis and methodology to address these. At this point in the thesis a further group of excerpts from the publications generated by this research process, are now arranged in discussion of how the described attributes of zero waste[93] align with and support the conception of the ꝏ infinity–continuum model of MZWM. As is now established in in academic discourse, zero waste:

- is … inherently hyper-aspirational in seeking to provide a "manifesto for the redesign of the material economy" (Murray, 2002, p. 30), in order to catalyse a 2nd – green - industrial revolution, (Murray, 1999, 2002; I. D. Williams, 2013)…
- … argues for a maximum trajectory in change making policies and programmes… implicitly seeks a continuum of aspiration, which aims to disrupt the current technical and socio-economic, barriers to sustainable practice and possibility (Elkington, 2012; UNEP et al., 2013)…
- is … depicted as a circular, closed-loop material eco-system and as being one of the key principles guiding the green urbanism movement's vision of and practice for future (eco)cities (S. Lehmann, 2010a, 2010b)…
- is … simultaneously controversial and indispensable, as a critical driver and grist in the societal debate about how to engineer the transition from unsustainable, into sustainable (zero) waste management (Lombardi & Bailey, 2015; Pollans, 2017)…

All of the above excerpts are from *Moving Toward Zero Waste Cities: A Nexus for International Zero Waste Academic Collaboration (NIZAC)* (Hannon et al., 2018).

- is … a creative milieu, functioning across the spectrum between, the ZWIA's formal definition and a wild-west of interpretive miscellany…
- is … described as a concept that embraces the diversity of measures, experiences, and interpretations arising in industrial, municipal, activist/community, development, and policy/government spheres of practice (Hannon, 2015a; Pietzsch et al., 2017)…
- … argues, not only for radical change making policies and programmes, but also for structuring an ongoing continuum of aspiration, beyond the current boundaries of known technical and socio-economic, possibility (Hannon, 2018)…
- … argues for shifting beyond a techno-centric, end of pipe focus, predicated on disposal (Silva et al., 2016; Zaman, 2016), into a more values based (including those of indigenous peoples),

[93] NB: which includes the *'city'* construct which has been a focus of these publications.

ethical approach, which recognises the human centred, sociological basis of waste (Harmsworth; Hawkins, 2006; Jones, Pimbert, & Jiggins, 2010; Pauling & Ataria, 2010)...

- ... includes refocusing on the criticality of consumer - producer responsibility (Bartl, 2011; S. Lehmann, 2011a; Murphy & Princetl, 2013; Nicol & Thompson, 2007; Zaman, 2015; Zero Waste Europe & FPRCR, 2015) and community participation and leadership (Allen et al., 2012; Lombardi & Bailey, 2015)...
- is ... in broad symmetry with other environmental brands / policy labels / keywords speaking to the issue of waste and resource management (Silva et al., 2016), zero waste voices a distinctive call to action, positioned in the radically optimistic end of the debate around the need and opportunity of socio-economic reform (Hawken et al., 1999; Homer-Dixon, 2006; Porritt, 2007; Stern, 2009)...
- ... is expressed in the ideal of seeking to eliminate, rather than forever just managing waste, as discarded material flow preordained disposal (Chandavarkar & UNDESA/UNEP, 2010; Snow & Dickinson, 2001, 2003). Zero waste seeks to reimagine the default characterisation of waste as being inevitably a problem (i.e., something to be quickly gotten rid of) into being reconceptualised as a resource and framed opportunity to be exploited (Murphy & Princetl, 2013; Pietzsch et al., 2017; Pollans, 2017)...
- ... arises out of industrial, municipal and activist / community experiences with apparent precedence and emphasis in that order (Hannon, 2015b; Hestin et al., 2010; Zaman, 2015)... Each distinct worldview contributes to and shapes the narrative, as well as a sense of juxtaposition associated with zero waste. Whilst, it can be recognised that the origins of zero waste success was pioneered in an industry setting (Hannon, 2015b; Murray, 2002) equally, endorsing and empowering the informal sector and grass roots-community based initiatives, is seen as instrumental to the future of zero waste (Allen et al., 2012; EEC, 2008; UN-Habitat, 2010; Van Vliet, 2014a, 2014b, 2014c). Adding to this diversity and debate, zero waste policies and programmes are being developed across the spectrum from developing to developed socio-economic settings (Allen et al., 2012; J Hill et al., 2006a)...
- includes an ... upstream sphere... where the issues around current products, production, consumption and urban systems are sought to be addressed through transformative design and social innovation (S. Lehmann & Crocker, 2012; Levitzke, 2012). Allied to this, the downstream expression of zero waste, is where conventional waste management's theory, policies and practices, are contested and sought to be radically reimagined and reformed (Pollans, 2017)...
- ... is less of a competitor to traditional solid waste theory than it is a synergist, catalysing a shift up into the top, largely unrealised priorities of the waste hierarchy (Song et al., 2014)...
- ... adds to the broad community of effort seeking to resolve waste issues, is conveyed in statements, such as: "there is no right or wrong answer" (D. C. Wilson, Rodic, et al., 2015b, p. 29), or "no one size fits all" (UN-Habitat, 2010, p. XXV). In sync with this advocacy, the zero waste movement enhances the bio-diversity of ideas seeking to address waste issues and expands reach and resilience of innovation seeking to address waste issues...
- exhibits ... the outsider characteristics of learning by doing and doing by learning, a sense of transgression and re-assemblage, a multi-actor heuristic, a lack of fixed typology and with this, practical contradictions and cognitive tensions around transcending, futuring and continuum above normative short-term, tactical obsequiousness to disposal. Zero waste can be recognised as fitting the PNS descriptor, of being a post normal sustainable technology (Frame & Brown, 2008; Klein, 2014)...

All of the above excerpts are from *Future Cities: Exploring the phenomenon of zero waste.* (Hannon & Zaman, 2018).

- ... should be regarded as, as much a consideration of social science, as it is a technological concern, needing a science, technology, engineering, mathematics (STEM) derived fix...
- an ... essential platform for engineering this transformation is the design and deployment of market-based economic instruments and incentives and regulatory interventions, which enact genuine producer–consumer responsibility (Zero Waste Europe & FPRCR, 2015) and empower regenerative re-design, dematerialising, detoxing, circularising and upcycling all resource flows within economy (McDonough & Braungart, 2013)...
- ... re-orientates waste management theory into a big picture mode, attuned to holistic, integrated systems thinking, ecological economics and socio-cultural imperatives (Ayres & Ayres, 2002; Kuehr, 2007; Murray, 2002). In future, efforts seeking to address the issue of waste, need to be applied at every stage, from inception in design, production, product and packaging systems and from the point of natural resource extraction, refining, transport, manufacturing, sale-purchase, use phase, as well as to end of life utility and eventual disposal (Ellen MacArthur Foundation, 2013a; McDonough & Braungart, 2002)...

All of the above excerpts are from *Exploring and Illustrating the (Inter-)Disciplinarity of Waste and Zero Waste Management* (Hannon, 2020).

- fosters ... the so-called *zeronautics* of solution/innovation seeking and overcoming barriers (to circularity, sustainability and zero waste) which occurs in these creative-transgressive zones of future/next/yet/other (Elkington, 2012; Klein, 2014) and requires imagination, persistent experimentation (trial and error across many options for innovation) and maximising the interdisciplinary collaboration of many experts, pioneers and worldviews...
- ...from an interdisciplinary perspective, the demand framing... [sic of zero waste] necessitates revolutionary insight, regenerative technologies, radical socio-economic restructuring and where necessary, circumventing inefficacious disciplinary convention and authority (Klein, 2014; Repko, 2012). The latter presupposes transitioning from the current business as usual defaults of linear disposal for the so-called management of waste...

All of the above excerpts are from *Reviewing Policy Analysis in Waste Management Research to Establish a Design Basis for Testing and Elaborating Municipal Zero Waste Methodology* (Hannon, 2022 in submission).

The MZWM ꝏ infinity–continuum model illustrated as Figures 14 and 15 is considered the best way of encompassing, graphically illustrating, and projecting the above listed spectrum of attributes (as well as the uncited broader perspectives offered by other researchers/commentators). In addition, critically this visual model is the rubric that most authentically emerges from the MMR HCA-T-MZWM quant + QUAL(quant) research procedure and reflects the content of the source data. Arranging and presenting the MZWM as a research finding within the selected ꝏ infinity–continuum symbol is the visual model commensurate with the extreme requirements of addressing the cited super-wicked scale of complexity, crisis, and risk (Krausz, 2012; Levin, Cashmore, & Bernstien, 2009; Levin et al., 2012) associated with global waste issues (Hannon, 2020).

The MZWM ꝏ infinity–continuum symbol was also considered the most evocative in representing the potential MZWM contribution in meeting the requirement for advancing interdisciplinarity comprehension, training, and collaboration across the spectrum of waste → zero waste-related research, education, and industry practice (Hannon, 2020). As has been asserted: "… literature supports the view that, a baseline of interdisciplinary skill and experience provides a necessary foundation for the kind of transgressive, transformational, transdisciplinary breakthroughs (Klein, 2014; Stock & Burton, 2011), which appear as a common aspiration across the waste → zero waste transition spectrum, but which have yet to be fully explored, or realised (Hannon & Zaman, 2018; Seadon, 2010)…" (Hannon, 2020, p. 5).

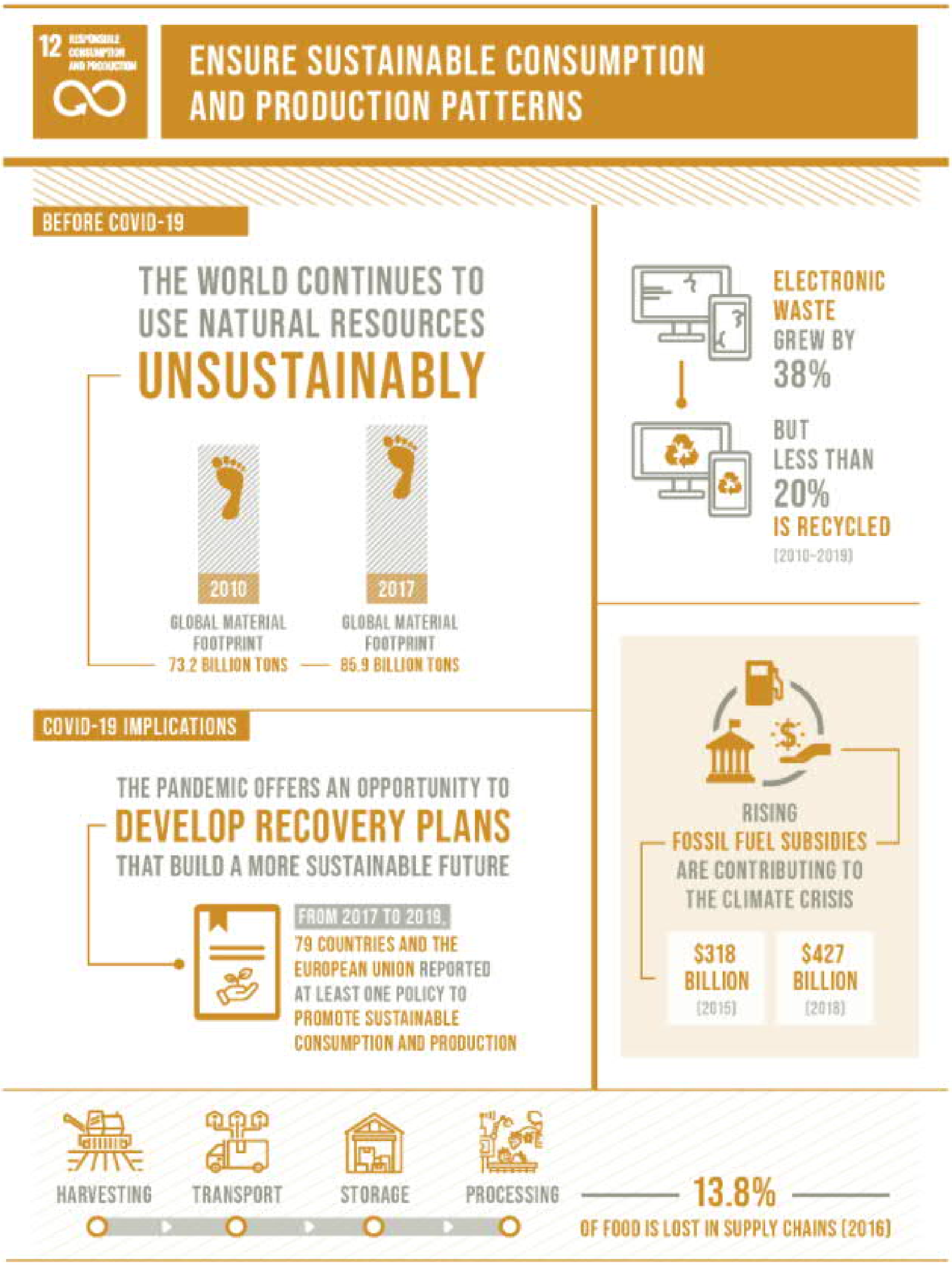
The MZWM ꝏ infinity–continuum model embodies the positive integration of many diverse strands of disciplinary knowledge, theory, and practice, arising from, for example, "… economists, designers, engineers/technologists, producers/retailers/marketers, politicians, business-people, development practitioners and natural and social scientists and environmental activists and consumers. All of whom are necessary contributors in the converging debate, research and practice underwriting the potential for, further progress along the waste → zero waste transition spectrum (Hannon & Zaman, 2018; Zaman, 2015)…" (Hannon, 2020, p. 25).

Without discarding the acuity and clarity conveyed in the hierarchy concept, the MZWM ꝏ infinity–continuum model characterises the flexibility, pluralism, and equivalence among the many policy/programme elements necessary to generate the types and trajectory of change necessary to address the issue of waste. The MZWM ꝏ infinity–continuum model illustrates a clear departure from any inference of linearity, and depicts the continual, kinetic, interactive aspiration, ideation, and innovation required to dissolve inertia, deconstruct barriers to progress, and catalyse the diverse and diffused whole of economy (i.e., upstream & downstream) change.

Waste is a not a neutral space or accidental outcome, it is a deliberate social construction, originally designed to enhance and underwrite economic development (McDonough & Braungart, 2002; Porritt, 2007). Waste and the issues associated with waste management result from a deeply embedded normalisation of disposability, consumerism, and the investments and profit centres of industries that make and manage waste (R Crocker & Lehmann, 2012; Hannon, 2015a). Control of waste and conversely any loss of control and unscripted change are highly contested by the sectors' powerful vested interest groups. This is why the long-envisioned potential for change, articulated in the priorities of the waste hierarchy, have been so delayed and difficult to realise.

These aspiration and potentials appear to be undermined by numerous real-world constraints, for example, contesting against vested commercial imperatives/interests, embedded social conditioning, political dysfunction/inertia, as well as the dissipating effects of theoretical schism and disciplinary chauvinism (Hannon, 2020; Stock & Burton, 2011). The machinations of vested interest contesting for continued control are also significant factors that give rise to the kind of unbalanced criticism and orchestrated misinformation collated in Table 1. The most extreme examples of this critique provided the critical prompt for the research question and hypothesis of this project. The MZWM ꝏ infinity–continuum model has been selected as an illustrative structure to convey the results of this research, because this much better reflects the reality of what is required to overcome barriers and to prosecute the intended shift in paradigm and practice from waste → zero waste and a circular economy. History has shown that the singular, stepwise, linear conceptions of progress and change-making policy/programme sequences have been inadequate. The MZWM ꝏ infinity–continuum model points toward an entirely new pluralised approach, involving interactive, functionally aggerated programme clusters and multiple simultaneous creative, flexible, interoperative actions and learning, all assertively focussed on continual solution seeking and change making.

While all the prior invocation based on the alignment of research finding and new and pre-existing literature offers a sound basis for adopting and arguing for the MZWM ∞ infinity–continuum model, the strongest reinforcement of this selection, is actually the alignment and resonance with the graphic symbolism of the relevant aspect of the United Nations Sustainable Development Goal (UNSDG) framework. Specifically, the MZWM ∞ infinity-continuum model matches the respective icon selected to exemplify the UNSDG goal number *12- Responsible Consumption and Production*. As the following graphics illustrate (Figure 20), the ∞ infinity–continuum symbol has been selected to portray the aspiration and actuation of the aspect of the UN's sustainable development framework, which is the sphere most clearly identified with subject and issues of waste and conversely zero waste in addressing this.



Figures 20: A graphic overview of the UNSDG framework (top) and a graphic outline of the *12- Responsible consumption and production* - goal, which is that which most directly aligned to waste and zero waste management.

Chapter Six: Conclusions:

Introduction: The *Conclusions* Chapter Six is based on four sections which overview the research project and outline the set of conclusions which are justified by the research findings (Sections 6.1 and 6.2). The limitations of this research and the future research opportunities building on this work are then examined (Sections 6.3 and 6.4). This research described in this thesis produced two integrated frameworks of results that combine to fulfil the research objectives. The first framework of results was derived from work undertaken in the original literature review and are reported via a key point summary, Section 4.1 and discussed Sections 5.1 – 5.3. These findings were initially translated into a set of publications from which excepts are selected and woven as content into the *Introduction, Literature review, Background / Context and Methodology* chapters. As expected, these formative thesis chapters established the problem statement, research objectives, question, and hypothesis, and, importantly, outlined the expansive and detailed approach taken in designing a methodology that addresses these. The annotation for this specific mixed methods content analysis is: MMR – HCA – T-MZWM quant + QUAL(quant).

The second framework of results (discussed Sections 5.4 – 5.8) represent a more conventional methodology derived set of findings which make up the remainder *Results* chapter, reported as:

- the series of explorative quantitative analysis (Sections 4.2.1 to 4.2.8);
- three selected excerpts of full written QUAL(quant) narrative results (Sections 4.3.2 to 4.3.4 with the remainder conveyed as Appendix 11);
- a series of final graphic summaries, namely: the proposed MZWM, a 16R zero waste hierarchy, the ∞ infinity–continuum model for illustrating the MZWM; and then a further synthesised expanded and explicated version of the ∞ infinity–continuum MZWM model (respectively Sections 4.4 to 4.7).

Both frameworks of results converge in this thesis and are conceptualised and compiled as a single, holistic research finding in the *Results* chapter and are thereafter discussed as such, in the *Discussion and Conclusions* chapters. This total combination of results, now merged into all parts of the thesis structure, have achieved all of research objectives set for this PhD project. Namely: 1- Contributed to a more unified contemporary understanding of the zero waste movement and how this interrelates with other sustainable waste/resource management disciplines/movements; 2- Evaluated the critique of zero relative to the opportunity the concept theory and practice represent to address waste issues; 3- Developed a new way of understanding (inter) disciplinarity of (zero) waste management, which sets a platform to improve the employment of interdisciplinary research training and practice to generate innovation and progress; 4- Examined New Zealand's recent (zero) waste management experiences as a real-world context for this research. The 5th and final research objective correlates directly with the research question and hypothesis and has been addressed through implementing the mixed-methods content analysis of a selection of authoritative municipal zero waste literature that has enabled the confirmation and explanation of a municipal zero waste methodology (MZWM).

6.1. Overview of Research Findings:

As a precursor to outlining the conclusions justified by these results, the following paragraphs provide a brief overview of how elements of the result are integrated and build across the sequence of thesis chapters. The current published outcomes of this research contribute an integrated series of information and arguments about the phenomenon of zero waste in academic literature. When combined with intended future articles on further results of this research, these results have addressed the most extreme misinformation and unfounded critique of zero waste. Left unaddressed, this critique casts a shroud of misunderstanding over the entire zero waste movement, which has, in contrast to negative aspersions, demonstrated a hugely positive potential to generate new ideas, initiatives, and innovation in addressing waste issues. Zero waste is a heterogenous community of practice inclusive of the original industry / commercial pioneers, the global proliferation of individual/household/family initiatives and the work of activist/NGO/community-based and municipal-town/city practitioners. This collective effort both confronts and responds to the crisis of waste and demonstrates a growing track-record of success and excellence through practices derived from the alternative zero waste world-view.

One of the key insights explored in the original literature review was to canvas the critique of zero waste (Table 1). The lack of balance and extremity exposed in this exercise, in particular the claims that zero waste is a super-mega project with no plan/blueprint that is variously a chronic failure, impossible and doomed (Clough, 2007; Krausz, 2011, 2013a; Premalatha et al., 2013) shaped the direction and approach adopted in this research. Examining the validity of this negative and inflammatory rhetoric appeared as the most critical research question exposed in the review of the state of knowledge in this work area. Consequently, the research objectives were framed in developing the evidence base for communicating a better understanding of zero waste and the research hypothesis focussed specifically on resolving debate about the existence and substance of a municipal zero waste methodology (MZWM).

Transcribing some of the key outcomes of the publications into *the Introduction and Literature review* chapters sought first to demonstrate the expected level of comprehension of and necessary contribution to the state of science in this work-area. Secondly and importantly, there was a corrective theme running through this body of work. The matrix of information/arguments now added to the scientific discourse of zero waste (ref. summary Table 17, Appendix 2) by this research provides a degree of rebuttal to some of the most erroneous misinformation, which for probity's sake needed to be challenged.

The *Background/Context* chapter builds on this contribution by detailing the New Zealand case study setting, which illustrates the real-world consequence of allowing a negative and erroneous view of zero waste to be constructed via the lobbying of vested interest groups. Examining New Zealand's political ecology relative to assertions of policy failure, capture and actual (zero) waste management performance[94] provides a pragmatic grounding that evidences and amplifies the value proposition of this research. This completed research thesis now counterposes the negation of zero waste with a

[94] The report utilises the framing of the 'Changing Behaviour: Economic Instruments and the Management of Waste' report (PCE, 2006) and draws on a focal period of 1999–2017, which involved two counterposed political cycles of collation government.

positive, evidence-based alternative – and has successfully tested and elaborated the hypothesised existence and efficacy of MZWM.

In addition, the *Background/Context* chapter contributes to *general* waste management discourse by evidencing how the significant complexity and numerous barriers to progress in addressing waste issues are being approached with a limited, outmoded, and unresolved conception of the complete (inter)disciplinary requirement (Hannon, 2020). Following the *Introduction and Literature review* chapter, which details how the entire sphere of waste and waste management is typified by crisis and failure, this finding offers a reality check and degree of explanation about why claims of failure and negation of MZWM exist. Contextualising and deconstructing these claims is an inverse mechanism aligned to supporting the critical fifth and final research objective, which was to prove the research hypothesis and to establish and explicate a MZWM.

The final background task undertaken in setting a contextual basis for this research was to provide evidence of an extensive and interpretable, municipal convention that can be considered established across (zero) waste management literature, theory, and practice. This municipal framing and terminology encompass a spectrum of geographic scopes, types of institutions and jurisdictional spheres of responsibility, socio-economic scenarios, materiality / mass flows and legislative/regulatory functions. Based on this focussed review and having specifically examined the municipal as an aspect the broader community of zero waste practice, it is justifiable to assert that this framing is a viable academic/research construct.

The specific design of research methodology was developed through a focussed three-stage review that began by generally examining policy analysis in both waste and zero management research. These first two review stages enabled the identification of content analysis as the methodology most fit for purpose for testing the MZWM hypothesis. The final focussed review of how content analysis was employed in the (zero) waste management research provided the specific basis for the reported methodology design (Hannon, 2022 in submission), which is summarised in the graphic illustration Figure 7 (Section 3.5). Alongside drawing methodological review / design content from the cited draft article and making the case for a mixed methods approach, the methodology chapter also outlined the implementation procedure of the methodology that was finalised and annotated as MMR HCA-T-MZWM quant + QUAL(quant). The choice of a mixed-methods format was based both on the reality that the data (aka content in the selected sources) were made up of empirical, written text, graphic elements, and photographic images (i.e., both quantitative and qualitative) and the recognition that, given the research objective and context, MMR provides the best opportunity of developing the most complete and richly informed result.

The Results chapter reports the second synergetic framework of results, i.e., the main body to results derived from implementing the methodology to answer the research question. As per the described concurrent mixed-methods approach, a sequence of seven interrelated findings from quantitative analysis are outlined (*quant* +...) are outlined. The results chapter then reflects the transition into the substantive, qualitative aspects of the content analysis that are reported in a hybrid, written narrative format that includes embedded empirical elements, i.e., (QUAL)quant. Because the scale of data, this raw written narrative *QUAL(quant)*, results are presented through three demonstrative excerpts, with the remainder (sans excerpts) outlined in Appendix 11. The project also illustrates an important attribute of mixed-methods content analysis in that the abductive back and forth reasoning reflection and iterative revision that occurred across all phases of the research procedure (i.e., before and then in NVivo and in and out of MS EXCEL) also yielded fully convergent *quant + QUAL(quant)* graphic summary illustrations of the final result. These illustrations are the proposed final MZWM schematic (Figure 11), the 16R zero waste hierarchy (Figure 13), the ∞ infinity–continuum MZWM model (Figure 14), and finally a further synthesised, expanded, and explicated version of the ∞ infinity–continuum MZWM (Figure 15).

As has been explained, the culminating series of tables, figures, written narrative, and summary graphic results, employ various mixed combinations of numeric/text as graphic devices (annotations, acronyms, supplementary figures / symbols, colour coding, bordered boxes, link bars, clustering, ordering/hierarchies/numbering and visual arrangements) in seeking the best means of conveying the rich field of meaning inferable from these data. While this combination of methodology and results can be considered quite distinctive, it can be expected that, in answering this specific question and identifying and variously explaining and illustrating the MZWM, this result is rigorous and replicable. It is argued that if the described research method was repeated independently by different researchers, the same generic findings would emerge and form the basis of the same generic conclusions (Bryman, 2012).

Correlated with the sequencing of the *Results* chapter and the conception of MMR CA as both an evolutionary process and an evolved end-point, the *Discussion* chapter examines each element of the findings as staging in a combined completed holistic result. However, as discussed, this involves an integration of both a framework of published findings now threaded as excerpts into the narrative of the thesis (addressing research objectives 1-4) and a framework of MMR CA derived findings, directly focussed on addressing the research hypothesis (and research objective 5). The meaning of the results is discussed relative to relevant research, the previously developed background and contextual considerations, and the landscape of current research findings. As has been discussed in reference to the already completed aspects of the research project's publication strategy [and as demonstrated in the inclusion of draft articles: 1- examining conventions around the term *municipal* (Appendix 3) and 2- exploring the implications of the 16R zero waste hierarchy (Appendix 12)], future publications are intended.

6.2. Research Findings → Research Conclusions:

So, based on the outlined research structure, methodology, and results, it can be concluded that the assertion that there is no *plan/blueprint/methodology* for implementing zero waste in the most critical and challenging municipal context is incorrect. The proposed MZWM developed on the basis of the described MMR HCA-T-MZWM quant + QUAL(quant) research methodology, which analysed a reputable sample of zero waste policy/programme literature, comfortably proves the research hypothesis. The related assertion of the *impossibility/chronic failure/doom* of MZWM now has a substantial rebuttal. In collating and drawing together all the key points and strands of argument outworked through the associated publications, in Table 17 (Appendix 2), this thesis joins with the growing body of zero waste literature that is presenting a better informed and more balanced view. It can be further concluded from this research that:

- The term *chronic failure* is now widely and more appropriately associated with the baseline status quo, which is a manifestation of conventional/traditional waste management theory and practice and the powerful vested interests who profit from *making and managing* waste. By default, through omission and active commission (now exposed as a well-established, globalised tool-kit of tactics and lobbying), these vested interest groups gain from and prolong the linear (aka, *take-make-waste*) socio-economic design setting. From its inception as a post-war/post-depression stimulus, this construction enfranchised the *mythology* of consequence-free consumerism and the *pathology* of the *throw-away society,* by maintaining normative and unobstructed *flame flush and fling* disposal pathways (Porritt, 2007; Seadon, 2010).

- In direct contrast, with the impression conveyed in the complied/reviewed critique of zero waste (Table 1, Section 1.0), a growing body of evidence exists that confirms that innovation, progress, and success are associated with zero waste in industry / commercial, activist / NGO, individual / family /household contexts, and importantly as well - municipal contexts. This comment does not infer that all critique of zero waste is wrong or malign. Aside from the most extreme critique that might arise from, for example, an antagonised contrarian worldview, flawed or deliberately manipulative research funded by partisan interests (i.e., for example that co-opted to perpetuate climate change denial), most criticism performs an essential peer review/quality assurance function within scientific and public discourse. However, the review of the critique zero waste undertaken in this research, illustrates that some criticism is misinformed and wrong. One of the objectives of this thesis has been to join with other authors in countering this overly negative bias and to contribute to building a more balanced and constructive discourse on zero waste, based on the reality of what is being achieved by this heterogenous global community of practice (Hannon, 2015a).

- Having examined the real-world context of New Zealand (zero) waste management performance of over a two-decade period, it is possible to conclude that rather than zero waste being a *chronic impossibility or failure*, in this case, setting poor performance and regression correlate with abandoning an established zero waste policy and programme. New Zealand's polarised zero waste story provided a reality check to the ideology that free-markets fix their own problems. New Zealand's deconstruction and replacement of zero waste with a less assertive, more free-market policy setting resulted in less progress and a bigger waste problem. The lesson from New Zealand's zero waste story is that addressing the super-wicked syndrome of waste (Krausz, 2012) requires recognising, understanding, and confronting the problem through community-based environmental educations, utilising systematic and pragmatic goals and targets to create aspirational, genuine, and assertive leadership and well-designed, market-based economic / social instruments and legislative / regulatory interventions and incentives (Hannon, 2018). The learning and Illustration derived from the New Zealand case setting is particularly relevant because some of the research issuing the most questionable critique of zero waste was based here and included Christchurch as a municipal case study (Krausz, 2012). Additionally, these questionable findings were widely reported in the New Zealand media and conceivably this played a role in catalysing the policy shift away from zero waste.

The element of critique of zero waste, i.e., that in a municipal context it represents an unacknowledged, super-mega project for which there is no accompanying, sufficiently comprehensive, and plausible blueprint for implementation , (Krausz, 2012) was centrally addressed in the formation of the research question and hypothesis of this project. This research proves its contrary hypothesis and has established and substantially described a MZWM. Interestingly, the extent and detail of this now proposed MZWM (blueprint / plan) appears commensurate with the asserted super-mega, super-wicked attribute of the waste crisis (Krausz, 2011, 2012). The written quant + QUAL(quant) narrative result, at >60 pages / >48,000 words, which has then given rise to four summary tabular / graphic illustrations and associated discussion, represent a really substantial knowledge-base of municipal zero waste methodology.

It is also worth further noting that the extensive, detailed, and yet comprehensible mixture of data forming the MZWM result, was derived from just three selected sources, as this demonstrates the interrogative power of the content analysis. Also, because the comprehension and data cannot be conjured out of what does not already exist, this result demonstrates the depth of knowledge and experience represented in zero waste's advocacy and guidance documents. The written and graphic expression of MZWM which has been generated by implementing this specifically designed research methodology shows that campaigns for zero waste in a municipal setting are not deceiving and rallying people to an impossible or fraudulent cause with no blueprint or plan and hence pre-destined for failure. In contrast, zero waste offers a detailed, pragmatic, and (relative to the status quo) cost-effective municipal methodology that is grounded in successful real-world practice addressing waste issues.

Given the acute polarisation between the opposing pro vs contra perspectives on zero waste, it seems unlikely they can ever be reconciled. The worldview of those who profit from making and managing waste resists change (often despite PR to the contrary), whereas a zero waste worldview seeks to disrupt the status quo, maximise the trajectory of change, and progress by promoting the most assertive regime of policy instruments and interventions aiming to conserve and cycle resources, avoid pollution, address climate change, and actualise sustainable development (Hannon, 2015b; Zaman, 2015). It is interesting to note that seminal and, later, theoretical and practitioner, and industry and community/activist zero waste commentators have consistently articulated the movement's exorbitant scope and hyper-aspiration in seeking transformational socio-economic redesign (Anthony, 2001; Knapp, 1981; S. Lehmann, 2011a, 2011b; Liss, 1997, 2001; Lombardi, 2001; Murray, 1999, 2002; Palmer, 2004; Platt et al., 2008; Snow & Dickinson, 2001, 2003; I. D. Williams, 2013).

It is also useful to examine perceptions formed in apparent reaction to this superlative aspiration and optimism for environmental progress. The concept of zero waste as a policy framing for addressing waste issues was once considered radical and unrealistic; however, today even the most mainstream international waste organisations have in various ways co-opted this language. What zero waste has for decades argued, i.e., that waste issues are an extreme, urgent, globalised public and environmental health crisis, which requires an immediate comprehensive internationalised response, is now broadly acknowledged (Hannon & Zaman, 2018; Mavropoulos et al., 2017; Mavropoulos et al., 2015).

The environmental and social consequences of mounting anthropogenic failures to manage waste are most acute in the world's mega-cities (Abarca Guerrero et al., 2012; Mavropoulos, 2010a; UN-Habitat, 2010), resulting in some of the most polluted and poverty stricken places on Earth (Mavropoulos et al., 2017). However, alongside any local manifestation of problem, the combined, interrelated aquatic and atmospheric dimensions of the impact of terrestrial waste issues, are now recognisable across the entire global biosphere (Hodzic et al., 2012; Moore, 2008; Ryan et al., 2009; Thompson, 2014; Wiedinmyer et al., 2014). At the conclusion of this research, it is possible to argue that it is wrong and inappropriate to associate the negative and inflammatory descriptors, such as, doom and chronic failure, with zero waste (or the other sustainability and circular economy-framed movements responding to waste issues). Ownership and responsibility for today's waste issues belongs squarely with the powerful vested interests that preside over conventional waste management theory and practice. Any attributable blame resides with those agencies that make and manage waste, rather than environmental movements such as zero waste, which raise the alarm and are actually relatively successful in responding to the issue.

In conclusion, while this statement may today seem obvious, the tirade of misinformation and criticism directed at zero waste in the New Zealand context in the subject period (Hannon, 2018) appeared to blur this common-sense perspective. The anti-zero waste campaign served to entrench the status quo and under-mined the opportunity for progress that zero waste had represented (Blumhardt, 2018; Hannon, 2018). The net result of the campaign that systematically denigrated and then displaced zero waste policy was that today New Zealand is now rated as amongst the worst wasters in the OECD (Hannon, 2018). Concerningly, rather than being exposed and chastened by the ongoing realisation of the growing acuity and urgency of global waste issues, these same vested interest groups making and managing waste, still consistently utilise delaying/delimiting tactics and evoke the cause of compromise and incrementalism (Blumhardt, 2018; R Crocker & Lehmann, 2012; Hannon, 2018).

It might be argued that the zero waste movement's acute strategic position-setting accumulates so much controversy and detriment that is by degrees self-defeating. However, it is salient to observe that despite the obvious challenges, and in the face of considerable ongoing opposition, the global zero waste community has, in repeated gatherings/dialogues, deliberately chosen to maintain high aspirations and an uncompromised definition. It can be concluded that the zero waste movement appears to select a uniquely confrontational identity and controversial advocacy role within the waste → zero waste transition spectrum (Hannon, 2020). A linked observation is that, despite any accrued detriment, as a grass-roots countercultural movement, operating for the most part on the economic periphery and outside the dominant modes of governing (which are still firmly adhere to the paradigm of disposal), zero waste can be considered relatively successful. Despite intense competition from vested interests, exercising controlling influence over material flows, and the flux of media ideas and policy development (Hannon & Zaman, 2018; Pollans, 2017; Silva et al., 2016), the zero waste movement's levels of achievement can be considered extraordinary.

Highlighted in the results of this research, this extensive body of international zero waste case studies profile best practice and demonstrate that significant environmental and social innovation and progress is possible (Pietzsch et al., 2017; ZeroWIN, accessed 2013). In conclusion, it is argued that the zero waste movement's growing track record (namely, progressing towards stated goals in relatively short timeframes[95]) makes this a critical sphere of activity (Hannon, 2018; Lombardi & Bailey, 2015; Zaman & Swapan, 2016) for mitigating climate change, implementing the UNSDGs, and accelerating a circular economy (Hannon & Zaman, 2018; Hoornweg et al., 2012; ISWA, 2009; UN-Habitat, 2010). The fact that these achievements have been derived in the face of such acute misinformation and opposition, makes the emerging achievements and experience of zero waste practitioners all the more interesting and valuable.

We currently do not yet know what individual or combination initiatives may catalyse the requisite breakthroughs and wholesale environmental progress required to address waste issues globally. In

[95] Current zero waste programme design advice is framed in the aim of achieving 90% diversion of waste to landfill (without incineration) targeted in a 10 year timeframe (Lombardi & Bailey, 2015).

particular, the New Zealand zero waste story suggests treating with caution those voices seeking to dissuade and cull the biodiversity in our mix of approaches to community and industry engagement in the journey towards zero waste and a sustainable circular economy (Hannon et al., 2018). Encouragingly, and possibly inevitably, the passage of time and accumulated data eventually exposed the failures and regression in New Zealand's performance in minimising and managing waste (Hannon, 2018). Today, the tides in New Zealand's political of political ecology appear to have us back on a policy and programme trajectory based in scientific evidence and international best practice (Hannon, 2022 in submission). However, the one critical concluding messaged of this research must be that it is not the various zero waste blueprint/plans/methodologies that are failures – it is that we invariably fail to overcome the orchestrated opposition and have consistently failed to implement these plans. International cases studies now confirm that wherever various zero waste blueprint / plans / methodologies are implemented and hence provided with the opportunity to be realised, the results speak for themselves.[96]

Numerous conclusions are supported by the combination of the proposed final MZWM schematic (Figure 11), the 16R zero waste hierarchy (Figure 13), the ꝏ infinity–continuum MZWM model (Figure 14), and the further synthesised, expanded, and explicated version of the ꝏ infinity–continuum MZWM (Figure 15). In providing an illustration of the proposed MZWM, these graphic summaries demonstrate that the significant extent, detail, and complexity of the mixed quantitative and qualitative results of this research (respectively outlined and discussed in Sections 4.2 and 4.3 and 5.4 and 5.5) can be synthesised into a simple, yet also complete, authentic, and meaningful portrayal of the much larger holistic result (Sections 4.4 to 4.7; discussed Sections 5.6 to 5.8).

This extension of outcome is an important feature of MMR-CA as a methodology and MZWM as a finding. The importance arises in that the waste → zero waste subject area is large, complex, often poorly understood, and that communicating the key essentials to a busy, sometime disinterested and issue-fatigued public is very challenging. While zero waste approaches can be shown to be scientific, practically successful, measurable/evidenced, a good economic investment, socially / culturally beneficial, framed in a continuum of learning and evolution, and democratically popular (Hannon, 2018), communicating this good news story is challenging. Unless the achievability and value proposition of zero waste can be communicated by effective illustration and simple narrative, the genuine opportunity that zero waste represents may be forfeit.

Overall, the zero waste movement remains a relatively marginalised and sometimes disparaged voice seeking to effect change and progress that benefit communities. Overcoming the significant barriers to progress in effecting zero waste's long-envisaged, globalised, transgressive, transdisciplinary, transformational solution-seeking and change-making ideals requires translating and communicating extensive detail and complexity into → a simple, optimistic, understandable, and inspirational format. In this endeavour, powerful symbols and clear, meaning-laden graphic illustration are essential. The culmination of designing and implementing the specific MMR HCA-T-MZWM quant + QUAL(quant) research methodology is the proposal of the ꝏ infinity–continuum model of MZWM as a final result. This MZWM model is expressed in both a summary and expanded/explicated format (respectively Figures 14 and 15). The symbolism of this model provides the best overall representation of the characteristics of zero waste that are reflected in scientific literature and are now further recompiled

[96] For example, https://zerowasteeurope.eu/publications_types/case-studies/

and supplemented through the publication strategy of this research (Hannon, 2020, 2022 in submission; Hannon & Zaman, 2018; Hannon et al., 2018).[97]

In conclusion, the ꝏ infinity–continuum model of MZWM reflects the disruptive hyper-aspiration of seeking to maximise the trajectory of progress in transitioning from an unsustainable into a sustainable circular economy, based on a closed-loop material eco-system. Accordingly, to drive change beyond the thresholds of known possibility, the MZWM embodies and illustrates a dynamic arrangement of the most assertive regime of market-based policy instruments, economic incentives, and legislative/regulatory interventions.

Zero waste has been interpreted as a big picture ideal, a creative milieu, a mutable stylistic for quantum innovation, and a continuum of revolutionary insight, innovation, and aspiration. The ꝏ infinity–continuum model of MZWM articulates these characteristics and enshrines the goal of forever eliminating, rather than forever accepting, and then managing waste. The ꝏ infinity–continuum model of MZWM reflects both the paradox and tension in presupposing the word waste with the word zero and in this creating the designation of radical envisioning, reimagining and reformation of the status quo. By implication this involves challenges all assumption, re-setting pre-existing power-balances, and revising mechanisms of pejorative and control, and prioritising community perspectives and benefits ahead of private sector / professionalised industry ownership and profit.

However also, the content, arrangement, and implication of the ꝏ infinity–continuum model of MZWM epitomises the attribute of zero waste as a unifying, heterogeneous concept/movement that encompasses a diverse multiplicity of actors, ways, other futures, etc. Centrally, this can be recognised as industrial / commercial, municipal / city and activist / NGO / community sector and individual / household / family practitioners / modes in collaboration across the spectrum from developing to developed socio-economic settings (in particular, empowering the informal/waste-picker sector). The ꝏ infinity–continuum model of MZWM offers insight to how zero waste can be viewed as being in symmetry and synergy with other post-waste movements responding to the global crisis of waste. In addition, this model articulates a distinctive call to action in catalysing a shift from the down-stream/end of pipe pejorative focus / paradigm / practice and investment / infrastructure / services to the largely unrealised, top priorities of the (zero) waste hierarchy (seeking up-stream regenerative (re)design, dematerialising, detoxing, circularising, and upcycling, etc.).

Zero waste recognises that waste is essentially a human-centred, sociological, rather than just a techno-centric issue. Zero waste is cited as being a post-normal sustainable (PNS) technology that embraces the outsider characteristics of learning by doing and doing by learning; as operating in the *zeronautical* future zone of next / yet / other; as being inspired by a sense of transgression, transcending, creative interdisciplinary re-assemblage; and where necessary, circumventing inefficacious disciplinary convention and authority (Elkington, 2012; Enkvist & Klevnas, 2018; Klein, 2014). The ꝏ infinity–continuum MZWM model that emerged as the key, final, encompassing research finding provides the best opportunity to encompass and communicate this spectrum of attributes.

[97] These excerpts are fully referenced to the original authors in the cited publications.

6.3. The limitations of this research

Some of the limitations of this research have been identified and discussed, as this is the point of most clarity and relevance. For example, the quantitative analysis of formal referencing utilised in the selected sources (Section 4.2.3. p. 114) provides insight as to the quality assurance which might be inferred from this formal academic construction where the preceding contribution of key ideas, even words, is acknowledged. In this instance, the analysis was not able to include one of the sources (Lombardi & Bailey, 2015), which did not utilise formal refencing. In effect this limited the scope of analysis by a third, meaning the resulting insights were only drawn from the remaining two sources (Allen et al., 2012; Snow & Dickinson, 2001). This limitation was mitigated through the inclusion of a fourth source (Zaman, 2015), which was a review article from an academic journal that uses formal refencing as part of scientific convention. This inclusion both restored the original scope of analysis and ensured the findings were examined and relativised against a peer-reviewed, quality-assured scientific backdrop.

Another previously discussed minor limitation emerged in the quantitative mapping of evolution in the type and rate of change in the process of development from the coding framework (CF) v final to MZWM v final development (Section 4.2.5. p. 122). In this analysis there was a glitch in the way the *MSWORD review* function and *Copy-leaks* had previously functioned when it came time to retrospectively examine the same document to document metrics (i.e., number text changes, the percentage identical to prior iteration and number of copied words, see Table 11). Other replacement software systems were tried without success; however, the *NAs* recorded in Table 11 did not appear to overly disrupt the pattern of apparent finding.

The last previously discussed limitation (in situ) relates to the quantitative analysis of the secondary *Zero Waste Motive – Argument Formation* data, which had been coded in parallel with the primary MZWM coding framework (Section 4.2.7., p. 128). It was recognised that establishing and according data to this secondary coding framework, opened up new and to a degree, a triangulating perspectives that contributed insight to the structural formation of the MZWM. However, opening up this second major front in the scope of content analysis also involves practical tensions and potential intellectual tangents that pragmatically required delimitation. The design decisions delimiting the scope of the research were subject to debate and the final outcome can be seen as mix of inclusive/explorative and pragmatic reflexes.

The most obvious critique and potential limitation of this research is that only three key sources were selected for content analysis. A related and relevant question is: was the answer to this research hypothesis too obvious and too easy if analysing just three samples provided the result? The decision to limit the coding process to three main sources (plus one further exploring a supplementary perspective) was made first on the basis of sufficiency (what amount of evidence is considered necessary to adequately answer the research question?), and also practically (for this scope of research and timescale, how much data and analysis is functionally manageable?). As the extent and detail of the results derived from undertaking this mixed model content analysis on just the three selected sources, show the three was a justifiable cut-off point. Any more would have been unmanageable and/or required a different methodology.

Another key question around the limitations of this research is, how representative are the three selected sources, relative to the entire group of all possible selectable options (for example, see Table 19 – Appendix 5). A conduit question and/or point of potential critique is: how different would the proposed MZWM be, if it was derived from a different selected group from all other possible sources? Unless the content and composition of all other possible source options are examined (which would require a quite different methodology) it is impossible to know exactly how alike any other resulting proposed MZWM would be. However, the overriding point is that, unless the content of any given other selections is vastly tangential or inferior (remembering other options were screened before selected three on the basis of being representative) it seems likely the research question will still be able to be answered in the affirmative. In simple terms, other versions of a MZWM might be derived, but it seems very likely all would be broadly similar and by simply existing all would similarly confirm the research hypothesis.

Zero waste is a collaboratively developed global phenomenon whose core concepts, definitions, and theory and practices are thoroughly and repeatedly discussed and debated[98] in a sequence of what are termed *dialogues*. The shared origins, acknowledgements, formal references, sources, and types of communication/dissemination, collaboration, authorship and basis of publications, support, campaign, and advocacy networks were all examined in the quantitative analysis undertaken in this research (see Sections 4.2.1 to 4.2.7). It appears that, as with other academic disciplines and industry, community and municipal knowledge spheres/sectors of activity, keynote personalities, thought leaders/commentators and collaborative clusters are apparent within the zero waste movement. So, despite the observed heterogeneity of this global community of practice, because of these normative processes of commonality and convergence, it seems likely that, even if another source option(s) was selected from the group of all other authoritative representative zero waste policy/programme documents/guides, the outcome would ultimately be reasonably similar. Certainly, the overarching answer to the research question of the disputed existence of MZWM will still be affirmative, even if other sources had been selected.

However, any such claims (of existing source representativeness and or around alternative source selections) can be tested by undertaking further research. Utilising the same MMR HCA-T-MZWM quant + QUAL(quant) research methodology in either a replicated or derivative fast indicative format, and drawing on alternative sources (and or newly published future sources) will enable both re-testing the current MZWM and/or revising and contemporising it in future. Recognised this as a future research opportunity, a schematic methodology illustrating how this can be undertaken is offered as Figure 21.

6.4. Where to from here – possible future research?

This research in its current format (the specific research methodology is illustrated as Figure 7) has proven the hypothesis and established a comprehensive MZWM. However, this or any given future MZWM should never be considered as a static finalised entity. A future research opportunity involves extending and extracting a deeper comprehension and contemporising the MZWM as further advances

[98] Ref. https://zwia.org/history-of-zwia/ which as just one main global zero waste affiliation and identity has aside from the many of conferences and workshops has organised series of eight international dialogues.

in knowledge and practices develop. In conclusion, the key future research direction encouraged in this section involves developing a research-led model for, in effect, making the MZWM into a dynamic, adaptive living guide for implementing zero waste in a municipal setting into the future.

In this mode of research the current and then each successive model of MZWM would become a coding framework for a future round of content analysis. Given that the subject of this research was undertaken via a deep-comprehensive analysis of a relatively small sample of sources, the suggested follow-on research format would be to undertake a shallower, faster examination of wider, larger and more diverse groups of sources. This suggested follow-on research format presents as a complementary approach that has the potential to test the alignment and level of confirmation between the current MZWM (which for convivence sake can be called MZWMv1) and ultimately a future new MZWMv2 result, which is iteratively formed via the same basic function of a MMR HCA-T-MZWM quant + QUAL(quant) methodology, albeit in a variety of possible abridged/adapted formats.

Actioning a future version of the basic MMR HCA-T-MZWM quant + QUAL(quant) methodology, which has proved so effective in this context, by examining a wider range of alternative and or, newly published sources as they emerge, would enable the resulting MZWM to remain current as zero waste knowledge and practice further develops (i.e., MZWMv1 → MZWMv2 → MZWMvfuture, etc.). If this research were to be coordinated as part of a wider internationally agreed framework [for example, via the *Nexus for International Zero Waste Academic Collaboration* (NIZAC) (Hannon et al., 2018)] it has the potential to lead to an internationally agreed definitive statement(s) of MZWM. This suggested future mode of future research would provide a systematic and transparent process that would genuinely realise the ideal of the ꝏ infinity–continuum symbolism, as the MZWM would essentially become a fluid, living, learning, and evolving rubric that would remain up to date, encompassing, and cognisant of all ongoing municipal/industry/community publications and contemporary research findings. Figure 21 illustrates a conceptual model[99] for a proposed next steps MMR HCA-T-MZWM quant + QUAL(quant)v2 format that would enable ongoing examination of a broad range of other/new sources.

The proposed future research model would be founded on the experience accrued in this research project and be able to build on, adapt, and refine the research design outlined in Figure 21. This research would be able to begin from the advanced starting point of translating MZWMv1 into a new coding framework and thereby encompassing all the knowledge accrued to date.

[99] This model would: 1- build on and refine the research design outlined in Figures 7 and 8, based on the experience accrued in this research project, 2- commence from the advanced starting point of MZWMv1; and 3- realise the ideal of the ꝏ infinity–continuum symbolism as the MZWMv2 would essentially become a ‘living’, evolving, internationally shared, contemporised, and agreed methodological guidance for Municipal zero waste programmes.

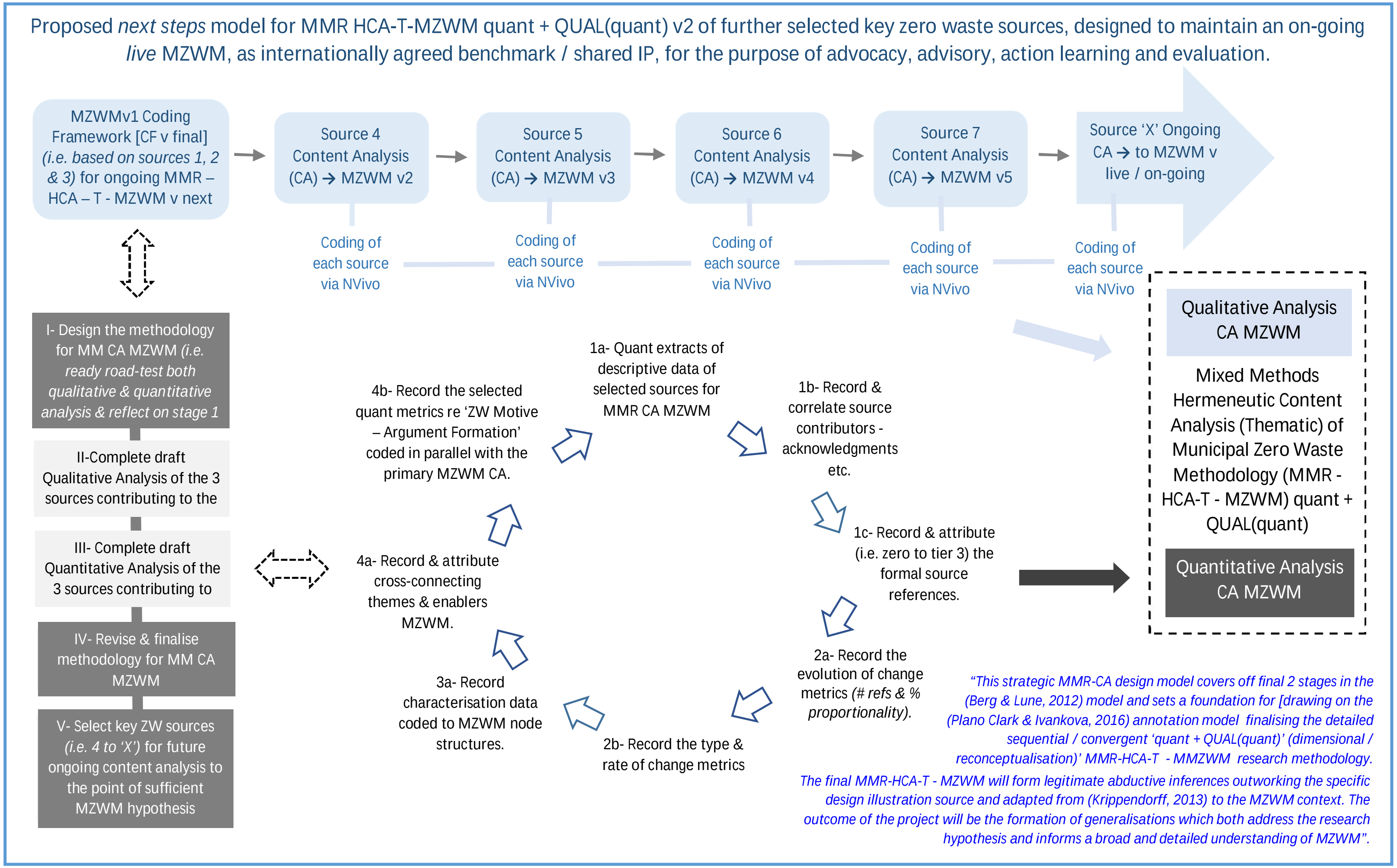


Figure 21: A Proposed next steps MMR HCA-T-MZWM quant + QUAL(quant)v2 format that would enable ongoing examining of a broad range of other/new 'sources' – potentially within a wider internationally agreed NIZAC type framework.

As such, this proposed next steps MMR HCA-T-MZWM quant + QUAL(quant)v2 would enable the international zero waste community to transparently and scientifically maintain a continually evolving and agreed MZWM guidance framework. Once established and agreed, this MZWM can be shared and advocated for via the same series of international *dialogues* as is undertaken for the existing zero waste hierarchy and definition as shared intellectual property of the global zero waste community.

In the same way as it can be argued that the current ∞ infinity–continuum MZWMv1 model is encompassing and reflective of the spectrum of zero waste attributes, the result of a next-steps, future project version of MMR HCA-T-MZWM quant + QUAL(quant) (i.e., annotated *vfuture*) would ensure this is maintained as a research-informed, educational, and public communications format, verifiable through periodic scientific peer review and publication. This presents as a robust opportunity to definitely rebut any ongoing future attempts of vested interest groups seeking to contest, oppose, and undermine the adoption and associated benefit of the zero waste through incorrect and unwarranted critique and or, campaigns of misinformation.

Unfortunately, the New Zealand (zero) waste story shows the efficacy and damage of allowing lobby groups to construct fake news and to spread confusion, fear, and doubt among the general public and government officials. This proposed next-future research opportunity provides an independent, internationally recognised, scientifically credible framework to counter deliberately anti-zero waste, alternative facts as they are curated and spread.

Another important future further research opportunity is illustrated in the rudimentary evaluation rubric of (Table 20, Appendix 6). This table illustrates the first *Proposed zero waste methodological consensus* (i.e., identifying what defines and drives progress towards zero waste), which was the first step in developing a coding framework for this research project. The original development of this table during the scoping phase of this research was also an opportunity to test the idea of measuring and evaluating progress towards a recognised framework of MZWM. Alongside each of the described 5-part, 50 elements of this so-called *zero waste methodological consensus* framework, is a set of respective observations and comments about New Zealand’s then state of development. These data are accompanied by a numeric score that grades the rate of progress as being between 0 and 1. For example, 0.25 would mean that an element of the MZWM was one quarter of the way toward being fully implemented. Alongside the associated commentary, the nett result of this evaluation model is a final total metric, in this case out of 50, that expresses the totality in that given context and time period, of how much of the MZWM has been implemented.

As discussed, establishing this MZWMv1 offers a foundation for a research programme that would maintain a contemporary, internationally recognised MZWM future version. Either now the MZWMv1 or at any given point in the concept of a MZWM *future version*, would provide one of the key requirements for developing and undertaking a formal evaluation process. Evaluation requires a framework of reference against which to measure progress. In this instance, the MZWM *vfuture* would provide the agreed evaluation framework against which the composition and progress in implementing zero waste in any given geographic setting and jurisdictional context could be measured (Burford et al., 2013; Planas, Soler, & Vila, 2014; Uitto, 2014).

Evaluation is a large, complex, and important scientific and practical discipline, shaped by waves of development and reform over many decades and is today increasingly recognised as an institutional norm (Berk, 2011; Jacob, Speer, & Furubo, 2015; Vedung, 2010). There are many types and purposes of evaluation, including often being used to measure the performance of government programmes relative to achieving set goals (T. Gore & Wells, 2009). Evaluation research and practice are cited as continuously (co)evolving, in relation to global trends in research methods in social science, programme evaluation/policy analysis and the growing imperative of evidence-based public policy (Berk, 2011).

Evaluation is employed across many industry, community, and municipal settings, including work areas such as environmental policy (Gysen, Bruyninckx, & Bachus, 2006) and waste management (Anderton et al., 1994; Wegener, 1998), to examine accountabilities, such as the ever present question, are we being effective? Zero waste researchers are already utilising various formats and techniques to evaluate the empirical outcome and costs and benefits of zero waste when implemented at the level of a city (Zaman, 2013; Zaman & Lehmann, 2013), national (Zaman, 2014) and international (Zaman, 2016; Zaman & Swapan, 2016). As a radically alternative and highly contested neologism, zero waste can benefit greatly from implementing all three of the identified goals of evaluation, i.e., to learn, measure, and understand (Berriet-Solliec, Labarthe, & Laurent, 2014). Contemporary modes of evaluation are cited as being particularly suited to, if not the super-mega (Krausz et al., 2013), at least the scale and complexity of the mega-project scenario (Lehtonen, 2014), cited as typical of MZWM. However, commentators also call for continuing efforts to tailor and improve evaluation methodologies to better account for complexity, multiple social-political realities, priorities and agencies (T. Gore & Wells, 2009) and the characteristics of specify environmental the policy area (Gysen et al., 2006).

It is not the intention of this final aspect of the *Conclusion* chapter to venture too far into the sphere of evaluation, comment on existing initiatives, or project advice on possible future research design. In simple terms however, policy/ programme evaluation can be really beneficial and a more defined, clarified, and possibly internationally agreed MZWM provides the foundation for developing a more complete and rigorous evaluation framework for municipal zero waste programmes. The MZWM derived from answering the research question is not proposed as a forever MZWM. Having proved the research hypothesis, this MZWMv1 itself makes the case for considering future further research programmes to continually re-create an ongoing internationally agreed MZWM *vfuture* that can provide the basis for evaluating existing as well as future implementation of zero waste in a municipal setting. Formal programmes evaluating MZWM appear as an important opportunity to keep learning from ongoing experience and to enhance future performance in this critical sphere of environmental management. Zero waste evaluation tools are generally cited as being important for assessing socio-economic and environmental performances, as well as rigorously accounting for the progress of achieving targets and goals – both of which are essential for verifying and communicating the value proposition of zero waste systems (Pietzsch et al., 2017; Zaman, 2015).

Improving all aspects of the evaluation of zero waste would supercharge the potential for generating and modelling innovation and catalysing progress and transition across the entire waste → zero waste management spectrum of activity (Zaman, 2016; Zaman & Swapan, 2016). This research enables us to say with renewed authority that zero waste has a plan, and based on current experience, this plan can be variously (and sometimes spectacularly) successful in catalysing new ideas, initiatives, progress, and even breakthroughs in addressing waste issues. It is widely agreed that breakthrough progress for the global waste crisis is essential to prevent pollution, detox material flows, transition from linear to sustainable circular economy, and achieve the UNSDGs (Ellen MacArthur Foundation, 2013a; Ellen

MacArthur Foundation & World Economic Forum, 2016; Hoornweg et al., 2014; ISWA, 2017b; Mavropoulos, 2010a; Mavropoulos et al., 2015; Pietzsch et al., 2017; Velis et al., 2017; D. C. Wilson, Rodic, et al., 2015a; Zaman & Ahsan, 2020). Many would argue that in this respect we are now well past the point where spurious debate, partisan malpractice, and equivocation are acceptable in respect of critical environmental issues. It is time for clear-sightedness and the best ideas and innovative change makers to be enabled rather undermined. This PhD research has addressed strident questions and critiques around zero waste and specifically presents a definitive MZWM that sets a renewed platform for successfully guiding and evaluating the implementation of zero waste in the critical municipal context.

References:

Abarca Guerrero, L., Maas, G., & Hogland, W. (2012). Solid waste management challenges for cities in developing countries. *Waste Management, 33*, 220-232.

Abdoli, M. A., Rezaei, M., & Hasanian, H. (2016). Integrated solid waste management in megacities. *Global J. Environ. Sci. Manage, 2*(3), 289-298. doi:10.7508/gjesm.2016.03.008

ACT Waste. (1996). No Waste by 2010: A Waste Management Strategy for Canberra. *Australian Capital Territories (ACT) Government Publication*. Retrieved from http://www.tams.act.gov.au/live/Recycling_and_Waste/The_No_Waste_Strategy

ACT Waste. (2004). No Waste by 2010: Turning Waste Into Resources - Action Plan 2004-2007. *Australian Capital Territories (ACT) Government Publication*. Retrieved from http://www.tams.act.gov.au/live/Recycling_and_Waste/The_No_Waste_Strategy

Agamuthu, P. (2017). The 4th Industrial Revolution and waste management. *Waste Management & Research, 35*(10), 997-998. doi:10.1177/0734242X17731419

Agudelo-Vera, C. M., Leduc, W. R. W., Mels, A. R., & Rijnaarts, H. H. M. (2012). Harvesting urban resources towards more resilient cities *Resources, Conservation and Recycling, 64*(July), 3-12. doi:10.1016/j.resconrec.2012.01.014

Aich, A., & Ghosh, S. K. (2019). *Conceptual Framework for Municipal Solid Waste Processing and Disposal System in India*, Singapore.

Ainge, J., & McIver, C. (2011). Rolling out residential SSO collection in Nanaimo Region. *Biocycle*, 29-31.

Allcock, S., Liefting, A., Tsuji, A., & Utley, T. (2010). Product Waste: Who Pays? Extended Producer Responsibility Trends and Case Studies [Report]. 96. Retrieved from www.envision-nz.com

Allen, C., Gokaldas, V., Larracas, A., Ann Minot, L. A., Morin, M., Tangri, N., . . . Walker, B. (2012). On The Road to Zero Waste: Successes and Lessons from around the World. *GAIA*, 1-88. Retrieved from http://www.no-burn.org/

Allesch, A., & Brunner, P., H. (2014). Assessment methods for solid waste management: A literature review. *Waste Management and Research, 32*(6), 461-473. doi:10.1177/0734242X14535653

Amengual, L. (2014). *25 years of waste management in Mallorca, Balearic Islands, Spain: Time to brush up on history*. Paper presented at the Alternatives to incineration and landfills: Zero Waste International Alliance Conference and Dialogue 2014, Nanaimo, Canada.

Anderson, C. (2011). Dealing with zero waste. *MSW Management, June,* 1-5.

Anderson, P., Edwards, J., Garfield, M., Gregory, J., Liss, G., Lombardi, E., & Montague, P. (2001). The impact of waste industry consolidation on recycling. *MSW Management, June*.

Anderson, R. C. (1998). *Mid-course correction. Toward a sustainable enterprise: the Interface model*. Atlanta, U.S.: Peregrinzilla Press.

Anderson, T., & Chapple, S. (2018). Grease or Sand in the Wheels of Democracy? The market for lobbying in New Zealand. *Policy Quarterly, 14*(2), 10-17. Retrieved from https://www.victoria.ac.nz/__data/assets/pdf_file/0007/1500829/Anderson_Chapple.pdf

Anderton, D. L., Anderson, A. B., Rossie, P. H., Oakes, J.-M., Fraser, M. R., Webber, E. W., & Calabrese, E. J. (1994). Hazardous Waste Facilitis "Environmental Equity" Issues in Metropolitan Areas. *Evaluation Review, 18*(2), 123-140.

Anthony, R. (2001). Confessions of a landfill apologist *Recycle Scene*. Retrieved from http://www.richardanthonyassociates.com/articles/landfill.html

Anthony, R. (2004). Getting the job done. *Biocycle, 45*(10), 24.

Arora, S., Rao, P. V. T., & Chakraborthy, D. S. (2000). Use of non-conventional slags for cement making. *Journal of the Institution of Engineers (India): Civil Engineering Division, 81*(2), 61-67.

Ashwood, F. E., Doick, K. J., Atkinson, G. E., & Chenoweth, J. (2014). Under-utilisation of organic wastes during brownfield regeneration to community woodland: Tackling the barriers. *Waste Management & Research, 32*(1), 49-51. doi:10.1177/0734242X13512717

Asian Development Bank. (2017). *Integrated solid waste management for local government: A practical guide* Retrieved from Manila, Philippines: www.adb.org

Auckland Council, & WasteMINZ. (2017). *Cost Benefit Analysis of a Container Deposit Scheme: Summary Report and FAQs*. Retrieved from Auckland: http://www.wasteminz.org.nz/wp-content/uploads/2017/12/Container-Deposit-Scheme-Summary-Report-Final.pdf

AUMA. (2012). *Zero Waste Backgrounder: Transforming Municipalities from Waste Managers to Resource Managers* Retrieved from https://www.abmunis.ca/sites/default/files/Advocacy/Programs_Initiatives/Toward_Zero_Waste/78149_zero_waste_backgrounder-july_4th.pdf

Ayres, R. U. (1997). *Toward Zero Emissions: Is There a Feasible Path?* Retrieved from Fontainebleau, France: https://flora.insead.edu/fichiersti_wp/inseadwp1997/97-80.pdf

Ayres, R. U., & Ayres, L. W. (Eds.). (2002). *A Handbook of Industrial Ecology* Cheltenham, UK: Edward Elgar Publishing Company.

Badaracco, C., & Weitzel, T. (2002). Teaching zero waste. *Waste Age, 33*(5), 30-32.

Baird, S. (2004). A manifesto for zero waste in Scotland. Retrieved from www.scottishgreens.org.uk/sendfile.php?id=4226 also see <http://www.scotland.gov.uk/News/Releases/2008/01/24145725>

Bajgier, S. M., Maragah, A., Saccucci, M., Verzilli, A., & Prybutok, V. R. (1991). Introducing students to community operations research by using a city neighbourhood as a living laboratory. *Operations Research, 39*(5), 701-709.

Ballon, P. D., & Delaere, S. (2005). *Test and experimentation platforms for broadband innovation: Examining European practice.* Paper presented at the 16th European Regional Conference by the International Telecommunications Society (ITS), Porto, Portugal.

Bammidi, V. S., Rao, A., & Sharma, P. (2009). *Zero-gen campuses development in India - A sustainable promise made to the society.* Paper presented at the Society of Petroleum Engineers - International Petroleum Technology Conference 2009, IPTC 2009, Doha, Qatar.

Bartels-Von Varnbüler, C., Kesseler, K., Peters, M., Pottie, P., Schmöle, P., & Stahl, L. (2003). *"Zero waste-zero cost" concept for integrated steel mills.* Paper presented at the 58th Congresso Anual da ABM (ASSociacao Brasileira de Metalurgia e Materiais) Rio De Janeiro, Brazil.

Bartl, A. (2011). Barriers towards achieving a zero waste society. *Waste Management, 31*(11), 2369-2370.

Bartl, A. (2013). Barriers towards achieving a zero waste. *Waste Management, 31*, 2369-2370.

Bartl, A. (2014a). Editorial: Ways and entanglement of the waste hierarchy. *Waste Management, 34*(1), 1-2.

Bartl, A. (2014b). Moving from recycling to waste prevention: A review of barriers and enablers. *Waste Management & Research, 32*(9), 3-18.

Batty, M., Axhausen, K. W., Giannotti, F., Pozdnoukhov, A., Bazzani, A., Wachowicz, M., . . . Portugali, Y. (2012). Smart cities of the future. *Eur. Phys. J. Special Topics, 214*, 481-518. doi:10.1140/epjst/e2012-01703-3

Bazeley, P. (2009a). Analysing Qualitative Data: More Than 'Identifying Themes'. *Malaysian Journal of Qualitative Research, 2*(2), 6-22.

Bazeley, P. (2009b). Integrating Data Analyses in Mixed Methods Research. *Journal of Mixed Methods Research, 3*(3), 203-207.

Bazeley, P. (2010). Computer assisted integration of mixed methods data and analysis. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods research for the social and behavioral sciences* (2nd ed.). Thousand Oaks, CA: SAGE.

Bazeley, P. (2013). *Qualitative data analysis: Practical strategies*. Thousand Oaks, CA: Sage.

Bazeley, P., & Jackson, K. (2013). *Qualitative data analysis with NVivo*. Thousand Oaks: Sage Publications Limited.

Bel, G., Fageda, X., & Warner, M. E. (2010). Is Private Production of Public Services Cheaper Than Public Production? A Meta-Regression Analysis of Solid Waste and Water Services. *Journal of Policy Analysis and Management, 29*(3), 553-577. doi:10.1002/pam.20509

Benyus, J. (1997). *Biomimicry: Innovation Inspired by Nature*. New York: Harper Collins Publishers Inc.

Berg, B. L., & Lune, H. (2012). An Introduction to Content Analysis. In *Qualitative Research Method for Social Sciences* (8th ed.). Boston: Pearson.
Bergman, M. M. (2008). The straw men of the qualitative and quantitative divide. In M. M. Bergman (Ed.), *Advances in mixed methods research: Theories and applications*. Thousand Oaks, CA: SAGE.
Bergman, M. M. (2010). Hermeneutic content analysis: Textual and audiovisual analyses within a mixed methods framework. In A. Tashakkori & C. Teddlie (Eds.), *SAGE handbook of mixed methods in social and behavioral research* (2nd ed.). Thousand Oaks, CA: SAGE.
Bergvall-Kåreborn, B., Ihlström Eriksson, C., Ståhlbröst, A., & Svensson, J. (2009). *A Milieu for Innovation – Defining Living Labs*. Paper presented at the 2nd ISPIM Innovation.
Berk, R. (2011). Evidence-based versus junk-based evaluation research: Some lessons from 35 years of the Evaluation Review. *Evaluation Review, 35*(3), 191-203. doi:10.1177/0193841X11419281
Bernard, S. *Three essays on environmental economics: Remanufacturing, Movements of Waste, and Democracy.* (Ph.D.). University of Ottawa (Canada), Canada. Retrieved from http://proquest.umi.com/pqdweb?did=2368427481&Fmt=7&clientId=13636&RQT=309&VName=PQD
Berriet-Solliec, M., Labarthe, P., & Laurent, C. (2014). Goals of evaluation and types of evidence. *Evaluation, 20*(2), 195-213. doi:10.1177/1356389014529836
Beynaghi, A., Trencher, G., Moztarzadeh, F., Mozafari, M., Maknoon, R., & Leal Filho, W. (2016). Future sustainability scenarios for universities: moving beyond the United Nations Decade of Education for Sustainable Development. *Journal of Cleaner Production, 112*, 3464-3478.
Björklund, A., Bjuggren, C., Dalemo, M., & Sonesson, Y. (1999). Planning Biodegradable Waste Management in Stockholm. *Journal of Industrial Ecology, 3*(4), 43-58.
Blick, G., & Comendant, C. (2018). *A circular economy for Auckland - scoping the potential economic benefits*. Retrieved from SBN & Sapere Research Group Ltd, Auckland, NZ: http://www.srgexpert.com/wp-content/uploads/2018/05/A-circular-economy-for-Auckland-9-May-2018.pdf
Blumhardt, H. (2018). Trashing Waste: Unlocking the Wasted Potential of New Zealand's Waste Minimisation Act 2008. *Policy Quarterly, 14*(4), 13-26.
Bogdan, R. C., & Biklen, S. K. (2003). *Qualitative research for education* (4th ed.). Boston. MA: Allyn and Bacon.
Bos, W., & Tarnai, C. (1999). Content analysis in empirical social research. Part I. *International Journal of Educational Research, 31*, 659-671.
Boucher, J., & Friot, D. (2017). *Primary Microplastics in the Oceans: A Global Evaluation of Sources*. Retrieved from International Union for Conservation of Nature and Natural Resources (IUCN). Gland, Switzerland www.iucn.org/resources/publications
Bourg, D., & Erkman, S. (Eds.). (2003). *Perspectives on industrial ecology*. Sheffield UK: Greenleaf Publishing Ltd.
Bovea, M. D., & Powell, J. C. (2016). Developments in life cycle assessment applied to evaluate the environmental performance of construction and demolition wastes. *Waste Management, 50*, 151-172. doi:http://dx.doi.org/10.1016/j.wasman.2016.01.036
Boyle, G., & Green, R. (2012). *Waste Management and Minimisation Plan 2012*. Retrieved from Palmerston North, NZ:
Brandon, P. (2012). Preface - Zero waste: Towards a vision of a new model for humankind. In R. Crocker & S. Lehmann (Eds.), *Designing for zero waste: Consumption, technologies and the built environment*. London: Earthscan.
Bryman, A. (2006). Integrating quantitative and qualitative research: How is it done? *Qualitative research, 6*(1), 97-113.
Bryman, A. (2007). Barriers to integrating qualitative and quantitative research. *Journal of Mixed Methods Research, 1*(1), 8-22.
Bryman, A. (2012). *Social Research Methods* (4th ed.). Oxford: Oxford University Press.

Bufoni, A. L., Oliveira, L. B., & Rosa, L. P. (2015). The financial attractiveness assessment of large waste management projects registered as clean development mechanism. *Waste Management, 43*, 497-508. doi:http://dx.doi.org/10.1016/j.wasman.2015.06.030
Bulls, K. (2009). A zero-emissions city in the desert. *Technology Review, 112*(2), 56-63.
Burford, G., Velasco, I., Janouskova, S., Zahradnik, M., Hak, T., Podger, D., . . . Harder, M. K. (2013). Field trials of a novel toolkit for evaluating 'intangible' values-related dimensions of projects. *Evaluation and Program Planning, 36*, 1-14. doi:10.1016/j.evalprogplan.2012.04.005
C40 Cities. (accessed 2015). C40 Cities: San Francisco Zero Waste Programme. *C40 Cities: Case Studies.* Retrieved from http://www.c40.org/case_studies/zero-waste-program
Caldeira, C., De Laurentiis, V., & Sala, S. (2019). Assessment of food waste prevention actions: development of an evaluation framework to assess the performance of food waste prevention actions. *Publications Office of the European Union, Luxembourg, JRC118276*. doi:10.2760/9773
Campanelli, J. (2011). Swell idea turns sour. *Waste & Recycling News, 17*(5), 1. Retrieved from http://www.wasterecyclingnews.com/article/20110711/NEWS99/307119947/swell-idea-turns-sour
Campbell, N. (2007). Setting the standard for zero waste. *Petroleum Review, 61*(731), 6-7&15.
CCC. (2006). Toward Zero Waste: Christchurch City Council Waste Management Plan 2006. Christchurch City Council -CCC, (pp. 1 - 53). Retrieved from <http://www.ccc.govt.nz/Waste/StrategiesPlans/ManagementPlan.asp>
CCME. (2014). *Progress Report on the Canada-wide Action Plan for Extended Producer Responsibility*. Retrieved from Canadian Council of Ministers of the Environment. Winnipeg, Manitoba http://www.ccme.ca/files/Resources/waste/extended/CAP-EPR%20Progress%20Report.pdf
Cerminaram, G. (2014). A Glance at the World. *Waste Mnagement, 34*, I-XII. doi:10.1016/S0956-053X(14)00199-8
Chalmin, P., & Gaillochet, C. (2009). *From waste to resources*. Retrieved from France: http://www.uncrd.or.jp/env/spc/docs/plenary3/PS3-F-Veolia_Hierso-Print%20abstract.pdf
Chandavarkar, N., & UNDESA/UNEP. (2010). *Introduction of the report of the Secretary-General on waste management*. Retrieved from http://sustainabledevelopment.un.org/content/documents/DSD.pdf
Chang, N.-B., & Davila, E. (2007). Minimax regret optimization analysis for a regional solid waste management system. *Waste Management, 27*, 820-832. doi:doi:10.1016/j.wasman.2006.05.002
Chang, N.-B., & Davila, E. (2008). Municipal solid waste characterizations and management strategies for the Lower Rio Grande Valley, Texas. *Waste Management, 28*, 776-794. doi:doi:10.1016/j.wasman.2007.04.002
Chang, N.-B., Davila, E., Dyson, B., & Brown, R. (2005). Optimal design for sustainable development of a material recovery facility in a fast-growing urban setting. *Waste Management, 25*, 833-846. doi:doi:10.1016/j.wasman.2004.12.017
Chaudhary, H. (2013). *A road map for zero waste Ahmedabad: A Visionary Document to Guide Ahmedabad towards becoming a 'resource efficient and zero wastecity' by 2031*. Retrieved from UNCRD/AMC. Ahmedabad, India: https://www.uncrd.or.jp/content/documents/25816-3R_City-Report_Ahmedabad_ref.doc3-Zero-Waste-Road-Map.pdf
Chen, H. W., & Houng, H. (2004, Sep 29-Oct 01). *Toward a zero waste society in Taiwan*, Rhodes, GREECE.
Chi, X., Streicher-Porte, M., Wang, M. Y. L., & Reuter, M. A. (2011). Informal electronic waste recycling: A sector review with special focus on China. *Waste Management, 31*, 731-742. doi:doi:10.1016/j.wasman.2010.11.006
Chiaroni-Clarke, R., & Gerrard, J. (2019). *Rethinking Plastics in Aotearoa New Zealand: A report from the panel convened by the Office of the Prime Minister's Chief Science Advisor, Kaitohutohu Mātanga Pūtaiao Matua ki te Pirimia*. Retrieved from Auckland, NZ: www.pmcsa.ac.nz

Chifari, R., Lo Piano, S., Bukkens, S. G. F., & Giampietro, M. (2018). A holistic framework for the integrated assessment of urban waste management systems. *Ecological Indicators, 94*(3), 24-36. doi:10.1016/j.ecolind.2016.03.006
Christensen, T. H., Simion, F., Tonini, D., & Møller, J. (2009). Global warming factors modelled for 40 generic municipal waste management scenarios. *Waste Management & Research, 27*, 871-884. doi:10.1177/0734242X09350333
Ciampichetti, A., Rocco, P., & Zucchetti, M. (2002). The zero waste option: Clearance of activated and first wall/blanket materials. *Journal of Nuclear Materials, 307-311*(2), 1047-1051.
Ciplet, D. (2009). An Industry Blowing Smoke: 10 Reasons Why Gasification, Pyrolysis & Plasma Incineration are Not "Green Solutions". Global Alliance for Incinerator Alternatives (GAIA). Retrieved from http://www.no-burn.org/downloads/BlowingSmokeReport.pdf
CIWM. (2014). *The Circular Economy: what does it mean for the waste and resource management sector?* Retrieved from Northampton UK:
Clay, S., Gibson, D., & Ward, J. (2007). Sustainability Victoria: influencing resource use, towards zero waste and sustainable production and consumption. *Journal of Cleaner Production, 15*(8-9), 782-786. doi:10.1016/j.jclepro.2006.06.021
Clift, R. (2004). Waste a waste! *Materials Today, 7*(2), 64.
Clift, R. (2008). Nanotechnology: A new organism in the industrial ecosystem? *Journal of Industrial Ecology, 12*(3), 259-262.
Clough, P. (2007). *Waste or Rationality? Economic perspectives on waste management and policies in New Zealand*. Retrieved from Wellington https://nzier.org.nz/publication/waste-and-rationality-economic-perspectives-on-waste-management-and-policies-in-new-zealand
Cobo, S., Dominguez-Ramos, A., & Irabien, A. (2018). From linear to circular integrated waste management systems: A review of methodological approaches. *Resources Conservation & Recycling.. 135*(August), 279-295. doi:10.1016/j.resconrec.2017.08.003
Collins, K. M. T., & O'Cathain, A. (2009). Tens points about mixed methods research to considered by the noivice researcher. *International Journal of Mulitple Research Approaches, 3*, 2-7.
Colon, M., & Fawcett, B. (2006). Community-based household waste management: Lessons learnt from EXNORA's 'zero waste management' scheme in two South Indian cities. *Habitat International, 30*(4), 916-931. doi:10.1016/j.habitatint.2005.04.006
Connett, P. (2013). *The zero waste solution: Untrashing the planet one community at a time*. White River Junction, VT: Chelsea Green Publishing.
Connett, P., & Sheehan, B. (2001). *A citizen's agenda for zero waste: A strategy that avoids incinerators and eventually eliminates landfills - A United States and Canadian perspective*. Retrieved from Athens, GA: www.grrn.org/zerowaste/community
Creswell, J. W. (1994). *Research Design: Qualitative and quantitative approaches*. Thousand Oaks, CA: SAGE.
Creswell, J. W. (2015). *Concise introduction to mixed methods research* Thousand Oaks, CA: SAGE.
Crittenden, G. (2005). Zeroing in on zero. *Solid Waste and Recycling,* (1 June). Retrieved from http://www.solidwastemag.com/news/zeroing-in-on-waste/1000152052/?&er=NA
CRN Wales. (2009). Towards Zero Waste One Wales: One Planet - Waste Strategy 2009 - 2050 (draft approved by Minister). Retrieved from <http://www.crn.org.uk/>
Crocker, R., Chileshe, N., Helliar, C., Ochoa Paniagua, J., Sandhu, S., Wallace, N., & Jonasson, A. (2022). *Implementing the Circular Economy in Regional South Australia: Identifying Targets and Developing Partnerships* (978-1-922046-35-2). Retrieved from UniSA, South Australia https://legatus.sa.gov.au/wp-content/uploads/2021/09/A-Circular-Economic-in-Regional-SA.pdf
Crocker, R., & Lehmann, S. (2012). Conclusion: The culture and politics of zero waste - looking ahead. In R. Crocker & S. Lehmann (Eds.), *Designing for Zero Waste – Consumption, technologies and the built environment* (pp. 385-393). London: Earthscan.
Crotty, M. (1998). *The foundations of soical research: Meaning and perspective in the research process*. Crows Nest, NSW: Allen Unwin.

Cubify. (accessed 2014). Ekocycle Cube: 3D printing, recycle, remake - zero waste + unlimited style. Retrieved from http://cubify.com/en/Ekocycle
Curran, T., & Williams, I. D. (2012). A zerowaste vison for industrial networks in Europe. *Journal of Hazardous Materials*(207-208), 3-7.
D-Waste. (2013a). *Waste management for everyone*. Retrieved from online: http://www.d-waste.com/
D-Waste. (2013b). *Waste managment for everyone*. Retrieved from online: http://www.d-waste.com/
Davené, J., & Herbertson, J. (2002). *Pyrometallurgical treatment of steelmaking slags to make value-added products.* Paper presented at the Green Processing 2002 - Proceedings: International Conference on the Sustainable Proceesing of Minerals, Carins, Australia.
De Jaeger, S., & Eyckmans, J. (2008). Assessing the effectiveness of voluntary solid waste reduction policies: Methodology and a Flemish case study. *Waste Management, 28*, 1449-1460. doi:10.1016/j.wasman.2007.08.007
den Boer, E., Williams, I. D., Fitzpatrick, C., Arranz, P., Dietrich, J., Kent, A., . . . Kopacek, B. (2012). *Bringing all Industrial Networks together and next steps*. Retrieved from http://www.zerowin.eu/
Depertment of Ecology State of Washington. (accessed 2013). The beyond waste plan. Retrieved from http://www.ecy.wa.gov/beyondwaste/
Díaz, M. J., Martínez, E., Piñeiro, C., Palavecinos, M., Benayas, J., & Angeles Toribio, M. A. (2012). Involvement of citizens in hazardous waste management and use of recycling centres in the city of Madrid (Spain). *Waste Management & Research, 30*(7), 689-699. doi:10.1177/0734242X11432189
Dileep, M. R. (2007). Tourism and waste management: A review of implementation of "zero waste" at Kovalam. *Asia Pacific Journal of Tourism Research, 12*(4), 377-392.
Dimino, R., & Warren, B. (2004). *Reaching for zero: The citizen plan for zero waste in New York City*. Retrieved from New York: http://www.maggieclarkeenvironmental.com/ZeroReport2004.pdf
Doppelt, B., Dowling-Wu, L., & Seldman, N. (1999). *Establishing environmentally sustainable and economically efficient economies: From waste management towards zero waste*. Retrieved from Portland Oregon: https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/2391/ZeroWaste.pdf?sequence=1
Downes, J. (2018). Recycling can be confusing, but it's getting simpler. *The Converstion*. Retrieved from https://theconversation.com/recycling-can-be-confusing-but-its-getting-simpler-68063
Dunlap, R. E., & McCright, A. M. (2010). Climate change denial: sources, actors and strategies. In *Routledge Handbook of Climate Change and Society* (1st Edition ed., pp. 21). London: Routledge.
EC. (1975). Council Directive 75/442/EEC of 15 July 1975 on Waste. The Council of the European Communities. *Official Journal L 194, Brussels.*
EC. (2005). *The story behind the strategy: EU waste policy*. Retrieved from Brussels: http://ec.europa.eu/environment/waste/pdf/story_book.pdf
EC. (2008). Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on Waste and Repealing Certain Directives. *Official Journal of the European Union, Strasbourg*.
EC. (2014). *Towards a circular economy: A zero waste programme for Europe + Annex*. Retrieved from Brussels: https://www.oecd.org/env/outreach/EC-Circular-econonomy.pdf
EC. (2018). Directive (EU) 2018/851 of the European Parliment and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste. *Official Journal of the European Union*. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L0851&from=EN
Ecocycle. (2008). Ecocycle Annual Report 2007 and 2008: The Year of Zero Waste - Eco-Cycle's Year in Review. *Ecocycle Reports*. Retrieved from <http://www.ecocycle.org/index.cfm>

Ecocycle Solutions. (2017a). *Zero Waste in Action Community Case Study #1: Arlington, VA*. Retrieved from Ecocycle Solutions, Boulder, Colorado: www.ecocyclesolutionshub.org
Ecocycle Solutions. (2017b). *Zero Waste in Action, Community Case Study #2: Missoula, MT*. Retrieved from Ecocycle Solutions, Boulder Colorado: www.ecocyclesolutionshub.org
Edgerly, J., & Borrelli, D. (2007). *Moving toward zero: From waste management to resource recovery*. Retrieved from Vermont, US: www.toxicsaction.org
Edwards, B. (2020). Vested interests in New Zealand politics are too big to ignore – we need a royal commission. *Guardian*. Retrieved from https://www.theguardian.com/commentisfree/2020/feb/19/vested-interests-in-new-zealand-politics-are-too-big-to-ignore-we-need-a-royal-commission
EEA. (2008). *Waste without borders in the EU? : Trans-boundary shipments of waste*. Retrieved from Luxembourg: <http://www.eea.europa.eu/publications/waste-without-borders-in-the-eu-transboundary-shipments-of-waste> and other related EEA publications <http://scp.eionet.europa.eu/publications>
EEA. (2013). *Managing municipal solid waste — a review of achievements in 32 European countries*. Retrieved from Copenhagen: http://www.eea.europa.eu/publications/managing-municipal-solid-waste
EEC. (2008). Sustainable waste management ladder. *Earth Engineering Center for Sustainable Waste Management*. Retrieved from http://www.seas.columbia.edu/earth/wtert/sofos/european_ladder.pdf
Ekvall, T., Åkesson, L., Björklund, A., Eriksson, E., Finnveden, G., Östblom, G., . . . von Borgstede, C. (2013). Towards Sustainable Waste Management (TOSUWAMA Plan). *Swedish Environmental Research Institute*. Retrieved from https://internt.ht.lu.se/media/documents/project-14/TOSUWAMA%20plan%20revised%20hela%20ansokan%20final%20version.pdf
Ekvall, T., Assefa, G., Bjorklund, A., Eriksson, O., & Finnveden, G. (2007). What life-cycle assessment does and does not do in assessments of waste management. *Waste Management, 27*, 989-996.
Electrolux. (accessed 2014). *Zero waste: always trendy: Body scan creates your new wardrobe*. Retrieved from online: http://electroluxdesignlab.com/2014/submission/zero-waste-always-trendy/
Eleyan, D., Al-Khatib, I. A., & Garfield, J. (2013). System dynamics model for hospital waste characterization and generation in developing countries. *Waste Management & Research, 31*(10), 986-995. doi:10.1177/0734242X13490981
Elkington, J. (2012). *The Zeronauts: Breaking the sustainability barrier*. New York: Routledge.
Ellen MacArthur Foundation. (2012). *Towards the circular economy: Economic and business rationale for an accelerated transition. Executive Summary*. Retrieved from Cowes, Isle of Wright: http://www.ellenmacarthurfoundation.org/business/reports
Ellen MacArthur Foundation. (2013a). *Towards the circular economy 1: Economic and business rationale for an accelerated transition*. Retrieved from Cowes, Isle of Wright: http://www.ellenmacarthurfoundation.org/business/reports
Ellen MacArthur Foundation. (2013b). *Towards the circular economy 2: Opportunities for the consumer goods sector*. Retrieved from Cowes, Isle of Wright: http://www.ellenmacarthurfoundation.org/business/reports
Ellen MacArthur Foundation, & World Economic Forum. (2016). *The New Plastics Economy: Rethinking the future of plastics*. Retrieved from Geneva: www.weforum.org
Elo, S., & Kyngas, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing, 62*(1), 107-115. doi:10.1111/j.1365-2648.2007.04569.x
Endemann, G., Lüngen, H. B., & Wuppermann, C. D. (2006). Dust, scale and sludge generation and utilisation in German steelworks *Stahl Eisen, 126*(9), 25-32.
Enkvist, P.-A., & Klevnas, P. (2018). *The circular economy – a powerful force for climate mitigation: Transformative innovation for prosperous and low-carbon industry*. Retrieved from Material

Economics Sverige AB. Stockholm, Sweden: https://www.sitra.fi/en/publications/circular-economy-powerful-force-climate-mitigation/
Envision New Zealand. (2015). *The inscentive to recycle: The case for a container deposit system in New Zealand*. Retrieved from Auckland: https://www.nzpsc.nz/wp-content/uploads/2017/12/Envision_The-InCENTive-to-Recycle_2015_C.pdf
Eriksson, M., Strid, I., & Hansson, P.-A. (2015). Carbon footprint of food waste management options in the waste hierarchy - A Swedish case study. *Journal of Cleaner Production, 93*, 115-125. doi:10.1016/j.jclepro.2015.01.026
ESA. (2013). *3D printing for space: the additive revolution*. Retrieved from France: http://www.esa.int/Our_Activities/Human_Spaceflight/Research/3D_printing_for_space_the_additive_revolution
EU, 1999. Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste. OJ L 182, 16.7.1999. pp. 1-19, 1-19 (1999).
Eunomia, & Resource Media. (2018). *Recycling –who really leads the world? Identifying the world's best municipal waste recyclers*. Retrieved from www.eunomia.co.uk
Evans, J., Jones, R., Karvonen, A., Millard, L., & Wendler, J. (2015). Living labs and co-production: university campuses as platforms for sustainability science. *Current Opinion in Environmental Sustainability, 16*(Oct), 1-6. doi:10.1016/j.cosust.2015.06.005
Evans, J., & Karvonen, A. (2011). Living laboratories for sustainability In H. Bulkeley, V. Castan Broto, M. Hodson, & S. Marvin (Eds.), *Cities and low carbon transistions* (Vol. 35, pp. 126-141). New York: Routledge.
Evans, J., & Karvonen, A. (2014). 'Give Me a Laboratory and I Will Lower Your Carbon Footprint!' — Urban Laboratories and the Governance of Low-Carbon Futures. *Int. J. Urban Reg. Res., 38*(2), 413-430. doi:10.1111/1468-2427.12077
Ezeah, C., Fazakerley, J. A., & Roberts, C. L. (2013). Emerging trends in informal sector recycling in developing and transition countries. *Waste Management, 33*, 2509-2519. doi:http://dx.doi.org/10.1016/j.wasman.2013.06.020
Favoino, E. (2020). *Building a bridge strategy for residual waste. Material Recovery and Biological Treatment to manage residual waste within a circular economy*. Retrieved from Brussels: https://zerowasteeurope.eu/2020/06/building-a-bridge-strategy-for-residual-waste/
FCM. (2009). *Getting to 50% and beyond: Waste diversion success stories from Canadian municipalities*. Retrieved from Ontario: www.fcm.ca/gmf
Fehr, M. (2014). The management challenge for household waste in emerging economies like Brazil: Realistic source separation and activation of reverse logistics. *Waste Management & Research, 32*(9), 32-39. doi:10.1177/0734242X14541985
Ferry, D. (2011). The urban quest for zero waste. *The Wall Sreet Journal, Sept 11, 2011*. Retrieved from http://online.wsj.com/article/SB10001424053111904583204576542233226922972.html
Fishbein, B. K., McGarry, L. S., & Dillion, P. S. (2000). *Leasing: A step toward producer responsibility*. Retrieved from New York: http://www.informinc.org/reportpdfs/wp/Leasing.pdf
Fleischanderl, A., Gennari, U., Borlee, J., Gimenez, M., Sorrentino, F., Delbecq, J.-M., . . . Raclavský, M. (2004). ZEWA - A new metallurgical process for the production of valuable materials from industrial by-products. *Stahl Eisen, 124*(12), 123-131.
Fleischanderl, A., Gennari, U., & Daum, T. (2005). *ZEWA - A new metallurgical process for the treatment of residues primarily from the steel industry to generate valuable products.* Paper presented at the 33rd Annual Conference - Canadian Society for Civil Engineering (CSCE), Toronto.
Fleischanderl, A., Gennari, U., & Gebert, W. (2004). *Zero-waste steel works - A commercially attractive way of recycling by-products.* Paper presented at the 2nd International Meeting on Ironmaking and 1st International Symposium on Iron Ore and Parallel Event- 5th Japan-Brazil Symposium on Dust Processing-Energy-Environment on Metallurgical Industries, Victoria, espirito Santo; Brazil.

Fontana, P., & Degel, R. (2004). SMS Demag technology for zero-waste steel production. *Revue De Metallurgie-Cahiers D Informations Techniques, 101*(6), 505-512. Retrieved from https://www.researchgate.net/publication/45705210_SMS_Demag_technology_for_zero-waste_steel_production
Fontana, P., & Degel, R. (2004). Zero waste steel production. *MPT Metallurgical Plant and Technology International, 27*(1), 66-68&70&72.
Frame, B., & Brown, J. (2008). Developing post-normal technologies for sustainability. *Ecological Economics, 65*, 225-241. doi:10.1016/j.ecolecon.2007.11.010
Friends of the Earth. (2014). *Bring waste full circle: How to implement the circular economy*. Retrieved from Brussels: https://www.foeeurope.org/bring-waste-full-circle-implement-circular-economy-80514
Friesen, Y. U. (1999). *Toward zero waste: An assessment of the current state and evolution of solid waste management at a large military facility.* (M.E.S.). Dalhousie University (Canada), Canada. Retrieved from http://proquest.umi.com/pqdweb?did=732221841&Fmt=7&clientId=13636&RQT=309&VName=PQD
Frosch, R. A. (1997). Closing the loop on waste materials. In National Academy of Engineering (Ed.), *The Industrial Green Game: Implications for Environmental Design and Management* (pp. 37-47). Washignton DC: National Academy Press.
Frosch, R. A., & Gallopoulos, N. E. (1989a). Strategies for manufacturing. *Scientific American, 261.3*, 144-152.
Frosch, R. A., & Gallopoulos, N. E. (1989b). Strategies for manufacturing: Waste from one industrial process can serve as the raw materials for another, thereby reducing the impact of industry on the environment. *Scientrific Amercian, 261*(3), 144-152. Retrieved from http://www.is4ie.org/resources/Documents/Strategies_For_Manufacturing_Sci_American_1989.pdf
Fu, H.-Z., Ho, Y.-S., Sui, Y.-M., & Li, Z.-S. (2010). A bibliometric analysis of solid waste research during the period 1993–2008. *Waste Management, 30*, 2410-2417.
Fujita, K., & Child Hill, R. (2007). The zero waste city: Tokyo's quest for a sustainable environment. *Journal of Comparative Policy Analysis, 9*(4), 405-425. doi:10.1080/13876980701674225
Fuller, R. B. (1969). *Operating manual for Spaceship Earth*. San Francisco: Arcana.
Funtowicz, S., & Ravetz, J. (2003). Post-Normal Science. In International Society for Ecological Economics (Ed.), *Internet Encyclopaedia of Ecological Economics* (pp. 1-10): http://isecoeco.org/pdf/pstnormsc.pdf (accessed 7th Dec 2020).
Galloway, L., & Metro Vancouver. (2009). *Zero Waste Challenge: Goals strategies and actions*. Retrieved from Vancouver:
Garcia-Herrero, I., Hoehn, D., Margallo, M., Laso, J., Bala, A., Batlle-Bayer, L., . . . Aldaco, R. (2018). On the estimation of potential food waste reduction to support sustainable production and consumption policies. *Food Policy, 80*(October), 24-38. doi:10.1016/j.foodpol.2018.08.007
Garnett, K., Cooper, T., Longhurst, P., Jude, S., & Tyrrel, S. (2017). A conceptual framework for negotiating public involvement in municipal waste management decision-making in the UK. *Waste Management, 66*(August), 210-221. doi:10.1016/j.wasman.2017.04.022
Gentil, E., Clavreul, J., & Christensen, T. H. (2009). Global warming factor of municipal solid waste management in Europe. *Waste Management & Research, 27*, 850-860. doi:10.1177/0734242X09350659
Gertsakis, J., Hannon, J., MacGibbon, J., Nixon, C., Tripathi, N., Wilkinson, S., & Zwimpfer, L. (2011). *eWaste in New Zealand: Five years on*. Retrieved from Wellington: http://www.eday.org.nz/template/ewaste_in_nz_2011_final2.pdf
Geyer, R. (2004). *Environmental and economic evaluation of supply loops and their constraints.* (Ph.D.). University of Surrey (United Kingdom), England. Retrieved from http://proquest.umi.com/pqdweb?did=1760407821&Fmt=7&clientId=13636&RQT=309&VName=PQD

Gharfalkar, M., Ali, Z., & Hillie , G. (2016). Clarifying the disagreements on various reuse options: Repair, recondition, refurbish and remanufacture. *Waste Management & Research*, 1-11. doi:10.1177/0734242X16628981

Gharfalkar, M., Richard Court, R., Campbell, C., Ali, Z., & Hillier, G. (2015). Analysis of waste hierarchy in the European waste directive 2008/98/EC. *Waste Management, 39*, 305-313. doi:10.1016/j.wasman.2015.02.007

Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production, 114*, 11-32. doi:10.1016/j.jclepro.2015.09.007

Gibbs, B. (2011). Green Nanotechnology. In D. Mulvaney & P. Robbins (Eds.), *Green Technology: An A-to-Z Guide* (pp. 226). London: SAGE Publications.

Gibbs, G. (2007). *Analyzing qualitative data*. Thousand Oaks, CA: SAGE.

Gillespie, G. (2002a). Linking organics recycling and zero waste. *Biocycle, 43*(2), 73-+. Retrieved from https://p2infohouse.org/ref/44/43276.pdf

Gillespie, G. (2002b). Zero waste author responds to "landfilling our way". *Biocycle, 43*(6), 11-11. Retrieved from http://www.biocycle.net

Gimenez, M., Bouillon, C., Ferey, F., & Sorrentino, F. (2005). Zero waste. *World Cement, 36*(9), 79-84.

Giusti, L. (2009). A review of waste management practices and their impact on human health. *Waste Management, 29*, 2227–2239. doi:10.1016/j.wasman.2009.03.028

Glavic, P., & Lukman, R. (2007). Review of sustainability terms and their definitions *Journal of Cleaner Production*(15), 1875-1885.

Godfrey, L., Scott, D., Difford, M., & Trois, C. (2012). Part 1: The role of waste data in building knowledge: The South African waste information system. *Waste Management, 32*, 2154-2164. doi:http://dx.doi.org/10.1016/j.wasman.2012.04.019

Göran Finnveden, G., Ekvall, T., Arushanyan, Y., Bisaillon, M., Henriksson, G., Gunnarsson Östling, U., . . . Guath, M. (2013). Policy Instruments towards a Sustainable Waste Management *Sustainability, 5*, 841-881. doi:10.3390/su5030841

Gore, A. (2007). *The Assault on Reason*. London: Penguin Press.

Gore, T., & Wells, P. (2009). Governance and evaluation: The case of EU regional policy horizontal priorities. *Evaluation and Program Planning 32 (2009) 158–167, 32*, 158-167. doi:10.1016/j.evalprogplan.2008.10.007

Graedel, T. E. (2010). *Metal stocks in society: Scientific synthesis*. Retrieved from New York: http://www.unep.org/resourcepanel/Portals/50244/publications/Metalstocksinsociety.pdf

Graedel, T. E., & Allenby, B. R. (2010). *Industrial Ecology and Sustainable Engineering*. Upper Saddle River, NJ: Prentice Hall.

Graedel, T. E., Buchert, M., Reck, B. K., & Sonnemann, G. (2011). *Assessing mineral resources in society: metal stocks and recycling rates*. Retrieved from Nairobi: http://www.unep.org/pdf/Metals_Recycling_Rates_Summary.pdf

Graneheim, U. H., & Lundman, B. (2004). Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse Education Today, 24*, 105-112.

Green Alliance UK. (2006). Flanders, Belgium. *An international survey of zero waste initiatives*. Retrieved from http://www.green-alliance.org.uk/uploadedFiles/Publications/CPPWFlanders.pdf

Greene, K. L., & Tonjes, D. J. (2014). Quantitative assessments of municipal waste management systems: Using different indicators to compare and rank programs in New York State. *Waste Management, 34*, 825-836. doi:http://dx.doi.org/10.1016/j.wasman.2013.12.020

Griffin, J., Jones, P., Brosnahan, E., McGlennon, S., Kenworthy, A., Stephenson, F., . . . Tomashek, M. (2017). *The circular economy opportunity for Auckland and how business can realise it*. Retrieved from SBN-NZ. Auckland, NZ: https://static1.squarespace.com/static/59d8312f268b96ed79bdadc3/t/5af25e570e2e729b66cb31ea/1525833380771/SBN_CircularEconomyOpportunity_ForAuckland.pdf

Grimm, N. B., Faeth, S. H., Golubiewski, N. E., Redman, C. L., Wu, J., Bai, X., & Briggs, J. M. (2008). Global Change and the Ecology of Cities. *Science, 319*, 756-760.
Grishina, I. N., Bashkatova, S. T., Errera, L., & Kolesnikov, I. M. (2007). A multifunctional additive for diesel fuels. *Chemistry and Technology of Fuels and Oils, 43*(3), 206-210.
Grover, V. I. (Ed.) (2000). *Solid waste management*. Rotterdam Brookfield, VT: A.A. Balkema.
GRRN. (2002). *Principles of Zero Waste: A new way to look at our resources*. Retrieved from Cotati, CA: http://www.grrn.org/zerowaste/resource_zw.html
Gulland, I. (2003). *Towards zero: Smart thinking for waste elimination.* Paper presented at the Sustainable Waste Management, Proceedings of the International Symposium, Dundee, Scotland.
Gutherlet, J. (2010). Waste, poverty and recycling. *Waste Management, 30*, 171-173.
Gysen, J., Bruyninckx, H., & Bachus, K. (2006). The Modus Narrandi A Methodology for Evaluating Effects of Environmental Policy. *Evaluation, 12*(1), 95-118. doi:10.1177/1356389006064176
Haas, W., Krausmann, W., Wiedenhofer, D., & Heinz, M. (2015). How Circular is the Global Economy? An Assessment of Material Flows, Waste Production, and Recycling in the European Union and the World in 2005. *Journal of Industrial Ecology, 19*(5), 765-777.
Hanagiri, S., Matsui, T., Shimpo, A., Aso, S., Inuzuka, T., Matsuda, T., . . . Nakagawa, H. (2009). Recent improvement of recycling technology for refractories. *Nippon Steel Technical Report, 98*, 93-98.
Hannah, K., Hattotuwa, S., & Taylor, K. (2021). *Mis- and disinformation in Aotearoa New Zealand*. Retrieved from The Disinformation Project, Te Pūnaha Matatini; Department of Physics, University of Auckland and Centre for Science in Society, Te Herenga Waka. Auckland, NZ: https://library.nzfvc.org.nz/cgi-bin/koha/opac-detail.pl?biblionumber=7614
Hannon, J. (2000). *An alternative shredding system for green waste composting in New Zealand.* (BAppSci Honours). Massey University, Palmerston North.
Hannon, J. (2015a). *Waste vs zero waste: The contest for engaging and shaping our ambient 'waste-making' culture*. Paper presented at the Unmaking Waste 2015: Transforming production and consumption in time and place, Zero Waste SA Research Centre for Sustainable Design and Behaviour and the University of South Australia, Adelaide. http://unmakingwaste2015.org/
Hannon, J. (2015b, 21-24 May 2015). *Waste vs zero waste: The contest for engaging and shaping our ambient 'waste-making' culture.* Paper presented at the Unmaking Waste 2015: Transforming production and consumption in time and place, Zero Waste SA Research Centre for Sustainable Design and Behaviour and the University of South Australia, Adelaide.
Hannon, J. (2018). *(Un) Changing Behaviour: (New Zealand's delay & dysfunction in utilising) Economic Instruments in the Management of Waste?* Retrieved from Palmerston North, New Zealand https://www.nzpsc.nz
Hannon, J. (2020). Exploring and Illustrating the (Inter-)Disciplinarity of Waste and Zero Waste Management *Urban Science, 73*(4). doi:10.3390/urbansci4040073
Hannon, J. (2022 in submission). *Reviewing Policy Analysis in Waste Management Research to Establish a Design Basis Testing and Elaborating Municipal Zero Waste Methodology.* Paper presented at the International Conference on Environmental Policy and Decision Making (ICEPDM), New York.
Hannon, J., & Dickinson, J. (2009). *Resource recovery and solid waste industry training implementation plan*. Retrieved from Palmerston North:
Hannon, J., & ROU. (2007a). *Introduction to composting science and management for industry training*. Retrieved from Palmerston North, NZ: www.wasteminz.org.nz and PDF
Hannon, J., & ROU. (2007b). *A Tool Kit for: NZS4454: 2005, The New Zealand Standard for Composts, Soil Conditioners and Mulches*. Retrieved from Palmerston North, NZ: www.wasteminz.org.nz and PDF
Hannon, J., Vidotto, L., Schiele, H., Batachel, M., Lynch-Karaitiana, S., Stevens, S., . . . Battman, S. (2019). *Palmy's Plastic Pollution challenge: Project Report August 2019*. Retrieved from ENM,

Rangitaane o Manawatu, Massey University. Palmerston North, NZ: https://drive.google.com/file/d/1KvefPGUOL4X1SUDrsFQUMHf5bvmJf9AU/view
Hannon, J., & Zaman, A. U. (2018). Future Cities: Exploring the phenomenon of zero waste. *Urban Science, 2*(90 - Special Issue Future Cities: Concept, Planning, and Practice), 1-26. doi:10.3390/urbansci2030090
Hannon, J., Zaman, A. U., Rittl, G., Meireles, S., & Demore-Palandi, F. E. (2018). Moving Toward Zero Waste Cities: A Nexus for International Zero Waste Academic Collaboration (NIZAC). In W. Leal Filho & U. Bardi (Eds.), *Sustainability on University Campuses: Learning, Skills Building and Best Practices*. Switzerland AG: Springer Nature.
Hansen, J. (2009). *Storms of my grandchildren: The truth about the coming climate catastrophe and our last chanch to save humanity*. London: Bloomsbury.
Harmsworth, G. *The role of Maori values in Low-impact Urban Design and Development (LIUDD): Discussion paper*. Retrieved from Landcare Research NZ Ltd. Palmerston North, NZ: http://www.landcareresearch.co.nz/publications/researchpubs/harsworth_maori_LIUDD.pdf
Hawken, P. (1995). *The ecology of commerce : a declaration of sustainability*. London: Phoenix.
Hawken, P., Lovins, A. B., & Lovins, H. (1999). *Natural capitalism: Creating the next industrial revolution*. Boston: Little Brown and Co.
Hawkins, G. (2006). *The Ethics of Waste: How We Relate to Rubbish*. Lanham, MD: Rowman & Littlefield.
Heidari, R., Yazdanparast, R., & Jabbarzadeh, A. (2019). Sustainable design of a municipal solid waste management system considering waste separators: A real-world application. *Sustainable Cities and Society, 47*(May). doi:10.1016/j.scs.2019.101457
Heikkilä, L., Reinikainen, A., Katajajuuri, J.-M., Silvennoinen, K., & Hartikainen, H. (2016). Elements affecting food waste in the food service sector. *Waste Management, 56*, 446-453. doi:http://dx.doi.org/10.1016/j.wasman.2016.06.019
Herbert, L. (1998). *The history of the Institute of Wastes Management 1898-1998: Celebrating 100 years of progress*. England: Warwick Publishing Co Ltd.
Hestin, M., Mudgal, S., Portugal, V., Obersteiner, G., Scherhaufer, S., Beigl, P., . . . Woolman, T. (2010). *ZEROWIN: Literature Review 'Approaches to zero waste'*. Retrieved from Southampton: http://www.4980.timewarp.at/sat/ZeroWIN/pdf_secure/D.1.1%20ZeroWIN%20Literature%20Review.pdf
Hill, J., Hislop, H., Steel, C., & Shaw, B. (2006a). *An International Survey of Zero Waste Initiatives*. Retrieved from London: http://www.green-alliance.org.uk/home/
Hill, J., Hislop, H., Steel, C., & Shaw, B. (2006b). Kamikatsu, Japan: Zero Waste Case Study. *Green Alliance Paper: An International Survey of Zero Waste Initiatives* Retrieved from http://www.green-alliance.org.uk/uploadedFiles/Our_Work/Kamikatsu.pdf and see http://www.resourcesnotwaste.org/assets/RRF-Reports/GREENALLIANCE(CIWMPaperJune06)ZW.pdf
Hill, J., Shaw, B., & Hislop, H. (2006). *A Zero Waste UK*. Retrieved from London: www.green-alliance.org.uk
Hodzic, A., Wiedinmyer, C., Salcedo, D., & Jimenez, J. L. (2012). Impact of trash burning on air quality in Mexico City. *Environ. Sci. Technol., 46*, 4950-4957.
Hoffart, M. (2012). Product stewardship: Priority products and landfill bans. *Waste Awareness, April(140),* 28.
Hoffart, M. (2018). Recycling in New Zealand: not so green, not so clean. *Pure Advantage: Thought Leader - 'Waste to Value'. Auckland, NZ*. Retrieved from http://pureadvantage.org/news/2018/02/27/recycling-in-new-zealand-not-so-green-not-so-clean/
Hogg, D., & Ballinger, A. (2015). *The potential contribution of waste management to a low carbon economy*. Retrieved from Brussels: http://www.zerowasteeurope.eu/downloads/the-potential-contribution-of-waste-management-to-a-low-carbon-economy/

Hogg, D., & Durrant, C. (2017). *A Circular Economy / Zero Waste Strategy for Derry City and Strabane District Council: Final Strategy*. Retrieved from Eunomia. Bristol, UK: www.eunomia.co.uk

Holmes, J. R. (1988). Report: Privatizing municipal waste collection in England. *Waste Management & Research, 6*(1), 80-85.

Homer-Dixon, T. (2006). *The upside of down: Catastrophe, creativity and the renewable of civilistion.*

Hood, I., & Ministry of Environment British Columbia. (2013). *Zero Waste Business Case: Draft for expert review*. Retrieved from Vancouver: http://www2.gov.bc.ca/gov/DownloadAsset?assetId=FE7D4A6A6BA44875894DE4EEA39B5A0E&filename=zero_waste_business_case_draft.pdf

Hoornweg, D., Bhada-Tata, P., & Kennedy, C. (2014). Peak Waste: When is it likely to occur? *Journal of Industrial Ecology, 19*(1), 117-128.

Hoornweg, D., Bhada-Tate, P., & Anderson, C. (2012). *What a Waste: A Global Review of Solid Waste Management*. Retrieved from Washington DC: http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTURBANDEVELOPMENT/0,,contentMDK:23172887~pagePK:210058~piPK:210062~theSitePK:337178,00.html

Hoornweg, D., & Thomas, L. (1999). *What a Waste: Solid Waste Management in Asia. East Asia and Pacific Region*. Retrieved from Washington DC: http://www.worldbank.org/urban/solid_wm/erm/CWG%20folder/uwp1.pdf

Hsieh, H.-F., & Shannon, S. E. (2005). Three Approaches to Qualitative Content Analysis. *Qualitative Health Research, 15*(9), 1277-1288. doi:10.1177/1049732305276687

Hua, Y. (2013). Sustainable campus as a living laboratory for climate change mitigation and adaption: the role of design thinking processes. In A. Konig (Ed.), *Regenerative sustainable development of universities and cities: The role of living laboratories* (pp. 49-69). Cheltenham, UK: Edward Elgar.

Humes, E. (2012). *Garbology: Our dirty love affair with trash*. New York: Avery.

ILSR. (2002). *Recycling Means Business*. Retrieved from Institute of Local Self-Reliance, Washington DC: http://www.ilsr.org/recycling-means-business/

IPLA. (2011a). *Chairperson's Summary of the CSD-19 Intersessional Conference on Building Partnerships for Moving Towards Zero Waste*. Retrieved from Tokyo: http://www.uncrd.or.jp/env/ipla/doc/PDF9-Chair%20Summary-CSD19-Feb2011.pdf

IPLA. (2011b). *Meeting Summary: Special IPLA event of the ISWA World Congress 2011- Moving towards zero waste for a green economy – Role of local authorities*. Retrieved from Daegu, Korea: http://www.uncrd.or.jp/env/ipla/doc/PDF10-Meeting-Summary-IPLA-Daegu-Korea-17-18Oct2011-FINAL.pdf

IPLA. (2012). *IPLA global forum 2012 on empowering municipalities in building a zero waste society — A vision for post-Rio+20 sustainable urban development*. Retrieved from Souel, Korea: http://www.uncrd.or.jp/env/ipla/doc/120905Meeting_Summary.pdf

IPLA. (2013a). *Borås declaration of the private sector on moving towards resource efficient and zero waste societies*. Retrieved from Boras, Sweden: http://www.uncrd.or.jp/env/ipla/doc/130909Annex_PrivateSectorDeclaration_IPLA_Boras.pdf

IPLA. (2013b). *Chair's Summary: 2013 IPLA Global Forum on sustainable waste management for 21st century cities - building sustainable and resilient cities through partnership*. Retrieved from Boras, Sweden: http://www.uncrd.or.jp/env/ipla/doc/130909Chairs_Summary_2013_IPLA_Global_Forum_FINAL.pdf

Isenmann, R. (2008). Further efforts to clarify industrial ecology's hidden philosophy of nature. *Journal of Industrial Ecology, 6*(3-4), 27-48.

Iskandar, L., & Tjell, J. C. (2009). Editorial - Cairo: A colossal case of waste mismanagement to learn from. *Waste Management & Research, 27*, 939-940. doi:10.1177/0734242X09354030

ISWA. (2009). Waste and Climate Change: ISWA White Paper Summary. Vienna: International Solid Waste Association. Retrieved from www.iswa.org

ISWA. (2012). *Globalisation and waste management: Phase 1 concepts and facts*. Retrieved from Vienna, Austria www.iswa.org
ISWA. (2015). *ISWA Annual Report*. Retrieved from Vienna, Austria: www.iswa.org
ISWA. (2017a). The impact of the 4th industrial revolution on the waste management sector. *ISWA world congress/SWANA wastecon, Baltimore, US*. Retrieved from https://www.acrplus.org/en/projects-vl/the-impact-of-the-4th-industrial-revolution-on-the-waste-management-sector
ISWA. (2017b). *Let's Close the World's Biggest Dumpsites!* Retrieved from International Solid Waste Association, Austria: http://closedumpsites.iswa.org/
Ive, A. (2009). Companies adopt efficient waste-management units. *Oil and Gas Journal, 107*(14), 35-37.
Jacob, S., Speer, S., & Furubo, J.-E. (2015). The institutionalization of evaluation matters: Updating the International Atlas of Evaluation 10 years later. *Evaluation, 21*(1), 6-31. doi:10.1177/1356389014564248
Jessen, M. (2002). Industry Product Stewardship and Beverage Container Waste Management Programs In Canada Retrieved from http://www.zerowaste.co.nz/assets/Reports/Industry_Stewardship.pdf
Jessen, M. (2003). *Discarding the idea of waste: The need for a zero waste policy now*. Retrieved from Nelson, B.C. Canada: http://www.zerowaste.ca/Discarding%20the%20Idea%20of%20Waste%20(Sept03).pdf
Jesson, M. (2003). *Discarding the idea of waste: The need for a zero waste policy now*. Retrieved from Nelson, BC:
Jick, T. D. (2008). Mixing qualitative and quantitative methods: triangulation in action. In V. L. Plano Clark & J. W. Creswell (Eds.), *The mixed methods reader*. Thousand Oaks, CA SAGE.
Johnson, A. (accessed 2013). Garbologie. Retrieved from http://www.garbologie.com
Johnson, B. (2013). *Zero waste home: The ultimate guide to simplifying your life by reducing your waste*. New York: Scribner.
Jones, A., Pimbert, M., & Jiggins, J. (2010). *Virtuous Circles: Values, Systems and Sustainability*. Retrieved from The International Institute for Environment and Development (IIED). London.: http://pubs.iied.org/pdfs/G02780.pdf
Kaikoura District Council. (2009). *Zero waste management plan*. Retrieved from Kaikoura, NZ: http://www.kaikoura.govt.nz/docs/operative_2009.pdf
Karak, T., Bhagat, R. M., & Bhattacharyya, P. (2012). Municipal solid waste generation, composition, and management: The world scenario. *Critical Reviews in Environmental Science and Technology, 42*(15), 1509-1630.
Kasemir, B. (2013). Foreword: a shared exploration of living laboratories for sustainability. In A. Konig (Ed.), *Regenerative sustainable development of universities and cities: The role of living laboratories* (pp. xix-xx). Cheltenham, UK: Edward Elgar.
Kasidoni, M., Moustakas, K., & Malamis, D. (2015). The existing situation and challenges regarding the use of plastic carrier bags in Europe. *Waste Management & Research, 33*(5), 419-428. doi:10.1177/0734242X15577858
Kathiravale, S., & Yunus, M. N. M. (2008). Waste to wealth. *Asia Europe Journal, 6*(2), 359-371. doi:10.1007/s10308-008-0179-x
Kathiravale, S., Yunus, M. N. M., & Abu, M. P. (2007). *Municipal solid waste: The economic opportunity.* Paper presented at the 3rd International Conference on Sustainable Development and Planning, Sustainable Development III, Algarve, Portugal.
Kawai, J. (2000). Development of environmentally-conscious steel products at the Nippon Steel Corporation. *Materials and Design, 22*(2), 111-122.
Kenward, M. (2013). UK seeks a 'zero waste economy'. *MRS Bulletin, 38*(March), 2002-2203.
Khan, M. M., & Islam, R. M. (2012). *Zero waste engineering*. Salem, MA: Scivener Publishing & John Wiley & Sons Inc.

King, A. M., Burgess, S. C., Ijomah, W., & McMahon, C. A. (2006). Reducing waste: Repair, recondition, remanufacture or recycle? *Sustainable Development, 14*, 257-267. doi:10.1002/sd.271

Klein, J. T. (2008). Evaluation of Interdisciplinary and Transdisciplinary Research: A Literature Review. *Am. J. Prev. Med, 35*(2), 116-123.

Klein, J. T. (2014). Discourses of transdisciplinarity: Looking Back to the Future. *Futures, 63*, 68-74.

Knapp, D. (1981). *The Berkeley burn plant papers*. Berkeley, California: Materials World Publishing.

Knauf, M. (2015). Waste hierarchy revisited —an evaluation of waste wood recycling in the context of EU energy policy and the European market. *Forest Policy and Economics, 54*, 58-60. doi:10.1016/j.forpol.2014.12.003

Kollikkathara, N., Feng, H., & Stern, E. (2009). A purview of waste management evolution: Special emphasis on USA. *Waste Management, 29*, 274-985.

Kondoh, M., Hamai, M., Yamaguchi, M., & Mori, S. (2001). Study of gasification characteristics of automobile shredder residue. *JSAE Review, 22*(2), 234-236.

Kondracki, N. L., Wellman, N. S., & Amundson, D. R. (2002). Content Analysis: Review of Methods and Their Applications in Nutrition Education. *Journal of Nutrition Education and Behavior, 34*(4), 224-230.

Konsti-Laakso, S., Hennala, L., & Uottila, T. (2008). *Living Labs: New ways to enhance innovativeness in public sector services.* Paper presented at the 14th International Conference on Concurrent Enterprising, Lisbon, Portugal (pp. 23-25).

Kopacek, B., & Schadlbauer, S. (2013). *Introduction to ZeroWIN*. Retrieved from Southampton: http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6360501

Korge, K. (accessed 2014). *The King's new clothes*. Retrieved from online: http://www.yankodesign.com/2014/07/25/the-king%E2%80%99s-new-clothes/

Korhonen, J. (2004). Industrial ecology in the strategic sustainable development model: strategic applications of industrial ecology. *Journal of Cleaner Production, 12*, 809-823.

Korst, A. (2012). *The zero-waste lifestyle: Live well by throwing away less*. New York: Random House Inc.

Koukosia, I., Makris, I., Marvropoulos, A., Marvropoulos, A., Marvropoulos, N., Psalida, A., & Tsakona, M. (2013). *Waste Atlas 2013 report*. Retrieved from Athens: https://www.researchgate.net/publication/351902376_WASTE_ATLAS_REPORT_2013

Kozlowski Russell, J. (2009). *From solid waste management to solid waste avoidance: A critical evaluation of zero waste strategic plans.* (M.U.P.). State University of New York at Buffalo, United States -- New York. Retrieved from http://proquest.umi.com/pqdweb?did=1789804461&Fmt=7&clientId=13636&RQT=309&VName=PQD

Krausz, R. (2011). *Show me the plan: why zero waste initiatives ultimately fail*. Paper presented at the Post-Graduate Conference Lincoln University, Lincoln, ChCh, NZ. https://researcharchive.lincoln.ac.nz/bitstream/10182/3842/1/zero_waste_initiatives.pdf

Krausz, R. (2012). *All for naught? A critical study of zero waste to landfill initiatives.* (Doctor of Philosophy). Lincoln University, Christchurch.

Krausz, R. (2013a). Wake up call for zero waste: The phenomenon of zero waste to landfill initiative failure. *Waste Awareness, May*(145), 22-23.

Krausz, R. (2013b). Zero Effect. *Waste 360, 3rd of April* Retrieved from http://waste360.com/zero-waste/zero-effect

Krausz, R., Hughey, K. F. D., & Montgomery, R. (2013). Zero Waste to Landfill: an Unacknowledged Supermegaproject. *Lincoln Planning Review, 5*(1-2), 10-26.

Krippendorff, K. (1989). Content analysis. In E. E. Barnouw, G. G. Gerbner, W. W. Schramm, T. L. T. L. Worth, & L. & L. Gross (Eds.), *International encyclopedia of communication* (Vol. 1, pp. 403-407). New York: Oxford University Press.

Krippendorff, K. (2013). *Content analysis: an introduction to its methodology* (3rd ed.). Los Angles: Sage Publications Ltd.

Krzemińska, A. E., Zaręba, A., D, Dzikowska, A., & Jarosz, K. R. (2017). Cities of the future—bionic systems of new urban environment. *Environmental Science and Pollution Research*, 1-9. doi:https://doi.org/10.1007/s11356-017-0885-2
Kuehr, R. (2007). Towards a sustainable society: United Nations University's zero emissions appraoch. *J. Cleaner Prod., 15*, 1198 - 1204. doi:10.1016/j.jclepro.2006.07.020
Kulkki, S. (2004). Towards an ideapolis: the creative Helsinki Region. Retrieved from http://www.hel.fi/hel2/tietokeskus/kvartti/2004/3/towards_an_ideapolis.pdf
Lang, J. C. (2005). Zero landfill, zero waste: The greening of industry in Singapore. *International Journal of Environment and Sustainable Development, 4*(3), 331-351.
Launch. (accessed 2013). Launch: Beyond waste. Retrieved from http://www.launch.org/challenges/waste
Laurent, A., Bakas, I., Clavreul, J., Bernstad, A., Niero, M., Gentil, E., . . . Christensen, T. H. (2014). Review of LCA studies of solid waste management systems – Part I: Lessons learned and perspectives. *Waste Management, 34*, 573-588. doi:http://dx.doi.org/10.1016/j.wasman.2013.10.045
Lavery, L. (2016). *Analysing Qualitative Data*. Retrieved from Auckland: http://www.academic-consulting.co.nz/
Leal Filho, W., & Bardi, U. (Eds.). (2018). *Sustainability on University Campuses: Learning, Skills Building and Best Practices*. Switzerland AG: Springer Nature.
Leao, A. L., Cesarino, I., Narine, S., & Sain, M. (2017). Innovation Under the Bioeconomy Context in Brazil. In S. D. e. al (Ed.), *Knowledge-Driven Developments in the Bioeconomy, Economic Complexity and Evolution*: Springer International Publishing.
Lee, J., Pedersen, A. B., & Thomsen, M. (2014). Are the resource strategies for sustainable development sustainable? Downside of a zero waste society with circular resource flows. *Environmental Technology & Innovation, 1-2*, 46-54. doi:10.1016/j.eti.2014.10.002
Lehmann, M., de Leeuw, B., Fehr, E., & Wong, A. (2014). *Circular Economy: Improving the Management of Natural Resources*. Retrieved from Zurich, SW. : www.satw.ch/circular-economy
Lehmann, S. (2010a). Green Urbanism: Formulating a series of holistic principles. *Sapiens, 3*(2).
Lehmann, S. (2010b). Resource Recovery and Materials Flow in the City: Zero Waste and Sustainable Consumption as Paradigms in Urban Development. *Sustainable Development Law & Policy: Sustainable Development in the Urban Environment, 11*(1 (Fall, Article 13)), 28-68.
Lehmann, S. (2011a). Optimizing urban material flows and waste streams in urban development through principles of zero waste and sustainable consumption. *Sustainability, 3*, 155-183. doi:10.3390/su3010155
Lehmann, S. (2011b). What is green urbanism? Holistic principles to transform cities for sustainability. In J. Blanco (Ed.), *Climate change – research and technology for adaptation and mitigation*. Retrieved from http://www.intechopen.com/books/climate-change-research-andtechnology-for-adaptation-and-mitigation/what-is-green-urbanism-holistic-principles-to-transform-cities-forsustainability
Lehmann, S., & Crocker, R. (Eds.). (2012). *Designing for zero waste: Consumption, technologies and the built environment*. London: Earthscan.
Lehtonen, M. (2014). Evaluating megaprojects: From the 'iron triangle' to network mapping. *Evaluation, 20*(3), 278-295. doi:10.1177/1356389014539868
Leroux, K. (2001). Is zero waste possible? *Waste Age, 32*(3), 102.
Levin, K., Cashmore, B., & Bernstien, S. (2009). *Playing it Forward: Path Dependency, Progressive Incrementalism, and the "Super Wicked" Problem of Global Climate Change.* Paper presented at the Climate Change: Global Risks, Challenges and Decisions Congress, Copenhagen, Denmark.
Levin, K., Cashore, B., Bernstein, S., & Auld, G. (2012). Overcoming the tragedy of super wicked problems: constraining our future selves to ameliorate global climate change. *Polcy Science, 45*, 123-152.

Levitzke, V. (2012). Foreword: Designing for zero waste. In R. Crocker & S. Lehmann (Eds.), *Designing for zero waste: Consumption, technologies and the built environment*. London: Earthscan.
Lewis, H., Downes, J., Verghese, K., & Young, G. (2017). Food waste opportunities within the food wholesale and retail sectors. *Prepared for the NSW Environment Protection Authority by the Institute for Sustainable Futures at the University of Technology Sydney.* Retrieved from https://www.researchgate.net/publication/319235194_Food_waste_opportunities_within_the_food_wholesale_and_retail_sectors
Li, N., Zhang, T., & Liang, S. (2013). Reutilisation-extended material flows and circular economy in China. *Waste Management, 33*, 1552-1560. doi:http://dx.doi.org/10.1016/j.wasman.2013.01.029
Liss, G. (1997). What is zero waste? *Grass Roots Recycling Network*. Retrieved from http://archive.grrn.org/zerowaste/articles/whatiszw.html
Liss, G. (2001). *Resource Recovery Parks: A model for local government recycling and waste reduction*. Retrieved from Sacramento, CA: https://www2.calrecycle.ca.gov/Publications/Download/423?opt=dln
Living Earth Foundation. (accessed 2015). Waste to Wealth. Retrieved from http://wastetowealth.livingearth.org.uk/
Lo, A., Savelli, H., Beunen, R., Kalz, M., Ragas, A., & Van Belleghem, F. (2017). Solutions for global marine litter pollution. *Current Opinion in Environmental Sustainability, 28*, 90-99. doi:10.1016/j.cosust.2017.08.009
Lohr, A., Savelli, H., Beunen, R., Kalz, M., Ragas, A., & Van Belleghem, F. (2017). Solutions for global marine litter pollution. *Current Opinion in Environmental Sustainability, 28*, 90-99. doi:10.1016/j.cosust.2017.08.009
Loiseau, E., Saikku, L., Antikainen, R., Droste, N., Hansjürgens, B., Pitk€anen, K., . . . Thomsen, M. (2016). Green economy and related concepts: An overview. *Journal of Cleaner Production, 139*, 361-371. doi:10.1016/j.jclepro.2016.08.024
Lombardi, E. (2001). Beyond Recycling! Zero Waste ...Or Darn Near. *Biocycle, 42*(9), 75.
Lombardi, E. (2006). The zero waste summer of 2006. *Biocycle, 47*(10), 18-19.
Lombardi, E., & Bailey, K. (2015). *The Community Zero Waste Roadmap*. Retrieved from Bolder, Colorado: www.ecocyclesolutionshub.org
Lombardi, E., & Rogers, K. (2007). 2,500 millionaires. *Biocycle, 48*(10), 32-35.
Lomborg, B. (2001). *The Skeptical Environmentalist: Measuring the real state of the world*. Cambridge: Cambridge University Press.
Louis, G. E. (2004). A historical context of municipal solid waste management in the United States. *Waste Management Research, 22*, 306-322. doi:10.1177/0734242X04045425
Lu, W., & Yuan, H. (2011). A framework for understanding waste management studies in construction. *Waste Management, 31*, 1252-1260. doi:doi:10.1016/j.wasman.2011.01.018
Ma, J., & Hipel, K. W. (2016). Exploring social dimensions of municipal solid waste management around the globe – A systematic literature review. *Waste Management, in print*. doi:http://dx.doi.org/10.1016/j.wasman.2016.06.041
Manahan, S. E. (1999). *Industrial ecology: Environmental chemistry and hazardous waste*. Boca Raton: Lewis Publishers.
Marshall, R. E., & Farahbakhsh, K. (2013). Systems approaches to integrated solid waste management in developing countries. *Waste Management, 33*, 998-1003. doi:10.1016/j.wasman.2012.12.023
MassonDelmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.). (2021). *IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. In Press*. Retrieved from Cambridge University Press. In Press.: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf

Matete, N., & Trois, C. (2008). Towards Zero Waste in emerging countries - A South African experience. *Waste Management, 28*(8), 1480-1492. doi:10.1016/j.wasman.2007.06.006
Matharu, A. S., de Melo, E. M., & Houghton, J. A. (2016). Opportunity for high value-added chemicals from food supply chain wastes. *Bioresource Technology, 215*, 123-130. doi:10.1016/j.biortech.2016.03.039
Mauck, R. J. (2003). Current chances of zero waste? Zero. *MSW Management, March-April*, 1.
Mauck, R. J. (2011). Beyond zero waste caNWE do it? *MSW Management, July-August*, 2.
Mavropoulos, A. (2010a). *Globalization, Megacities and Waste Management*. Retrieved from Athens: www.iswa.org/index.php?eID=tx_iswatfg_download&fileUid=22
Mavropoulos, A. (2010b). Waste Management 2030+. *Waste Management World*. Retrieved from http://www.waste-management-world.com/articles/print/volume-11/issue-2/features/waste-management-2030.html
Mavropoulos, A. (accessed 2014). *Megacities sustainable development and waste management in the 21st century*. Retrieved from online: http://www.iswa.org/uploads/tx_iswaknowledgebase/Mavropoulos.pdf
Mavropoulos, A., Chohen, P., Greedy, P., Plimakis, S., Marinheiro, L., Law, J., & Loureiro, A. (2017). *A Roadmap for closing waste dumpsites: The world's most polluted places*. Retrieved from Vienna, Austria: http://www.iswa.org/programmes/closing-the-worlds-biggest-dumpsites/
Mavropoulos, A., Newman, D., & ISWA. (2015). *Wasted Health: The tragic case of dumpsites*. Retrieved from Vienna, Austria: https://www.researchgate.net/publication/281774422_Wasted_Health_the_tragic_case_of_dumpsites
May, D. R., & Flannery, B. L. (1995). Cutting waste with employee involvement teams. *Business Horizons*(Sept/Oct), 28-38.
Mayring, P. (2000). Qualitative Content Analysis. *Form: Qualitative Social Research, 1*(2), Art. 20. Retrieved from http://nbn-resolving.de/urn:nbn:de:0114-fqs0002204
McCormick, K., & Kautto, N. (2013). The Bioeconomy in Europe: An Overview. *Sustainability, 5*, 2589-2608. doi:10.3390/su5062589
McDonough, W., & Braungart, M. (2002). *Cradle to Cradle: Remaking the Way We Make Things*. New York: North Point Press.
McDonough, W., & Braungart, M. (2013). *The upcycle: Beyond sustainability - designing for abundance*. New York: North Point Press.
McDonough, W., Braungart, M., Anastas, P. T., & Zimmerman, J. T. (2003). Applying the Principles of Green Engineering to cradle-to-Cradle Design. *Environmental Science and Technology, Dec*(1), 435-441. Retrieved from https://pubs.acs.org/doi/pdf/10.1021/es0326322
McKinnon, C. (2016). Should We Tolerate Climate Change Denial? *Midwest Studies in Philosophy: Ethics and Global Climate Change, 40*, 205-216. Retrieved from https://doi-org.ezproxy.massey.ac.nz/10.1111/misp.12056
McTavish, D. G., & Pirro, E. B. (1990). Contextual Content Analysis. *Quality & Quantity, 24*, 245-265.
MED-Zero Waste. (2013a). *Transnational SWOT analysis on waste managment concepts*. Retrieved from Ano Liossia, Greece: http://www.med-zerowaste.eu/zerowaste.html
MED-Zero Waste. (2013b). *Zero waste handbook of alternative waste management schemes*. Retrieved from Ano Liossia, Greece: http://www.med-zerowaste.eu/
MED-Zero Waste. (2013c). *Zero waste systems' analysis: Common report*. Retrieved from Ano Liossia, Greece: http://www.med-zerowaste.eu/zerowaste.html
Medeiros, J. A., & Pinto, M. L. C. C. (2005). *Chemical processing and recycling of residues and wastes of a zinc plant in sepetiba bay, Rio De Janeiro.* Paper presented at the REWAS'04 - Global Symposium on Recycling, Waste Treatment and Clean Technology, Madrid.
Metzger, N., & Zare, R. N. (1999). Interdisciplinary Research: From Belief to Reality. *Science, 29*(5402), 642-643. doi:10.1126/science.283.5402.642

Meyers, G. D., McLeod, G., & Anbarci, M. A. (2006). An international waste convention: measures for achieving sustainable development. *Waste Manag Res, 24*, 505-513. doi:10.1177/0734242X06069474
Meyers, M. B. (2009). *Qualitative research in business & management* (2nd ed.). Thousand Oaks, CA: SAGE.
MfE. (2002). The New Zealand Waste Strategy (NZWS2002): Towards Zero Waste and a Sustainable New Zealand. Retrieved from http://www.mfe.govt.nz/publications/waste/
MfE. (2007a). Targets in the New Zealand Waste Strategy 2006: Review of Progress. Retrieved from http://www.mfe.govt.nz/publications/waste/
MfE. (2007b). *Towards a Sustainable New Zealand: Measures to minimise solid waste*. Retrieved from Ministry for the Environment, Wellington, NZ: http://www.mfe.govt.nz/more/cabinet-papers-and-related-material-search/cabinet-papers/pol-07-132-towards-sustainable-new
MfE. (2007c). Waste Management in New Zealand: A Decade of Progress. Retrieved from http://www.mfe.govt.nz/publications/waste/
MfE. (2009). Solid waste compostion: Environmental report card - July 2009. Retrieved from http://www.mfe.govt.nz/environmental-reporting/waste/waste-composition-2009/index.html
MfE. (2010). The New Zealand waste strategy: Reducing harm, improving efficiency (NZWS:2010). Retrieved from http://www.mfe.govt.nz/publications/waste/waste-strategy/
MfE. (2017a). *Briefing to the Incoming Minister for the Environment: 'ENVIRONMENT PORTFOLIO'*. Retrieved from Ministry for the Environment, Wellington, NZ: https://www.beehive.govt.nz/sites/default/files/2017-12/Environment.PDF
MfE. (2017b). *Review of the Effectiveness of the Waste Disposal Levy 2017*. Retrieved from New Zealand Ministry for the Environment, Wellington, NZ: http://www.mfe.govt.nz/sites/default/files/media/Waste/Review-of-the-effectiveness-of-the-waste-disposal-levy-2017.pdf
MfE (Producer). (accessed 2019). Redesigning our thinking – A circular economy. *Circular economy – Ōhanga āmiomio, New Zealand Ministry for the Environment, Wellington, NZ* Retrieved from https://www.mfe.govt.nz/waste/circular-economy
MfE, & LGNZ. (2000). Towards A National Waste Minimisation Strategy - Advice of the Waste Minimisation and Management Working Group on the establishment of a National Waste Minimisation Strategy for New Zealand: valuing our RESOURCES - preventing WASTE - protecting our ENVIRONMENT. Retrieved from www.mfe.govt.nz and www.lgnz.co.nz
Ministry for the Environment. (2002). Solid Waste Analysis Protocol (SWAP). Retrieved from www.mfe.govt.nz
Modal, P. (2017). *Circular Economy Opportunites*. Paper presented at the WasteMINZ, NZ. https://www.wasteminz.org.nz/wp-content/uploads/2017/11/Wasteminz-2017-Promises-of-the-circular-economy-in-Australasia.pdf
Mohan, S. V., Modestra, A., Amulya, K., Butti, S. K., & Velvizhi, G. (2016). A Circular Bioeconomy with Biobased Products from CO2 Sequestration. *Trends in Biotechnology, 34*(6), 506-519. doi:10.1016/j.tibtech.2016.02.012
Molinari, F., & Schumacher, J. (2011). *Best practices Database for Living Labs: Overview of the Living Lab approach & Living Lab Best Practice Database Specification*. Retrieved from https://www.yumpu.com/en/document/view/28112160/best-practices-database-for-living-labs-alcotra-innovation
Moňok, B., Stoykova, I., Bendere, R., Tömöri, B., & Popelková, J. (2009). *Zero waste as best environmental practice for waste management in CEE countries*. Retrieved from Czech Republich: www.ipen.org
Mont, T., & Lindhvquist, T. (2003). The role of public policy in advancement of product service systems. *Journal of Cleaner Production, 11*, 905-914.
Moore, C. J. (2008). Synthetic polymers in the marine environment: A rapidly increasing, long-term threat. *Environmental Research*(108), 131-139.

Morgan, D. L. (2008). Methodological implications of combining qualitative and quantitative methods. In V. L. Plano Clark, & Creswell, J. W. (Eds.). (2008). (Ed.), *The mixed methods reader.* Thousand Oaks, CA: SAGE.
Morgan, J. (2013). Amaze project aims to take 3D printing 'into metal age'. *BBC News: Science and Environment,* (15 October). Retrieved from www.bbc.com/news/science-environment-24528306
Morgan, J., Mitchell, P., & Green Alliance / WRAP. (2015). *Employment and the circular economy: Job creation in a more resource efficient Britain*. Retrieved from London: https://www.researchgate.net/publication/284186700_Employment_and_the_circular_economy_Job_creation_in_a_more_resource_efficient_Britain
Morris, D. (1997). Ensuring We Know What We're Wasting. *Youth Affairs / Associate Minister for the Environment - Speech*. Retrieved from https://www.beehive.govt.nz/speech/ensuring-we-know-what-were-wasting
Morris, J., Favoino, E., Lombardi, E., & Bailey, K. (2012). *What is the best disposal option for the "Leftovers" on the way to Zero Waste?* Retrieved from Boulder, Colarado: www.ecocycle.org/specialreports/leftovers
Morse, J. M., & Richards, I. (2002). *Read me first: For a users guide to qualitative methods*. Thousand Oaks, CA: Sage.
Morton, G. (1998). Civil society, municipal government and the state: enshrinement, empowerment and legitimacy. Scotland, 1800-1929. *Urban History, 25*(3), 248-367.
Motavalli, J. (2001). Zero Waste. *E: Environmental Magazine*(Mar/Apr), 27-33.
Murdoch, M. (2010). The road to zero waste: A study of the seattle green fee on disposable bags. *Environmental Practice, 12*(1), 66-75.
Murphy, S., & Princetl, S. (2013). Zero waste in Los Angeles: Is the emperor wearing any clothes? *Resources, Conservation and Recycling, 81*, 40-51.
Murray, R. (1999). *Creating Wealth from Waste*. London: Demos.
Murray, R. (2002). *Zero Waste*. London: Greenpeace Environmental Trust.
Nair, S. K., & Jayakumar, C. (2008). A Handbook for Waste Management in Rural Tourism Areas: A Zero Waste Approach. Ministry of Tourism, Government of India / UNDP. Retrieved from http://www.no-burn.org/article.php?id=630
Nakamura, T., Mabuchi, H., Okada, E., & Uesugi, H. (2000). Activities of the Total Energy and Materials Control System investigation committee in the Japan Research and Development Center for Metals. *ISIJ International, 40*(3), 212-217.
Nanotechnology Development Blog. (acessed 2013). Green refineries will offer zero waste products. (19 Feburary). Retrieved from http://www.nanotechnologydevelopment.com/news/green-refineries-will-off-zero-waste-products.html
Naylor, D. (2012). *Trash backwards: Innovating our way to zero waste*. Retrieved from www.islandpress.org Island Press e-ssential, Washington DC.
Nemerow, N., L. (1995). *Zero pollution for industry: Waste minimization through industrial complexes* Hoboken, NJ: Wiley-Interscience.
Nevens, F., Frantzeskaki, N., Gorissen, L., & Loorbach, D. (2013). Urban Transition Labs: co-creating transformative action for sustainable cities. *Journal of Cleaner Production, 50*, 111-122.
New Zealand Packaging Council. (accessed 2009). Conatiner Deposit Legislation. *Web page information*. Retrieved from http://www.packaging.org.nz/policy/policy_container_deposit_legislation.php
Nicol, S., & Thompson, S. (2007). Policy options to reduce consumer waste to zero: comparing product stewardship and extended producer responsibility for refrigerator waste. *Waste Management & Research, 25*, 227-233.
Niitamo, V.-P., Kulkki, S., Eriksson, M., & Hribernik, K. A. (2006). *State-of-the-Art and good practice in the field of living labs.* Paper presented at the 12th International Conference on Concurrent Enterprising: Innovative Products and Services through Collaborative Networks, Milan, Italy.

Nisbett, M. (2013). Protection, survival and growth: an analysis of international policy documents. *International Journal of Cultural Policy, 19*(1), 84-102. doi:10.1080/10286632.2011.605450
Noel, C. (2010). Solid waste workers and livelihood strategies in Greater Port-au-Prince, Haiti. *Waste Management, 30*, 1138-1148. doi:doi:10.1016/j.wasman.2010.01.029
NZBCSD. (2002). *Industry guide to zero waste: Towards zero waste and a sustainable New Zealand*. Retrieved from Auckland: http://www.nzbcsd.org.nz/
NZBCSD. (2007). *How Economic Incentives Motivate Sustainable Development: An Introduction*. Retrieved from Auckland, NZ: <http://www.nzbcsd.org.nz/economicincentives>
O'Brien, J. K. (2011). The landfill disposal rates of of waste-to-energy and zero-waste communities. *MSW Management, March-April*, 5.
O'Connell, F. (2011). *Zero waste in business*. London: Legends Business.
Oakdane Hollins Ltd. (2011). *EPOW: Eurpean pathway to zero waste: Demonstrating the route to zero landfill: Study into the feasibility of protecting and recovering critical raw materials through infrastructure development in the south east of England.* Retrieved from Reading, UK:
Oakes, P. (2008). Western Australia reaches for zero waste. *Biocycle, 49*(4), 49-50.
OECD. (2007). Guidance Manual for the Implementation of the OECD Recommendation C(2004)100 on Environmentally Sound Management (ESM) of Waste. *Paris, France*, 1-69. Retrieved from www.oecd-ilibrary.org
OECD. (2012a). *OECD Environmental Outlook to 2050: The consequences of inaction*. Retrieved from http://dx.doi.org/10.1787/9789264122246-en
OECD. (2012b). Sustainable Materials Management - Making Better Use of Resources. *Green Growth Policy Brief. Paris, France*, 20. Retrieved from www.oecd-ilibrary.org
OECD. (2015). *OECD Factbook 2015-2016: Environment and Science - Water and Waste*. Retrieved from Paris: http://www.oecd-ilibrary.org/docserver/download/3015041ec059.pdf?expires=1469141298&id=id&accname=guest&checksum=1463E7EDCE7681F195C6421596EF9C0C
OECD. (2016). *Extended Producer Responsibility: Updated Guidance for Efficient Waste Management*. Retrieved from OECD Publishing, Paris: www.oecd.org/environment/waste/
OECD. (2018). *Global Material Resources Outlook to 2060: Economic Drivers and Environmental Consequences*. Retrieved from Paris: https://www.oecd.org/environment/waste/highlights-global-material-resources-outlook-to-2060.pdf
Oko-Insitut e.V, CIEL, & ECOS. (2015). *Toxicity of engineered nanomaterials*. Retrieved from Berlin: http://www.oeko.de/oekodoc/2215/2015-002-en.pdf
Oreskes, N., & Conway, E. M. (2010). *Merchants of doubt: How a handful of scientists obscured the truth on issues from tobacco smoke to global warming*. London: Bloomsbury.
Owens-Wilson, S. (2013). *Transforming trash in urban America*. Retrieved from Washington DC: https://www.forworkingfamilies.org/blog/report-release-transforming-trash-urban-america
PACE, & WEF. (2019). *A New Circular Vision for Electronics - Time for a Global Reboot*. Retrieved from the Platform for Accelerating the Circular Economy (PACE) and the E-waste Coalition, Geneva: www.weforum.org
Palmer, P. (2004). *Getting to Zero Waste: Universal Recycling as a Practical Alternative to Endless Attempts to Clean-up Pollution*. Sebastol, CA: Purple Sky Press.
Park, S., & Berry, F. S. (2013). Analyzing effective municipal solid waste recycling programs: the case of county-level MSW recycling performance in Florida, USA. *Waste Management & Research, 31*(9), 896-901. doi:10.1177/0734242X13495725
Pauli, G. (1997). Zero emissions: the ultimate goal of cleaner production. *J. Cleaner Prod., 5*(1-2), 109-113. doi:10.1016/S0959-6526(97)00013-9
Pauli, G. (1998). Technology Forecasting and Assessment: The Case of Zero Emissions. *Technological Forecasting and Social Change, 58*, 53-62. doi:10.1016/S0040-1625(97)00055-3
Pauling, C., & Ataria, J. (2010). Tiaki Para: A Study of Ngai Tahu Values and Issues Regarding Waste. *Manaaki Whenua Press, Landcare Research, Lincoln, NZ, Landcare Research Science Series No. 39*.

PCE. (2006). *Changing Behaviour: Economic Instruments in the Management of Waste*. Retrieved from Parliamentary Commissioner for the Environment, Wellington, NZ: http://www.pce.parliament.nz/work_programme/reports_by_subject#472
Pearce, D., & Turner, R. (1989). *Economics of Natural Resources and the Environment,* . Baltimore, NJ: Johns Hopkins University Press.
Peters, M., Schmöle, P., Korthas, B., & Rüthe, P. (2004). *Improving productivity and reducing costs at the blast furnace - The experience of TKS.* Paper presented at the 2nd International Meeting on Ironmaking and 1st International Symposium on Iron Ore and Parallel Event- 5th Japan-Brazil Symposium on Dust Processing-Energy-Environment on Metallurgical Industries, Victoria, espirito Santo; Brazil.
Petticrew, M., & Roberts, H. (2006). *Systematic Reviews in the Social Sciences: A Practical Guide*. Oxford: Blackwell.
Pfau, S. F., Hagens , J. E., Dankbaar, B., & Smits, A. J. M. (2014). Visions of Sustainability in Bioeconomy Research. *Sustainability, 6*, 1222-1249. doi:10.3390/su6031222
Pierre, F. (2001, Dec 11-15). *Becoming a zero waste to landrill facility in the USA.* Paper presented at the IEEE Computer Society, Tokyo, Japan.
Pietzsch, N., Ribeiro, J., L, D, & Fleith de Medeiros, J. (2017). Benefits, challenges and critical factors of success for Zero Waste: A systematic literature review. *Waste Management, 67*, 324-353. doi:10.1016/j.wasman.2017.05.004
Planas, A., Soler, P., & Vila, M. (2014). Assessing youth policies. A system of indicators for local government. *Evaluation and Program Planning, 45*, 22-28. doi:10.1016/j.evalprogplan.2014.03.003
Plano Clark, V. L., & Creswell, J. W. (Eds.). (2008). *The mixed methods reader*. Thousand Oaks, CA: SAGE.
Plano Clark, V. L., & Ivankova, N. V. (2016). *Mixed methods research: A gudie to the field*. Thousand Oaks, CA: SAGE.
Platt, B. (2004). Resources up in Flames: The economic pitfalls of incineration versus a zero waste approach in the global south. *Institute of Local Self Reliance, Global Anti-Incinerator Alliance /Global Alliance for Incinerator Alternatives (GAIA)*. Retrieved from <http://www.no-burn.org/article.php?list=type&type=70>
Platt, B., Ciplet, D., Bailey, K. M., & Lombardi, E. (2008). Stop Trashing the Climate. Institute for Local Self-Reliance, Global Anti-Incinerator Alliance, Global Alliance for Incinerator Alternatives, Ecocycle. Retrieved from <http://www.ilsr.org/recycling/index.html>
PNCC. (2009). Waste Management and Minimisation Plan 2009. Retrieved from www.pncc.govt.nz
PNCC. (2012). *Waste Management and Minimisation Plan 2012: Summary of Information*. Retrieved from Palmerston North, NZ:
PNCC. (2019). *Waste Management & Minimisation Plan 2019*. Retrieved from Palmerston North, NZ https://www.pncc.govt.nz/media/3132018/waste-management-minimisation-2019.pdf
Pollans, L. B. (2017). Trapped in trash: 'Modes of governing' and barriers to transitioning to sustainable waste management. *Environment and Planning, 49*(10), 2300-2323. doi:10.1177/0308518X17719461
Pongrácz, E., & Pohjola, V. J. (2004). Re-defining waste, the concept of ownership and the role of waste management. *Resources Conservation and Recycling, 20*, 141-153. doi:10.1016/S0921-3449(03)00057-0
Popson, C. P. (2002). Museums: The truth is in our trash. *Archaeology: Online Archive, Archaeological Institute of America, 55*(1). Retrieved from http://archive.archaeology.org/0201/reviews/trash.html
Porritt, J. (2007). *Capitalism as if the world matters* (Revised ed.). London: Earthscan.
Premalatha, M., Tauseef, S. M., Tasneem Abbasi, & Abbasi, S. A. (2013). The promise and the performance of the world's first two zero carbon eco-cities. *Renewable and Sustainable Energy Reviews*(25), 660-669.

PS. (accessed 2014). *Benefits of 3D Printing: Zero or close to zero waste*. Retrieved from Cumming, USA: http://www.plasticscribbler.com/item/8-real-world-benefits-of-3d-printing
QSR. (2017). *The NVivo guide to mixed methods* Retrieved from Victoria, Australia. QSR International Pty Ltd: https://qsrinternational.com/MediaLibraries/QSR/QSR-Media/NVivo-guide-to-mixed-methods_Final.pdf?utm_campaign=ANZ%2B-%2BAug%2B17%2B-%2BROA%2BNewsletter&utm_source=Email&utm_medium=article&_cldee=ai5iLmhhbm5vbkBtYXNzZXkuYWMubno%3d&recipientid=contact-03964754309be6118d2c0050568a11bc-4df54c4670464a6c84db5c9f0552ad3f&utm_source=ClickDimensions&utm_medium=email&utm_campaign=APJ%20Newsletter_August_Stc_WH&esid=3e810417-a680-e711-a66e-0050568a11bc
Ragossnig, A. (2006). Zero waste - a desirable goal in residue utilization? (Editorial). *Waste Management & Research, 24*(5), 403-403. Retrieved from https://www.researchgate.net/publication/6677158_Zero_waste--a_desirable_goal_in_residue_utilization
Rajendran, K., Björk, H., & Taherzadeh, M. J. (2013). Borås, a zero waste city in Sweden. *Journal of Development Managment, 1*(1), 3-8.
RCBC. (2009). *On the Road to Zero Waste: Priorities for Local Government*. Retrieved from Vancouver: http://www.rcbc.ca/files/u7/policy_090622_zwlocgovreport.pdf
RCBC. (accessed 2014). What is zero waste. *Recycling Council of British Columbia*. Retrieved from http://www.rcbc.ca/resources/zero-waste
Recology. (accessed 2014). Waste Zero. Retrieved from http://www.recology.com/index.php/waste-zero
Reed, C. (2015). Plastic Age: How it's reshaping rocks, oceans and life. *New Scientist, 223*(3006).
Remenyi, D., & Money, A. (2004). *Research supervision for supervisors and students* Kidmore End, U.K.: Academic Conferences Ltd.
Repko, A. F. (2012). *Interdisciplinary Research: Process and Theory* (2nd ed.). Washington DC: Sage.
Repko, A. F., & Szostak, R. (2017). *Interdisciplinary research: Process and theory* (3rd ed.). Los Angeles: Sage.
Residua et al. (2001). Zero Waste. *Warmer Bulletin*. Retrieved from http://www.resourcesnotwaste.org/Warmer%20Bulletin
Rhoten, D. (2004). Interdisciplinary Research: Trend or Transition.
Richards, L. (2015). *Handling qualitative data: A practical guide* (3rd ed.). Thousand Oaks CA: SAGE.
Robinson, B. H. (2009). E-waste: An assessment of global production and environmental impacts. *Science of the Total Environment, 408*, 183-191.
Robinson, J., Berkhout, T., Cayuela, A., & Campbell, A. (2013). Next generation sustainability at The University of British Columbia: The university as a societal test-bed for sustainability. In A. Konig (Ed.), *Regenerative sustainable development of universities and cities: The role of living laboratories* (pp. 27-48). Cheltenham, UK: Edward Elgar.
Rogge, N., & De Jaeger, S. (2012). Evaluating the efficiency of municipalities in collecting and processing municipal solid waste: A shared input DEA-model. *Waste Management, 32*, 1968-1978. doi:http://dx.doi.org/10.1016/j.wasman.2012.05.021
Rosa, F. (2018). *Zero Waste Case Study 9: The Story of Besancon*. Retrieved from Zero Waste Europe, Netherlands: http://zerowasteeurope.eu/wp-content/uploads/edd-free-downloads-cache/CS9-Besancon-EN.pdf
Rosa, F., & Chatel, L. (2016a). *Zero Waste Case Study 7: The Story of Parma*. Retrieved from Zero Waste Europe, Netherlands: www.zerowasteeurope.eu
Rosa, F., & Chatel, L. (2016b). *Zero Waste Case Study 8: The Story of Roubaix*. Retrieved from Zero Waste Europe, Netherlands: www.zerowasteeurope.eu
Rostik, L. F. (1999). *EAF steel company and the by-product synergy environment.* Paper presented at the Symposium on Recycling, Waste Treatment and Clean Technology (REWAS 1999), San Sebastian, Spain.

Rucevska, I., Nellemann, C., Isarin, N., Yang, W., Liu, N., Yu, K., . . . Nilsen, R. (2015). *Waste Crime – Waste Risks: Gaps in Meeting the Global Waste Challenge*. Retrieved from Nairobi & Arendal: www.grida.no

Ryan, P. G., Moore, C. J., van Franeker, J. A., & Moloney, C. L. (2009). Monitoring the abundance of plastic debris in the marine environment. *Phil. Trans. R. Soc. B*(364), 1999-2012.

Sakai, S., Sawell, S. E., Chandler, A. J., Eighmy, T. T., Kosson, D. S., f, V., . . . Hjelmar, O. (1996). World trends in municipal soid waste managment. *Waste Management, 16*(5/6), 341-350.

Saldana, J. (2012). *The coding manual for qualitative researchers* (2nd ed.). Thousand Oaks, CA: SAGE.

Sanjeevi, V., & Shahabudeen, P. (2015). Development of performance indicators for municipal solid waste management (PIMS): A review. *Waste Management & Research, 33*(12), 1052-1065. doi:10.1177/0734242X15607428

Santally, M. I., Cooshna-Niak, D., & Conruyt, N. (2014). *A Model for the Transformation of the Mauritian Classroom based on the Living Lab Concept.* Paper presented at the IST-Africa 2014 Conference, Mauritius.

SBN-NZ. (2015). *Circular economy model office guide: The what, why and how of designing out waste in office refurbishments and builds*. Retrieved from Auckland:

Schaffers, H., Cordoba, M. G., Hongisto, P., Kallai, T., Merz, C., & van Rensburg, J. (2007). *Exploring business models for open innovation in rural Living Labs.* Paper presented at the 13th International Conference on Concurrent Enterprising, Sophia-Antipolis, France.

Scheinberg, A. (2010). *The need for the private sector in a zero waste, 3R and circular economy materials managment strategy - discussion draft*. Paper presented at the CSD 18/19 Intercessional, Tokyo. http://www.uncrd.or.jp/env/spc/docs/plenary3/PS3-f_WASTE_Anne%20Scheinberg.pdf

Schiele, H., Knox, H., Hannon, J., Finch, B., Britto, C., & Zhu, J. (2021). *Manawatu River Source to Sea: Plastic Pollution Challenge 2020-21 project report*. Retrieved from Environmental Network Manawatu, Palmerston North, NZ: https://www.enm.org.nz/plastic-challenge/pppc-report

Schnitzer, H., & Ulgiati, S. (2007). Less bad is not good enough: approaching zero emissions techniques and systems (editorial). *Journal of Cleaner Production*(15), 1185-1189.

Schumacher, J. (2013). *Alcotra Innovation project: Living Labs Definition, Harmonization Cube Indicators & Good Practices*. Retrieved from https://silo.tips/download/alcotra-innovation-project-living-labs-definition-harmonization-cube-indicators

Scott, J. (1990). *A matter of record: Documentary sources in social research*. Cambridge: Polity Press.

Seadon, J. K. (2010). Sustainable waste management systems. *Journal of Cleaner Production*(18), 1639-1651.

Seife, C. (2000). *Zero: The Biography of a Dangerous Idea*. New York: Penguin Group.

Seldman, N. (2004). Creating a zero waste future in Europe. *Biocycle, 45*(8), 66-67&70.

Seldman, N., Lease, K., Knapp, D., Liss, G., Schneider, A., Anthony, R., . . . Ward, T. (2000). *Del Norte Zero Waste Plan*. Retrieved from Del Norte: https://archive.grrn.org/reports/zwap/Del_Norte_TOC.pdf

Sen, S., Roy, J., Ranjan, K., & Mukhopadhyay, B. N. (2006). Recycling, usage and disposal of steel plant waste. *Journal of the Institution of Engineers (India) Part MM: Metallurgy and Material Science Division, 87*(Oct 2006), 23-41.

Shekdar, A. V. (2009). Sustainable solid waste management: An integrated approach for Asian countries. *Waste Management, 29*(4), 1438-1448.

Silva, A., Rosano, M., Stocker, L., & Gorissen, L. (2017). From waste to sustainable materials management: Three case studies of the transition journey. *Waste Management, 61*, 547-557. doi:10.1016/j.wasman.2016.11.038

Silva, A., Stocker, L., Mercieca, P., & Rosano, M. (2016). The role of policy labels, keywords and framing in transitioning waste policy. *Journal of Cleaner Production, 115*, 224-237. doi:10.1016/j.jclepro.2015.12.069

Simon, J.-M. (2015a). *Zero Waste Case Study 4: The Story of Contarina*. Retrieved from Zero Waste Europe, Netherlands: www.zerowasteeurope.eu

Simon, J.-M. (2015b). *Zero Waste Case Study 5: The Story of Ljubljana*. Retrieved from Zero Waste Europe, Netherlands: www.zerowasteeurope.eu
Simon, J.-M. (2015c). *Zero Waste Case Study 6: The Story of Gipuzkoa*. Retrieved from Zero Waste Europe, Netherlands: www.zerowasteeurope.eu
Smith, D. M. *Citizens plan for Zero Waste in New York City - Reaching for Zero*. Retrieved from New York: http://www.grrn.org/zerowaste/zerowaste_faq.html
Snow, W., & Dickinson, J. (2001). *The End of Waste: Zero Waste by 2020*. Retrieved from Auckland: www.zerowaste.co.nz
Snow, W., & Dickinson, J. (2003). *Getting there: The road to zero waste: Strategies for sustainable communities*. Retrieved from Auckland: www.zerowaste.co.nz
Snyman, J., & Vorster, K. (2010). Towards zero waste: a case study in the City of Tshwane. *Waste Management & Research, 29*(5), 512-520. doi:10.1177/0734242X10382947
Song, Q., Li, J., & X, Z. (2014). Minimizing the increasing solid waste through zero waste strategy. *Journal of Cleaner Production, 104*, 199-210. doi:10.1016/j.jclepro.2014.08.027
Soon-Ching, H., Shou-Chien, L., & Ying-Ying, L. (2007). *Zero waste policy for municipal solid waste in Taiwan*. Retrieved from EPA, Taipei, Taiwan: https://www.epa.gov.tw/public/Data/781614325071.pdf
Spiegelman, H. (2006). *Transitioning to Zero Waste - What can local governments do NOW? Within a Zero Waste / EPR planning framework, local governments will get out of the business of managing product wastes.* Retrieved from Portland Oregan: http://www.rcbc.ca/files/u3/PPI_Zero_Waste_and_Local_Govt.pdf
SQW energy, & The Scotish Government. (2010). *Meeting Scotland's zero waste targets assessing the costs associated with new waste management infrastructure*. Retrieved from Edinburgh: https://www.gov.scot/publications/meeting-scotlands-zero-waste-targets-assessing-costs-associated-new-waste/
SRMG Inc. (2009). *Environmental Life Cycle Assessment of Waste Management Strategies with a Zero Waste Objective: Study of the Solid Waste Management System in Metro Vancouver, British Columbia*. Retrieved from Olympia, WA: http://www.rcbc.ca/files/u7/ement_for_ZeroWaste_Objective_ReportJune2009.pdf
Stahel, W. R., & Reday-Mulvey, G. (1981). *Jobs for tomorrow: The potential for substituting manpower for energy*. Retrieved from New York: Vantage Press. Report for the Commission of the European Communities:
Stember, M. (1991). Advancing the Social Sciences Through the Interdisciplinary Enterprise. *Social Science Journal, 28*(1), 1-14.
Stern, N. H. (2006). Stern Review: The Economics of Climate Change. *HM Treasury UK - Report*, (Executive Summary). Retrieved from http://www.hm-treasury.gov.uk/d/Executive_Summary.pdf
Stern, N. H. (2009). *A blueprint for a safer planet: How to manage climate change and create a new era of progress and prosperity*. London: The Bodley Head.
Stock, P., & Burton, R. J. F. (2011). Defining Terms for Integrated (Multi-Inter-Trans-Disciplinary) Sustainability Research. *Sustainability, 3*, 1090-1113. doi:10.3390/su3081090
Stone, L. (2002). *From lifewith...to lifeafterwaste: A strategic approach*. Paper presented at the Waste Management Institute of NZ Annual Conference, Rotorua, NZ.
Strasser, S. (1999). *Waste and Want: A Social History of of Trash*. New York: Metropolitian Books Henry Holt and Company LLC.
Strijbos, J.-W., Martens, R. L., Prins, F. J., & Jochems, W. M. G. (2006). Content analysis: What are they talking about? *Computers & Education, 46*, 29-48.
Su, H. C., Lee, M. S., Yu, C. F., Huang, Y. C., & Hwang, I. J. (2005, Nov 09-15). *New approach to Taiwan's zero waste strategy - Perspectives of Tainan eco-industrial park*, Beijing, PEOPLES R CHINA.

Su, J.-P., Hung, M.-L., Chao, C.-W., & Ma, H.-w. (2010). Applying multi-criteria decision-making to improve the waste reduction policy in Taiwan. *Waste Management & Research, 28*, 20-28. doi:10.1177/0734242X09103839
Sukholthaman, P., & Sharp, A. (2016). A system dynamics model to evaluate effects of source separation of municipal solid waste management: A case of Bangkok, Thailand. *Waste Management, 52*, 50-61. doi:http://dx.doi.org/10.1016/j.wasman.2016.03.026
Sunthankar, M., & Aesf, A. (1999, Apr 20-22). *Zero-waste cadmium plating for the aerospace industry*, Jacksonville, Fl.
Sunthankar, M., & Joshi, S. (1998). *Zero-waste PVD cadmium for high strength steels*. Paper presented at the Airframe/Engine Maintenance and Repair Conference and Exposition: SAE Technical Papers, Long Beach, CA; U.S.
Sunthankar, M., & Joshi, S. (1999). The zero-waste, physical vapor deposition process addresses environmental concerns related to cadmium electroplating. *Aerospace Engineering, 19*(4), 39-41. Retrieved from https://www.researchgate.net/publication/298135541_The_zero-waste_physical_vapor_deposition_process_addresses_environmental_concerns_related_to_cadmium_electroplating
Surface Active Solutions. (2004). Technology today: Cleaning oil. *Process Engineering, 85*(5), 10. Retrieved from http://www.surfaceactive.com/index.html
Sustainability Victoria. (2007). Towards Zero Waste Strategy Progress Report for 2006-07. *Sustainability Victoria Annual Reporting*. Retrieved from <http://www.sustainability.vic.gov.au/www/html/1517-home-page.asp>
Suzuki, M. (2000). *Realization of a Sustainable Society: Zero-Emission Approaches*. Retrieved from Tokyo, Japan: http://archive.unu.edu/zef/publications_e/suzuki_intro_ZE.pdf
Swan, S. H., & Colino, S. (2021). *How Our Modern World Is Threatening Sperm Counts, Altering Male and Female Reproductive Development, and Imperiling the Future of the Human Race*: Scribner.
Tangri, N. (2003). *Waste Incineration: A Dying Technology*. Retrieved from Berkeley, CA: http://www.no-burn.org/
Tartiu, V., & Petrache, A. M. (2009). *The zero waste system - An enduring solution for the waste management in Romania?* Retrieved from Wien, Austria: www.iswa.org/uploads/tx_iswaknowledgebase/wm_2009_1-300.pdf
Tashakkori, A., & Teddlie, C. (2003). *Handbook of Mixed Methods is Social and Behavioral Research*. Thousand Oaks, CA: SAGE.
Tashakkori, A., & Teddlie, C. (Eds.). (2010). *SAGE Handbook of mixed methods in soical and behavioral research* (2nd ed.). Thousand Oaks, CA: SAGE.
Tathavadkar, V., Jha, A., Fülöp, T., Török, T., & Rédey, Á. (2005). *A comparison of the mineralogical characteristics and alkali roasting behaviour of red mud of different origins.* Paper presented at the REWAS'04 - Global Symposium on Recycling, Waste Treatment and Clean Technology, Madrid.
Taylor, S. (2014). *Waste Management Implications of 3D Printing*. Retrieved from Doha, Qatar: http://www.ecomena.org/3d-printing-waste-management/
Teigiserova, D., A, Hamelin, L., & Thomsen, M. (2020). Towards transparent valorization of food surplus, waste and loss: Clarifying definitions, food waste hierarchy, and role in the circular economy. *Science of the Total Environment, 706*. doi:10.1016/j.scitotenv.2019.136033
Tekin, N., Aslan, O., & Yilmaz, S. (2016). Research Trends on Socioscientific Issues: A Content Analysis of Publications in Selected Science Education Journals. *Journal of Education and Training Studies, 4*(9), 16-24. doi:10.11114/jets.v4i9.1572
Teshome, F. B. (2012). Municipal solid waste management in Ethiopia; the gaps and ways for improvement. *Journal of Material Cycles and Waste Management, 23*, 18-31. doi:10.1007/s10163-020-01118-y

Thakur, V., & Ramesh, A. (2015). Healthcare waste management research: A structured analysis and review (2005–2014). *Waste Management & Research, 22*(10), 855-870. doi:10.1177/0734242X15594248

Thanawala, P., & Seidel-Wassenaar, L. (2013). Towards the Goal of Zero Waste SWANA "Rags to Riches" Conference.

The Scottish Government. (2010). *Scotland's zero waste plan*. Retrieved from Edinburgh:

Themelis, N. J. (2009). Dont trash waste-to-energy plants. *Cape Cod Times*. Retrieved from http://www.capecodonline.com/apps/pbcs.dll/article?AID=/20091021/OPINION/910210332&cid=sitesearch

Themelis, N. J. (acccessed 2013). Search result: Comments by Prof. Themelis on "zero waste" discussion in D-Waste blog of Linked In:. Retrieved from http://www.seas.columbia.edu/earth/wtert/

Thompson, A. (2014). Burning trash bad for humans and global warming. *Scientific American, September*. Retrieved from http://www.scientificamerican.com/article/burning-trash-bad-for-humans-and-global-warming/

Townend, W., K. (2010). Zero waste: An aspiration or an oxymoron? *Waste Management and Research, 28*, 1-3.

Trencher, G., Yarime, M., McCormick, K. B., Doll, C. N. H., & Kraines, C. B. (2014). Beyond the third mission: Exploring the emerging university function of co-creation for sustainability. *Science and Public Policy, 41*, 151-179.

Trencher, G. P., Yarime, M., & Kharrazi, A. (2013). Co-creating sustainability: cross-sector university collaborations for driving sustainable urban transformations. *Journal of Cleaner Production, 50*, 40-55.

Tromans, S. (2001). EC waste law - A complete mess. *Oxford University Press, 13*, 133-156.

Troschinetz, A. M., & Mihelcic, J. R. (2009). Sustainable recycling of municipal solid waste in developing countries. *Waste Management*(29), 915-923.

Trotti, J. (Ed.) (2012). *MSW Management: SWANA Golden Anniversary Issue* (Vol. 22). Sanata Barbara. CA: Forrester Media Inc.

Truini, J. (1999). Zero waste seen on horizon. *Waste News*. Retrieved from http://www.richardanthonyassociates.com/articles/wastenews.html

Tsuzuki, T. (2010). *Nanotechnology commercialization* Florida, US: CRC Press.

Tucker, M. F. (2006). Zero waste plan for Vermont Solid Waste District. *Biocycle, 48*(10), 43-46&48.

Uitto, J. I. (2014). Evaluating environment and development: Lessons from international cooperation. *Evaluation, 20*(1), 44-57. doi:10.1177/1356389013517443

UN-Habitat. (2010). *Solid waste management in the worlds's cities*. London: Earthscan.

UNEP. (2009). *Developing Integrated Solid Waste Plan: ISWM Plan - Training Manuals Volume 1- 4*. Retrieved from Osaka/Shiga, Japan:

UNEP, UNITAR, Hyman, M., Turner, B., & Carpintero, A. (2013). *Guidelines for National Waste Management Strategies: Moving from challenges to opportunities*. Retrieved from Osaka / Switzerland: http://cwm.unitar.org/national-profiles/publications/cw/wm/UNEP_UNITAR_NWMS_English.pdf

USEPA. (2013). Solid Waste Management Hierarchy. Retrieved from http://www.epa.gov/wastes/nonhaz/municipal/hierarchy.htm

USEPA. (2015). U.S. EPA Sustainable Materials Management Program - Strategic Plan (2017-2022). Retrieved from https://www.epa.gov/sites/production/files/2016-03/documents/smm_strategic_plan_october_2015.pdf

van de Klundert, A., & Anschütz, J. (2001). *Integrated Sustainable Waste Management - the Concept: Tools for Decision-makers - Experiences from the Urban Waste Expertise Programme (1995-2001)*. Retrieved from Gouda, The Netherlands: www.waste.nl

Van Ewijk, S., & Stegemann, J. A. (2016). Limitations of the waste hierarchy for achieving absolute reductions in material throughput. *Journal of Cleaner Production, 132*, 122-128. doi:10.1016/j.jclepro.2014.11.051

Van Vliet, A. (2014a). *Zero Waste Europe Case Study 1: The Story of Capannori.* Retrieved from Netherlands: http://www.zerowasteeurope.eu/
Van Vliet, A. (2014b). *Zero Waste Europe Case Study 2: The story of Argentona*. Retrieved from Netherlands: http://www.zerowasteeurope.eu/
Van Vliet, A. (2014c). *Zero Waste Europe Case Study 3: The story of Vrhinika 'Slovenian traiblazers'*. Retrieved from Netherlands: http://www.zerowasteeurope.eu/
Varga, M., & Kuehr, R. (2007). Integrative approaches towards Zero Emissions regional planning: synergies of concepts. *Journal of Cleaner Production, 15*, 1373-1381. doi:10.1016/j.jclepro.2006.07.009
Vedung, E. (2010). Four Waves of Evaluation Diffusion. *Evaluation, 16*(3), 263-277. doi:10.1177/1356389010372452
Veleva, V., Bodkin, G., & Todorova, S. (2016). The need for better measurement and employee engagement to advance a circular economy: Lessons from Biogen's "zero waste" journey. *Journal of Cleaner Production, 154*, 517-529. doi:10.1016/j.jclepro.2017.03.177
Velis, C. A., Lerpiniere, D., & Tsakona, M. (2017). *Prevent marine plastic litter - now! An ISWA facilitated partnership to prevent marine litter, with a global call to action for investing in sustainable waste and resources management worldwide*. Retrieved from International Solid Waste Association (ISWA). An output of ISWA Marine Litter Task Force. Vienna, pp.75: http://marinelitter.iswa.org/marine-task-forcereport-2017/
Vision 2020. (accessed 2014). Acieving zero food waste to landfill - Households. *Vision 2020*. Retrieved from http://www.vision2020.info/support/households/
WA. (2001). Government of Western Australia, Department of Environmental Protection: Landfill Waste Classification and Waste Definitions. *Government of Western Australia, Perth*, 1-16.
Wainwright, O. (2014). Work begins on the world's first 3D-printed house. *The Guardian: Architecture and design blog,* (Friday, 28 March). Retrieved from http://www.theguardian.com/artanddesign/architecture-design-blog/2014/mar/28/work-begins-on-the-worlds-first-3d-printed-house
Warren, K., Grandy, S., Davis, G. A., Read, A., Fitzgerald, J., & Holdaway, E. (2013). *Waste to energy background paper - Zero Waste SA*. Retrieved from Adelaide, South Australia:
Waste Watch UK. (2004). *History of Waste and Recycling*. Retrieved from London: http://dl.dropbox.com/u/21130258/resources/InformationSheets/HistoryofWaste.pdf
WasteMINZ. (2001). *Lifeafterwaste: Closing the loop on waste by changing the way we act*. Auckland: The Waste Management Institute of New Zealand.
WasteMINZ. (2009). *WasteMINZ Behaviour Change Sector Group Practitioners Survey - Summary*. Retrieved from Auckland:
WasteMINZ. (2018). *Local Government Waste Management Manifesto: Developed by the Territorial Authority Forum, a sector group of WasteMINZ*. Retrieved from Auckland: https://www.wasteminz.org.nz/wp-content/uploads/2018/01/Local-Government-Waste-Manifesto-final-22012018.pdf
WasteMINZ, & Eunomia Research & Consulting. (2018). *Rebooting Recycling - What can Aotearoa do? A discussion paper presented by the Waste Management Institute of New Zealand (WasteMINZ)*. Retrieved from Auckland, NZ http://www.wasteminz.org.nz/wp-content/uploads/2018/05/Rebooting-Recycling.-What-can-Aotearoa-do-FINAL.pdf
WasteMINZ TA Forum. (2017). *Cost benefit analysis of a container depostit scheme: Summary report and FAQS*. Retrieved from Auckland: https://static1.squarespace.com/static/539a5fdee4b09201c768daef/t/5a25e1c324a694db5acab5dc/1512432077409/Cost+Benefit+Analysis+of+a+CDS+Summary+Report.pdf
WasteNot Consulting, & Maunsell Ltd. (2003). *Zero waste action planning system (ZAP): Zero waste strategy for Councils*. Retrieved from Wellington:
Watson, M. (2008). A review of literature and research on public attitudes, perceptions and behaviour relating to remanufactured, repaired and reused products. Pp. 1-17 and see also

the Remanufacturing Opportunity Tool (ReOpT). Retrieved from <http://www.remanufacturing.org.uk/>
Wegener, A. (1998). Evaluating Competitively Tendered Contracts - Local Governments in Comparative Perspective. *Evaluation, 4*(2), 189-203.
Welsh Assembly Government. (2010). *Towards Zero Waste: One Wales: One Planet - The overarching waste strategy document for Wales*. Retrieved from Cardiff: https://gov.wales/sites/default/files/publications/2019-05/towards-zero-waste-our-waste-strategy.pdf
Wen, L., Lin, C.-H., & Lee, S.-C. (2009). Review of recycling performance indicators: A study on collection rate in Taiwan. *Waste Management, 29*(8), 2248-2256.
Weng, Y.-C., Fujiwara, T., & Matsuoka, Y. (2009). Municipal solid waste management and short-term projection of the waste discard levels in Taiwan. *Journal of Material Cycles and Waste Management, 11*(2), 110-122.
Wiedinmyer, C., Yokelson, R. J., & Gullett, B. K. (2014). Global emissions of trace gases, particulate matter, and hazardous air pollutants from open burning of domestic waste. *Environmental Science & Technology, 48*, 9223-9530.
Williams, I. D. (2013). ZEROWIN. Retrieved from Retrieved May 2020 from http://www.southampton.ac.uk/mediacentre/news/2013/feb/13_30.shtml
Williams, M. (2000). *A sustainable resource management system for Wales: Introducing and using 'Cleanstream Total Resource Recovery Systems*. Retrieved from Cardiff: http://www.cylch.org.uk
Wilson, D., Eve, L., & Middleton, B. (2018). *Palmerston North City Council Waste Assessment*. Retrieved from Palmerston North, NZ http://palmerstonnorth.infocouncil.biz/Open/2018/12/PLA_20181203_AGN_7665_AT_files/PLA_20181203_AGN_7665_AT_Attachment_17527_3.PDF
Wilson, D., Eve, L., Yates, S., & Middleton, B. (2012). *Waste Assessment for Waste Management and Minimisation Plan Review: Prepared for the Palmerston North City Council*. Retrieved from Auckland:
Wilson, D. C. (1993). 'The landfill stepladder: Landfill policy and practice in an historical perspective. *Wastes Management, CIWM, Northampton, UK*, 24-28.
Wilson, D. C. (2007). Development drivers for waste management. *Waste Management and Research, 25*, 198-207.
Wilson, D. C., Rodic, L., Cowing, M. J., Velis, C. A., Whiteman, A. D., Scheinberg, A., . . . Oelz, B. (2015). 'Wasteaware' benchmark indicators for integrated sustainable waste management in cities. *Waste Management, 35*, 329-342. doi:10.1016/j.wasman.2014.10.006
Wilson, D. C., Rodic, L., Modak, P., Soos, R., Carpintero, A., Velis, C. A., . . . Simonett, O. (2015a). *Global Waste Management Outlook*. Retrieved from Austria: https://www.uncclearn.org/wp-content/uploads/library/unep23092015.pdf
Wilson, D. C., Rodic, L., Modak, P., Soos, R., Carpintero, A., Velis, C. A., . . . Simonett, O. (2015b). *Global waste management outlook: Summary for decision-makers*. Retrieved from Austria:
Wilson, D. C., Rodic, L., Scheinberg, A., Velis, C. A., & Alabaster, G. (2012). Comparative analysis of solid waste management in 20 cities. *Waste Management and Research, 30*(3), 237-254.
Wilson, D. C., & Scheinberg, A. (2010). What is good practice in solid waste management? (ed). *Waste Management & Research, 28*(12), 1055-1056.
Wilson, D. C., Velis, C. A., & Cheeseman, C. (2006). Role of informal sector recycling in waste management in developing countries. *Habitat International, 30*, 797-808.
Wilson, D. C., Velis, C. A., & Rodic, L. (2013). Integrated sustainable waste management in developing countries. *Waste and Resource Management, 166*(WR2), 52-68. doi:10.1680/warm.12.00005
Wilson, D. C., Whiteman, A., & Tormin, A. (2001). Strategic Planning Guide for Municipal Solid Waste Management. *World Bank*. Retrieved from www.worldbank.org/urban/solid_wm/erm/start_up.pdf

Wishart, L. (2015). *A Resourceful Aspiration: Understanding the Governmentality of Zero Waste in Scotland.* (PhD). University of St Andrews, Scotland.

Wismer, S., & Lopez de Alba Gomez, A. (2010). Evaluating the Mexican Federal District's integrated solid waste management programme. *Waste Managment & Research, 29*(5), 480-490. doi:10.1177/0734242X10380493

WMAA, & AIEN. (2013). Resource Recovery - It's just good business: 4th Australasian Industrial Ecology Conference. *Waste Management Association of Australia, Australian Industrial Ecology Network, Syndey.* Retrieved from http://www.wmaa.com.au/conf/cw2ie2013/home.html

Yoshida, H., Christensen, T. H., & Scheutz, C. (2013). Life cycle assessment of sewage sludge management: A review. *Waste Management & Research, 31*(11), 1083-1101. doi:10.1177/0734242X13504446

Young, C.-Y., Ni, S.-P., & Fan, K.-S. (2010). Working towards a zero waste environment in Taiwan. *Waste Management and Research, 28*(3), 236-244.

Yuan, H., Chini, A. R., Lu, Y., & Shen, L. (2012). A dynamic model for assessing the effects of management strategies on the reduction of construction and demolition waste. *Waste Management, 32*, 521-531. doi:10.1016/j.wasman.2011.11.006

Yuan, H., & Shen, L. (2011). Trend of the research on construction and demolition waste management. *Waste Management, 31*, 670-679.

Zaman, A. U. (2012). Developing a Social Business Model for Zero Waste Management Systems: A Case Study Analysis. *Journal of Environmental Protection, 3*, 1458-1469. doi:10.4236/jep.2012.311163

Zaman, A. U. (2013). Measuring waste management performance using the 'Zero Waste Index': the case of Adelaide, Australia. *Journal of Cleaner Production, xxx2013*, 1-13.

Zaman, A. U. (2014). Identification of key assessment indicators of the zero waste management systems. *Ecological Indicators, 36*, 682-693.

Zaman, A. U. (2015). A comprehensive review of the development of zero waste management: lesson learned and guidelines. *Journal of Cleaner Production, 91*, 12-25. doi:10.1016/j.jclepro.2014.12.013

Zaman, A. U. (2016). A comprehensive study of the environmental and economic benefits of resource recovery from global waste management systems. *Journal of Cleaner Production, 214*, 41-50. doi:10.1016/j.jclepro.2016.02.086

Zaman, A. U., & Ahsan, T. (2020). *Zero-Waste: Reconsidering Waste Management for the Future*. London: Routledge.

Zaman, A. U., Arnott, J., McIntyre, K., & Hannon, J. (2018). Resource harvesting through a systematic deconstruction of the residential house: a case study of the 'Whole House Reuse' project in Christchurch, New Zealand. *Sustainability, 10*(10), 3430. doi:10.3390/su10103430

Zaman, A. U., & Lehmann, S. (2011a). Challenges and Opportunities in Transforming a City into a "Zero Waste City". *Challenges, 2*, 73-93. doi:10.3390/challe2040073challenges

Zaman, A. U., & Lehmann, S. (2011b). Urban growth and waste management optimization towards 'zero waste city'. *City, Culture and Society, 2*, 177-187.

Zaman, A. U., & Lehmann, S. (2013). The zero waste index: a performance measurement tool for waste management systems in a 'zero waste city'. *Journal of Cleaner Production, 50*, 123-132.

Zaman, A. U., & Swapan, M. S. H. (2016). Performance evaluation and benchmarking of global waste management systems. *Resources, Conservation and Recycling, 114*, 32-41. doi:10.1016/j.resconrec.2016.06.020

Zeiss, C. (1999). Waste facility impacts on property values. *Waste Management & Research, 17*, 50-58.

Zero Waste Europe. (2012). Zero Waste Europe. Retrieved from http://www.zerowasteeurope.eu/

Zero Waste Europe. (2013). *Introducing Zero Waste Europe: The main principles*. Retrieved from Brussels https://www.foeeurope.org/sites/default/files/materials_and_waste/2015/introducing-zwe-the-main-principles.pdf

Zero Waste Europe. (2015). *Zero waste to landfill and/or landfill bans: false paths to a circular economy*. Retrieved from Brussels: www.zerowasteeurope.eu

Zero Waste Europe. (2017). *The Zero Waste Masterplan: Start-up toolkit for European city planner policy-makers and community leaders*. Retrieved from Netherlands: https://zerowastecities.eu/

Zero Waste Europe, & FPRCR. (2015). *Redesigning producer responsibility: A new EPR is needed for a circular economy - Executive summary.* . Retrieved from Brussels: https://www.zerowasteeurope.eu/zw-library/reports/

Zero Waste International Alliance. (accessed 2013). Zero Waste Standards. *ZWIA website (ed Liss, G).* Retrieved from http://zwia.org/standards/

ZeroWIN. (accessed 2013). Zero Waste Industrial Networks Project. Retrieved from http://www.zerowin.eu/

Zotos, G., Karagiannidis, A., Zampetoglou, S., Malamakis, A., Antonopoulos, I.-S., Kontogianni, S., & Tchobanoglous, G. (2009). Developing a holistic strategy for integrated waste management within municipal planning: Challenges, policies, solutions and perspectives for Hellenic municipalities in the zero-waste, low-cost direction. *Waste Management, 29*(5), 1686-1692.

Zucchetti, M. (2005). The zero-waste option for nuclear fusion reactors: Advanced fuel cycles and clearance of radioactive materials. *Annals of Nuclear Energy, 32*(14), 1584-1593. doi:10.1016/j.anucene.2005.04.005

Zucchetti, M., & Bonavigo, L. (2010). *Adavanced fuel fusion reactors: Towards a zero waste option.* Paper presented at the 1st International Nuclear and Renewable Energy Conference (INREC10), Amman, Jordan.

Zucchetti, M., Cambi, G., Cepraga, D., & Ciampichetti, A. (2007). Neutronics, activation and waste management of the Candor experiment. *Annals of Nuclear Energy, 34*(9), 687-692.

ZWA-UK. (accessed 2013). Zero Waste Alliance UK. Retrieved from http://www.zwallianceuk.org/circular-economy/

ZWIA. (accessed 2018). *Global Principles for Zero Waste Communities: The Zero Waste Hierarchy* Retrieved from San Diego, US.: Retrieved May 2020 from http://zwia.org/zwh/

Zwier, J., Blok, V., Lemmens, P., & Geerts, R.-J. (2015). The ideal of a zero-waste humanity: Philosophical reflections on the demand for a bio-based economy. *Journal of Agricultural Environmental Ethics, 28*, 353-374. doi:10.1007/s10806-015-9538-y

ZWNZ Trust. (2007). What is zero waste? *Zero Waste New Zealand Trust, Kaipatiki Project. Auckland.* Retrieved from Reterived 2015, from http://www.zerowaste.co.nz/zero-waste-1/about-us-2/

ZWSA. (2005a). Background Paper to South Australia's Waste Strategy 2005-2010. *Zero Waste South Australia Publication*. Retrieved from <http://www.zerowaste.sa.gov.au/Home.mvc>

ZWSA. (2005b). South Australia's Waste Strategy 2005-2010. *Zero Waste South Australia Publication*, 1 -19. Retrieved from <http://www.zerowaste.sa.gov.au/Home.mvc>

ZWSA. (2011). *South Australia's Waste Strategy 2011-2015*. Retrieved from Adelaide: http://www.zerowaste.sa.gov.au/upload/resource-centre/publications/waste-strategy/4821/ZWSA%20WASTE%20STRATEGY%2011.12.11.pdf

ZWSA. (2013). *Interim consultation paper: Zero Waste SA position on waste to energy*. Retrieved from Adelaide, South Australia:

ZWSA, MMA, & BDA Group. (2007). South Australia's waste strategy 2005 -2010 benefit cost assessment, Volume 1: Summary report. Retrieved from <http://www.zerowaste.sa.gov.au/Publications.mvc/List>

Glossary of Terms:

GLOSSARY OF TERMS / ABBREVIATIONS & ACRONYMS		
16R: A new zero waste hierarchy proposed by this research	HDPE: High-density polyethylene	RA: Risk Analysis
3 / 5 / 6 / / #R: Various number versions of a waste hierarchy	HEV: Hybrid Electric Vehicle	RC: Responsible care
3Cs: Confine, Compact, Cover	HHW: Household hazardous waste	RCBC: Recycling Council of British Columbia
3-R Forum: A programme of UNCRD	HIC: High-income country	RDF: Refuse Derived Fuel
3-R: Reduce, Reuse, Recycle	HSNO: Hazardous Substances and New Organisms Act 1996.	RE: Recycling
5-Ps: Pro-poor public–private partnerships	ID: Identify	Recology: A worker owned cooperative company providing service to San Francisco https://www.recology.com/
A: Alaminos, Philippines	IDR: Interdisciplinary research	Recyclate: Material resources separated and processed for recycling
ACR+: Association of Cities and Regions for Recycling and Sustainable Resource Management	IE / IS: Industrial ecology / symbiosis	REE: Rare Earth Elements
ACT: Australian Capital Territories	IGO: Intergovernmental organisation	REEE: Recycled / Reused electrical electronic equipment
AD: Anaerobic digestion	ILO: International Labour Organisation	REPA: Resource and Environmental Profile Analysis
ADF / ARF: Advanced disposal/recycling fee	IMO: International Maritime Organisation	RF: Remanufacturing
AIEN: Australian Industrial Ecology Network	IPC/F: Intermediate processing centre / facility	RFID: Radio frequency identification
APPA: The Aotearoa Plastic Pollution Alliance http://nzappa.org/	IPC: Integrated Pollution Control	RG: Regeneration
ASEAN: Association of Southeast Asian Nations	IPCC: Intergovernmental Panel on Climate Change	RHoS: Restriction on Hazardous Substances
AUT: Auckland University of Technology https://www.aut.ac.nz/	IPLA: International Partnership for Expanding Waste Management Services of Local Authorities	RLP: Recycling Linkages Programme
BA: Buenos Aires, Argentina	IPPC: Integrated Pollution Prevention and Control	RMA: Resource Management Act 1991

BAU: 'Business as usual'	ISO: International Standards Organisation	RoI / RfP: Registration of interest / Request for proposals
BE: Bio-economy	ISP: Informal service provider	RP: Repair
BMW: Biomedical waste	ISWA: International Solid Waste Association	RRC / RRP / RRN: Resource recovery center / park / network
BOD: Biological oxygen demand	ISWM: integrated solid (sustainable) waste management	RRDF: Refined Renewable Biomass Fuel
C&D: Construction and demolition waste	ISWMP: Integrated Solid Waste Management Programme	RRF: Resource Recovery Forum
C&I: Commercial and industrial waste	IULA: International Union of Local Authorities	RU: Reuse
C/N ratio: Carbon/Nitrogen ratio (weight ratio)	IWB: Itinerant waste buyer	RV: Recovery
CA: Content analysis	JV: Joint venture	SA: Sustainability Assessment
CAQDAS: Computer Assisted Qualitative Data Analysis Software	JWG: Joint Working Group	SC: Selective Collection (source separated collection)
CBA: Cost benefit analysis	Kg/pp/dy/yr: Kilogram per person per day / year	SC: Sustainable consumption
CBE: Community-based enterprise	Kiwi Bottle Drive: https://kiwibottledrive.nz/	SCM: Supply chain management
CBO: Community-based organisation	kWh: Kilowatt-hour	SD: Sustainable development
CC: Centralised Composting	LAPC: Local Authority Pollution Control	SEA: Strategic Environmental Assessment
CC: Climate change	LCA / LCM: Life Cycle Analysis / Management	SEEDA: South East of England Development Agency
CCL: Climate Change Levy	LCAA: Life Cycle Activity Analysis	SEIA: Strategic environmental impact assessment
CDD: Construction deconstruction and demolition	LCC: Life Cycle Costing	SEPA: Scottish Environment Protection Agency
CDM: Clean Development Mechanism	LCCA: Life Cycle Cost Analysis	SETAC: Society of Environmental Toxicology and Chemistry
CDS / CRS: Container deposit/refund system	LCD: Liquid Crystal Display	SF: San Francisco, US
CE: Circular economy	LCI: Life cycle inventory	SFA: Substance Flow Analysis
CEM: Continuous Emissions Monitoring	LCIA: Life cycle impact assessment	SLCA: Social Life Cycle Assessment

CER: Certified emission reduction (generated through the CDM)	LCO: Life Cycle Optimisation	SME: Small- and medium-sized enterprise
CF: Carbon Footprint	LCT: Life Cycle Thinking	SMM: Sustainable materials management
CF: Coding framework	LD: Landfill Directive	SP: Sustainable production
CH4: Methane	LDC: Least / less developed country consist of all countries except those in the “more-developed” category	SPD: Sustainable Process Design
CHP: Combined Heat and Power	LDPE: Low-density polyethylene	SPG: Strategic Planning Guide for Municipal Solid Waste Management
CIWM: ‘Chartered Institute of Wastes Management’ UK	LED: Light Emitting Diode	SPREP: South Pacific Regional Environment Program
CIWMB: California Integrated Waste Management Board	LF: Landfill	SR: Source reduction
CLO: Compost-Like Output	LFG: Landfill gas capture/extraction	SRE: Social responsibility
CO: Carbon monoxide	LGA 1974 / 2002: Local Government Act 1974 and or 2002	SRF: Solid Recovered Fuel (see "RDF")
CO2e: Carbon dioxide equivalent	LGA local government authority	SRMG: Sound Resource Management Group
COD: chemical oxygen demand	LGA: local government areas	SS: Separation at source
COP: Conference of the Parties	LGNZ: Local Government New Zealand.	STEM: ‘Science Technology Engineering and Mathematics’
CP: Cleaner production	LIC: Low-income country	Store-fill / Mono-fill: a specific type of temporary landfill storage with the anticipation of enabling future recovery and recycling / landfill mining
CRN: Community Recycling Network	LL: Living labs	STS: Small transfer station
CRT: Cathode Ray Tube	LMIC: Lower middle-income country	SWANA: Solid Waste Association of North America
CV: Calorific Value	LMRF: Large material recovery facility	SWAP: ‘Solid waste analysis protocol’ typically used in NZ for monitoring the mass and composition of waste to landfill
DBOO: Design–build–own–operate	LoveNZ: The National recycling brand / logo for New Zealand	SWM: Solid waste management
DEFRA: Department of Environment Food and Rural Affairs	LP: LaPintana, Chile	T: Taiwan

DeNox: NOx removal technology	LR: Literature review / lit. rev.	TCA: Total Cost Accounting
DfE: Design for the environment	LTS: Large transfer station	TCO: Total Cost of Ownership
Dirty MRF: – a specific types of MRF usually processing C&D + C&I skip bin types waste for recycling	M: Mumbai, India	tCO2e: Tons of carbon dioxide equivalent
DIY: Do it yourself	MBT: Mechanical biological treatment	TDC: Taupō District Council https://www.taupodc.govt.nz
DRDF: Densified Refuse Derived Fuel	MCA: Multi Criteria Analysis	TEQ: Toxic Equivalent
D-Waste: An international initiative to share and improve waste data	MDC: The more-developed countries (MDC): are Australia, Canada, the European Union EU15, Norway, Switzerland, Japan, New Zealand, and the United States	Tetrapak: proprietary brand of multi-layered multi material packaging which is regarded as being difficult to recycle
E2: Eco-efficiency	MDG: Millennium Development Goal	The Rubbish Trip: https://therubbishtrip.co.nz/
EA: Energy/Exergy Analysis	Megacity: Definitions vary but a megacity is a very large city, typically with a population of more than 10 million people.	TPA: Tonnes Per Annum
EA: Environment Agency	MfE: New Zealand Ministry for the Environment	TPD: (metric) Tonnes per day
EAcc: Environmental accounting	MIPS: Material Input Per unit of Service	TPY: (metric) Tonnes per year
EC: European Commission	MJ: Megajoule	TRACI: Tool for the Reduction and Assessment of Chemical and other environmental Impacts
ED: Eco-design	MMR–HCA-T-MZWM quant + QUAL(quant): Mixed methods research - hermeneutic content analysis - theme/thematic – municipal zero waste methodology - quantitative + qualitative	TRI: Toxics Release Inventory
eDay NZ Trust: https://www.eday.org.nz/	MRBT: Mechanical recovery biological treatment a deliberately	TS: Transfer Station
EE: Environmental engineering	MRF: Municipal recycling / recovery faciliatory - usually processing general (i.e. curbside collected) recyclables	UA: Unitary Authority
EEA Eco-Efficiency Analysis	MRU: Minimisation of resource usage	UBC: Used beverage container
EEA: European Environment Agency	MS EXCEL: Microsoft Excel software	UEEE: Used electrical electronic equipment

EEC: Earth Engineering Centre	MS WORD: Microsoft Word software	UK: Untied Kingdom of Britain
EEE: Electronic and Electrical Equipment	MSE: Micro- and small enterprise	UM: Urban metabolism
EE-IOA: Environmental Extended Input- Output analysis	MZWM: Municipal zero waste methodology	UMIC: Upper middle-income country
EfS: Education for Sustainability	NBRIC: Nanotechnology, Biotechnology, Radioactive, Information Communication types of wastes	UNCHS: United Nations Centre for Human Settlements (Habitat) (now UN-Habitat)
EfW: Energy from Waste	NfP: Not for profit - also 'more than profit' community enterprise business model	UNCRD: United Nations Centre for Regional Development
EfWg: Energy from Waste Gasification	NGO: Non-government organisations	UNCTAD: United Nations Conference on Trade and Development
EfWi: Energy from Waste Incineration	NIMBY: 'Not In My Back Yard'	UNDESA: United Nations Department of Economic and Social Affairs
EfWp: Energy from Waste Pyrolysis	NIZAC: Nexus for International Zero Waste Academic Collaboration	UNDP: United Nations Development Programme
EI: Ethical investment	NVivo: The proprietary brand-name of a type of Computer Assisted Qualitative Data Analysis Software (CAQDAS)	UNEP: United Nations Environment Program
EIA: Environmental Impact Assessment	NZ: New Zealand	UNESCO: United Nations Educational, Scientific and Cultural Organisation
EIP: Eco-industrial park	NZBCSD: New Zealand Business Council for Sustainable	UNFCCC: United Nations Framework Convention on Climate Change
EIT: Economies in transition (former Soviet Union and Central and Eastern European nations)	NZIER: New Zealand Institute of Economic Research	UN-Habitat: https://unhabitat.org/
EL: Environmental legalisation	NZPSC: New Zealand Product Stewardship Council https://nzpsc.nz/	UNIDO: United Nations Industrial Development Organisation
EMC: Environmental Municipal Commission	NZWS: New Zeeland Waste Strategy	UNITAR: United Nations Institute for Training and Research
EMS: Environmental management strategy	OECD: Organisation for Economic Cooperation and Development	Unpackit: An awareness raising awards programme for NZs best and worst packaging
Enviro-schools: https://enviroschools.org.nz/	∞: Infinity – continuum symbol	UNSDGs: United Nations Sustainable Development Goals
Envision NZ: https://www.envision.nz/	OR: Organic recycling	URF: Uniform reporting format

EoL: End of Life	OSH: Occupational safety and health	US: United States
EPA: Environmental Protection Act (or Agency)	P: Pune, India	USEPA: United States Environmental Protection Agency
EPLCA: European Platform on Life Cycle Assessment	P: Purification	USGS: United States Geological Survey
EPR: Extended producer responsibility	P2: Pollution prevention	UWEP: Urban Waste Expertise Programme
ERM: Environmental Resources Management	PAH: Polycyclic Aromatic Hydrocarbons	VCS: Voluntary Carbon Standard
ERMA: Environmental Risk Management Authority.	Para Kore: The Maori phrase for zero waste	VEA: Voluntary environmental agreement
ERU: Emissions reduction unit (generated through joint implementations projects)	PAYT: 'Pay as you Throw'	VOC: Volatile organic compound
ESD: Environmentally sustainable (green) design	PBDE: Polybrominated diphenyl ether	VOS: Voluntary Offset Standard
ESM: Environmentally sound management	PC: Pollution control	W→ZW: Waste to zero waste transition spectrum
ET: Environmental technology	PCB: Polychlorinated biphenyl	W2E / WtE: Waste to Energy
EU ETS: European Union Emissions Trading Scheme	PCE: New Zealand Parliamentary Commission to the Environment https://www.pce.parliament.nz/	WA: Western Australia
EU: European Union	PET: Polyethylene terephthalate	WAC: Waste Acceptance Criteria
EV: Electric Vehicle	PFC: Perfluorocarbon	Waste Watchers: https://www.wastewatchers.co.nz/
EWC: European Waste Catalogue	PFD: Process flow diagram	WasteMINZ: Waste Management Institute of New Zealand https://www.wasteminz.org.nz/
EW-MFA: Economy-wide Material Flow Analysis	PFI: Private Finance Initiative	WC: Word-count
F: Flanders, Belgium	PGM(s): Platinum Group Metal(s)	WCA: Waste Collection Authority
FCM: Federation of Canadian Municipalities	PHEV: Plug-in Hybrid Vehicle	WCC: World Climate Conference
FGT: Flue Gas Treatment	PIL: Public interest litigation	WDA: Waste Disposal Authority
Freecycle: a web based free recycling / sharing platform.	PIMS: Performance indicators for municipal solid waste management	WEEE: Waste electrical and electronic equipment
FX: Factor X	PM: Particulate Matter	WFD: Waste framework directive

GAIA :Global anti-Incinerator Alliance / Global Alliance for Incinerator Alternatives https://www.no-burn.org/	PMCSA: Prime Ministers Chief Science Advisor	WHO: World Health Organisation
GC: Green chemistry	PNCC: Palmerston North City Council	WID: Waste Incineration Directive
GCOS: Global Climate Observing System	POEMS: Product Oriented Environmental Management System	WISARD: Waste Integrated Systems Assessment for Recovery and Disposal
GDP: Gross Domestic Product	PP: 'Polluter pays' principle	WM: Waste minimisation
GHG: Greenhouse Gas	PP: Polypropylene	WMA:2008 Waste Minimisation Act
GIS: Geographical information systems / Green investment scheme	PPC: Pollution Prevention and Control	WMAA: Waste Management Association of Australia
GNP: Gross national product	PPPP: Public Private People / Planet partnerships	WMF: Waste Minimisations Fund
GOVT3: A program promoting triple bottom line report and sustainability in the New Zealand public sector	PPP-SD: public–private partnership for sustainable development	WMMP: Waste Management and Minimisation Plan
Green Ribbon: An awards program recognising environmental initiatives in NZ	PRN: Packaging Recovery Note	WPA: Waste Planning Authority
GRRN: Grass Roots Recycling Network http://www.grrn.org	PS: Polystyrene	WRAP: Waster Resources Action program – UK
GS: Gold Standard	PS: Product stewardship	WREP: Waste and Resources Evidence Programme
GWh: Gigawatt-hour	PSP: Private-sector participation	WSSD: World Summit on Sustainable Development
GWP: Global Warming Potential	PSS: Product service system	ZWA: Zero Waste Academy
H&S: Health and safety (or OHS Occupational Health and Safety	Q&Q, q&Q, q&q, quant/QUANT and qual/QUAL: quantitative and qualitative in various order and emphasis	ZWA-LL: Zero Waste Academy – Living Lab
H: Herani, Spain	QAQC: Quality assurance quality control	ZWIA: Zero Waste International Alliance https://zwia.org/
Hazwaste: Hazardous waste	QCA: Qualitative content analysis	ZWN: Zero Waste Network https://zerowaste.co.nz/
HC: Home composting	QDA: Qualitative / quantitative data analysis (depending on clarification of usage)	ZWSA: Zero Waste South Australia
HCA: Hermeneutic content analysis	R&D: Research and Development	ZWtL: Zero waste to landfill

HCC: Hamilton City Council https://www.hamilton.govt.nz	R2: Renewable resources	
HDI: Human Development Index	∞ infinity – continuum symbol	

Appendix 1: Publications and Publication declaration forms:

1A- Waste vs zero waste: The contest for engaging and shaping our ambient 'waste-making' culture (Hannon, 2015).

DRC 16

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

GRADUATE RESEARCH SCHOOL

STATEMENT OF CONTRIBUTION
DOCTORATE WITH PUBLICATIONS/MANUSCRIPTS

We, the candidate and the candidate's Primary Supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the candidate's contribution as indicated below in the *Statement of Originality*.

Name of candidate:	Jonathon B Hannon
Name/title of Primary Supervisor:	Professor Chris Anderson
In which chapter is the manuscript /published work:	Chapter One

Please select one of the following three options:

(●) The manuscript/published work is published or in press

- Please provide the full reference of the Research Output:

Hannon, J. (2015). Waste vs zero waste: The contest for engaging and shaping our ambient 'waste-making' culture. Paper presented at the Unmaking Waste 2015: Transforming production and consumption in time and place, Zero Waste SA Research Centre for Sustainable Design and Behaviour and the University of South Australia, Adelaide. https://www.unisa.edu.au/research/china-

( ) The manuscript is currently under review for publication – please indicate:

- The name of the journal:
- The percentage of the manuscript/published work that was contributed by the candidate:
- Describe the contribution that the candidate has made to the manuscript/published work:

( ) It is intended that the manuscript will be published, but it has not yet been submitted to a journal

Candidate's Signature:	Digitally signed by Jonathon Hannon DN: cn=Jonathon Hannon, c=NZ, o=Massey University, ou=School of Agriculture and Environment, email=j.b.hannon@massey.ac.nz Date: 2022.06.08 11:08:55 +12'00' Jonathon Hannon
Date:	08-Jun-2022
Primary Supervisor's Signature:	Chris Anderson Digitally signed by Chris Anderson DN: cn=Chris Anderson, c=NZ, o=Massey University, ou=School of Agriculture and Environment, email=c.w.n.anderson@massey.ac.nz Location: Palmerston North Date: 2022.07.04 14:42:01 +12'00'
Date:	4-Jul-2022

This form should appear at the end of each thesis chapter/section/appendix submitted as a manuscript/ publication or collected as an appendix at the end of the thesis.

GRS Version 5 – 13 December 2019
DRC 19/09/10

1B- Future Cities: Exploring the phenomenon of zero waste (Hannon & Zaman, 2018).

DRC 16

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

GRADUATE RESEARCH SCHOOL

STATEMENT OF CONTRIBUTION
DOCTORATE WITH PUBLICATIONS/MANUSCRIPTS

We, the candidate and the candidate's Primary Supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the candidate's contribution as indicated below in the *Statement of Originality*.

Name of candidate:	Jonathon B Hannon
Name/title of Primary Supervisor:	Professor Chris Anderson

In which chapter is the manuscript /published work: Chapther One

Please select one of the following three options:

(●) The manuscript/published work is published or in press

- Please provide the full reference of the Research Output:

Hannon, J., & Zaman, A. U. (2018). Future Cities: Exploring the phenomenon of zero waste. Urban Science, 2(90 - Special Issue Future Cities: Concept, Planning, and Practice), 1-26. doi: 10.3390/urbansci2030090

( ) The manuscript is currently under review for publication – please indicate:

- The name of the journal:
- The percentage of the manuscript/published work that was contributed by the candidate:
- Describe the contribution that the candidate has made to the manuscript/published work:

( ) It is intended that the manuscript will be published, but it has not yet been submitted to a journal

Candidate's Signature:	Jonathon Hannon
Date:	08-Jun-2022
Primary Supervisor's Signature:	Chris Anderson
Date:	4-Jul-2022

This form should appear at the end of each thesis chapter/section/appendix submitted as a manuscript/ publication or collected as an appendix at the end of the thesis.

GRS Version 5 – 13 December 2019
DRC 19/09/10

Moving Toward Zero Waste Cities: A Nexus for International Zero Waste Academic Collaboration (NIZAC) (Hannon et al., 2018).

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

GRADUATE RESEARCH SCHOOL

STATEMENT OF CONTRIBUTION
DOCTORATE WITH PUBLICATIONS/MANUSCRIPTS

We, the candidate and the candidate's Primary Supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the candidate's contribution as indicated below in the *Statement of Originality*.

Name of candidate:	Jonathon B Hannon
Name/title of Primary Supervisor:	Professor Chris Anderson

In which chapter is the manuscript /published work: Chapther One

Please select one of the following three options:

(●) The manuscript/published work is published or in press

- Please provide the full reference of the Research Output:

Hannon, J., Zaman, A. U., Rittl, G., Meireles, S., & Demore-Palandi, F. E. (2018). Moving Toward Zero Waste Cities: A Nexus for International Zero Waste Academic Collaboration (NIZAC). In W. Leal Filho & U. Bardi (Eds.), Sustainability on University Campuses: Learning, Skills Building and Best Practices. Switzerland AG: Springer Nature.

( ) The manuscript is currently under review for publication – please indicate:

- The name of the journal:
- The percentage of the manuscript/published work that was contributed by the candidate:
- Describe the contribution that the candidate has made to the manuscript/published work:

( ) It is intended that the manuscript will be published, but it has not yet been submitted to a journal

Candidate's Signature:	Digitally signed by Jonathon Hannon DN: cn=Jonathon Hannon, c=NZ, o=Massey University, ou=School of Agriculture and Environment, email=j.b.hannon@massey.ac.nz Date: 2022.06.08 11:11:27 +12'00' Jonathon Hannon
Date:	08-Jun-2022
Primary Supervisor's Signature:	Chris Anderson Digitally signed by Chris Anderson DN: cn=Chris Anderson, c=NZ, o=Massey University, ou=School of Agriculture and Environment, email=c.w.n.anderson@massey.ac.nz Location: Palmerston North Date: 2022.07.04 13:41:14 +12'00'
Date:	4-Jul-2022

This form should appear at the end of each thesis chapter/section/appendix submitted as a manuscript/ publication or collected as an appendix at the end of the thesis.

2C- (Un) Changing Behaviour: (New Zealand's delay & dysfunction in utilising) Economic Instruments in the Management of Waste? (Hannon, 2018).

DRC 16

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND
GRADUATE RESEARCH SCHOOL

STATEMENT OF CONTRIBUTION
DOCTORATE WITH PUBLICATIONS/MANUSCRIPTS

We, the candidate and the candidate's Primary Supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the candidate's contribution as indicated below in the *Statement of Originality*.

Name of candidate:	Jonathon B Hannon
Name/title of Primary Supervisor:	Professor Chris Anderson
In which chapter is the manuscript /published work:	Chapther Two

Please select one of the following three options:

(●) The manuscript/published work is published or in press

- Please provide the full reference of the Research Output:

Hannon, J. (2018). (Un) Changing Behaviour: (New Zealand's delay & dysfunction in utilising) Economic Instruments in the Management of Waste? Retrieved from Palmerston North, New Zealand. https://nzpsc.nz/wp-content/uploads/2018/09/NZPSC-open-submission-to-PCE-v-final-sept-2018.pdf

( ) The manuscript is currently under review for publication – please indicate:

- The name of the journal:

- The percentage of the manuscript/published work that was contributed by the candidate:

- Describe the contribution that the candidate has made to the manuscript/published work:

( ) It is intended that the manuscript will be published, but it has not yet been submitted to a journal

Candidate's Signature:	Jonathon Hannon (Digitally signed by Jonathon Hannon DN: cn=Jonathon Hannon, c=NZ, o=Massey University, ou=School of Agriculture and Environment, email=j.b.hannon@massey.ac.nz Date: 2022.06.08 11:11:58 +12'00')
Date:	08-Jun-2022
Primary Supervisor's Signature:	Chris Anderson (Digitally signed by Chris Anderson DN: cn=Chris Anderson, c=NZ, o=Massey University, ou=School of Agriculture and Environment, email=c.w.n.anderson@massey.ac.nz Location: Palmerston North Date: 2022.07.04 16:10:29 +12'00')
Date:	4-Jul-2022

This form should appear at the end of each thesis chapter/section/appendix submitted as a manuscript/ publication or collected as an appendix at the end of the thesis.

GRS Version 5 – 13 December 2019
DRC 19/09/10

2B- Exploring and Illustrating the (Inter-)Disciplinarity of Waste and Zero Waste Management (Hannon, 2020).

DRC 16

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

GRADUATE RESEARCH SCHOOL

STATEMENT OF CONTRIBUTION
DOCTORATE WITH PUBLICATIONS/MANUSCRIPTS

We, the candidate and the candidate's Primary Supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the candidate's contribution as indicated below in the *Statement of Originality*.

Name of candidate:	Jonathon B Hannon
Name/title of Primary Supervisor:	Professor Chris Anderson

In which chapter is the manuscript /published work: Chapther Two

Please select one of the following three options:

(●) The manuscript/published work is published or in press

- Please provide the full reference of the Research Output:

Hannon, J. (2020). Exploring and Illustrating the (Inter-)Disciplinarity of Waste and Zero Waste Management Urban Science, 73(4). doi:10.3390/urbansci4040073

( ) The manuscript is currently under review for publication – please indicate:

- The name of the journal:
- The percentage of the manuscript/published work that was contributed by the candidate:
- Describe the contribution that the candidate has made to the manuscript/published work:

( ) It is intended that the manuscript will be published, but it has not yet been submitted to a journal

Candidate's Signature:	Digitally signed by Jonathon Hannon DN: cn=Jonathon Hannon, c=NZ, o=Massey University, ou=School of Agriculture and Environment, email=j.b.hannon@massey.ac.nz Date: 2022.06.08 11:12:55 +12'00' Jonathon Hannon
Date:	08-Jun-2022
Primary Supervisor's Signature:	Chris Anderson Digitally signed by Chris Anderson DN: cn=Chris Anderson, c=NZ, o=Massey University, ou=School of Agriculture and Environment, email=c.w.n.anderson@massey.ac.nz Location: Palmerston North Date: 2022.07.04 13:41:54 +12'00'
Date:	4-Jul-2022

This form should appear at the end of each thesis chapter/section/appendix submitted as a manuscript/ publication or collected as an appendix at the end of the thesis.

GRS Version 5 – 13 December 2019
DRC 19/09/10

3A- Reviewing Policy Analysis in Waste Management Research to Establish a Design Basis Testing and Elaborating Municipal Zero Waste Methodology (Hannon, 2021 in submission).

DRC 16

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

GRADUATE RESEARCH SCHOOL

STATEMENT OF CONTRIBUTION
DOCTORATE WITH PUBLICATIONS/MANUSCRIPTS

We, the candidate and the candidate's Primary Supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the candidate's contribution as indicated below in the *Statement of Originality*.

Name of candidate:	Jonathon B Hannon
Name/title of Primary Supervisor:	Professor Chris Anderson

In which chapter is the manuscript /published work: Chapter Three

Please select one of the following three options:

○ The manuscript/published work is published or in press

- Please provide the full reference of the Research Output:

Hannon, J. (2022 in submission). Reviewing Policy Analysis in Waste Management Research to Establish a Design Basis Testing and Elaborating Municipal Zero Waste Methodology.

○ The manuscript is currently under review for publication – please indicate:

- The name of the journal:
- The percentage of the manuscript/published work that was contributed by the candidate:
- Describe the contribution that the candidate has made to the manuscript/published work:

◉ It is intended that the manuscript will be published, but it has not yet been submitted to a journal

Candidate's Signature:	Digitally signed by Jonathon Hannon DN: cn=Jonathon Hannon, c=NZ, o=Massey University, ou=School of Agriculture and Environment, email=j.b.hannon@massey.ac.nz Date: 2022.06.08 11:13:21 +12'00' Jonathon Hannon
Date:	08-Jun-2022
Primary Supervisor's Signature:	Chris Anderson Digitally signed by Chris Anderson DN: cn=Chris Anderson, c=NZ, o=Massey University, ou=School of Agriculture and Environment, email=c.w.n.anderson@massey.ac.nz Location: Palmerston North Date: 2022.07.05 15:48:30 +12'00'
Date:	5-Jul-2022

This form should appear at the end of each thesis chapter/section/appendix submitted as a manuscript/ publication or collected as an appendix at the end of the thesis.

GRS Version 5 – 13 December 2019
DRC 19/09/10

Appendix 2: Tabular illustration mapping the interrelated the key points from the publication strategy examining MZWM.

Table 17: A tabular illustration mapping the interrelated the key points established in the sequence of six publications which provide a foundation for examining the central research question around MZWM.

Mapping the how each of and the collection of publications together cover off various key points and areas of discussion from the literature review and background context		
Literature Review Chapter 1		
1A: Waste vs zero waste: The contest for engaging and shaping our ambient 'waste-making' culture (2015).	1B: Exploring the Phenomenon of Zero Waste and Future Cities (2018).	1C: Moving Toward Zero Waste Cities: A Nexus for International Zero Waste Academic Collaboration (NIZAC) (2019).
Introduction + The failure waste and zero waste? ZW encompasses heterogeneous global community of practice industry, community / activist & municipal / government and up + down-stream conceptions etc.	Introduction: commentary/ review article - drawing in NZ case study + 2A reporting. NZ experiences reinforce importance of properly understanding ZW	Introduction: Historic conception - universities public good role now sust. dev. enviro - ed / ESD = mega-trend / 3rd mission call for sust uni to provide local / regional outreach, relational influence + opportunity for campus ops to serve as a model sustainable community.
ZW = ambitious / aspirational ideal for 2nd green industrial revolution = tension & debate grist for critique = accusation of ZW failure (esp. municipal)	ZW is evolving, emerging, controversial part of broad waste / sust. dev. discourse. ZW popular response of: individuals, families, communities, business orgs. + local municipal / national govt.	ref UNDESD 2005-2014 + post SDGs ref: sustainable human settlements / cites, sanitation / chemicals / waste, + construct of built & natural spaces functioning as a 'living laboratory' ref: (zero)waste LL public/private sector, city/region - uni ESD nexus.
Reality check waste = failure + waste management is failing. ZW aligns with other sust. dev. movements in challenging this. ZW + IE + CE all based on ubiquitous natural ecosystem metaphor	Cities and Global Waste Issues: Why Zero Waste? Cities increasingly drain & discharge resources from and into the biosphere, cities apex of anthroposphere hence epitome of lineal resource use - waste model	outline ZWA-LL early stage engagement (Brazil – Australia – Italy - Nepal – NZ) & activities re 'nexus for international zero waste academic collaboration' (NIZAC).
Key in waste's spectre of dis-achievement & failure, is zero waste more or less effective, relative to other provocations for enhancing environmental progress	future zero waste cities = zero-carbon transport, building, energy systems max resource conservation, efficiency, recycling & reabsorbing non-toxic non-polluting water + waste flows i.e. CE	**Transitioning from Waste → Zero Waste:** Overview global waste crisis / emergency. Background dev. of consumerist throw-away society + growing public concern - hence ZW both activism + assertive integrated policy now linked & ubiquitous + acceptance of issue and call for reform e.g. GWMO goals ZW now mainstream concept.
WM data overview = failure of conventional approaches opens door to disruptive idealities aka zeronautics	Some evidence of progress ref FZWC, but now a litany of data of WM esp. megacity issues + 2100 'peak waste' + grim World Bank / UNEP / ISWA GWMO reporting	Summary explanation reiteration of est. ZW i.e. IE CE BE ecosystem metaphor - continued adoption individuals, families, communities, business organisations, as well as by municipal and national governments
Can zero waste be considered Successful? initial ZW success pioneered in industry - MZW more complex relatively only influence bearer.	Recycling multiple positives but data shows limited progress + China policy highlight issues with NZ current approach encourages both ZW CE model NB: W2E not CE	The Notion of Zero Waste Cities: future ZW city labs for innovation smart' , zero-energetic / waste, enviro sust. self-sufficient, (organic) food secure, industrially & enviro- symbiotic & more socially enlightened, democratic, equitable & high quality life experience aka idealised aspirational spaces.
However ZW = success trans trash, ZW Europe, NZ vison 2050 + Auck 2040, ZeroWIN realism + ZW stylistic of innovation.	ZW key part of sust. + neologism related to and complimentary with IE BE CE shared cognitive DNA, ZWIA defn ZW heterogeneous movement self ID. Activist element confronts waste/incineration.	future ZW city , depicted as a circular, closed-loop material eco-system = key principles of green urbanism. ZW not technical utopianism via practices and & grounding in industry success. ZW refs public ahead of private good
New Zealand: An example of political shifts and vested push back on zero waste.	Current and Future Cities: A Crucible of Issues and a Milieu for Innovation and Opportunity	ZW simultaneously controversial & indispensable, as a critical driver & grist in the societal debate re-engineering transition from lineal unsustainable, into sustainable circular economy NB: waste a social not just technical issue
NZ background, NZEIR push back', 'Business New Zealand' funding neo liberal policy capture.	cities nexus of both issues and future opportunities / innovation for WM included in wider CC SD issues.	Living labs - 'Engines for Innovation': ZW requires quantum innovation = LL = 'imaginative infrastructure', new modes of knowledge generation + inspiring the 'fresh politics' required for social & technical transformation.

political pendulum swing = NZWS: 2002 vs 2010 no targets / consultation etc. anti ZW / sust. dev.	Future city discourse inc. ZW with eco /solar /smart-city spaceship living lab metaphor. ZW = creative milieu / interpretive miscellany / paradox / zeronautic pioneering SD change as well as ZWIA defn to preserve integrity of concept.	Waste + uni city ESD partnerships feature in LL typology. Overview of LL dev. trajectory. Expand explore and justify framing of ZWA-LL model "Innovating innovation ": Living labs relevance to the 'waste – zero waste' sustainable development transition.
Conclusion: Balanced examination of ZW's diverse & evolving global experience shows that this policy can in spite of significant challenge/ complexity can be successful	ZW confronts vested interest which make / manage waste ZW cities = ideaopolis aka living lab	ideas factories', real world approximant test beds for CC SD mitigation inc. of place / PSS / people / policy', the typifying resume of living labs, reads as a 'good fit' for the waste → ZW, issue - opportunity polemic link to NIZAC.
ZW critique questionable, overall debate informs & challenges both conventional WM & ZW	LL waste re household / living enviro, 'smart spaces', sust product & service system (PSS), SMEs & larger business models (inc. PPPP), + enhancing rural / regional / international dev policies.	The Zero Waste Academy - 'Living Lab' (ZWA-LL): A subject focussed education for sustainable development initiative. ZWA ref NZ ZW background history learning v1 & 2 PNCC R&D relationship
ZW continues to evolve in a globalised free-market of ideas.	LL cogenerate, quantum innovation, partnership real world issues settings e.g. future ZW cities: UniSA ZWSD+B, ZWA-LL Italy ZW research centre, ECO LivingLab@Chamusa	The institutional context for the development of the ZWA-LL approach. Ref Massey University LL approaches where LL part of academic lexicon as a sustainability-related tool applicable to problem-solving in diverse subjects and areas
	Zero Waste: Formation, Convergence, Circularity and Critique. i.e. populist, over-simplified, reactionary and or extreme - but also now ubiquitous e.g. ISWA + 'globalised free-market' of ideas & activity = 'faux v authentic.	ZWA-LL elaborated as LL case study now contributing to NIZAC formation b/c low cost, high RoI, durable, flexible, evolving & scalable model for generating potentially high quality waste → zero waste related research ESD outcomes, within the crux of local 'real world' issues and existing (city – university)
	outline ZW CE IE BE socio-econ design linked, UN = continuum ref waste issues + cost effective, but ZW also unique ID assertive integrated collection of polices and practices for CC SD	The concept of and process in forming a 'Nexus for International Zero Waste Academic Collaboration' (NIZAC). Overview stakeholders stages and outcomes est. Brazil ref Table 1
	Who – How – What – Why: Zero Waste? Waste critical municipal service scaffold other developments + Duration & consultation re ZWIA defn = strategic embrace of provocation / opposition role & associated criticism. ZW not 'black n white' both evolutionary and revolutionary perspectives	Proposed NIZAC scope and framework for collaboration. Outline model of engagement + An emerging philosophy of collaboration in a collective approach to education & research for zero waste: ref Figure 1: Graphic overview of NIZAC initial engagement and collaboration model + Table 2 Examples of the proposed actions to realise the scope and objectives of collaboration:
	ZW reframe issue from waste to resource / problem to opportunity = (re)design manifesto '2nd – green - industrial revolution' + overview heterogeneous global community of practice etc. municipal construct / roadmap / 10 steps all = up to top of ZW hierarchy	Establishing key roles with the NIZAC. Zero Waste Campus – Student Coordinator' + b) 'Zero Waste Education and Research Coordinator' + Outline of Next steps: Emerging outcomes, future prospects, recognising challengers and developing strategies to overcome barriers.
	ref specific ZW critique 2nd or 4th law / absolutism / oxymoron just aspiration stretch targeting ISWA / one of many zeroisms in reaction to acute issues ref NZ smoke-free by 2025 , or predator-free by 2050 or the goal of 'zero suicide	Conclusions: uni sust. assessed globally, as only being in the early stages of the requisite learning in order to authentically realise, the full potential of HEI to embody & lead society in transformational sustainable development. Ref lagging behind commercial sectors.
	NZ case study further detail and explanation cite NZIER but link to overview of WMF outcomes + Auck + Para Kore achievements	NIZAC, LL model + ongoing actions have a positive potential in challenging & supporting the cluster of participating universities / organisations, in partnership with host cities / communities / business sectors, to cultivate new platforms for collaboration & co-generating innovation in addressing the anthropogenic waste crisis.
	Conclusion: Zero Waste and the Design of Future Cities. Cites 'hot-spots' of unsustainable production- consumption / ecological footprint but also future ZW city re-conceptualised as a critical locus of future circularity, resilience & sust. via 'urban harvesting' / 'above ground mining'.	NIZAC multilateral (MoU), ref future vision, expectation around shared commitment and processes for joint action in realising a new and effective nexus for international zero waste networking, academic collaboration and direct engagement focussed on zero waste universities, cities and the circular global economy.
	Even conventional WM now reformed as 'circular IWMSs. ZW part of post normal era of science (PNS), ref value loading + plurality of legitimate perspectives / adaptive ecosystem of CC waste responses + ZW now has dev. success story + science basis.	

Background Context Chapter 2		Methodology Chapter
2A: (Un) Changing Behaviour: (New Zealand's delay & dysfunction in utilising) Economic Instruments in the Management of Waste? (2018)	2B: Exploring and Illustrating the (Inter-)Disciplinarity of Waste and Zero Waste Management.	3B: Reviewing Policy Analysis in Waste Management Research to Establish a Design Basis Testing and Elaborating Municipal Zero Waste Methodology.
Introduction: examination and critique of New Zealand's lack of progress in addressing waste issues + highlights multiple 'red flag' issues re acute public policy failure. Background: Globally, waste is now recognised as being amongst the most challenging & complex anthropogenic problems interrelated aquatic and atmospheric impacts of terrestrially generated waste, are now understood as negatively affecting the entire global biosphere + enviro emergency ZW CE = future focus for	Intro to IDR esp. connection to R&D breakthrough to big global issues. Intro to waste as now universally recognised (i.e. ISWA) as challenging, complex, global human / enviro. health emergency. Ref ISWA emergency GWMO response 100% dump / burn goals. Overview number and acuity of waste disposal issues means sust. waste management (WM) = sphere needing transformational break-through i.e. IDR connection. Waste is both technical and social science - ref. waste vs resource definition just a human value judgement. This argument supped but reduce at top of 5R wate hierarchy i.e. education behaviour change. NB disconnect between this priority and actual WM praxis which defaults to disposal burn / bury. cite evidence % R&D focus	Waste provides an historical and environmental precis of the society producing it. The act of managing waste has evolved, throughout human history [5] into the modern confluence of municipal, industry and community systems, technologies, legislative / policy frameworks, social / cultural expectations, vocational practices, as well as associated environmental issues, controversy and debate. Today local impact have morphed to global scale aka 'take make waste'
The 1st section covers unaddressed guidance of the PCE's 2006 'Changing Behaviour' report. The 2nd section overviews the prior decade of neglect and failure around NZ WM. 1. How well has the government addressed the recommendations of the pce's 2006, 'changing behaviour: economic instruments and the management of waste' report?	Link to IDR concept of disciplinary chauvinism in WM segway to ref WM issues vs ZW track-record success, yet marginalisation of ZW. Now body of academic literature defining and describing ZW esp. up the pipe of resolving issues before they manifest. discussion of ZW antithesis of throwaway society confront status quo in keeping with tradition of cited sustainability lit. ID linearity as socio-econ. construct enabled by 'flame flush fling'. ID issue of externalisation, invisibility and normalisation of waste cost / subsidies which undermines positives of capitalism. Recognised direction from waste / linearity to circular economy (CE) now ubiquitous but how and change trajectory still much debated by vested interest groups.	Int. waste data indicates that, the central premise / priorities of waste hierarchy, as key emblem of waste policy, are often remain unrealised. Broad spectrum of enviro / social issues of waste now widely reported and accepted. Although rhetoric of CE ZW is increasingly co-opted and promulgated, in reality, the deeply embedded linear economy model, still dominates contemporary waste management praxis
1.1. Under-utilisation of market based economic instruments in addressing waste issues? [1.1.1. The national waste levy + 1.1.2. Managing the Waste Minimisation Fund (WMF) + 1.1.3. Implementing the WMA:2008]. A key recommendations of the PCE - the 'Waste Minimisation Act' (WMA:2008) which inc. a $10/t waste levy is new NZ law & is now being implemented. because waste is still increasing the levy rate, investment model, return on investment & WMA mangt.model must all be examined & questioned.	Link ZW CE origins to German, French and subsequent Japanese and Korean experience + EPR. ID ZW and other progressive movements, all part of dynamic milieu of sust. dev. / climate change response. Milieu inc. zero waste (ZW), zero emissions (ZE), circular economy (CE), industrial ecology / symbiosis (IES), urban metabolism (UM) and bioeconomy (BE), which all identify in the commonality of seeking to actualise the ecosystem metaphor of infinite-perpetual resource life-cycles and naturalistic design principles	Despite obvious negative consequences the throwaway society - disposal defaults are deeply embedded socio-economic construction which vested interests maintain i.e. infinity fallacies of economic growth, population, production – consumption and pollution. Data indicates that, despite a significant tenure / volume of investment, the theoretical priorities of waste hierarchy, are not being realised
1.2. Continued reliance on 'voluntary only' solutions in waste minimisation and management? Historically the PCE questioned the overreliance on voluntary measures. Despite overwhelming democratic support for utilising the 'priority product' mechanism in the WMA:2008, this has not occurred.	Genre = highly aspirational, future-focussed movements, align in seeking to disrupt and replace routine environmental exploitation, disposal and externalised pollution costs, with the polar opposites. Namely: normalised maximum material resource conservation, stewardship / responsibility, efficiency and circularity. An essential platform for engineering this transformation is the design and deployment of market-based economic instruments and incentives and regulatory interventions, which enact genuine producer–consumer responsibility and empower regenerative re-design, dematerialising, detoxing, circularising and upcycling all resource flows within economy.	waste issues embedded in interrelated impact cluster includes: further natural resource exploitation, environmental damage, declining biodiversity, excessive soil erosion, excessive material resource, energy and water consumption and the build-up of pollution (i.e. nutrients, sediments, macro to nano plastics / particulate matter, GHG emissions, chemical toxins) within air, water and terrestrial eco-systems and the biosphere global
1.3. A lack of transparency and reciprocity with community consultation, which undermines democratic engagement? The regressive policy settings on PS/EPR appear more based on political ideology, than int. experience, or scientific consensus, or industry community consultation.	PS/EPR critical to local WM into big picture ZW / CE for CC SD etc. acknowledge progress but WM data shows we are still at btm. of 5R waste hierarchy. Despite value proposition and popularity of green change. ZW = aspiration and assertion re-set now int. set of proven policy, plans and experience .	waste as an issue, is exacerbated by the intersection of, for example: multiple disciplines, geographical / development contexts, material / hazard types, numerous technological, service-infrastructure, legal, financial and social / cultural considerations, a past-future nexus of competing political ideology, ideas, innovation and investments, all of which are being socially mediated against a complex backdrop of converging negative environmental, socio-economic consequences of population, consumption, urbanisation, anthropogenic climate change and the occasional geo-political (aka China's Green Fence, Blue Sky and National Sword policies) and epidemiological curve-balls = super-wicked complexity. waste inc. understood as, being a social science, as a STEM-based consideration.
1.4. Clarity and accountability around the 'Waste Advisory Board' (WAB) processes? The WAB function is opaque and WMA interpretation and implementation is not sufficiently evidence based, genuinely democratic, or fit for purpose, or cost effective	Commonality acknowledged but also ZW unique in embracing extremity confrontation activism and lightning rod for criticism / controversy = polarisation and attack by vested interests. Whist ZW antithesis of waste also in reality interconnected + synergy aka Hulme's everything quote. NB: recycling also associated with duality + since antiquity, managing the issue and opportunity of waste (i.e. recycling) has involved contested and overlapping theorem, terminology, commercial interests, materiality, ownership and merged intellectual formation and histories	

1.5. Deficiencies in government leadership and policy dysfunction, relative to community expectations? New Zealand's plastic waste issues puts omissions in central govt leadership into sharp relief. Void filled by well-meaning but confusing, disparate & potentially self-defeating (i.e. SUPB/BE) initiatives across retail environment.	This history = a window to the (inter) disciplinary formation of waste (and latterly ZW) management + composition & synthesis, which involves overlapping motive, objective, function, locus, context, activity, process, materiality, economics, socialisation, status, edict & censure. ZW, ZE, CE, IES, UM, BE and CIWMs etc. all focus on deriving new & transformational ways of addressing the issues & opportunities of waste. This genre of activity = a change-making transitional spectrum & abbreviated /annotated via the encompassing extremities of: waste →	No singular black box, technological fix for WM but zeronautic solution seeking at top priorities of the waste hierarchy + overcoming barriers to circularity, sustainability & ZW occurs in these creative-transgressive zones of *next / yet / other* . ZW demand framing necessitates revolutionary insight, regenerative technologies, radical socio-economic restructuring & where necessary, circumventing inefficacious disciplinary convention/
1.6. Omissions in reliable baseline waste and resource management data? Key purpose of WMA is to fix WM data issue highlighted by the PCE. NZ waste / recycling data is still limited, fragmented and not yet, 'fit for purpose' - e.g. ewaste	B/C we don't know what will fix waste issues??? Hence inherent value in both maintaining a biodiversity of responses, prospecting a range of potential solutions and in cultivating an urgent continuum of experimentation around all opportunities for generating progress. This article explores how the concept of failure vs success, which is debated in respect of the waste → zero waste transition spectrum, can be interpreted and explored within a wider realisation of the shortcomings of traditional disciplinary thinking and practice	transitioning from the current business as usual, lineal – disposal defaults of WM even for traditional ISWM perspective requires engagement of many contributing disciplines - ZW CE increases IDR requirement. ZW = 'parenthesis of history' past → future transitional space, between a waste and future hypothesis of what will work better and be more sustainable. heterogenous global ZW community of practice, is part of an emerging cluster of sustainability focussed waste
1.7. New Zealand waste going AWOL? Currently, the positive environmental impact of the waste levy, as a critical market based economic instrument, is constrained, because it only applies to a limited amount of the waste material being disposed = market distortion + rogue dumping in 'non-	This omission is compounded by inadequate understanding of the complex (inter) disciplinarity of (zero) waste management. Moreover, it can be argued that the cited super wickedness of the globalised waste crisis, necessitates an urgent advancing of interdisciplinarity comprehension, training and collaboration across the spectrum of waste → zero waste related research, education and industry practice.	All are energised and popularised by key waste foci, such as plastic waste polluting the oceans. Within green grouping, the global ZW movement, is arguably the most extreme, confrontational, controversial and contested variant, seeking to catalyse revolutionary solutions to waste issues. All integrated with CE, CC mitigation and progressing the UNSDGs.
2. A broad range of other indicators of political mis-management in New Zealand waste policy? 2.1. Unjustifiable inconsistency in waste policy? Radical policy shift between National led (2008-2017) NZWS:2010 & prior Labour led (1999 – 2008) NZWS:2002 entitled *"Towards Zero Waste and a Sustainable New Zealand"*	Literature supports the view that, a baseline of interdisciplinary skill and experience, provides a necessary foundation for the kind of transgressive, transformational, transdisciplinary breakthroughs, which appear as a common aspiration across the waste → zero waste transition spectrum, but which are yet to be fully explored, or realised. By examining the composition and contribution of disciplines and interdisciplinarity across the spectrum from, traditional WM to ZW/CE the purpose of this research is to contribute to the opportunity of enhancing the (zero) waste management sector's understanding and future employment of interdisciplinary theory	Catalysing the necessary socio-economic transformation involves both, reengineering how the entire concept of producer–consumer responsibility is instrumented and redesigning the operating parameters of all production, products, packaging and service systems (PPPSS). Key is incentivise regenerative re-design, dematerialise, detoxing and circularise all material resource (aka biological and technical nutrients). financial sust. requires upcycling, rather than downcycling.
2.2. Rejecting the aspiration and accountability offered by targets? NZWS:2010 rejected all prior 30 targets + provides a simple metric to assists public understanding ID key priorities & motivate, measure progress or conversely expose lack of...	Intro to IDR i.e. historically, disciplinary excess (aka chauvinism) has been associated with over-reaching 'truth claims', reductionist pretence, the questionable proposition of singular final solutions, even denial/delay of scientific consensus and delimited progress in overcoming wicked issues. The phenomena of interdisciplinarity is part of the 'where to from here', as the limitations of overly rigid disciplines were realised and then deliberately disrupted	plastic pollution (PP) is acute window into WM issues NZ exp with ZW and PPC. Overview of global. The premise of 'mngt', promulgated within traditional 'ISWM theory / practice, is being sharply confronted by the ecological de-synchronicity of plastic as a material type, i.e., degradation resistance - yet intense de-aggregation into micro-particles, fugitivity, mobility, adsorbed toxicity and harms communicated via ingestion,
2.3. Vested industry lobbying trumps consultation and community consensus? policy pendulum swing away from enviro assertive ZW approach, was based on push back and lobbying by business interests = long-term policy capture.	Large IDR section covers history of transgression / disruption which equates to ZW confronting vested interest complicity in the environmental issues stemming from the current, lineal socio-economic model premised on making and managing waste. IDR now major megatrend in academic / R&D policy. Makes the equation that both ZW & IDR = deliberate and necessary circumvention of disciplinary convention and authority.	New Zealand's policy & performance in addressing waste issues has been characterised by dysfunction and delay. This has derived real enviro harms, significant cost, confusion & consternation within the local community + int. reputational damage. Outline NZ, PNCC and PPPC data perspectives. NZ decline in WM performance notable b/c previously NZ reputed as a leading example of a nationally coordinated approach to ZW which at its zenith, had >70 % NZ local councils signed on.
2.4. The 'Minister Knows Best' + 'Voluntary Only' + A Flawed and Risky Approach to PS/EPR? NZ poor track-record managing eel tyres = window into our illogical &un-business like fixation with 'voluntary only' PS. 'Minister knows-best' superimposes govt ideology over industry community consultation / consensus & PS scheme design e.g. 'Tyrewise'.	IDR = bridging rapid change and exponential complexity. Via cognitive processes beyond the perceived limitations of traditional disciplinary silos and provokes the exceeding, deconstruction and recombination of traditional disciplines. Key drivers: complexity of nature and society, encourages boundary work / deconstruction barriers / transcend redundant conventions - post-modern conception of the individual and the recognition of: multiple intellectual curiosities and interests	Govt change from a centre-left Labour led coalition (1999-2008), to a centre-right National led coalition (2008 to 2017) = political shift & significant reset in waste policy, away from the prior political endorsement of the ethos of ZW / sustainability. ZW in NZ undermined by business centric packaging industry lobbying = decline in performance = wasteage of WMF $, yet positives Para Kore & Auckland Council. NZ a case study into negative when ZW abandoned b/c of vested interest lobbying.
2.5. The negative impacts of vested industry lobbying? The longstanding pattern of packaging industry lobbying has engineered 'policy capture' and WMF funding of greenwashing proxy PS schemes designed to delay progress & subvert public good, beneath private sector interests = lose-lose scenario	Key: circumventive tools inherent to interdisciplinarity, such as cognitive decentring - merging IQ and EQ. NB: interdisciplinarity discourse recognises and values traditional disciplines i.e. the contribution to scientific method (i.e., in the form of shared frames of reference, language, theoretical canon and peer recognition, which enhances epistemological and ontological rigor) and the progression of knowledge. Disciplines are seen as essential foundations, rather than entirely rejected by most interdisciplinarians	NZ now using WMA and ZW CE more broadly accepted possibility exists that waste policy debate will pivot less upon, semantics and brand identity and more around awareness and acceptance of the realpolitik of transition, the intercession of competing private vs public interests, and the choice of trajectory, necessary policy mix and tool-kit for programming change.

2.6. Comparing New Zealand against international good practice? NZ's limited & dysfunctional approach to PS/EPR compares poorly with Canada, where PS/EPR is described as an "environmental success story", which is being optimised, embedded and expanded, because it is successful and	The attribute of mutable plurality, is of particular interest and analogy to this research context which examines (inter)disciplinarity in respect of the concept of a transitional waste → zero waste spectrum of activity, i.e. the concept of zero waste (i.e. as reflected in the alternative zero waste hierarchy) can interpreted as maximally assertive of some key waste management fundamentals (i.e. the 3Rs: reduce, reuse and recycle), whilst notionally rejecting others.	The largely unexamined, full cost of waste, eludes the majority of our economic and is still not accurately factored into market pricing. This lack of economic sagacity coupled with negligence policy, perversely incentivises the sectors of the economy making - managing waste. Market based econ. instruments ensure that market prices more accurately
2.7. A crisis in rural waste management? NZ Ag sector is an important part of economy negatively impacted by the regressive NZWS:2010 period of waste policy. this is b/c mandatory PS is key answer to multitude of polluting micro farm dump / burns sites across rural NZ which are a significant environmental and reputational risk to New Zealand.	Coverage of directionality, big/small, weak/strong IDR + defns of IDR + the outline of sustainable waste management systems (WMS) ref - Seadon MIT spectrum and then overview of Transdisciplinarity which aligns with the characteristics of disruption, transgression and hyper-aspirational continuum, attributed, to zero waste and the cluster of alterative sustainable waste management brands and movements, which conceptually reject waste and occupy the futurist conception of other, next and beyond i.e. post normal science (PNS).	NZ experience raises ? - what evidence / influences shape policy development? What research methods are most appropriate for objectively defining (zero) waste management policy and evaluating its performance? PhD explored a range options for policy analysis in waste and resource management research and then, more specifically examined the use of content analysis (CA) in research related to waste and then zero waste management policy and practice. Article covers policy analysis generally and in WM and ID content analysis and then explored in detail how this research methodology could be most appropriately applied to the research objective of testing and explicating MZWM.
2.8. Ignoring the proven efficacy of PS/EPR systems? Effective mandatory PS increases: recycling rates, waste diversion from landfills and farm dumps, the exercise of higher environmental / OSH standards, new 'green collar' jobs & businesses opportunities, eco-design of new more environmentally products, opportunities for R&D around the socio-economic and environmental impacts of waste, new long term more finically sustainable recyclate markets are developed, the diversity, volume and value of reuse pathways, material upcycling, funding for enviro-education / community programmes and waste and resource management data (transparency, monitoring and compliance), whilst, the following generally decrease: rates of chemical pollution, littering / fly-tipping, nett energy and water usage, GHG	Methodology: define discipline rubric then disciplines of WM. NB: WM is not described as a separate discipline. The nearest, indirect reference to waste management appears to be the inclusion of sustainability/sustainable development, as a demarcation within the interdisciplinary sciences. Based on the identification of waste minimisation and zero waste within a defined sustainability framework. Research highlights a sense of omission and lack of clarity around how the concept of a transitional waste → zero waste management spectrum, interfaces with the disciplinary rubric of science. Next step design a more formal systematic search - review strategy (illustrated as Figure 2 below) to further explore the disciplines and interdisciplinarity across the evolving spectrum from waste →zero waste management. Seven interrelated (inter)disciplinary indictors were selected. Even at this scoping level of investigation, produced a broad array of indicative discipline and interdisciplinary terminology, references, descriptors and insight	CA is a sci. methods with long history, evolution and now wide application i.e. health, education / digital learning, accounting, governance / political evaluation, journalism, sociology / psychology, business, and consumer research. Today CA has come to be described as, one of the most important research techniques in social science. CA can provide reliable new research insights and understanding of phenomena and or, inform practical actions. This attribute fits squarely with the subject research objective of examining the proposition of a municipal zero waste methodology (MZWM), as a currently ill-defined, debated, misunderstood, but hypothetically discernible and actionable programme of policies and practice. The research creates the academic precedent for identifying and discussing the many key attributes of content analysis, when employed as a research methodology - including specifically for analysing (zero) waste policy and management practices.
2.9. New Zealand's reversal of the 'polluter pays' principle? The high level of public funding accorded to the packaging lobby illustrates that, in-stead of enacting the 'polluter pays' principle, NZ has done the opposite - and 'pays the polluters'. Litter an e.g. of how packaging lobby superseded public agencies in collecting & communicating NZ recycling and litter data hence acts as 'message manager' green-washing the NZ waste / recycling story.	These results contribute new insights in understanding why waste issues have reached the numerously described global crisis. This complex and entrenched environmental imperative is being approached, via an unresolved and outmoded conception of the complete disciplinary requirement for fully encompassing the holistic issue of waste. Further, that what disciplines are contributing, are engaged at less than the advanced level of inter → trans disciplinary synergy necessary, to catalyse breakthrough levels of innovation and inspiration to address waste issues	The key outcome of the review strategy, which first generally explored how policy analysis was undertaken in waste management research and then, latterly examined the application of content analysis in this sphere, was to learn how this policy analysis tool might specifically be employed in examining MZWM. Figure 1 provides a conceptual illustration of the methodological design for content analysis of key sources, which will enable the hypothesis of a municipal zero waste methodology (MZWM) to be tested and elaborated
2.10. Indicators of New Zealand's tarnished international reputation? NZ has not developed, nor explicated the overarching national business case, for moving towards zero waste and a more sustainable, circular economy = no value proposition / driving rationale for urgent progress = NZ WM performance now ranks amongst the worst in the OECD.	One observation, which reinforces commentary on the desirability vs. difficulty and rhetoric vs. reality of achieving genuinely transdisciplinary research is that, there appears to be far more research practice in the waste work area, which is described as, interdisciplinary, rather than transdisciplinary. It is interesting to correlate transdisciplinary discourse with how zero waste can be a similarly conceived/interpreted as being at the pioneering, hyper aspirational end of a dynamic continuum of global activity, provoking transition from managing → to eliminating (aka zero) waste.	
3. Summary - Conclusions: a call for urgent action by the PCE. In simple terms, scientific literature supports the view that zero waste is successful, practicable, scientific, measurable, learning & evolving, controversial in challenging the status quo, socially & culturally popular & beneficial and a good investment economically.	Today has been conceptualised is as a parenthesis in history, in which society is currently caught between a traditional, but now outdated and unsustainable waste centric model and another, yet to fully actualised, next model, founded in the principles of environmental sustainability. The adoption of the waste → zero waste terminology expresses this concept of a past → future transitional space, between what isn't working well enough - and the proposed future hypothesis of, what will work better and be more sustainable	
4. Key recommendations: Proposals for a future PCE 'waste management in New Zealand' report: NZPSC submission argues that it is time for New Zealand to upcycle our '100% PURE' mythology and to convert this into a 'clean green' circular economic reality.	Enhancing understanding and normalising good interdisciplinary (and potentially even the transdisciplinary) practice within the (zero) waste management sector, appears as a critical opportunity for achieving the commonly held aspiration for breakthrough and progress. Enhancing understanding and normalising good interdisciplinary (and potentially even the transdisciplinary) practice within the (zero) waste management sector, appears as a critical opportunity for achieving the commonly held aspiration for breakthrough and progress.	

Appendix 3: Exploring the formation of a convention in the use of the term municipal in respect of waste and zero waste management.

A draft journal article – working title

1.0. Introduction TBA - ref. excerpt commandeered for Section 2.3

1.1. Municipal zero waste: A critical challenge.

It is apparent within the broad gamut of sustainable waste/resource management literature that movements such as zero waste and circular economy have points of convergence in some common fundamental principles. For example, conceiving all waste as resources, recognising the need for synchronicity between human and natural design principles, and requiring transition from the current linear, to a circular economy based on transitioning into non-toxic, renewable, bio-degradable, and circularised flows of technical/biological material resources. Zero waste can be said to be one of many eco-brands/movements/disciplines engaging, contesting, and to a degree overlapping in a dynamic marketplace of sustainability ideas and activities (Glavic & Lukman, 2007). The intellectual architecture of the municipal zero waste movement appears to have been subject to revision and evolution over time, based on this external peer engagement, as well as on ongoing cycles of internal zero waste community/NGO/practitioner learning and real-world experience from confronting the challenge of waste. While convergence and resolution can be observed, duality and tension also exist within zero waste theory, because of:

- the coexistence of high-level, hyper-aspiration and theoretical ideal intertwined with a grass-roots, hands-on, pragmatic focus.
- the heterogeneity of the movement in encompassing disparate industry, municipal and activist/community worldviews.

Stark differences exist amongst the distinct world-views seeking to implement zero waste in these disparate spheres. As Murray (2002) observed, the initial pioneering success of zero waste in a commercial/industrial context inspired and catalysed the municipal zero movement. However, it quickly became apparent that implementing zero waste in a municipal context is an exponentially more complex and challenging proposition. A much lesser degree of direct control of material flows and activity combined with increased socio-economic complexity in the municipal setting, ensures the municipal zero waste proposition is subject to a much greater risk of (and perception of and or accusation of) failure (Connett, 2013; Murray, 1999).

This highlights the difference between scenarios where total control over input/purchase → production/consumption → output/discharge decision-making, as well as outward public relations communication, can be exercised, compared with those scenarios where such control is compromised, lessened or absent (R. C. Anderson, 1998; Hawken et al., 1999). Typically, in a municipal context direct control is diffused, contested, and watered-down, so that the agency of leadership/government is to a degree compromised and lessened. The agency of leadership/change-making in a municipal context is exercised indirectly, for example by influence bearing, example setting, legislative instruments/incentives, service contract design, provision of infrastructure, R&D and public funding systems, advertising/awareness raising, education/training, nudge theory-based behaviour change programmes, and the slow and costly corequisite processes of consultation and monitoring-reporting-compliance (Stone, 2002; WasteMINZ, 2001, 2018; WasteMINZ & Eunomia Research & Consulting, 2018).

The inherent additional difficulty faced by the municipal zero waste proposition arises because municipalities are normally prescribed with the legal responsibility for dealing with waste problems they neither create nor fully control. With the advent of the neo-liberal phenomenon of privatisation in MSW management (P. Anderson et al., 2001; D. C. Wilson, 2007), municipalities invariably have lessened (sometime completely lost) ownership of the fiscal, technical, and infrastructural levers for controlling the problem (i.e., the flow of material resources/waste) they are legally accountable for dealing with.

The Palmerston North City Council (PNCC), in New Zealand, provides a relevant local illustration of this phenomenon. The PNCC's Waste Management and Minimisation Plan (WMMP) notes that the Council owned and controlled services directly manage just 40% of the waste stream (PNCC, 2012). This waste stream is generated predominantly by households and businesses over which the Council only exercises indirect, regulatory influence. These material flows are often collected by autonomous private sector entities, with which local councils and central government compete and over which they have limited and contested control. In the New Zealand context, over recent decades, the entire concept of so-called *command and control* by government has been vociferously contested and directly opposed, in the name of free-market ideology (Clough, 2007). This opposition manifests in national-level socio-economic policy discourse, as well as in street-level competition around practical programmes, and has even resulted in legal challenges to test-case by-laws excised by local government (Hannon, 2018).[100] The exponential challenge of zero waste in a municipal context highlights the requirement for fundamental meta-level redesign of the socio-economic paradigm for products, packaging, production and consumption, and consumerism.

The numerously self-reported claims of success by those making personal/individual, family/household zero waste commitments compare favourably with the success claims from the commercial/industry sectors that pioneered and originally popularised the concept of zero waste. Currently globally the industrial/commercial and community/household sectors, combine as the predominant generators of the problem of waste and also as demonstrators of innovation and high levels progress and problem-solving. It appears that a key opportunity for municipal zero waste programmes is to provide a common good, public interest platform where the outlier practices and success pioneered by zero waste's industrial/commercial and personal/household community can become more mainstream and form a new, environmentally sustainable whole-of-community model where everybody benefits. MZWM presents as the critical next collective public echelon where the already demonstrated zero waste solution, progress, and success can be generated, shared, and benefit more widely.

The reported experience and outcomes of the industrial/commercial and community/household sectors involve private actors voluntarily developing and self-imposing resets in their sphere of socio-economic and environmental paradigm and practices. Realising the positives outcomes of zero waste in a municipal setting involves translating and imposing similar resets in socio-economic and

[100] Ref: section 3.3 p. 32 (PCE, 2006) *"The Auckland Councils' bylaws and one of the Christchurch City Council bylaws were the subject of a legal challenge in the High Court in February 2006 (see Sections 3.3.2 and 3.3.3).91 The High Court quashed the parts of the bylaws that imposed waste levies, after finding that the waste levies, in the form implemented or proposed by the Councils, were not authorised by the LGA 1974 or the LGA 2002".*

environmental paradigm and practices across the collective public sector sphere of influence, which impacts all of society. The municipal context is, then, the point of access and leverage into the full positive potential of the zero waste and circular economy movements, with all the contingent benefits (more sustainable material resource management, preventing pollution, addressing climate change, and progressing towards sustainable development). The criticality of the municipal context in waste and zero waste management underwrote the decision to include an examination of a New Zealand-based case setting, as part of the background framing of this research project. This real-world background provided salient perspectives and highlighted the importance of addressing the hypothesis of this research.

1.2. Defining and discussing and emerging *municipal*[101] convention: Definition, boundaries, historic and contemporary meaning, and context

The term *municipal,* when used in reference to the ubiquitous term municipal solid waste (MSW), is applied to an array of geographic, cultural, and socio-economic scenarios, connotations of government, physical and material contexts. For example, the term MSW is variously discussed in wide-ranging contexts: tribal, vestry, parish, village, shire, town, prefecture, commune, local government areas (LGA), city, metropolitan, local and unitary authorities, county, province, district, region, territory, state, federal, principality, and national and international scales (such as the EU) (Herbert, 1998; Trotti, 2012; Waste Watch UK, 2004).

For this reason, the term *municipal*, when used in the research subject of (zero) waste management requires examination and if possible, some clarification. Regarding the challenge of testing the research hypothesis, this section seeks to discuss what socio-economic scenarios, materials/mass flows, geo-physical spaces, governing authorities and legislative/regulatory functions, etc., are (and are not), encompassed by the term municipal (solid) waste. The intention is then to offer a precedent for framing and understanding the hypothesised implementable methodology for zero waste in a municipal context. Better understanding the municipal part of the municipal zero waste proposition is fundamental to a more focussed and bounded discussion about what methodology might further enable and actualise progress in the municipal zero waste context.

The Oxford Dictionary[102] defines municipal, as an adjective as: "relating to a town or district or its governing body". In common usage, the word municipal also relates to the word municipality, which as a noun is defined as: "a town or district that has local government". The Merriam-Webster Dictionary[103] adds both "city" to this latter definition and the scope of government responsibility to dealing with "local problems". While legal, governance and urban planning contexts, etc., all feature in the historical usage of the term (Waste Watch UK, 2004), it is perhaps the inclusion of the term *problem* in the definitions that possibly explains why there is a frequent association between municipal and waste and regulation. Generic open-source discussion[104] of the term municipality demonstrates a linking of spatial jurisdiction, corporate status, the exercise of powers of self-government and general-purpose administrative subdivision, anywhere from small villages to parts of cities to sovereign states.

---

101 i.e. as in Municipal Solid Waste (MSW) or Municipal Zero Waste Method.
102 Origin: *"Mid-16th century (originally relating to the internal affairs of a state as distinct from its foreign relations): from Latin municipalis (from municipium 'free city', from municeps, municip- 'citizen with privileges', from munia 'civic offices')"* http://www.oxforddictionaries.com/definition/english/municipal
103 See: http://www.merriam-webster.com/dictionary/municipality
104 i.e. https://en.wikipedia.org/wiki/Municipality

A chronology of waste observes that, as early as 500 BC, municipal officials in the Greek city-state of Athens, are reported to have prescribed the distance from the physical boundary of the City, beyond which waste must be dumped (Waste Watch UK, 2004). It is reported that, between 1297 and the formation of the British Public Health Act[105] in 1848 (and especially in regulations iteratively accumulating thereafter), a spectrum of European legal instruments emerged that sought to control municipal waste (Waste Watch UK, 2004). In a UK context, municipal becomes the common jurisdictional phrasing applied by cleansing superintendents from towns and cities, who initially formed the *Association of Cleansing Superintendents of Great Britain* in 1998. This organisation eventually became the *Chartered Institute of Wastes Management (CIWM)* (Herbert, 1998; Waste Watch UK, 2004), which is the peak UK industry body representing waste and recycling interests.

1.3. The evolving materiality of MSW

The changing materiality of what is understood as municipal solid waste (MSW) provides an opportunity to examine the evolving conception of and language about waste. A simple illustration, which demonstrates the changing material typology of municipal waste over time, occurs when comparing:

a. how historically, when organic material formed the largest percentage of waste materials, "pigs were often used as an efficient method of disposing of municipal waste" (Waste Watch UK, 2004, p. 1), with for example…
b. a contemporary Solid Waste Analysis Protocol (SWAP) quantification of MSW.

The latter evidences a diverse array of complex, synthetic material types and the relatively low percentage that is organic/biodegradable (Ministry for the Environment, 2002). Citing historical data from the *Institute of Wastes Management – UK,* Herbert (1998) provides a clear illustration of the transition between historical vs contemporary material composition of MSW[106] over time. Notably, historically there was a high percentage of both ash (commonly ~80% from household fireplace used for heating, cooking and burning of household waste) and the contents of household privies and water closets were a major constituent MSW (Herbert, 1998). Because of the associated air pollution, the former was progressively banned and as cities modernised the latter was progressively diverted through piped catchments for differentiated waste-water treatment, which being based on different technical processes, evolves to become a separate and distinct public service sector.[107]

Aligning Herbert's historical UK CIWM perspective alongside those from the EU (EC, 2005) and US/SWANA, Trotti (2012) provides a trans-Atlantic overview that highlights critical differences as well as an interesting commonality and convergence in the evolving understanding of municipal solid waste (MSW) management. Independent of these industry sector group/professional association-derived perspectives, non-industry academic analysis, which draws various insights into the evolution of US and global MSW, provides confirmation of the previously described patterns of development (Karak, Bhagat, & Bhattacharyya, 2012; Kollikkathara, Feng, & Stern, 2009; D. C. Wilson, 2007; D. C. Wilson et al., 2012). Collectively, a picture emerges of regionally variant terminology and ideas morphing over

[105] NB: This was preceded by the important and related 'Nuisance Removal and Diseases Prevention Acts' (1846–1860), which is alternatively cited as beginning the process of modern waste regulation in Britain (Herbert, 1998).
[106] Ref. the figure entitled *Dustbin Waste Composition 1890s to 1990s* (Herbert, 1998).
[107] For examples in New Zealand all aspects of water treatment are covered by 'Waste NZ' see https://www.waternz.org.nz/ whilst all aspects of aspect of solid waste is covered by WasteMINZ see http://www.wasteminz.org.nz/

time into a shared globalised research-led, theoretical/technical consensus and language about waste and waste management. In large part, this is mediated by the formative process of national industry associations and the eventual affiliate-based, peak international organisation, the *International Solid Waste Association* (ISWA).

1.4. The evolving language of MSW

A key outcome of the development of professional waste/recycling industry organisations is the associated development of agencies for information sharing, publication, and professional development that document and reinforce the evolution in the comprehension and language of waste management. The replacement of archaic with contemporary terminology, documents this evolution. For example: salvage becomes recycling, night soil becomes compostable biosolids, cleansing superintendent becomes waste manager, ash-pits and privy middens become transfer stations, dust-carts become self-loading compaction trucks, and destructors become incinerators (Herbert, 1998). In particular, the terms refuse[108] and rubbish give way to utilising MSW as the universal acronym and umbrella term that encompasses the spectrum of all things *municipal* (geographies, community structures, organisations, and governing authorities, as well as the materiality applied in managing waste. In the USA context this terminological ascendance is most clearly interpreted in the title of the industry journal *MSW Management* (Trotti, 2012).

In the respective reporting of the UK, EU, and USA waste industry evolution, the 1990s appears as a formative period in the adoption of the terminology of municipal and MSW. In the UK context, the early uptake of the word municipal[109] is associated, in the 1970s, with municipal waste incinerators and from the 1980s onwards, appears driven by the superimposition of European Commission policy and legislation. For example, this is illustrated in 1996, by the EU Municipal Incineration Directive, which enforces higher emission standards (Herbert, 1998). A capstone example of European influenced (more accurately, directed) collectivisation and contemporising of viewpoint and language emerges in the inclusion of the word municipal in the title of the European Environment Agency report – *Managing municipal solid waste — a review of achievements in 32 European countries* (EEA, 2013). Within the presumptive municipal framing of this national – international reporting, the selected nomenclature of municipal (solid) waste is defined as:

> Municipal waste is mainly produced by households, though similar wastes from sources such as commerce, offices and public institutions are included. The amount of municipal waste generated consists of waste collected by or on behalf of municipal authorities and disposed of through the waste management system. (EEA, 2013, p. 7)

This report is cited as building on the preceding EU theoretical and legislative conventions, such as the 1999 *EU Landfill Directive*, in the assumption that municipal waste is primarily a "public sector responsibility" and is understood as "waste collected by, or on behalf of municipalities"

---

[108] This term was locked into the title of the seminal US industry organisation 'Governmental Refuse Collection and Disposal Association' (GRCDA). It wasn't until the early 1990s when the term 'refuse' was deemed *"out of step with current technology of solid waste"* that this title was changed to the 'Solid Waste Association of North America' (SWANA) (Trotti, 2012).

[109] Latterly a common understanding of MRF also includes the variant 'municipal recycling facility' (also recognised as materials recovery facility).

(EEA, 2013, p. 5). The accumulating sense of international definition of MSW now appears to include:

- …"Waste from households, as well as other waste which, because of its nature or composition, is similar to waste from households (EU, 1999)"…
- "Waste collected directly by the private sector (business or private non-profit institutions) not on behalf of municipalities (mainly separate collection for recovery purposes) (Eurostat, 2012e)" (EEA, 2013, p. 8)…

and to acknowledge:.

- The role public perception plays, alongside that of technical science in distinguishing MSW[110] from commercial and industrial (C&I) and construction and demolition (C&D) and other waste types (for example, medical, biosecurity and hazardous waste) requiring a specific policy focus and different treatment (UNEP et al., 2013; D. C. Wilson, Rodic, et al., 2015b).
- The importance of broader systems and sustainability thinking (such as in industrial ecology/urban metabolism studies) in identification of waste streams/material resource flows, which are generated from a variety of different sources (UNEP et al., 2013) and which exist and transition into, stocks, sinks and cycles (Ellen MacArthur Foundation, 2013a; Graedel, 2010; M. Lehmann, de Leeuw, Fehr, & Wong, 2014).
- That within the EU's directive legislative framework (for example the imposition of the 50% recycling target in the 2008 Waste Framework Directive) definitional issues exist, such as when technically a material ceases to be a waste and the distinction between waste and non-waste by-products (EC, 2005).
- The mutability and mobility of all that is defined/interpreted as connecting to the issue of waste in globalised world, for example NBRIC, ocean plastics and pharmaceuticals/forever chemicals (Boucher & Friot, 2017; EEA, 2008; Graedel & Allenby, 2010; Reed, 2015; B. H. Robinson, 2009; Swan & Colino, 2021).

This snapshot of the discourse around the definitions and understanding of the term *municipal* also highlights the now ubiquitous global neo-liberal phenomena of privatisation in waste management. One result of privatisation is that, in most jurisdictions, the public and private sectors operate in a form of market equilibrium in terms of how the legislated responsibility for the physical management of waste is outworked. While the phenomenon of privatisation[111] is both acknowledged and endorsed in respect of waste (EEA, 2013; Holmes, 1988) and zero waste[112] (IPLA, 2013a; Scheinberg, 2010; D. C. Wilson & Scheinberg, 2010), aspects of this are also strenuously debated (P. Anderson et al., 2001; D. C. Wilson, 2007). In the New Zealand context this issue has resulted in the realisation that because local and national authorities no longer physically control the majority of MSW flows, they have lost control both of data critical to the formation of national waste strategies and the ability to directly implement local *Waste Management and Minimisation Plans* (WMMP) (MfE, 2007a, 2010; PCE, 2006; PNCC, 2012).

[110] i.e. because for *"many countries, MSW, originating from sources such as households, shops, small businesses and public spaces, is the most visible and most important category of waste, at least in the eye of public opinion"* (UNEP et al., 2013).
[111] In a developing country context the 'informal sector is recognised as part of the private sector construct (Mavropoulos, accessed 2014).
[112] … and circular economics. NB: in the cited context the authors specifically include the informal sector of developing economies as part of the private sector. At the other end of this spectrum are the large multinational waste and recycling companies.

In the relatively modern (arguably USA centric) retrospective article *Development drivers for waste management* (D. C. Wilson, 2007) the municipal construct and language are superimposed on the historic drivers, trajectory, and eventual shape of waste industry development. Wilson's (2007) commentary reinforces the discourse on the importance of privatisation and also the view that resource valorisation is integral to historical and now all municipal waste management (Herbert, 1998; Waste Watch UK, 2004). Specifically, an 18th century example is discussed in which municipal waste provided an important raw material feedstock for brickmaking in the high demand periods of rapid infrastructural development (D. C. Wilson, 2007). Additionally, Wilson (2007, p. 199) explains that right up until the late 19th century "services were generally provided directly by municipalities" but now in many jurisdictions "the private sector has recently become much more involved in delivering the services", while it remains the ultimate "responsibility of the municipality" to ensure service provision. It can be argued, on the basis of this perspective, that the USA provides an illustration of the more extreme end of the phenomenon of privatisation, in which the "free market (i.e., business interests and the profit motive)" is identified as a critical driver of development (D. C. Wilson, 2007). A possible corollary to this observation occurs in the sphere of zero waste, where a success cluster[113] of industry/commercial exemplars are cited as being the inspiration for the latter uptake of the zero waste challenge in a municipal setting (Murray, 2002).

Today, numerous municipal zero waste case studies are confirming new dimensions of activity, experience, learning, and success for the movement. The city of San Francisco and *Recology*, the local service providing organisation, are cited as being a world-leading example of large-scale municipal zero waste practice (Allen et al., 2012; Lombardi & Bailey, 2015). The numerous small to medium-size community-based municipal case studies now being generated by Zero Waste Europe are documenting how further success and excellence are being pioneered (Rosa, 2018; Rosa & Chatel, 2016a, 2016b; Seldman, 2004; Simon, 2015a, 2015b, 2015c; Van Vliet, 2014a, 2014b, 2014c; Zero Waste Europe, 2017). At the other end of the socio-economic development spectrum, many small, diverse, village-scale, municipal zero waste initiatives, are pushing out the thresholds of learning and success in this context (Allen et al., 2012). Despite the cited barriers to progress in New Zealand, the actions and activism of the local grass roots zero waste/Para Kore networks and the Auckland Council feature in this global spectrum of municipal zero waste methodology and success (Hannon, 2018; Hannon et al., 2019; Hannon & Zaman, 2018; Hannon et al., 2018).

1.5. Embedding the *municipal* convention

The evolution whereby the term *municipal* offers the predominate socio-demographic framing in waste terminology is reinforced through the development of so-called *municipal waste indicators*. These analytic criteria were developed to enable meaningful international, *country-by-country* comparative reporting of progress to date across the EU, in support of future planning (EEA, 2013). A corollary to this development and precedent appears in academic reporting, notably the review of the development of *Performance indicators for municipal solid waste management* (Sanjeevi & Shahabudeen, 2015). This emerging terminological convention is evident across other related EU documents, such as the *Story behind the EU's strategic approach to waste* (EC, 2005), as well as that

[113] For example, the following have been variously claimed publicly, see Appendix 1: Toshiba 100%, Honda US – 100% & Canada – 98%, Toyota US – 94%, Ricoh – 100%, Xerox – 99.5%, Fujitsu – 100%, Subaru – 99.8%, Suzuki – 100%, Interface – 99%, Boeing SC – 100%, MillerCoors – 100%, Anheuser-Busch – 99.2%, Unilever – 100%, Procter & Gamble – 100%, GM – 97%, Goodyear – 100%, DuPont – 100%, UK Tesco – 100%, Sainsbury's – 100%.

of pretty much all other peak international entities and initiatives reporting on waste globally, for example:

- Both the UNEP and the OCED similarly articulate emerging indices and protocols for the accounting of international municipal waste and especially its role within the encompassing scientific and societal imperatives of climate change and sustainable development. These definitions of MSW appear to broadly align with the EU thinking, language, and approach (OECD, 2015; UNEP et al., 2013).
- The ISWA *Global Waste Management Outlook* utilises the terminology of MSW as a key measurable and framework for goal setting[114] relative to the UN's post-2015 *Sustainable Development Goals* (UNSDGs). Importantly, this documentation is useful in distinguishing MSW from total (inc. household, commercial and industrial (C&I) , construction and demolition (C&D), etc., waste generated in an urban environment (D. C. Wilson, Rodic, et al., 2015b). NB: related commentary observes that, "definitions of municipal solid waste vary widely between countries, including varying proportions of their commercial, industrial and construction and demolition (C&D) wastes" (D. C. Wilson et al., 2012, p. 242). Clearly, while international convergence is apparent, this remains incomplete and/or, is still trickling down in terms of aligned national conventions.
- World Bank reporting provides further confirmation of the acceptance the developing convention[115] of using *municipal* as an holistic, catch-all label for reporting across the global socio-economic development spectrum and additionally, distinguishes MSW as a key constituent in reporting total solid waste generation and handling (Hoornweg et al., 2012). Building on prior reporting (Hoornweg & Thomas, 1999) the World Bank provides an annexed disclosure and comment based on waste types, composition, management practice, generation density, collection rates and destination by region, and socio-economic status (Hoornweg et al., 2012). This reporting elaborates on the importance of the MSW services in the context of global cities, observing that "municipal solid waste management is the most important service a city provides; in low-income countries as well as many middle-income countries, MSW is the largest single budget item for cities and one of the largest employers" (Hoornweg et al., 2012, p. vii).
- The current and future importance of the world's cities (Abarca Guerrero et al., 2012; UN-Habitat, 2010; D. C. Wilson et al., 2012) [and megacities[116] (Mavropoulos, 2010a, accessed 2014)] and hence municipal waste as the driver of global waste issues is widely reported. In particular, the UN-Habitat report *Solid Waste Management in the World's Cities*, in selecting 20 indicator cities from across the development spectrum, does much to highlight the ascendant influence of the city/municipal waste construct. This reporting annotates and supports a global convergence in language and protocols for developing an accurate collective understanding and description of MSW.[117] Additionally, this report represents a significant

[114] For example, with a specific focus on developing countries: *"achieve 100% collection coverage in all cities with a population more than 1 million + eliminate open burning of municipal solid wastes and similar wastes"* (D. C. Wilson, Rodic, et al., 2015b).
[115] This report provides a comparative outline of OECD, PAHO and IPCC definitions of MSW.
[116] Interestingly, this author refrains from using a 'municipal/MSW framing', instead commenting that megacities should develop an overall and prioritised *Strategic Urban Waste Management Plan* (Mavropoulos, accessed 2014).
[117] Acknowledging national variance based on who is collecting the material, hence data, the report utilises the following working definition of MSW as "wastes generated by households and wastes of a similar nature generated by commercial and industrial premises, by institutions such as schools, hospitals, care homes and prisons, and from public spaces such as streets, markets, slaughter- houses, public toilets, bus stops, parks, and gardens. This working definition includes most commercial and business wastes as municipal solid waste, with the exception of industrial process and other hazardous wastes" (UN-Habitat, 2010, p. 6).

benchmark in in the articulation and acceptance of the concept of Integrated solid (sustainable) waste management (ISWM) (D. C. Wilson & Scheinberg, 2010).

- The global *Waste Atlas* initiative undertaken by the D-Waste collaborative grouping (supported by ISWA) provides a further articulation and confirmation of the emerging consensus of what, where, when, who and how the term, municipal is framed in waste management discourse (D-Waste, 2013b; Koukosia et al., 2013). For example: "Today, the total amount of waste generated annually worldwide (municipal, industrial, hazardous) is… Almost 45% of it is considered as municipal solid waste, while the rest is industrial waste…" (D-Waste, 2013b, p. 7). In addition, this project both reinforces other commentary on the poor state of international waste data (Hoornweg et al., 2012; UN-Habitat, 2010; D. C. Wilson, Rodic, et al., 2015a), as well as seeking to rectify this via "a crowd-sourcing, non-commercial, free access map that visualises municipal solid waste management data across the world for comparison and benchmarking purposes" (Koukosia et al., 2013, p. 12).
- Rather than challenging and or counterposing what appears as an emerging consensus, parallel independent academic analysis and discussion of the world scenario are articulated inside the construct of MSW generation, composition, and management (Karak et al., 2012).
- Another window into understanding how the term *municipal* is interpreted and applied appears in the description of the objectives of the journal, *Waste Management* (http://www.journals.elsevier.com/waste-management . This is cited as an "international journal devoted to the presentation and discussion of information on the generation, prevention, characterisation, monitoring, treatment, handling, reuse and ultimate residual disposition of solid wastes, both in industrialised and in economically developing countries. The journal addresses various types of solid wastes including municipal (e.g., residential, institutional, commercial, light industrial), agricultural, and special (e.g., C and D, health care, household hazardous wastes, sewage sludge)".

1.6. Confirming, supplementing, and disconfirming a *municipal* convention

As discussed, it appears there is a general alignment between the way the term *municipal* is understood and applied among peak national and international waste industry/environmental governance support agencies and the relevant academic/research community (Karak et al., 2012). The following is a representative selection of contexts in relevant scientific/academic literature that illustrate the way the term *municipal* features in waste research.

In the review article entitled *Assessment methods for solid waste management*, Allesch and Brunner (2014) report that most studies focus on municipal solid waste and they adopt *MSW* as the common acronym of for this work area. However, in their research of assessment tools for waste management system evaluation these authors choose to distinguish "companies, municipalities and governments" as identifying common application levels and commissioning scenarios (Allesch & Brunner, 2014, p. 461). Overall, it appears that, because of the strong connection and interplay between the policy and practice of local and national waste management, the term *municipal* functions as an unspecified catch-all phrase. Illustrating this point in a New Zealand context, the LGA:2002 and WMA:2008 both locate the practical responsibility of and funding for waste management with, respectively, local government and the local rating system.

This New Zealand legislation requires local government to consult with their communities in the formation of a *Waste Management and Minimisation Plan* (WMMP) that must be submitted to and approved by MfE as the relevant central government body. Central government establishes the *New Zealand Waste Strategy* (NZWS:2010[118]) as a guiding document and collects and distributes the *Waste Minimisation Fund* (WMF) derived for the national waste levy. Approximately half the waste levy funding is passed on to the respective local government agencies with an approved WMMP. The remaining waste levy funding forms the WMF, which is an open nationally contestable fund administered by MfE. This scenario is illustrative of the close interrelationship between the local (and regional[119]) and central government in the overall exercise of national waste management government. As such, New Zealand provides a relevant example, and a strong rationale for considering the local and national government functions in respect of waste as a combined municipal construct.

A study that modelled global warming factors for a selection of 40 European municipal solid waste (MSW) management scenarios[120] utilised the baseline of 1 tonne of the European average municipal waste as its unit of analysis (Christensen et al., 2009). This is interesting in that, while recognising there is "no standard methodology exists in Europe for defining waste composition", the authors developed an average based on a compilation of recent studies (i.e., which estimated the composition of average European MSW, based upon comparable studies[121] (Christensen et al., 2009, p. 872). The key relevance to discussion examining the usage of term *municipal* is that in this study the suite of 40 scenarios all assume a complete system basis. This means each scenario will, by design and function, in reality be receiving the material flow/waste-stream of an entire city/regional catchment. Yet municipal is the designate term encompassing the respective totals of, both waste flows and ISWM system types (x40). Notably, despite the universalism exhibited in the interpretation and application of the term *municipal*, the findings of this study are presented as relevant to national policy domain. i.e., "waste management, in addition to offering safe and hygienic management of the waste, may also contribute to reducing the GHG emissions in society" (Christensen et al., 2009, p. 883). Other research comparing international approaches in modelling of waste system performance with respect to climate change impacts also entrenches the convention (i.e., the encompassing plasticity and universalism) apparent in how the term *municipal* is interpreted (Gentil, Clavreul, & Christensen, 2009; Laurent et al., 2014).

Academic expository of waste industry development (Karak et al., 2012; Kollikkathara et al., 2009; D. C. Wilson, 2007) offers a synthesis view (with particular relevance to the use the term *municipal*) on the historical schema of management, materiality, and language of waste. Louis (2004, p. 306) broadens this synthesis view (albeit U.S. centric) in offering that municipal solid waste management (MSWM) is a "system comprised of regulatory, administrative, market, technology, and social subcomponents". This author frames this histography around the intersection of federal/state laws/regulations (primarily the *Resource Conservation and Recovery Act* and *Clean Air Act*) and precedents established through recourse to the USA Supreme Court (re the Commerce Clause of the Constitution) and the outsourcing of municipal waste management to a relatively small number of private companies (Louis, 2004).

---

[118] See: http://www.mfe.govt.nz/sites/default/files/wastestrategy.pdf

[119] In effect, this includes regional government *"Under the Resource Management Act, regional councils regulate the environmental effects of waste disposal facilities by granting and monitoring resource consents"* (MfE, 2010).

[120] i.e., made up of a selected variety of reasonable combinations of *"recycling systems (paper, glass, plastic and organics) and residual waste management by landfilling, incineration or mechanical–biological waste treatment"* (Christensen, Simion, Tonini, & Møller, 2009).

[121] Cited as: (Kreißig & Stoffregen, 2008), (Sander, 2008) and (ETC/RWM, 2008)).

In examining trends in municipal solid waste management (Karak et al., 2012) similarly collectively *municipalises* all scales of country and region and frames this review around factors such as the waste hierarchy, which is described as a menu adopted by most industrialised nations for developing MSW strategies. Other factors cited as relevant to MSWM are: topography, population density, transportation infrastructures, socioeconomics and environmental regulations… economic instruments, resource bases, energy requirements (Sakai et al., 1996). A latter-day example of an editorial overview (cited as *A glance at the world*) similarly collectivises and municipalises the MSW framed discussion of selected city and national scenarios (Bangalore – India, Nigeria, Ghana, Albania) (Cerminaram, 2014).

Conversely, another similar editorial overview completely omits to use the term municipal in discussing what constitutes good practice in solid waste management (D. C. Wilson & Scheinberg, 2010). These industry leaders instead utilise the terminology construct of *Integrated Solid (sustainable) Waste Management* (ISWM) as the critical lens for viewing a city's solid waste management system. Success under a ISWM model is described by these authors as progressively addressing all the components of a so-called *Two Triangles* model.[122] This article illustrates how the otherwise ubiquitous municipal framing can just as easily be overlooked or by-passed in favour of reaching out for new (in this case integrative) framings for organising and explaining waste management. The article also aligns with others in highlighting the ascendance of the city as a paramount nexus of future problems and opportunities related to population, resource use, social-economic development status, environmental impacts, the efficacy institutional/governance and the built environment/physical and virtual infrastructure (Grimm et al., 2008; Mavropoulos, 2010a; UN-Habitat, 2010).

In line with the precedents offered in the previously outlined historical overviews, (Cerminaram, 2014; Kollikkathara et al., 2009; Sakai et al., 1996; D. C. Wilson, 2007) authors Louis (2004) and Morton (1998) both adopt what can be described as a currently prevailing interpretation of the term *municipal*, in respect of the waste related interaction between civil society and government. It is notable that focally these discussions are also framed around the ascendance of the global (mega)city, as a formation of converging megatrends such as urbanisation, institutional development, socio-economic liberation, consumerism, science and technological development and the phenomena of social media and globalisation (Louis, 2004). While wrapping this development overview in the universalism of municipal (as in MSWM), this narrative stops short of orientating this trajectory (as others do) to either the global context of climate change and sustainable development (ISWA, 2009; D. C. Wilson, Rodic, et al., 2015a). Nor do these works reference aspirational/transformational thesis such as zero waste, industrial ecology/urban metabolism, nor the circular economy movement, all of which seek to surpass the linear, end of pipe worldview, tethered as this is to the historic origins of waste management in sanitary disposal.

Similarly, the collective strands of globalised socio-economic development are identified as contributing to what is summarily described as a municipal solid waste crisis that exceeds any given single technological fix (Ma & Hipel, 2016). While also assuming municipal universalism, the authors propose the "involvement of all stakeholders as well as social, economic, and psychological

[122] The literature review includes an adaption of the 'two triangles' arrangement of the six critical frameworks of the ISWM 'hard and software' (UN-Habitat, 2010; UNEP et al., 2013) – where the original source is cited as: David Wilson, Costas Velis, Ljiljana Rodic. Concept adapted from: Scheinberg, A., Wilson, D.C. and Rodic, L. (2010) Solid Waste Management in the World's Cities. Earthscan for UN-Habitat.

components" as a necessary advancement on the prior reliance on technological fixes (Ma & Hipel, 2016). In undertaking a systematic literature review exploring the social dimensions of global municipal solid waste management, Ma and Hipel identify four key and interconnected categorises, namely: research into risk and vulnerability (i.e., "health, economic / wage inequity, environmental injustice, and inequity in service provisioning" of affected populations especially children); public participation (via government functions of education, mediating all sector involvement and collaboration); attitude and behaviour (as a shaper of effective community participation); and policy (the effectiveness of regulations and incentives) (Ma & Hipel, 2016).

1.7. Conclusion ref. excerpt commandeered for Section 2.3

Appendix 4: A brief comparative analysis of various commentaries around mixed methods content analysis.

Table 18: A brief comparative analysis of various commentaries around mixed methods content analysis – utilised as a framework to discuss the design of the mixed methods hermeneutic content analysis – thematic of municipal zero waste methodology (MMR-HCA-T MZWM).

A brief comparative analysis of various commentaries around mixed methods content analysis – utilised as a framework to discuss the design of the mixed methods hermeneutic content analysis – thematic of municipal zero waste methodology (MMR-HCA-T MZWM) .

- *A compilation and adaption of (Creswell, 2015) 'Steps in the process of designing mixed methods research (MMR)'*
- *'Table 11.1 'Applying the soico-ecological framework to Collins and O'Cathain' (2009) "Recommended points to consider for novice researchers implementing a mixed methods research study" (Plano Clark & Ivankova, 2016).*
- *The multi-stage, MMR / quantitative compatible model for 'Qualitative Content Analysis (QCA)' offered by (Berg & Lune, 2012, p. 373) and…*
- *'A simplified three-step analysis framework utilised in Hermeneutic Content Analysis (HCA) offered by (Bergman, 2010, p. 389).*

MMR Process Steps (Collins & O'Cathain, 2009; Creswell, 2015)	Applied Socio - Ecological Framework (Plano Clark & Ivankova, 2016)	Multi-stage MMR QCA (Berg & Lune, 2012, p. 373)	Three-step Hermeneutic Content Analysis (HCA) framework (Bergman, 2010, p. 389).	Specific discussion and reflection related to this proposed Mixed methods hermeneutic content analysis – thematic of municipal zero waste methodology MMR-HCA-T MZWM:
1. Define mixed methods research (MMR).	MMR CONTENT: • MMR definitions			In this instance MMR is defined as: 'A research approach in which the investigator gathers and integrates both qualitative (open ended, i.e. themes, information and experiences from zero waste municipal policy / methodology documents) and quantitative (closed ended i.e. statistical indicators & trends) data and then draws interpretations based upon the combined strengths of both sets of data to address the hypothesis for a municipal zero waste methodology (MZWM) in a more authentic expansive and robust way, than what insight would be gained by using either form of data in isolation' (Creswell, 2015).
2. Be cognisant of your mental model, for mixing methods (i.e. assumptions, values & experiences).	MMR CONTEXT: • Personal context • Social context			My personal / social context (values & assumptions) will reflect background and life experience i.e. as working-middle class, pakeha New Zealander, married with a family tertiary educated, business background, politically and theologically liberal believing in the science of climate change and seeking authentic, pragmatic successful community based environmental responsibility. In respect of my professional paradigm / mental model this is shaped around my longstanding roles as coordinator for the Zero Waste Academy (ZWA) which mixes academic research, education and industry community development in particular this is outworked via a 'living labs' theory / methodology. This outlook / approach is annotated in a series of publications (cite).
3. Consider the inclusion of discussion of worldview and research theory.				Section 1&2 the original literature review outlines and argues the interdisciplinarity of waste and zero waste. Similarly, section 3 positions the W→ZW paradigm inside the broader science, debate and imperative of climate change and sustainable development. ZW is examined in context of waste & sustainable development policy frameworks, commercial realities, political & social barriers, opportunities of market based economic instruments and the cognitive connections /

				interrelationship with industrial ecology and circular economy. This worldview is also annotated in a series of publications (cite).
4. Utilise typologies for MMR to provides overall guidelines.	MMR CONTENT: • MMR designs • MMR intersecting with other approaches			Proposed mixed methods hermeneutic content (thematic) analysis (HCA-T) utilising the simplified three-step analysis framework (Bergman, 2010, p. 389). This discussion culminates in sections 6.9-& 6.10 of the literature review
5. Identify / Select the reason rational & purpose for mixing methods.	MMR CONTENT: • MMR rationales			The basis rationale is that for this research construct MZWM MMR is better than mono-method research. A fundamental principle and rationale of mixed methods research is the concept of combining and complementing the strengths (of both Q&Q) whilst distinguishing, isolating and mitigating the weaknesses of research methods (i.e. to exclude or minimise alternative explanation of results, for example, by providing information explaining divergent aspects of the phenomena studied) (Plano Clark & Ivankova, 2016).
6. Define and working title for the project				'Mixed methods hermeneutic content analysis – thematic of municipal zero waste methodology (MMR-HCA-T MZWM)
7. Identify the problem or issue underlying the need for the study.				Excerpt from the 'Problem Statement / Concise Statement of the Research Thesis' (confirmation report): *"… Whilst extensive, zero waste literature does not yet demonstrate the overarching analysis to have firmly established agreement on all key concepts, methods and evaluation tools. Specifically, it had been argued that, understanding around the design and implementing municipal zero waste methodology is deficient. This critique is of particular concern, because translating the recognised success of zero waste in an industrial setting, to the critically influential municipal context, presents as a breakthrough strategy. Failure to clarify a methodology for zero waste in a municipal context, risks undermining the potential of this popular, scientific and successful movement to address waste issues and contribute to more effective resource management"…*
8. Identify the general intent of questions & determine the specific research question.	MMR PROCESS: • Research questions.	ID research question		References 'Concise statement of the Research Question' (confirmation report): Can a scientifically defendable municipal methodology be developed through content analysis of a selection of critical zero waste policy documents?
9. Specify the types of data collection and analysis to be used.		Determine analytic categories (sociological constructs) – Read through data & establish grounded categories (open & axial coding)		Ref. Table 19 Appendix 5: 'Assessment and prioritisation for evaluating sampling options to support source selection from examples of 'Municipal Zero Waste Methodology' (theoretical and applied) documents from which selection can be made for Content Analysis..

10. Select and develop a MMR design.	MMR PROCES: • Methods MMR CONTENT: • MMR designs • MMR intersecting with other approaches.	Determine systematic (objective) criteria of selection for sorting data chunks into analytic and grounded categories		MMR-HCA-T research theory emerges (and is anchored) in the nexus of MMR and content analysis literatures, where HCA-T provides an authentic warp around methodology, which meets the quality parameters of: 1. sophisticated 'within method' triangulated (scaling – testing) design strategy and for convergence and complementarity between Q&Q elements (Jick, 2008), 2. efficacy (rather than the reported excess) of pragmatism (D. L. Morgan, 2008) and… 3. 'validation, validity, reliability, trustworthiness, credibility, inference quality / transferability and legitimacy' as foundational requirements all scientific research (Plano Clark & Ivankova, 2016).
11. Determine a sampling design.	MMR PROCESS: • Methods MMR CONTEXTS: • Interpersonal contexts			This project will utilise a sampling theory providing for the generalisation of themes, information and experience relevant to MZWM over the total possible population of ZW policy discussion documents from which the sample is drawn (Krippendorff, 2013). Sampling will be based upon non-subjective, representation of relevant sample sources / content) (Bergman, 2010). As such the sampling theory mediates scientific validity and strikes a negotiated rationale around practical issues such as data volume / limitation, divergence / symmetry and estimating and managing bias, whilst selecting a HCA-T sample from all, sections and subsections of all text, *"to give a research question a fair chance of being answered correctly"* (Krippendorff, 2013).
12. Draw a figure of the MMR design.				See the sequence of two general CA and MMR-CA MZWM specific schematics outlined in the literature review respectively section 5.2 page 85 and section 7.11 page 128
13. Consider methodological and validity issues in your study				The MMR design utilised in this project seeks to enhance the respective rigor in both Q&Q methods employed in the HCA-T (where key elements of rigor include considerations such as: types of design, ethical permissions, sampling approach, number of participants, types of and instruments for data collection, organisation and cleaning of analytical database and procedures and sound approaches, which establish validity and reliability (Creswell, 2015). In this research context 'Validation', is described as *"the process of assessing the rigor of the methodological procedures which are selected used in research" and* 'Validity', the *"extent to which accurate inferences can be made based upon test scores or other measures"* (Plano Clark & Ivankova, 2016). NB: in terms of generic research 'Quality' see section 10. Point 3 above.
14. Write a MMR aim and or purpose				Reference 'Research Aim 3' (confirmation report): *"To scientifically analyse municipal zero waste literature and practice to quantify and qualify the level of a consensus around what constitutes a municipal zero waste methodology".* This is undertaken in order to test the hypothesis: *"That a defendable municipal zero waste methodology can be established".*
15. Add in any final (quant, qual & MM) research questions which match your design				A range of sub questions are utilised to explore the primary research question. For example: • Who first commentated key zero waste ideas? (sources / people / influencers)? Set against a time line • Has there been an evolution over time as to what zero waste means / is and isn't included? • What elements of MZWM (practices / actions / policies interventions etc) are the most effective (and hence are priorities) in producing change / progress towards targets • What are the financial costs of each elements of MZWM? • Do any prerequisites / contingencies exist between elements of method? In particular between national and local government jurisdictions • What elements of method encounter the most barriers / opposition / problems / confusion?

				• What are the barriers / who produces the most opposition and why? • Are there different worldviews / key tensions / schism within zero waste (i.e. W2E)? • What are the key differences between industry, municipal and community / NGO perspectives of ZW? • What are the key differences between industry developed and developing socio-economic contexts? • What are the key differences between small towns / villages and big cities in the way MZWM is understood and implemented?
16. Collect data (from participant or process).	MMR PROCESS: • Methods MMR CONTEXTS: • Interpersonal contexts	Begin sorting the data into various categories (revise categories or selection criteria, if necessary after several cases have been completed	1- An initial 'Qualitative Content Analysis' (e.g. either thematic or narrative) of non-numeric material in conjunction with a research focus aligned to hermeneutic limits.	Three key source documents were selected for the purposes of iterative abductive development of sources the coding framework (CF) on the from the initial starting point of the 'MZWM 50 pt plan' see section 4.2 of the literature review. These were coded using the CAQDAS selected for this research project. Specifically NVivo is cited as addressing the challenge of integrating analysis and interpretation of qualitative and quantitative data in a singular unified research theory and narrative (Bazeley, 2013; Bazeley & Jackson, 2013; Bryman, 2006, 2007; Lavery, 2016; QSR, 2017)
17. Conduct data analysis	MMR PROCESS: • Methods	Count the number of entities in each category for the descriptive statistics & allow for demonstration of magnitude – Review textural materials as sorted into various categories seeking patterns (NB: no apparent pattern is a pattern).	2- A subsequent (aka convergent - complementary) 'Quantitative Dimensional Analysis'. This may be based upon a joint frequency matrix of a sub-sample of elements	The strategic research involves the results of the above procedure being formed drafted into a post-CF draft initial (three sources) Q&Q MMR-CA write up which is designed to road-test and finalise the overarching research methodology - in particular to establish which quantitative analysis procedures are feasible and worthwhile. This draft MMR HCA-T MZWM write-up will cover: • A reflective, independent consideration and edit of the nodes and node descriptions, external to the CA formative process, + A summary and discussion of the qualitative analysis of the text / data coded at each node (i.e. what further information and meaning does this offer), + A summary and discussion of the selected quantitative analysis which are undertaken is support of the mixed methods CA. This strategic MMR-CA design model covers off final 2 stages in the (Berg & Lune, 2012) model and sets a foundation for [drawing on the (Plano Clark & Ivankova, 2016) annotation model see sections 7.5-7.6 lit rev] finalising the detailed sequential 'QUAL&QUANT (dimensional) & QUAL (reconceptualisation)' MMR-HCA-T MMZWM research methodology. Once the research methodology is finalised and road-tested it can be implemented over the full sample of selected documents, from the collective group: *Theoretical [conceptual proposal (15), academic analysis (10), related project (2), national / state policy statement / strategy (5)] and Applied municipal contexts [national strategy + implementation track record (3), state strategy + implementation track record (3), county strategic + implementation track record (1), city municipal strategy + implementation track record (14)] illustrated as Appendix 3 of the lit. rev*. The final MMR-HCA-T MZWM will form legitimate abductive inferences outworking the specific design illustration source and adapted from (Krippendorff, 2013) to the MZWM context (see section 7.11 page 128). The outcome of the project will be the formation of generalisations which both address the research hypothesis and informs a broad and detailed understanding of MZWM.
18. Legitimate inferences & formulate generalisations	MMR PROCESS: • Inferences MMR CONTENT: • MMR quality	Consider the patterns in light relevant literature and/or theory (show possible links to theory or other research) – Offer an explanation (analysis) for your findings – Relate your analysis to the extant literature of the subject.	3- A second 'Qualitative Reconceptualisation Analysis' of the Quantitative results from step 2 by interpretation within text and context a- associating findings with context, b- employing and integrative post-hoc explorative analysis.	

Appendix 5: An assessment and prioritisation schedule for evaluating sampling options to support source selection.

Table 19: An assessment and prioritisation schedule for evaluating sampling options to support the selection of sources which provide insight on (theoretical and applied) zero waste municipal method (MZWM).

Cases Descriptions / Attributes					THEORETICAL MUNICIPAL CONTEXT
Type	Location	Impact Success	Context	Dev. Status	
Conceptual / Propositional (15)	UK				A Zero Waste UK (J. Hill et al., 2006)
					A sustainable resource management system for Wales: Introducing and using 'Cleanstream Total Resource Recovery Systems (M. Williams, 2000)
					The proposed 'zero waste policy for Britain' (Murray, 2002).
	NZ	high			'Getting there: The road to zero waste: Strategies for sustainable communities (Snow & Dickinson, 2003)
		high			'The end of waste: zero waste by 2020' & 'Getting there: The road to zero waste: Strategies for sustainable communities (Snow & Dickinson, 2001).
	US				A citizen's agenda for zero waste: A strategy that avoids incinerators and eventually eliminates landfills - A United States and Canadian perspective (Connett & Sheehan, 2001)
					Discarding the idea of waste: The need for a zero waste policy now (Jesson, 2003)
					Reaching for zero: The citizen plan for Zero Waste in New York City' (Dimino & Warren, 2004)
					Transforming trash in urban America: A sustainable recycling system matrix (Owens-Wilson, 2013)
	Canada				Zero Waste Challenge: Goals strategies and actions' (Galloway & Metro Vancouver, 2009).
					Getting to 50% and beyond: Waste diversion success stories from Canadian municipalities (FCM, 2009)
					On the Road to Zero Waste: Priorities for Local Government (RCBC, 2009).
	Int.				MED-Zero Waste. (2013a). Transnational SWOT analysis on waste management concepts. Ano Liossia, Greece: MED-Zero Waste. Retrieved from http://www.med-zerowaste.eu/zerowaste.html
					MED-Zero Waste. (2013b). Zero waste handbook of alternative waste management schemes. Ano Liossia, Greece: MED-Zero Waste. Retrieved from http://www.med-zerowaste.eu/
					MED-Zero Waste. (2013c). Zero waste systems' analysis: Common report. Ano Liossia, Greece: MED-Zero Waste. Retrieved from http://www.med-zerowaste.eu/zerowaste.html
					The Community Zero Waste Roadmap. (Lombardi & Bailey, 2015)
Academic analysis / Commentary (10)					
	NZ				Industry guide to zero waste: Towards zero waste and a sustainable New Zealand (NZBCSD, 2002)
	??				From solid waste management to solid waste avoidance: A critical evaluation of zero waste strategic plans (Kozlowski Russell, 2009)
	UK				ZeroWIN: Literature review 'approaches to zero waste' (Hestin et al., 2010).
					Zero Waste Places Initiative, UK (Waste and Resources Action Programme, 2012).
	Int.				Solid waste management in the worlds Cities [Cases studies of San Francisco, US and Adelaide, SA, Aust (UN-Habitat, 2010)

					Establishing environmentally sustainable and economically efficient economies: From waste management towards zero waste (Doppelt, Dowling-Wu, & Seldman, 1999).
					On the road to zero waste: Successes and lessons from around the world' (Allen et al., 2012).
					'Zero Waste Systems Analysis: Common Report', 'Zero Waste Handbook on Alternative Waste Management Systems' and' Transnational SWOT analysis on waste management concepts' – all for "Low cost zero waste municipality" (MED-Zero Waste, 2013a, 2013b, 2013c).
					Comparative international reporting such as the UNCRD supported forum, the International Partnership of Local Authorities – IPLA which hosted the 'Moving Towards Resource Efficient and Zero Waste Cities' workshop in 2013 http://www.uncrd.or.jp/env/ipla/index_form.htm
					The ZWIA zero waste business recognition programme (Zero Waste International Alliance, accessed 2013).
	EU				The European Pathway to Zero Waste (EPOW) project: Demonstrating the way to zero waste (http://www.environment-agency.gov.uk/aboutus/wfo/epow)
Financial & other related analysis					Zero Waste Business Case: Final Report (Hood & Ministry of Environment British Columbia, 2013)
					Transitioning to Zero Waste - What can local governments do NOW? Within a Zero Waste / EPR planning framework, local governments will get out of the business of managing product wastes (Spiegelman, 2006)
	NZ				'Zero waste action planning system (ZAP): Zero waste strategy for Councils' (WasteNot Consulting & Maunsell Ltd, 2003).
	India				A handbook for waste management in rural tourism areas: A zero waste approach' (Nair & Jayakumar, 2008).
National / State Policy Statement / Strategy (5)	Aust				'No Waste by 2010: A waste management strategy for Canberra' and 'No Waste by 2010: Turning waste into resources - action plan 2004-2007' (ACT Waste, 1996, 2004). 4- Canberra, Australia (Australian Capital Territory, 1996) - 1996: Zero waste to landfill by 2010
					South Australia's Waste Strategy 2011-2015 & 2005-2010 (Warren et al., 2013; ZWSA, 2005a, 2005b, 2011, 2013; ZWSA, MMA, & BDA Group, 2007). 2- South Australia (Government of South Australia, 2011) - 2011: 35% reduction in landfill disposal from 2002-2003 level, by 2020; 5% reduction in per capita waste generation by 2015.
	NZ				The New Zealand waste strategy (NZWS2002): Towards zero waste and a sustainable New Zealand (MfE, 2002)
	UK				The 'zero waste Scotland strategy' (The Scottish Government, 2010) and 'Meeting Scotland's zero waste targets assessing the costs associated with new waste management infrastructure' (SQW energy & The Scotish Government, 2010) Scotland (The Scottish Government, 2010) - 2010: 95% diversion of waste from landfill by 2025.
					Towards zero waste: One Wales: One Planet - The overarching waste strategy document for Wales (Welsh Assembly Government, 2010). Wales (Welsh Assembly Government, 2010) - 2010: 65% reduction in waste by 2050.
					APPLIED MUNICIPAL CONTEXT
National strategy + implement. track record (3)					Victoria's Waste Policy and the 2005 Sustainability in Action: Towards Zero Waste Strategy (TZW) and Towards Zero Waste Strategy Progress Report for 2006-07 (Sustainability Victoria, 2007).
					Del Norte zero waste plan'(Seldman et al., 2000).
					4- Buenos Aires, Argentina (Lacunza, 2013) - 2006: Zero waste to landfill by 2020.
					1- Yorkton, Canada (City of Yorkton, 2012).
					1- Burlington, Canada (City of Burlington, 2009).

State strategy + implement. track record					1- Nelson, Canada (City of Nelson, 2012).
County strat + imp. track record					4-Toronto, Canada (City of Toronto, 2005) - 2001: Zero waste to landfill by 2010.
City Municipal strategy + implement. track record					2- Cape Town, South Africa (City of Cape Town, 2006) - 2006: 20% reduction in waste generated, and 30% reduction in waste to landfill, by 2012.
					2- Vancouver, Canada (Metro Vancouver, 2011) - 2011: 70% diversion of waste from landfill by 2015; an aspirational target of 80% diversion of waste from landfill by 2020; 10% reduction in per capita waste generation by 2020.
					3- Seattle, USA (Seattle City Council, 2007) - 2007: 70% diversion of waste from landfill by 2025.
					San Francisco City (http://www.sfenvironment.org/zero-waste) 5- San Francisco, USA (SF Environment, 2003) - 2003: Zero waste to landfill by 2020.
					1- Irvine, USA (City of Irvine, 2007).
					4- Austin, USA (City of Austin, 2005) - 2005: Zero waste to landfill by 2040.
					3- Masdar City, Abu Dhabi, United Arab Emirates (Masdar City, 2008) - 2008: 99% diversion of waste from landfill by 2015.
					4- Christchurch, New Zealand (Christchurch City Council, 1998) - 1998: Zero waste to landfill by 2020.
					Auckland WMMP 2040
					Road map for zero waste Ahmedabad: A Visionary Document to Guide Ahmedabad Towards Becoming a 'Resource Efficient and Zero Waste City' by 2031 (Chaudhary, 2013)
					4- Kamikatsu, Japan (Hill, Hislop, Steel and Shaw, 2006) - 2003: Zero waste to landfill by 2020.
					Kaikoura District Council Zero waste management plan (Kaikoura District Council, 2009) 5- Kaikoura, New Zealand (KDC, 2012) - 1998: Zero waste to landfill by 2015.
					1- Annapolis Royal, Canada (Town of Annapolis Royal 2012).
Town / District strategy + implementation track record					Van Vliet, A. (2014). Zero Waste Europe Case Study 1: The Story of Capannori. Netherlands: Zero Waste Europe. Retrieved from http://www.zerowasteeurope.eu
					Van Vliet, A. (2014). Zero Waste Europe Case Study 2: The story of Argentona. Netherlands: Zero Waste Europe. Retrieved from http://www.zerowasteeurope.eu
					Van Vliet, A. (2014). Zero Waste Europe Case Study 3: The story of Vrhinika 'Slovenian traiblazers'. Netherlands: Zero Waste Europe. Retrieved from http://www.zerowasteeurope.eu
					+ new ZW Europe case studies

Appendix 6: The first initially proposed *Zero Waste Methodological Consensus.*

Table 20: Proposed *Zero Waste Methodological Consensus* - stage one in developing a coding framework for utilisation with NVivo .

Proposed ZERO WASTE METHODOLOGICAL CONSENSUS *i.e. what defines & drives progress towards zero waste*		
50 Key Elements of *proposed* Zero Waste Municipal Method	Comment / Background	NZ
Principles:		
1. Documented declaration of a zero waste goal and establishment of progressive stretch targets.	At the peak >70% of Local Govt officially adopts ZW & the NZWS:2002 is subtitled *"towards zero waste and a sustainable NZ".* Now LGNZ ZW % is uncertain & NZWS:2010 has no ZW reference or targets.	0.25
2. Documented collaborative strategic planning processes designed to achieve goals (i.e. emphasising central leadership and coordination body, process, flexibility, contextualisation.	The NZWS:2010 emphasis is on 'reducing harm & improving efficiency', not zero waste.	0.25
3. Transparent monitoring and reporting of high quality material flow data (i.e. measure what you seek to manage progress towards).	The WMA:2008 results in better NZ data on waste to landfill & landfill GHG emissions. But there is an absence of material resource & substance flow data – so only a partial data picture.	0.5
4. Execution of the priorities expressed in the ISWM 5R hierarchy (i.e. which may include in a developing context immediate sanitary clean-up and pollution control / social and environmental protection measures).	NZ reports it is down from 327 landfills in 1995, to 60 in 2006 predicted to fall further & the remaining landfills better managed.[123]	0.75
5. Recognition of the need for a regulatory / compliance approach which balances and encourages the value and application of both voluntary and mandatory approaches in generating progress and quality.	Current review of RMA:1991 seen to be weakening environmental protections. Government favours voluntary only approached to product stewardship.[124]	0.5
6. Utilise life cycle analysis (LCA) to support technology choice and programme evaluation.	LCA only in early stages of uptake in NZ waste sector most references rely on international work.	0.25
7. Facilitate optimal public private people partnership (PPPP) engagement and service delivery models (i.e. which values and engages the best of each worldview, resource and skill-set.	NZ has seen aggressive privatisation with associated loss of local government control over waste / resources stream. NZ is only early stages of piloting PPPP approaches.	0.25
8. Utilise 'market eco-economic principles' and 'continuous innovation' for driving change (i.e. where environmental responsibility is pathway to, rather than impediment to business competitiveness).	In 2008 the flagship Govt³ resource efficiency programme was discontinued, with a resulting loss of leadership by example and NZ case studies. The NZ waste levy is only $10 / t and as a result WMF is significantly oversubscribed suggesting this is limited as an investment driver for innovation.	0.25
9. Overarching community ownership / public good stake implicit in the waste stream (i.e. so that public good goals can be exercised in respect of access to the waste and resource stream).	By way of example, privatisation the PNCC "presently '*controls' just 40% of the waste stream"* (Boyle & Green, 2012) this limits the ability to facilitate positive environmental change.	0.5

[123] An increase in the proportion of sites with an engineered liner from 20 per cent in 2002 to 52 per cent in 2006. - Improvement in leachate collection at landfill sites from 47 per cent of all sites in 2002 to 78 per cent in 2006, with some of the remaining landfills having natural outlets for leachate. - 93 per cent of landfills now measure the amount of waste being disposed of, an increase from 83 per cent in 2002 (MfE, 2007c).

[124] See http://www.mfe.govt.nz/issues/waste/progress-and-outcomes/product-stewardship.html or http://www.beehive.govt.nz/release/government-accredits-new-product-stewardship-scheme-0

10. Prioritise 'separation at source' & 'source responsibility' (as a key to community engagement to minimise processing cost maximise product quality).	Currently a number or MRFs report contamination /quality issues + improved glass PS, processing and pricing and the Chinese 'green fences' has pushed separation at source back to prominence	0.5
11. Integrate 'extended operator liability' into disposal pricing (i.e. for long term environmental effects of landfills, incinerators, etc).	NZ has a large number of current orphaned contaminated & fly-tipping sites and closed landfills, NZ used a mix of retrospective public funding and prosecution for enforcement and clean-up.	0.5
12. Apply 'precautionary principle (i.e. in terms of new treatment process evaluation and licensing (WTE, landfills and new types of wastes and nano-technology).	The combination of landfill ETS, RMA:1991 protections, past protest challenges to incineration proposals suggest NZ has a strong conception of this. However rural waste pit burning and a slow use of priority provisions in WMA:2008 undermine this.	0.5
13. Recognise and support broader and synergetic spheres of science and practices, i.e. promote: sustainable development, climate change mitigation, social justice and responsibility, industrial ecology, resource efficiency (factor 4,10,X), carbon, nutrient and water foot-printing, the required transition to renewable energy, the transformation of the production economy from linear to cyclical material flows, endorsing the broader perspective of waste including dimensions of chemical, time, solid, liquids and gas etc.	The policy change from NZWS:2002 to NZWS:2010 represents a step back from both zero waste aspiration and support. This reflects an broader preferential government focus on economic development over environmental protection. However, there is a growing public debate and consensus around sustainability and climate change	0.5
Policy Mechanisms:		
14. Employ resource recovery contracts (i.e. 3R) vs waste disposal - emphasising product recovery, quality and value, efficient logistics, constructive competition, service quality, fair pricing).	There a several national guidelines for: recycling and waste management contracts[125], resource recovery centres[126] and health and safety[127] which are available and being used use.	0.75
15. Coordinate and resource new and 'up-cycling' market R&D programme for all recycled commodity types so as to drive long term financially sustainable diversion and circularity.	This is limited nationally by the previously discussed limitations of the waste levy/WMF and post GFC restrictions economic investment R&D.	0.25
16. Utilise extended producer responsibility (EPR) / Product stewardship (PS) (i.e. for whole of product life cycle management of hazardous and special materials).	Limited to accrediting voluntary PS approaches. The non-application of the WMA 'priority product' ministerial declaration is widely questioned.	0.25
17. Utilise deposit refund schemes (i.e. container deposit levy –CDL or 'bottle bills').	There have been past voluntary packaging accords, there is currently only a voluntary glass packaging PS scheme. Generally an anti CDL environment is promulgated by this strong industry lobby.	0
18. Utilise a packaging levy / Plastic bag tax (i.e. on non-biodegradable & non-reusable packaging).	Only peripheral and minor movement on plastic bag and other litter. Some positive NGO clean-up work[128] supported by costly LGNZ intervention.	0
19. Employ backstop landfill and or incineration bans (i.e. mainstream recyclables and EPR covered special/hazardous waste).	No landfill bans this instrument remains unlikely till further progress on PS / EPR is facilitated.	0

[125] See http://www.mfe.govt.nz/publications/waste/best-practice-recycling-waste-mgmt-jul07/html/index.html and
[126] See http://www.zerowaste.co.nz/resource-recovery-centres/ and http://www.wasteminz.org.nz/pubs/the-new-zealand-resource-recovery-park-design-guide-2008/
[127] See http://www.wasteminz.org.nz/pubs/health-and-safety-guidelines-for-the-solid-waste-and-resource-recovery-sector-parts-one-and-two/
[128] See http://www.knzb.org.nz/ and http://sustainablecoastlines.org/

20. Support 'green procurement' guidelines/ regulations (i.e. public sector, businesses and organisations) to drive markets for environmentally sustainable design (ESD).	Most initiative in this sphere died off with the end of the well regarded GOVT3 programme. Some positive NGO activity via the sustainable business network (SBN[129]) and the Sustainable Business Council (SBC) is in play.	0.25
21. Support minimum recycled content standards / programmes (i.e. city, state or federal) for recycled commodity market development.	Some voluntary NGO eco-labelling and standards activity.	0.25
22. Facilitate standards/ permits (create standards / accreditation for resource recovery and recycling facilities as part of specifications for tenders).	The RMA and LGA consenting and permitting processes provide good coverage. However an omission is clean-fills and rural waste	0.75
23. Progress mandatory corporate environmental reporting (i.e. including waste surveys, plans, targets, monitoring & reporting).	GOVT3 did in the past push this in public sector. Some positive private sector & local government leadership.	0.25
24. Progress recycling targets for industry and the public sector (i.e. by accord or mandate).	See 17 and 18 voluntary only supported by green ribbon type awards, etc.	0.25
25. Facilitate construction and deconstruction (C&D) standards (i.e. guidelines and standards for construction / demolition for reuse and recycling NB: including disaster waste management protocols, processes and practices).	Some good BRANZ and ChCh (earthquake related) information and case studies. 'GreenSTAR' making inroads through high profile exemplars such as Meridian and Dept of Conservation HQ.	0.5
26. Utilise imported and local product (recyclability criteria and labelling) and tools to identify discards (resource ID beyond SWAP).	Mostly a hands-off free market ideology applies. NZ recycling symbols available for free	0.25
Financial Mechanisms:		
27. Utilise landfill, WTE and incineration tipping fees (which are based on real / full cost accounting with no hidden subsidies for wasting).	Landfill full cost accounting guide[130] available & small national waste levy in operation. Questions exist as to the degree of outstanding externalisation & the effectiveness in encouraging waste minimisation.	0.5
28. Employ user-pays approaches (i.e. pay as you throw – PAYT - by waste generator).	Mostly user PAYT, some funding via universal annual charge (UAC) at municipal level.	0.75
29. Employ landfill levies (to reinvest as kick-start funding of waste minimisation initiatives).	Yes from 2009, but at $10 relative to international standards this amount is widely considered too low.	0.75
30. Employ 'advance disposal fee' (ADF, i.e. up-front prepaid end of life recycling fee associated with EPR and PS) as an zero end of life cost incentive for maximum recovery.	No mandatory national PS schemes using ADFs.	0
31. Invest in R&D, business development grants programme / Low interest loans / Tax Incentives (i.e. concessionary loans or grants funding for start-ups and development of 3R businesses or organisations or processes. Support and incentivise industry to use recycled commodities, reverse logistics service leasing models, dynamic modularity, dematerialisation, remanufacturing, ease of disassembly, inert – non toxic – bio-degradable – fair trade substitution, industrial symbiosis, technical and financial support for circular economy).	The effectiveness and impact of the WMF and general R&D environment is subject to question. Considering the scale of economic re-design contemplated when moving to circular economy, this must be considered to be pretty limited. There is some positive CRI, university and private sector R&D activity has been supported by funding.	0.5
32. Encourage design for the environment (DfE) environmentally sustainable design (ESD) assistance	As above.	0.5

[129] See http://www.sustainable.org.nz/ and http://www.sbc.org.nz/
[130] See http://www.mfe.govt.nz/issues/waste/landfills/full-cost.html

(i.e. access to R&D grants, loans, competitions, awards & incentives)		
33. Invest in and support human resource development of 3R environmental service sector (i.e. local 3R job creation / quality (i.e. application of state federal programmes for economic development, 'living wage', health care benefits, representation & occupational safety & health).	In NZ there is good baseline employment legislation, monitoring and compliance. The story of NZQA industry training for resource recovery and solid waste industry is patchy. Current outcomes to date are mainly driven by community recycle sector (CRN) rather than large corporates.	0.5
Physical Mechanisms:		
34. Ensure effective hazardous and special waste interception and treatment programmes (i.e. to detox the waste/resource stream) are in action.	There was a strong hazardous waste collection movement i.e. 'Haz-mobile' etc and also MfE Agri chemical and POP collection and treatment. Under the WMA:2008, in theory this should be replaced by PS frameworks, but this has been slow to evolve.	0.5
35. Facilitate the introduction of a progression of curbside recycling programmes (single family - multiple dwelling - business) linking to cost effective material recovery facilities (MRFs).	The 3 0r 4 bin revolution is midcourse in NZ as we move from various forms of public / private, general to organic curbside and commercial collections.	0.75
36. Development of requisite organics recycling programmes covering household / commercial food scrap, garden green waste and commercial organic materials (i.e. 'city to soil' ethos to support food security / soils amendment.	See above. Some positive research and WMF funding projects. The loss of NZWS:2002 targets blunted initiative is this space.	0.5
37. Development of requisite C&D recycling programmes.	CCC brought disaster recycling into view, but generally this is off the radar expecting for a treated timber R&D project.	0.5
38. Facilitate resource recovery parks (RRP or RR-centres or RR-networks (i.e. retrofit transfer station and or major disposal points).	Some historically good big city CCC 'Red Sheds' and small town examples Raglan 'Xtreme Waste', but sector under recognised / utilised and under competitive pressure. Auckland now driving progress in a RR network.	0.5
39. Facilitate other, public spaces and event resource recovery infrastructure/ signage (waste disposal universally matched with a visible & user friendly recycling opportunity).	The shift of 'LoveNZ' public spaces recycling programme from Local Government to the private sector 'Glass Packaging Accord' management raises questions of around the effectiveness. After the RWC2011 event recycling appears de-prioritised.	0.5
40. Encourage last resort 'dirty MRF', MBT, C&I recycling processes to minimise residues for disposal.	Some activity. But also some large commercial failures apparent in this space.	0.25
41. Build capacity for where necessary stockpiling resources (i.e. store-filling, mono-filling) pending market and technology development / Landfill mining for recycling resources and space / Contaminated site clean-up and bioremediation etc.	See 37 - mostly off the radar - some publically funded contaminated site remediation.	0.25
Social Mechanisms:		
42. Engage community environmental education / social marketing programmes (with zero waste component i.e. to encourage the right kind of public engagement and response – ideally a consistent with national or state EfS principles).	Past MfE in partnership with regional councils developed the 'Reduce Your Rubbish' campaign[131] (2003). LoveNZ, Unpackit awards & NZ recycling symbols are the limited public face of recycling.	0.50

[131] See http://www.mfe.govt.nz/issues/waste/waste-pilot/conference-paper.html

43.	Ensure national or state education system based environmental education resources, matched with high standard recycling programmes.	There are effective national EfS programmes with a strong waste/resources theme these are funded by a mix central and local government initiatives.	0.50
44.	Engage in international networking, liaison and collaboration to support shared and best practice (i.e. participation in associations, conferences and research initiatives).	NZ has effective industry associations such as WasteMINZ[132] and CRN[133] however these represent an underutilised opportunity for progress in the 'public good' space.	0.75
45.	Empower industry training and R&D (i.e. certified ZW/3R training and qualifications including scholarships and incentives – engagement with and funding for tertiary level research institutions.	See 33 - NZ has strong generic education and research frameworks, but relative to the scale of the social, environmental and economic paradigm shifts that sustainable development and climate change requires, it can be argued that this is opportunity is under-utilised.	0.5
46.	Facilitate zero waste advisors / capacity building (i.e. to assist Councils, businesses and community groups with their projects).	After the demise of the 'Zero Waste NZ trust' CRN (annual hui) is the main junction for collectivising and sharing zero waste IP & support. CRN does a great job but is in real terms under resourced.	0.5
47.	Recognise Branding /Accreditation/Endorsement / Labelling systems for zero waste businesses / products (i.e. facilitation of the ZWIA model).	The ZWIA business programme or similar is not active in NZ. Other eco-labelling is voluntary and lacks support and profile.	0.25
48.	Awards and positive zero waste recognition programmes.	The MfE 'Green Ribbon' awards & Unpackit by CRN.	0.75
49.	Encourage campaign platforms and critical debate where essential zero waste policy and practices are absent and /or dependencies on federal or national level governance exist as barriers to progress – which draw upon active participation in collective lobbying for required change.	Under the current WMA:2008 framework the MfE is the is the key facilitator (or otherwise) of leadership and sole arbitrator of the WMF funding. This scenario dampens down critical debate. Local government association (LGNZ) is an emerging avenue for debate.	0.5
50.	Recognise, promote compliance with all relevant local and international waste and pollution laws, regulations, conventions, treaties, accords and agreements(i.e. to ensure global and intergenerational environmental equity).	NZ is active and responsible in terms of international obligations. The key threat to this is limited resources for monitoring and compliance and slow move into mandatory PS scheme which work to established standards and with adequate monitoring of self-policing structures build in.	0.75

[132] See http://www.wasteminz.org.nz/
[133] See http://communityrecyclers.org.nz/

Appendix 7: Revised v2 Analytic Construct for MZWM Content Analysis.

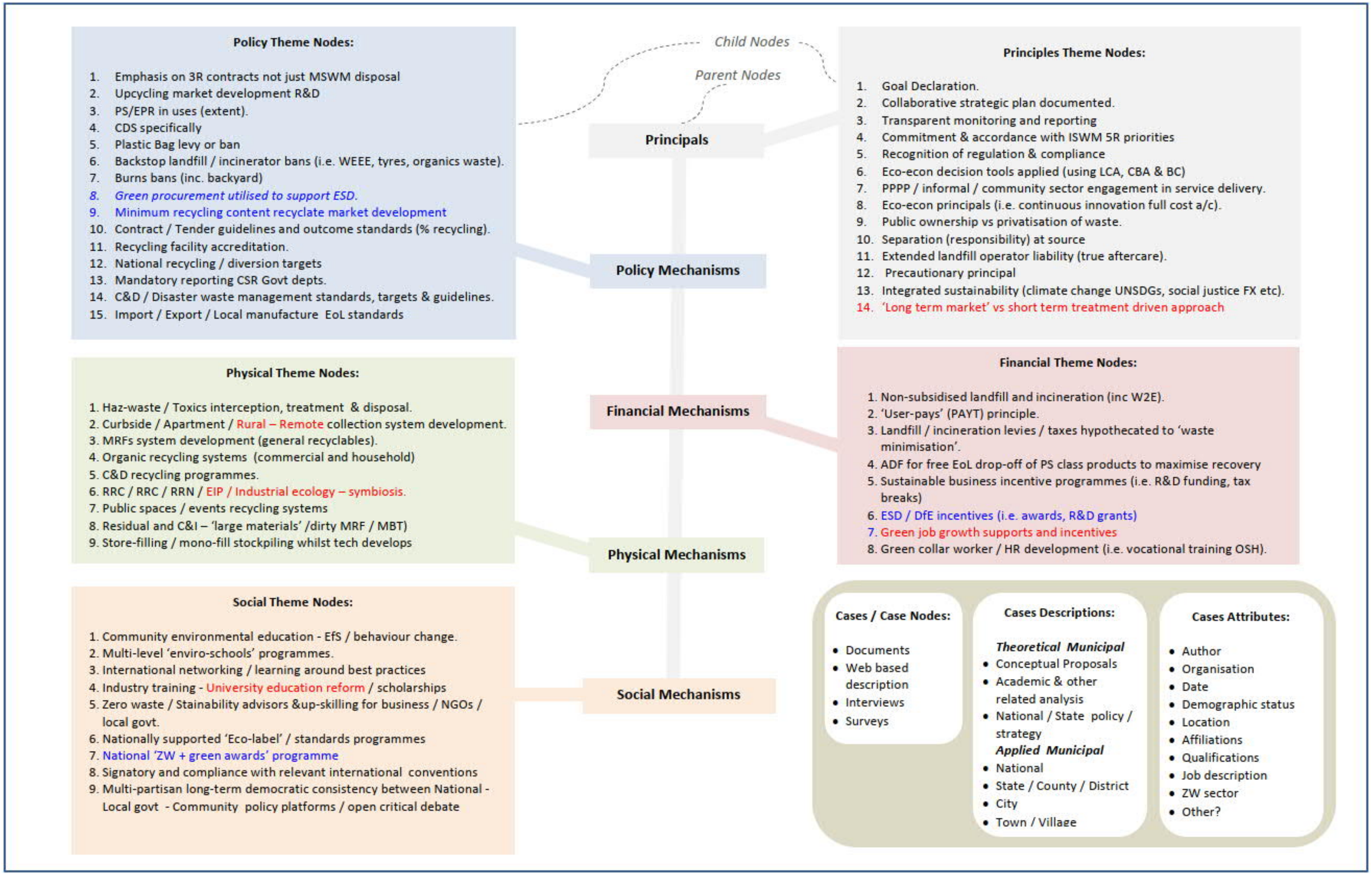


Figure 22: Revised v2 'Analytic Construct for MZWM Content Analysis' prepared as stage 2 process for utilisation as a coding framework within NVivo

Appendix 8: Project Map / Coding Frameworks x2

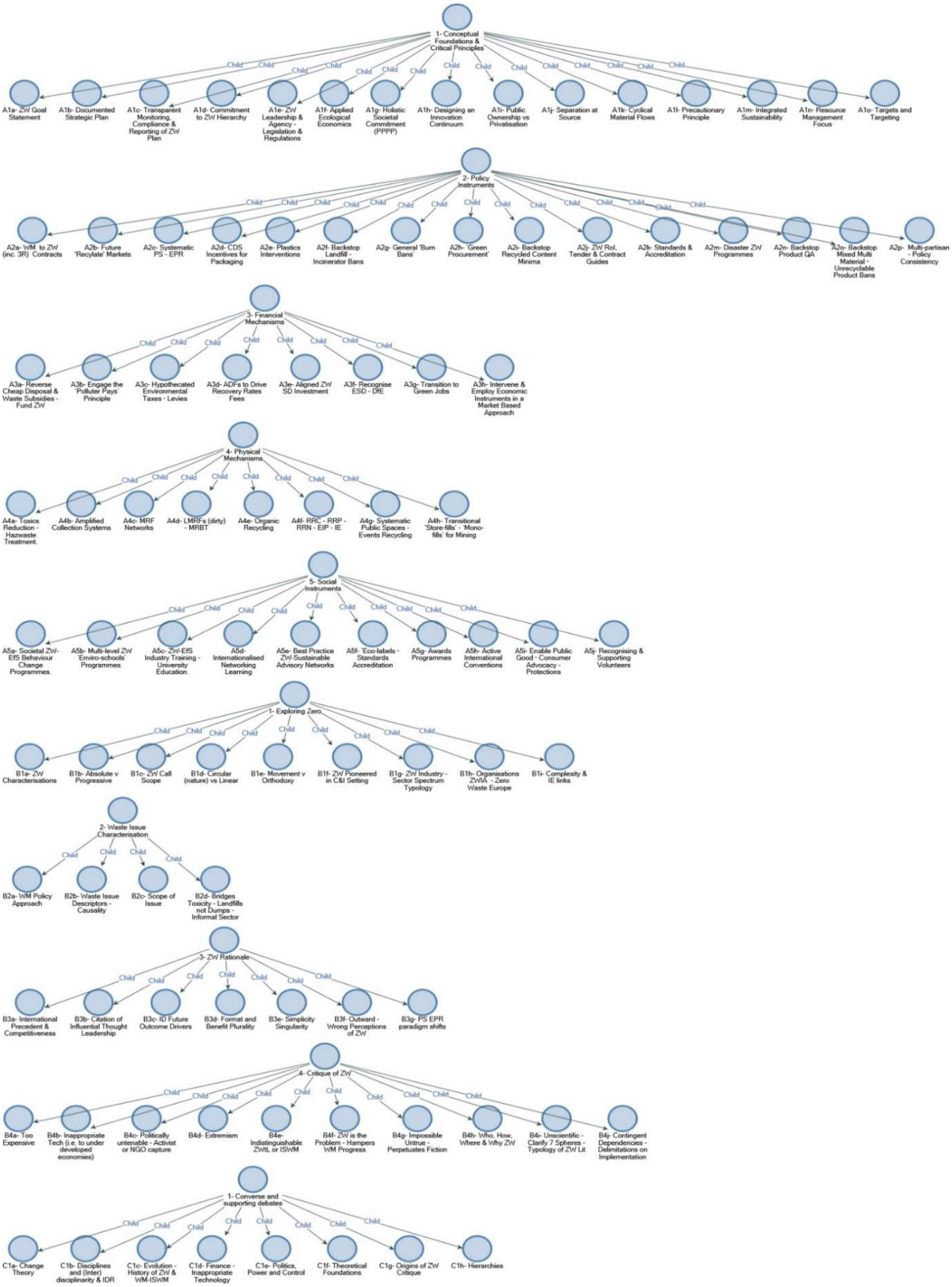


Figure 23: Project Map / Coding Frameworks illustrated via a print-out function within NVivo - as at 14th of March 2017. *NB: this records the illustrative function and development at this point rather than the absolute finalised versions of both coding frameworks*

Appendix 9: Final Coding Framework (CF v final) as an input for MS EXCEL content analysis.

Table 21: Final Coding Framework - as at 21st of April 2017, i.e., ready to undertake draft write up and then commence the next phase of the content analysis.

Node Name	Node Description
A1- Conceptual Foundations & Critical Principles	Essential foundations and key principles upon which MZWM depends
A1a- ZW Goal Statement	Public declaration of a ZW goal often with an associated timeframe
A1b- Documented Strategic Plan	Establishing (via wide stakeholder collaboration) and documenting a strategic ZW plan with a programme of implementable actions, where this is framed around holistic multi-stakeholder roles - partnership, involvement and collaboration. A critical consideration is incorporating the grass-roots, bottom-up, real world knowledge and experiences of waste-ZW workers
A1c- Transparent Monitoring, Compliance & Reporting of ZW Plan	Transparent programmes for monitoring, compliance & reporting of the implementation of the ZW plan. Emphasis on good data i.e. waste surveys - research to create data sets to enable planning.
A1d- Assertive or Alternative WZW Hierarchy	Recognition of and assertive commitment to a conventional WM or an alternative ZW hierarchy (i.e. derivative but different to ISWM 5R elements and priorities) where the distinction of both notional exclusion of burn bury disposal options and actualising rather then apparently forgetting, subverting and ignoring the expressed hierarchy of priorities
A1e- ZW Leadership & Agency - Legislation & Regulations	Accepting and establishing leadership role and agency and developing enabling legislation and regulatory frameworks which support and direct zero waste planning and implementation + Includes govt institutions leading by example i.e. NZ mode GOVT3
A1f- Applied Ecological Economics	Aligned ecological and economics principles applied via life cycle management (LCM, CBA) decision making tools.
A1g- Holistic Societal Commitment (PPPP)	Whole of society engagement involvement and commitment to transitioning to ZW and SD this will manifest in all sector and levels of society having roles as well as in PPPP type arrangements inc. embedded community informal sector engagement in policy planning and service delivery - 'public private people partnerships' (PPPP)
A1h- Designing an Innovation Continuum	Investment in generating a design lead continuum of innovation relative to ever-changing nature of the waste problem, future technologies and issues. The concept of continuous innovation connects with the hyper-ambition, challenge and aspirational of the other broad range of ‘zeroisms’ (i.e. accidents defects, harm, etcs).
A1i- Public Ownership vs Privatisation	The expression of the 'public good' through retaining a balanced influence of public vs privatised waste and resource material flows

Node Name	Node Description
A1j- Separation at Source	Enacting the 'separation at source' principle which requires community participation in and responsibility for maximising recycling and minimising contamination. Sep source especially organics for other resources is observed as catalyst for improved recycling (collection rates, OSH and profitability).
A1k- Cyclical Material Flows	Engineer an assertive transition from linear to cyclical material flows through the economy by enhancing resource recovery, reuse and recycling
A1l- Precautionary Principle	The precautionary principle is accepted in policy and put into practice. Extended disposal operator (landfill and incineration liability (i.e. reflecting and internalising the true aftercare, full life cycle costs). In a general sense this means including all otherwise externalised - overlooked cost into evaluation of environmental impact and where uncertainty exists environmental protection retains priority and the burden of proof of minimal harm resides with the proponent of change
A1m- Integrated ZW - SD & CC mitigation	Waste & ZW are understood within and driven by the broader context of climate change (GHG emissions, energy mngt,) conservation, biodiversity, social – cultural justice and sustainable development - sustainability policies. ZW is pursued in alongside and synergy with the 'Glavic and Luckman' type spectrum of other related sust actions and imperatives.
A1n- Resource Management Focus	A focus on material resource management under a long-term planning horizon, rather than just short-term reactive waste treatment disposal mentality. Encompasses strategies to maximise resource quality and value (reflected in market price and demand).
A1o- Targets and Targeting	Are targets utilised i.e. institutionalised jurisdictional (national, state or local municipal) and how are these framed i.e. waste diversion, 3R rates and or targeting of priority waste types and or problem industry sectors etc.
A1p- General to Local - Contextualisation, Adaption, Evolution, Flexibility & Prioritisation	Illustrations of generalised international shared - critical ZW concepts, experience learnings & model which can - needs to be locally - individually interpreted by champions and communities and contextualised, flexibly-adapted, prioritised when adopted understood and implemented. NB: approaches evolve over time (voluntary / awareness raising to mandatory / compliance with social change. This links and aligns with the B1a ZW characterisation and B1e movement orthodoxy nodes
2- Policy Instruments	Essential policy settings and instruments upon which MZWM depends
A2a- WM to ZW (inc. 3R) Contracts	Establishing ZW contractual obligations which include and emphasise 3R, rather than just MSW treatment and disposal. A related emphasis is to seek to continually expand the range of material and product types which are recovered and recycled.
A2b- 'Recylate' Markets	Investing in current quality assurance increased market returns as well as future, higher value, enhanced material quality - upcycling market development i.e. thorough R&D into new products which can incorporate recycled content and hence grow market demand and prices for 'recyclate'.
A2c- Systematic PS - EPR	Indicators confirming PS EPR as a fundamental paradigm shift essential to ZW & transformational of enviro material responsibility- Systematic product stewardship (PS) and or extended producer responsibility (EPR) for the class of products whose end of life (EoL) issues (marginal

Node Name	Node Description
	recyclability and or issues around toxic constituents) make this a necessity. key PS –EPR scheme design principles: ensure cost effectiveness, competition, minimum thresholds for accessibility and user friendliness etc.
A2d- CDS Incentives for Packaging	Container deposit system (CDS) incentives employed to deal with packaging waste problems such as litter and fugitive plastics.
A2e- Plastics Interventions	Plastic bag - macro bead taxes, levies and or bans are utilised to specifically address issues around fugitive plastics (i.e. ocean plastics
A2f- Backstop Landfill - Incinerator Bans	Backstop landfill - incinerator bans can and are utilised to support PS –EPR systems and other incentive programmes for cortical – priority types of products (i.e. WEEE, tyres, organics waste).
A2g- Command & Control - 'Regulations, Bans & Directives'	Examples of command and control i.e. 'regulations, bans & directives' vs voluntary approaches and agreements for example general backyard, farm, open dump 'burns bans' are in place for all forms of inorganic waste. Query landfill regulations
A2h- 'Green Procurement'	Mandated public – incentivised private sector 'green procurement' (i.e. recycled content) utilised to support 'environmentally sustainable design' (ESD) programmes.
A2i- Backstop Recycled Content Minima	Raising backstop benchmarks for minimum recycled content in key compactable product types (i.e. paper, plastic).
A2j- ZW RoI, Tender & Contract Guides	Investing in creating a suite of free, user friendly ZW 'registration of interest' (RoI), tender, and final contract templates – guidelines (national and local) which enable efficient ZW outcomes and standard's to be procured for a range to sectors (i.e. government departments, events amendments and schools etc) from a range service providers (i.e. cleaners, caterers and recyclers etc).
A2k- Standards & Accreditation Programmes	Creating and utilising minimum environmental – socio economic standards (inc. ISO + various international - national ewaste and compost etc) and accreditation for key ZW infrastructure, processes and services (i.e. landfill operations, recycling facilities). Support the development of standards accreditation programmes.
A2m- Disaster ZW Programmes	As part of adaptation to the impacts of climate change establish plans and programmes for disaster waste and recycling management.
A2n- Backstop Product QA	In order to enable a more circular ZW economy intervene to develop and utilise minimum product quality assurance (QA) guides- standards on imported, exported, locally manufactured goods (for example extending the horizon for planned obsolesces to increase durability and reduce toxicity i.e. EU RoHS regulations for WEEE.
A2o- Backstop Mixed Multi Material – Unrecyclable Product Bans	Backstop mixed multi-layer material - product (which in effect erodes profitability of recycling or makes products and packaging unrecyclable) bans for example where PS-EPR systems do not work for 'tetrapak' type packaging, or in comparable polymer typed slaved plastic bottles or micro-beads plastics.

Node Name	Node Description
A2p- Multi-partisan - Policy Consistency	Transition Multi-partisan, long-term, democratised, apolitical consistency within national - local government and community ZW-sustainable development policy frameworks and programmes. This will avoid the transaction cost and wastage associated with the divestment cycles – swings from current politicisation - polarity of environmental policy.
3- Financial Mechanisms	Essential financial mechanisms (interventions and incentives) upon which MZWM depends
A3a- Reverse Cheap Disposal & Waste Subsidies - Fund ZW	Stop and reverse all indirect and direct subsidisation of disposal and pollution which results in cheap disposal (i.e. landfill and incineration - inc W2E) by transitional funding invested into ZW change cycle, Increasing disposal cost is a market signal which encourages resource inefficiency and throwaway linearity
A3b- Engage the Polluter 'PAYT' Principle	Engage the 'polluter pays' principle through instruments such as 'user-pays'. 'pay as you throw' (PAYT) and appropriate penalties for fly tipping, littering and environmental pollution (inc. both macro i.e. chemical spills) and micro level (i.e. the chemical impacts - toxification of biological systems, such as from PFC coating fast food packaging).
A3c- Environmental Taxes – Eco Levies	Introduce and utilise environmental taxes – levies (i.e. landfill / incineration) to generate transition funding indirectly or hypothecated to 'waste minimisation' investment to drive a reversal of the throw away society phenomena.
A3d- ADFs to Drive Recovery Rates Fees	Utilise 'advance disposal fees' (ADF) to ensure baseline free EoL drop-off of PS – EPR class products to maximise recovery rates and reduce costly fly tipping.
A3e- Aligned ZW SD (Tech Infrastr. Service) Investment	Invest integrate and incentivise ZW infrastructure, tech and services - aligned broader sustainable (business, urban – city, household) development programmes (i.e. R&D funding, tax refunds etc). NB: intro the tipping point - saturation concept in access, user friendliness & normalcy. Critical to this is innovation & investment in R&D driving new tech, improved infrastructure and service levels i.e. questing for lifting 'best' - 'good' practice benchmarks
A3f- Fundamental ESD - DfE	Recognise the critical - fundamental role and incentivise and promote environmentally sustain design (ESD – design for the environment (DfE) programmes through awards, R&D grants and student competitions and scholarships etc). NB: this shifts ZW from end of pipe to mid and upstream focus addressing and redesigning our way out of problems - eliminating them at source.
A3g- Transition to Quality Green Jobs	Grow green and better jobs and empower the transition to a low carbon ZW economy (for example fund green collar worker retraining costs and education & awareness & HR development (i.e. vocational training OSH). NB critically this involves incorporating and improving the HR interests and employment rights of waste, recycling and informal sector workers
A3h- Market Based Approaches - Intervene & Employ Economic Instruments	Employ market based approaches - when necessary intervene with market based economic instruments to drive change (i.e .step beyond the inertia and polarity of command and control vs hands off, free market lasize faire model), It can be recognised that in the case of market failure ZW

Node Name	Node Description
	requires holistic, economically savy, market based approaches - economic instruments which steer and influence financial drivers for effective change.
4- Physical Mechanisms	Essential physical mechanisms (infrastructure and programme actions) upon which MZWM depends
A4a- Toxics Reduction - Hazwaste Treatment.	Develop assertive programmes to detoxify at source, all products and materials flows in the economy. Actively intercept, collect, treat & dispose of existing hazwaste streams.
A4b- Amplified Collection & Sorting Systems	Develop and institutionalise highly efficient, accessible, multi-materials, low contamination rate, collection systems: for all households (i.e. curbside), apartments, rural – remote (i.e. agricultural and tourist) areas and businesses. Resource recovery systems are the engine of material recovery, diversion for waste and economic circularity.
A4c- MRF Networks	Facilitate best practice, appropriate technology for a network, system of 'municipal recycling – materials recovery facilities' (MRFs) sufficient for logistically efficient sorting (SS) general recyclables. NB: may involve mobile at source sorting & process systems consistent the 'slow recycling' – 'clean stream' movement seeking to maximise resource quality & value. NB: in a dev. country context where transport is limiting - high cost MRF may translate as highly localised, small scale sorting facility.
A4d- Address C&D - C&I i.e. LMRFs (dirty) - MRBT	In order to address C&D - C&I recycling facilitate large material recovery facilities (so-called dirty MRFs) and or material recovery (mechanical) biological treatment (MRBT – MBT) to service high efficiency commercial and industrial (C&I) and construction and demolition (C&D) recycling programmes.
A4e- Organic Recycling AD + Compost etc	Facilitate and maximise market driven quality assured organic recycling systems – networks (commercial and household level) which enable organic resources to be local recycled back to beneficial use as a soil amendment. - links to the big picture of maintaining agricultural systems (soil carbon, fertility, food security, nutrient - carbon cycles) noticeable Anaerobic Digestion (AD) is the only W2E process which fits inside a ZW rubric
A4f- RRC - RRP - RRN - EIP - IE	Facilitate resource recovery centres – parks – networks, eco-industrial parks and programmes and locations for industrial ecology – symbiosis. This community based infrastructure's is and essential support mechanism for second hand 3R cycles (Freecycle trade me other?). (In parallel a virtual online version of this 3R enabling infrastructure is also required (for example Freecycle, Trade-me EBay other?? private garage – car boot sales school bring and buy events etc).
A4g- Systematic Public Spaces - Events - Everywhere Recycling	Develop a systematic public spaces - events - everywhere (at least general and organic) recycling programme – network which fills in the recycling accessible gap between home and work (school) as the two key places where people occupy their time. The intent is to normalise recycling behaviour and responsibility so that people are consistently able to access the necessary infrastructure and system to outwork environmental choices.

Node Name	Node Description
A4h- Transitional ‘Store-fills’ - ‘Mono-fills’ for Mining	Facilitate a strategic network of ‘store-fills’ – ‘mono-fills’ which enables the transitional practice of stockpiling rather landfilling resources whilst tech develops to recycle and recover resource from these material streams. This practice can be transformational for conventional landfill management and synchronise with the current dirty MBT based landfall mining practices which enable strategic reuse of these sites.
5- Social Instruments	Essential social instruments (education, behaviour change etc) upon which ZWMM depends
A5a- Societal ZW-EfS Behaviour Change Programmes.	Long-term society wide investment (community - business) in zero waste, climate change awareness raising, public communication, environmental – education for sustainability (EfS) and behaviour change programme to explain, build support for programmes & reverse the decades long social induction – normalisation of the ‘throwaway society’.
A5b- Multi-level ZW ‘Enviro-schools’ Programmes.	Long-term multi-level (early childhood, primary, secondary, tertiary) sustainable practice based ‘enviro-schools’ programmes which include ZW as a critical element of sustainable development. + must involve practical demonstration and example of leadership. -walking the talk
A5c- ZW-EfS Industry Training - University Education.	Invest in embedding ZW-EfS into vocational training and university education via for example curricular reform, scholarship programmes, post-graduate. Critically linked to this is a R&D driven approach i.e. funding for real world, problem based (living labs type) research, as well as enacting uniform requirements for practical demonstration of sustainable campus management in all learning environments. + must involve practical demonstration and example of leadership. -walking the talk
A5d- Internationalised Networking Learning	Participate in international networking and collaboration for sharing of experience and learning around best practices and new innovation. A particular focus in the ZW space needs to be bridging across the developed developing divide as waste is a globalised ‘super-wicked’ problem.
A5e- Best Practice ZW-Sustainable Advisory Networks	Establish and fund best practice advisory network to share and innovate ZW-sustainable practice Train and equip ZW-SD advisors for up-skilling and enabling households, business, non-government organisations (NGOs) and government departments.
A5f- ‘Eco-Enviro' Labels & Products	Support participation in and uptake of national – international ‘eco-label and enviro-product' programmes to identify, inform and promote environmental sustainability credentials and raise environmental performance.
A5g- Awards Programmes	Support local, national and integration participation in ZW- ‘green awards’ programme individuals, NGOs, schools and private and public sector organisations.
A5h- Active International Conventions	Participate in the development expansion of scope and targets, signing, promotion, monitoring, compliance and reporting around necessary relevant international environmental conventions.
A5i- Enable Public Good – Consumer Advocacy - Protections	Provide support to enhance consumer rights - protection, enable a balance of voices interventions in the public good space to balance out and moderate the vested interest lobbying and bias of industry association - sector initiatives.

Node Name	Node Description
A5j- Enable Participatory Dev. - Ensure Appropriate Technology	Ensure appropriate technology & enable participatory - 'grass-roots' - 'bottom up' development and recognise & support the volunteer - not for profit (NfP) - third - community enterprise sector and local ZW champion - change agent - activism. NB: this in dev. context this relates to the informal 'waste picker' sector. *NB: this criteria also links to the concept of 'decentralisation' where programme detail is contextualised - actualised locally to outwork high level national - regional policy settings.*

Appendix 10: An example of the worksheets in this MS Excel based qualitative (mostly) analysis spreadsheet system.

The name of this worksheet is ‘Participate A5j, A1j, A2p, Ali’. This provides an example of the other worksheets in this MS Excel based qualitative (mostly) analysis spreadsheet system. NB: this transcription is annotative, abbreviated and acronymised so equates to industry expert level shorthand, which is subsequently expanded, elaborated, explained and reformatted and formalised into succinct but hopefully effective written narration of the result which can be logically inferred from this data when examined in the framework of content analysis.

Table 22: A Worksheet of ‘Participate A5j, A1j, A2p, Ali’. This provides an example of the other worksheets in this MS Excel based qualitative (mostly) analysis spreadsheet system.

author	date	ref	scope	ref A5j part. dev. 108	ref A1j sep. source 70	A2p non partisan 2	A1i pub. v priv. 41	Participatory development	Appropriate technology	Separation at source	SS drivers PD/AT motivations	Barriers / issues
Snow & Dickinson	2002	NZ for int. ref re ZWIA	national		4		1	community householder participation encouraged. Local Authorities will guard community ownership of the waste stream.	household basic unit in national strategy	proper' SS + mandatory wet vs dry SS		
Allen et al	2012	Global - Community	global	1	4	1	1	success ZW = inclusive programme, respect community all social actors esp. informal sector neutral negotiation to resolve conflict & form progress. ZW = revolution in the relationship between waste & people	resident participation in 'consuming sustainably', minimising waste, separating discards + home composting + active implementation & monitoring	ZW recognised SS + govt (3) linked to 75% diversion goal. SS applies to 'reuse, repair, & recycle (inorganic materials) + separate collection of organic materials (to compost or AD)'.	high quality - value resources + lower contamination issues & cost.	
Tangri, N.		Pune, India	city		6		2		WP are in direct completion with private sector waste Co	SS in conjunction with WP door to door collection and support (2) applies to OR for biogas	high quality - value resources + lower contamination issues, time & cost + higher recycling / waste diversion rates + service levels. In ref OR SS = higher quality compost	compliance issues need education & enforcement. SS requires WP resort. Without legal rights to access resources lives & livelihoods of WP very insecure .
Gokaldas, V.		SF, US	city	7	1		3	WP/IFS coops / federations / formalisation is positive NB: historic fist + third world WM recycling industry dev pathways similar. Municipal regs can support this. Market development green procurement by govt + preferential 'green job'employment supports benefit / development of WP/IFS.	WP/IFS can grow from small beginnings to become big/formal service provider (Recology = private waste management partner with a union workforce contracted for household business recycling & waste disposal with ZW diversion goals). CDS is an appropriate technology income provider for WP/IFS	SS laws for resident & business	SF city & Recology in symbiotic relationship.	

Larracas, A.		Alaminos, Philipines	city	9	7	1	5	Bottom-up' planning generate local village ZW plans, technical consultation with WP/IFS coop (Barangay = village) + resident community creates agreed signed ZW plan, once plan completed local leaders take ownership for ongoing management ZW is equated with hight grassroots / community engagement, support & tenure in involvement. ZW non partisan - pan political. participatory, bottom-up approach proved that communities can solve their own WM problems.	WP/FS sector development can involve better services, low cost (+1), remove middle exploitation & improve carbon footprint & free market function. ZW infrastructure owned by local institution or society + serviced by WP/IFS - biogas reused locally. Private sector itinerant buyers collaborate with WP/FIS model (2)	WP/IFS can collect, sort & clean recyclables, increase the reach & specificity of collection services. SS part of law rA9003 + waste regs (+7) *backyard & village-level composting, source separation programs, & small-scale sorting facilities".* +ve impacts on resorts / inns, hospitals / clinics & schools / universities + tourists educated re strict no-littering & waste separation policies = tech and program investment in ZW.	govt contracts pricing policy can be WP/IFS sector development tool = better working conditions higher recycling rates & $ returns (3). b/c of decentralised SS +IFS sort combo open burning & dumping have virtually ended. SS can be integrated in user pays collection systems (i.e. *"no-segregation, no-collection"* policy + 2 warnings) + targets + ban on incineration.	existing political tensions & rivalries, fear of change hostility towards cooperation grassroots = progress / top down = issues.
Allen, C.		Herani, Spain	city	3	6		2	PS/EPR model + 'citizens committees' provide monitoring, networked volunteer ZW groups arose for anti incinerator to now focus on waste prevention (design, prodn & consumption) & sust recycling. *"Collection is done by a public company called Garbitania, created by the governments of Hernani, Usurbil, and Oiartzun".* OR operated by *"provincial consortium".*	drop-off networks in synergy with door to door, NfP PSO (created by producers, packers, bottlers & recyclers) fund PS/EPR model	ZW anti incinerator resulted in govt est door to-door collection + mandatory SS recycling inc. OR *"enthusiastically embraced by residents"* = 80% waste diversion from landfill + 1.5% contamination (3) once demonstrated model spreads to other provinces.	*"Our state-of-the-art technology is the neighbours"* (aka the community themselves) + citizens committee for monitoring.	
Allen, C.		LaPintana, Chile	city	3	6		2	Govt focus (food) OR only. Recycling via facilitation of NfP NGOs at 'green points' + recognition & promo of how to support informal sector 1/3 of city is serviced by the municipality 2/3 by a private company. C&D managed privately by producers		SS model (+6) for 'green points' network & informal sector. 35 litter bins for SS OR	Govt position is to limit public sector involvement push privatisation (NB: this has limits) low cost model grows steadily over 7 yrs. SS requires education (80% household visits) + green incentives i.e. tree planted locally	Govt support only partial - blocks network organisation, worker rights and OSH improvements. working toward inc. financial support of model. System issues i.e. space in MUD + bad experience equates to low OR participation
Gokaldas, V.		Mumbai, India	city	15	5		1	WPs/IFS coops are critical opportunity for driving ZW (+2), improved management of SS, inc. incomes = poverty alleviation / improved status, gender equality & reducing municipal costs and corruption / policy harassment local direct reuse of recycled resources e.g. biogas for cooking (3). thriving informal recycling economy not regulated by govt. in parts of Mumbai growing movement to formalise the WP/FS + further integrate & implement ZW principles. NGOs offer woman WP ZW training + coop organisation + contract (multiple work strands inc. cleaning) & marketing support (600 women op in 150 diverse locations).	simple design for non skilled workers community ownership contract management , small footprint. In dev. context people WPs/IFS are appropriate tech.. Size of WM issue tempts largescale - tech solutions tempting. However, the opposite approach—a highly decentralised, people-powered WM model has proven successful. OR by local biogas & composting + less transport cost (2) also linked to gardening + informal sector green jobs + recycle material supply + enviro services. OR supported landfill bans of organic waste.	law enquires SS of waste + landfill ban of biodegradable waste. SS / segregation top priority / *"most important activity"* (3+2) even best not perfect needs recheck + final sort. waste picker coops (+2)/ informal sector can perform this on-site. Relevant to: biogas	avoid damage to processing plant (+1), WP/IFS workshop for SS, collection, composting and legal / reg training. WP income model sale of recyclables + service fee (collecting, sorting, or managing composting pits/biogas plants). SS reduces waste cost burden on the municipality. = *"thriving informal recycling economy" ZW success (inc. SS) = WM policies transitioned from disposal to SS & recycling, & finally to waste prevention.*	Mumbai's rapid growth, high density & sheer size = WM challenge. waste picker / informal sector vulnerable (+1) to privatising (= regulate role). Lack of OSH & market price supports.

Allen, C.		Fanders, Belgium	region	5	5		3	Ambitious regional policies coordinated with local programs = decentralised, efficient, and highly effective WM (2). focus on prevention = waste gen. rate stabilised + 3/4 material circularity best in EU. Govt subsidies to 2nd hand shops, reuse & recycling centres. Mandatory EPR with stds, targets and community NGO engagement i.e. take-back points. UAC for OR (support for demonstration sites & schools+ HC - gardening edu. est. 'compost masters' training program. *"308 Flemish municipalities handle MSW almost all are grouped themselves into associations to provide these services collectively. There are currently 27 inter-municipal WM associations in Flanders" (2). "Flemish compost organisation, VLACO. A non-profit organisation constituted cooperatively by OVAM, the inter-municipal waste associations, private compost producers, and some independent municipalities".*		OVAM promote SS + subsidise recycling RRC *("337 recycling parks")* MRF + OR (composting + AD) + enviro ed. Later SS made mandatory in regional plans then nationwide	SS integrates with *"door-to-door collection, drop-off centres, street containers & retailer product take-backs".*	lack of SS = poor OR quality issues + shift to mandatory SS. Once SS mad OR ops successful programme was expanded to achieve highest waste diversion in EU
Allen, C.		Taiwan	national	3	2			Anti-incinerator / enviro community action leads govt to ZW	redirect prior waste subsidies to sust ZW options	SS (2) applies to recyclables, food waste & residual waste	high cost + enviro issues of incineration. Waste Disposal Act frames actions i.e. food waste recovery & reuse plan.	
Allen, C.		Buenos Aires, Argentina	city	17	7		1	WM story in Buenos Aires is defined by the persistent commitment of Cartoneros / grassroots recyclers (transformed into 'environmental promoters 'with a 'wealth of experience' now recognised, facilitation, legal, financial support from the city govt (5). people opposition protest against landfill & enviro campaigns. formalisation =s formal working conditions (health / public liability insurance), regular schedules, child care facilities, uniforms, better levels of service (i.e. ringing the doorbells + engaging when collecting)	Cartoneros coops becoming organised + political lobbying + networking with allies + enviro edu. citizens (collab with BA university) + contracts to manage 'Green' RRC (3+1) with tech (i.e. sorting, baling storing & sale of materials) + transport support via govt investment. green RRC in synergy with door to door collection	govt recognise SS (2+7) + exclusive recycling licences / rights to cartoneros / WP coops (+1) = better access = better recycling rates. SS education / train people & large waste producers (2). inorganics with market value = paper, glass, plastics	agency created within govt dedicated to cartoneros = coop dev. + worker rights + inc. OSH. positive profile for city amongst other cities (+1). new laws (2005 ZW law built upon Law 992 + inc. formalisation of grass-roots recyclers) + recognise enviro, social & economic impacts (informal employment during econ crisis) of recovery & recycling (+1). cleanliness of the city & enviro protection. City accesses national funding support.	inconsistent enforcement. Half of informal sectors engaged & incorporated in coops 10yrs NB: independent WPs not excluded

Lombardi & Bailey	2015	Global - Community	global	26	14		20	ZW built by both community / citizens & govt (10 +4 ref 'community table' / 'inside-outside partnership strategy' - 'not top down') Ecocycle as an ongoing hub (3) for participatory learning & support (i.e. citizen, business owner, student, government official or public staff member = ZW champions (5+2) for support) -who develop and drive local ZW plan +4) local action drives global ZW movement. ZW = citizens, businesses & govt collaborating (+2, public/private partnership approach NB: Social enterprise = new private sector partner) + individual action and change (3). *"Only the Community Table* (i.e. citizen advocates) *can create the bold community vision that ignites systemic change, public benefit and sustainable prosperity"* (+9). For systemic change we need to create Zero Waste communities.	ZW = ESD resource efficient design. ZW = parts policies, programs & infrastructure (2), but requires robust community engagement / driver (3+1). Subsidy switch from waste to ZW ('long-term public sector support' for ZW business enterprises +1), ZW = universal recycling (=1 - imp. by franchise or contract agreements (single or multiple haulers), municipal ordinance or government-run trucks) + diverse RRC networks / 'sharing econ' + build on existing infrastructure + PPPP (+1) & special role on community NGO NfP options essential (2). 'Community table' = small group of people come together in organised education & envisioning process to improving the community outcomes (+7). ZW = an individual mindset / personal ethic for living / life affirming principle / releasing the *power* of one" / living within our means on our one shared planet, Earth". *"Zero Waste Park" RRC model*	maximise SS (14) delegitimise wasting mandatory recycling composting + then enforcement (5) (zero mixed trust in ZW future). SS supported by econ policy of full-cost accounting, residual waste processing, ban on incineration / landfill & community education for long term social change (start general then specific targets CHRM products) i.e. SS single most important behaviour change is personal responsibility to SS. public outreach enviro ed for SS to schools (embed in kids early), businesses, households & events. successful OR (not W2E except AD) requires source-separated organics (SSO) + QA products. SS supported by *"no sort, no pick-up"* policy.	invest in local green jobs / econ (3). ZW roadmap = priorities (+1) & checklist for success (3). Production, consumption & disposal of products & food = 42% of all U.S. GHG. ZW = 'fastest, easiest, most cost-effective' way to address climate change + pollution prevention +sust prosperity +2. ZW fundamental to CE. future resource scarcity = conflict - ZW = resource conservation (aka peace movement) + civic pride. max social environmental goals and balance pub v private sector values (+1). ZW needs 'home base' repository of history and knowledge within local govt to ref & support next step planning. Ongoing community engagement transparency monitoring of progress (2). targets 90% diversion in 3 phases in 10 yrs. (2) ZW = reduce waste at the source. SS encourage then mandatory then enforce (2) self haul and skip bin waste co required to back-up SS	catalysing & sustaining 'social change' is hard (hit bumps in the road). EU govts provide leadership but in US bottom up is required. ZW benefits 90% of community but 10% current vested private sector interests powerfully resist change (2) 'stakeholder table vs 'community table' (14 +9) i.e. need a new approach to reverse priority for engagement & decision making *"stakeholder table"* should provide *"innovation and design thinking" i.e. what business very good at delivering"*, but not block good ideas / change (2). Role of government is to provide for the general welfare of the whole community / general public. NB: negotiating less controversial / middle ground consensus with vested interests does not necessarily equate to best enviro socio-economic outcome - or level of change that is actually required (2). Where market competition is lacking it is public sector responsibility to step in to create / facilitated this (2).
Unspecific commentary					3							
non code	1+1		TOTAL	89	70	2	41					

Appendix 11: The remaining seven of nine elements of the final MZWM as a written narrative.

NB: the 6. Rationale (ref. Section 4.3.2), 1. Vison / Data (ref. Section 4.3.3) and 2. xR Priorities (ref. Section 4.3.4) elements of this result have been previous been reported within Section 4.3.

1. Vision / Data: *(ref section 4.3.3, page 118) The following is a section of brief commentary which were originally located with the respective section within the original compete set of written narrative results*

Brief Commentary:

The *Vision / Data* excerpt selected for inclusion as exemplar in this *Results* Section 4.3. is organised around seven new knowledge theme headings namely: *1.1. Goal / Target relationship, 1.2. Typology, descriptors, compilations and association with success, 1.3. The origins of and reactions / responses triggered by zero waste goals, 1.4. Outcomes resulting from zero waste goals / targets, 1.5. Monitoring and reporting on zero waste goals / targets, 1.6. The focus of monitoring and reporting* (with a list of twenty two examples of *real-world* foci identifiable in the data), *1.7. Agency of monitoring and reporting* (with seven examples of agencies / actors identified from the data as being engaged in various forms of monitoring and reporting).

An interesting aside supporting this selection is that the data attributed to this parent node was the first tranche transcribed from NVivo, into MS EXCEL and back out again, as a written narrative result. As such this body of work might potentially be seen as setting the procedural pattern for the formation of results. However, my direct observation as a researcher would be that actually this was the first opportunity to witness the refractive power of content analysis opens up, separates out an makes multiple strands of new information explicit. So, rather than supplying a researcher imposed template for future result formation, this section provides the initial illustration of the patination of new knowledge exposure and theme definition, which is the described propensity of content analysis cite. So, rather than this this excerpt setting a prescription for researcher derived result formation, which is followed for future sections, the illustrated pattern of results forthcoming in the next (i.e., *16R Priorities*) and future section(s), further evidences the implicit expressive functionality of content analysis as a methodology.

Whilst the results all generally utilise the quant + QUAL(quant) system of empirical annotation and colour coding which is so explicit in the previous excerpt (ref. Section 4.3.2), in this excerpt (despite each of the three child nodes, i.e., 1Aa Goals + A1c Targets + A1o Monitor / report being colour coded and individually quantified in MS EXCEL), because these three functions appear inseparable they were grouped as a single *cluster* in the relational matrix of the CF vfinal → Figure 11, and hence these differences were not transcribed as colour coding into this reporting. This excerpt in the context of the overall results illustrate that the quant + QUAL(quant) system of empirical annotation and colour coding is a consistent feature expressing the full dimension of result, but is applied variably in accordance with what is apparent in the data-set. In simple terms, this variability is evidenced in less and more and the distribution of colour / numerics.

Whilst demonstrating general attributes of all the results and typifying key aspects of content analysis as a research methodology, specifically this excerpt, evidences(44) the *criticality* of goals / targets in MZWM. Alongside asserting the necessity of goals / targets on the basis of citing numerous global experiences, this excerpt documents several clarifying and moderating phrase associations which broadened our comprehension of the phenomenon. This excerpt offers a further demonstration of the heterogeneity of zero waste in that the expression of goals / targets encompasses a spectrum from the explicit and absolute (i.e., *eliminate, concrete and end to waste*) to the quite abstract (i.e., *vision, target, journey, non-absolute, steps, approach, path, resolution, planning-principle, vision-plan, roadmap*), with an noticeable experience derived evolution towards then latter over time.

This specific result also evidences several real-world time – progression data, which both support the assertion that goals / targets are essential, but also extends this assertion to include monitoring and reported as co-requisites of MZWM. Further the result entrenches this argument in annotating upside examples where progressive achievement of goals / targets translates into further higher levels of achievement and ongoing momentum for zero waste framed change-making. Further illustrating the extent, detail and focus of the new knowledge formation manifest in this research and content analysis generally, this result lists (and geographically locates): a- twenty two examples of programme parameters / attributes which, based on the variously cited contexts, can be suitable foci for… and b- seven variously cited agencies / and actors suitable for conducting the requisite monitoring the reporting, requisite to goals / targets.

2. 16R Priorities:

(The analysis of data attributed to the above three vision/data theme nodes was initially coded to the generic model of 'Commitment & accordance with ISWM 5R priorities', iterated later to 'Assertive or Alternative WZW Hierarchy' in the coding framework development process following categorises established as a coding framework in NVivo. These data were then summarily analysed via an MS excel spreadsheet, which enabled translation and reporting in MS word format, based on the following headings, as finally derived reporting parameters).

Introduction: For many decades the generic concept of the 'waste hierarchy' has been accepted internationally as providing the foundational theoretical model for waste management policy and priority. However, it must be recognised that the concept of the waste hierarchy is also much debated and there is a diverse spectrum of iterative versions that are applied in contexts ranging from traditional ISWM to more contemporary zero waste management/circular economy approaches. The key concept of the (zero) waste hierarchy is to establish notional priorities among the range of management and programme options on offer to address the complex and interrelated issue of waste. Whatever version of the (zero) waste hierarchy is articulated and adopted in any given socio-economic, geographical, and strategic context, this conceptual model will provide a framework for prioritisation and decision making about what mix and arrangement of interventions and investment (i.e., in the form of policies and practices etc), will best give effect to targeted goals/outcomes of the (zero) waste management programme.

In the course of reviewing literature and undertaking this research a variety of configurations of (zero) waste hierarchy have been observed in the strategic framing of a variety of local to international contexts of (zero) waste management policy. A general observation across this spectrum is that the zero waste versions, relative to more conventional/traditional version of a waste hierarchy, are more complex, multiply layered in terms of content and cognition. In addition, zero waste management hierarchies tend to delete or deliberately de-emphasise the normalised default towards (burn/bury) waste disposal with associated destruction of resource value. In respect of this specific theme cluster, which has priority setting, the process of coding and analysis sought to explore and report indicators of priority (i.e., *xR's*) and hence to extrapolate and expand on the 'hierarchy rubric' in terms of how expressions of priority (i.e., actions, change, concepts, and practices, etc.) can be discerned as elements within selected zero waste literature. The following is the distilled analysis of what ultimately emerged as a sixteen level (16R) zero waste hierarchy that can be derived from the content analysis procedure for MZWM.

3. Empowering Policy - Leadership:

A1e ZW lead agent + A2c systematic PS/EPR + A2d CDS + A3d ADFs and A2g com contrl law reg + A2f bkstop LF/burn bans + A2o bkstop MMM pkging / non recyc - [A5h Int conventions] + A3h mkt basd econ instrm - A3a revrse waste subs + A3b engage PAYT + A3c green taxes eco levies

3.1. Leadership - Agency

Whilst it is clear that zero waste acknowledges and endorses the potential of the informal sector, grass roots participatory community development and alternative perspectives and pathways for generating innovation and *change-making*, a reoccurring expectation is the requirement for government to provide (and resource) a leadership framework. A government engaged leadership framework involving all necessary levels and agencies of authority, is required to fulfils the mandated responsibility to participate in designing and driving the processes of change[+1 NZ]. The described dimensions of the leadership on offer from government are:

- Enacting legislation / regulations, which encompass and build on foundational waste management systems, yet powerfully repurpose these into zero waste programmes. These new zero waste programmes need to be able to shift society away from the current linear waste paradigm, by setting high level aspirational goals and a range of specific targets and timelines to reduce waste generation and disposal[+1 NZ]. Examples of legislative intervention for zero waste involve establishing:
  - ✓ user / polluter 'pay as you throw' (PAYT) disposal fees, based on full cost accounting,
  - ✓ applying progressively applying material / product bans to landfill and incineration,
  - ✓ establishing funding models, which relocate subsidies from disposal to resource recovery, recycling & other interventions[+2]
  - ✓ regulating, banning or utilising market based economic instruments (i.e. product stewardship / extended producer responsibility systems) to disincentivise products *designed for disposal* in favour of and alternatives design ethos supporting a circular economy.

- Facilitating zero waste policy and planning frameworks: A range of formally articulated planning models / case studies now exist which to support zero waste policy and plan development in highly socio-economically developed contexts, where are certain level of structure and function can be assumed. Increasingly, the evolution of these zero waste policy and planning models also appear inclusive and cognisant of the good practice and experience emerging from other less socio-economically developed contexts. These formative *globalised* zero waste policy and planning models, seek to provide framing principles, experiential information, ideas and impetuous to progress in any given zero waste setting (but not necessarily via linearly step I→ 2→ 3 etc) irrespective of context and or starting point. A feature of these emergent zero waste policy and planning frameworks is the precondition that the zero waste imperative and planning process, needs to be tenured within a lead coordinating agency (i.e. *home-base)* within government, which is variously referred to as local / national[+6 NZ]. The expectation is that government will provide an authentic and ongoing (i.e. phased) leadership commitment[+2 AI, H]. In particular this involves facilitating monitoring and reporting of progress[+1 +1 +1 NZ] relative to zero waste goal / target, strategies / action plans, which have been developed and implemented in collaboration with the community.

- Hosting and facilitating the agency of zero waste leadership: Because waste is a highly interdisciplinary subject and hence (zero) waste management crosses departmental boundaries, it is argued that, a lead zero waste agency must be independent, yet integrative and facilitate strong links to other relevant / affected agencies of government[NZ]. Aligned to the observation around optimising the connectivity and location of the *agency of zero waste leadership*, is the assertion that government and public institutions should lead by example[+2 +1 SF]. Exemplary public sector actions are recognised as promoting wider societal change by modelling new programme and new service contract design and building the capacity of services providers to implement these. N*B: Zero waste identifies the needs 'home base' repository of history and knowledge within local govt to ref & support next step planning.*

- Interpreting, mediating and coordinating modes of social change: Alongside being optimally positioned to provide the locus of imperative for and exemplar of zero waste leadership, government can play an important coordination role, involving interpreting ongoing social change, as a transitional process with succeeding elements and phases (aka zero waste 'road-map') which build the momentum and trajectory of assertion i.e. from voluntary to mandatory[+2 +3]. This process is underwritten by strategically facilitating the education of the host community and integrating both, the initiation of new rules that re-direct behaviour[+3 +1] and new infrastructure / services which accommodate the sought after new behaviours and convert them into environmental outcomes. Zero waste argues in support of the opportunity for government to undertake a planning and facilitation role to achieve systematic *end of life material / product return-collection-processing* for societal reuse and recycling, aka circular economy systems[NZ].

- Zero waste envisions a virtuous interdependence, which combines and optimises the mutual contributions and potentials of both government and community: In simple terms, the case for government exercising zero waste leadership is based on the principle that public service policy should be directing the greatest good to the greatest numbers of people and coinciding observation that zero waste programme transitions benefits over 90% of population(+2). The government is uniquely positioned to ensure that everybody works together to transition from wasteful to resourceful community mind-set, i.e. away from the 'throw-away society' into a sustainable prosperous community-based system designed around 'eliminating' waste by reusing, recycling and composting nearly everything. This vision is reported across the various zero waste contexts from high to low socio-economic development status, in observations such as:
  - ✓ The so-called 'inside-outside partnership strategy'(+6 +2 +2) is one described framework for community / NGO groups to work in partnership with local government. This strategy is based on the engagement and collaboration of, at a minimum, two zero waste champions (1 inside & 1 outside government).
  - ✓ That progress towards a zero waste – circular economy(+1) may arise out of top-down or bottom-up / grass-roots derived leadership initiatives, but a genuine and self-sustaining on-going zero waste community cannot be built by govt alone(+1).
  - ✓ Buenos Aries's provides a pioneering example of regional leadership(+1) in creating a dedicated agency within government which preferentially and meaningfully supports (i.e. via transport, financial incentives, worker insurance, public liability, uniforms, child care and protection)(+2) a designated, but independent, role for the Cartoneros (grass-roots recycling cooperatives)(BA) in delivering zero waste operations.
  - ✓ A similar example of government – community collaboration around zero waste, is afforded by the Pune Municipal Corporation (PMC) subsidisation of the SWaCH waste picker cooperative (i.e. via providing equipment, health insurance, educational support for families and conflict resolution to the 2,000 members servicing 330,000 houses and other institutions, which equates to 47% of city). The exponential growth in the commercial sign-on to the resulting user-pays recycling collection system demonstrates general public support and a fusion of market-based, with social justice / development principles in a mutually reinforcing exemplar of government – community collaboration and success(P).

- A key principle of zero waste leadership is to recognise and address the latent inequity between community / public interest and the commercial / private (often vested) interests which make and manage waste (Brandon, 2012; R Crocker & Lehmann, 2012). This inequity which applies across spheres such as technical knowledge, practical experience, financial power and political leverage but can be rebalanced by ensuring that the 'community' is assigned a pre-emptive role ahead of *industry stakeholders* at the zero waste leadership and decision making table. Proactively reversing the norm, whereby the industry *stakeholder table* overpowers the *community table* addresses the innate imbalance between public and private interest. The concept is that the *community table* sets the vision and values, whilst the *stakeholder table* provides the innovation, creative design thinking and combines diverse perspectives, experience and expertise in a practical, constructive way to implement the community zero waste vision(+2). A further example of the zero waste principle of redress for the imbalance between public and private interests is the argument that city / local government should lobby state / national levels of government for mandatory EPR as a way of shifting the tax burden off government (i.e. for paying for environmental costs externalised by the private sector) and locating this back as a core responsibility of producers(+1 +3).

- Zero waste endorses government's potential for authoritative neutral coordination, problem solving and mediating between conflicting interests: The role has been identified as a critical in enabling collaboration with relevant NGOs (GAIA and the Mother Earth Foundation) which funded, trained and provided the technical consultation which enabled the increasing numbers of Barangays (village councils) to take responsibility for local waste and recycling management in Alaminos, Philippines. This NGO project investment including MRF infrastructure and services for proper materials collection, segregation, composting / recycling and storage, which ultimately fulfilled the government RA9003 ordinance(AI). The statement *"If only governments dare to lead the way and count on their citizens"* illustrates collaborative mutuality that zero waste envisions between government and the resulting community-based waste management systems, which have been shown to deliver impressive results in a short period(H). In this development model, volunteer activists advanced the community conversation beyond just opposing incinerators into promoting an authentic and collaborative zero waste strategy(H), whereby the government provides collections infrastructure / services, monitoring, reporting and enforcement to support citizen participation in a cost effective separation at source progamme.

3.2. In the absence of government (municipal) leadership, intervention and facilitation / mediation– zero waste progress can be generated:

However, the following two scenarios illustrate that, even where government (municipal) leadership, intervention[(+1 LP, M)] and facilitation / mediation is absent – zero waste progress can be generated:

- ✓ In La Pinatana, Chile, free compost and neighbourhood improvement, via the construction of public parks, planting of new trees, maintenance of sports clubs, etc., that improve their quality of life and their relationship with the environment provides direct and indirect incentives for community participation in separation at source as a foundational action for driving progress towards zero waste[(LP)].
- ✓ In Mumbai, India the NGO 'Stree Mukti Sanghatana' (SMS) started (1998) the Parisar Vikas (PV) program to train the waste picker community (85% poor, low-caste women) as 'parisar bhaginis' (aka *neighbourhood sisters*) in the principles and practices of zero waste (i.e. how to sort and handle waste from multi-family dwellings, managing composting and biogas plants, gardening, and how to organise as worker cooperatives and negotiate contracts)[(M)].

The City of San Francisco provides an example of a highly socio-economically developed context where the government (i.e. the San Francisco Departments of Public Works, Public Health and Environment (SFE) outworks its responsibility for implementing zero waste goals, via a symbiotic, contractual, working relationship with the NGO Recology[(+2)]. In this partnership equation SFE staff develop and implements local & state legislation, regulation, strategies, policies[(+1)] and programmes (i.e. a total of 11 employee positions focussed on management[(+1)], policy (inc. EPR, ballot measures, an online waste exchange and other incentives for zero waste, such mandating green procurement), commercial[(+4)] and residential[(+3)] waste, whilst other staff delivering educational outreach (i.e. waste reduction[(+3+1)], inc. hazardous waste management). Within a regime of long-term (5 year) service contract cycles and weekly management meetings with SFE, the employee owned cooperative Recology creates, tests, and runs infrastructure to collect and process trash, recyclables and compostables[(SF)]. In broad terms, the SFE governance / oversight model (aka 'Board of Supervisors' which encompasses environmental, legal, R&D and educational perspectives) ensures the law, education and infrastructure are in sync. In this collaborative model civic leaders and environmental experts / activists are empowered and continual research on technology and best practices is undertaken.

Similarly, two scenarios with a high development index, where zero waste leadership is exercised by government, is the Regional context of Flanders, Belgium, and the National context of Taiwan:

1. In Flanders the legal responsibility for waste management is decentralised from national, to federal / state, to local / municipal levels of government. 'OVAM'[(+6)] is the Flanders public waste agency develops and monitors waste management related legislation and policies on behalf of 308 Municipalities, grouped into 27 associations. OVAM integrates with both 'VLACO', a not for profit operation which works in the sphere of organic recycling and 'FOST Plus', a packaging product stewardship organisation, which funds the efficient[134] public collection and recycling of these materials. OVAM signs, sponsors / subsidises[(+2)] agreements with municipalities to carry out public waste prevention campaigns[(+4 +1)], involving technical and financial assistance to citizens (i.e. home composting programs)[(+5)] and target groups, such as schools (re water fountains) and parents (re promoting reusable nappies), etc[(F)].
2. The zero waste policy adopted[135] in 2003, by Taiwan Environmental Protection Authority (TEPA) resulted in this government agency directing a number of initiatives to reduce waste generation[(+1+1)]. This programme includes: the 'waste disposal act' (2005), which requires citizens to participate in separation at source of recyclables and organics from waste and the mandatory 'extended producer responsibility' (EPR) legislation, which requires that the TEPA board[(+2)] receives and distributes 'resource recycling management fund' (RRMF) fees. The RRMF fees are based on the material, volume, weight and level of recycling[(+3)] and are paid by manufacturers and importers the product classes / types, which are covered by this system. The EPR system covers recyclable packaging and containers[(+4+3)], tires, some EEE goods[(+3 +3)], automobiles, batteries, and fluorescent lamps. Alongside labelling[(+3)] and reporting requirements, the Taiwanese EPR system stipulates that the RRMF fees be used to fund recycling collection and processing costs and also to provide subsidies to companies and governments to develop reuse and recycling systems[(+2)].

[134] Indicating the link and benefit to climate change and sustainable development actions FOST Plus estimates that compared to incineration, recycling prevented the emission of 860,000 tons of CO2. A 2006 study estimated that the total per person cost for the Belgian packaging management system (inclusive of returns form sales) was €5.78 (US $7.34) per year (2).

[135] Defined as *"effectively recycling and utilising resources through green production, green consumption, source reduction, recovery, reuse, and recycling."*

3.3. The development of zero waste laws / regulations by government: [i.e. legal measures which interface with and are enforced to backstop the achievement of zero waste goals].

In a general sense zero waste argues for *changing the rules* (read developing and implementing new city / state / federal / national / international laws, legislation / acts, ordinances and regulations etc) so as to tilt the *playing field* toward the outcomes of detoxifying material flows and incentivising the recovery and recycling rather than the wasting of resources[+5 +7 +1 SF, F]. An assertive and directive legally supported framework, so-called *rates and dates* approach, is advocated by zero waste for setting and achieving waste reduction / division targets[+3 AL]. The cited zero waste approach commences with voluntary measures, which are then slowly, but progressively superseded by mandatory regulation and compliance measures, as community understands and supports change[+2 +2].

The Flanders case study of a zero waste legislative / regulatory approach, illustrated how a Federal level of government mandated a requirement for regional waste management plans (i.e. in 4-5 yr cycles with set goals for: reducing residential waste generation, establishing separation at sources / collection and home composting[+3] and signed waste minimisation cooperation agreements (i.e. between Federal - Regional government agencies) which were approved and supported (by OVAM) and then achieved by both municipalities and regions. This case study also included numerous laws to enact 'polluter pays principle' to promote sustainable production & consumption[F].

Alongside recognising examples of direct legislative / regulatory approaches (i.e. such as Flanders re the EU context) as 'drivers of progress', zero waste also more identifies the importance of esoteric values based environmental considerations. Another commonly reported driver for zero waste are rudimentary socio-economic considerations around the positive pressure exerted by landfill *(but not incineration)* i.e. limited life, or replacement issues and cost[SF]. Once initiated, the progressive 'save landfill space / life' driver can be superseded and locked in by escalating waste minimisation goals / targets (i.e. which can be publicly stated and or legally binding).

At a conceptual level, rather than subsidising wasting, zero waste reverses this malfunction. This means reengineering the economy's normal commercial and operational settings so that, the competitive advantage resides with 'clean green', instead of 'dirty-wasteful' companies. Zero waste advocates for the design of market based economic and regulatory interventions, instruments and incentives[+1] which, in anecdotal terms means, taxing *bad* and rewarding public *good* outcomes. This means that commercial and other organisations which, for example, reduce packaging, practice EPR, undertake cleaner production, green procurement and corporate social responsibility (CSR) will operate with enhanced, rather than undermined profitability. Various zero waste case studies illustrate examples of this generic enabling strategy, whereby positive outcomes such as increases recycling are incentivised. For example a, 5% real estate tax rebate was offered to apartment buildings in Pune, India which selected service providers (in this case the waste picker co-ops which were members of SWaCH) which operated on-site composting / organic recycling processes[P].

3.4. A phased approach for progressing a regulatory platform: *(i.e. 1, 2 & 3)*[5].

For example, a simple regulatory platform for progressing a phased approach to zero waste reported from Alaminos, Philippines. This involves terminating unsorted mixed waste collection[+4 +3 AL] and substituting these with a mandatory recycling and composting requirement for all: households and multi-family units (MFUs), schools and educational institutions, public events, businesses organisations and government departments[+3 +6 +4 AI]. Similarly, zero waste generally advocates that various forms of landfill and incinerator disposal restrictions, if not outright bans[136] [+11 +4] be established in synergy with the strategic development of: recycling processing capably and technical infrastructure[+1], supported by awareness raising / educational programmes[+1 AL], backstopped by enforcement of separations at source (SS) requirements[+2 +2 AL] and a strong emphasis[T] on developing a framework of mandatory extended producer responsibility (EPR) schemes[+12 +2].

3.5. Target big early gains / *low hanging fruit*:

An obvious starting point for targeted recycling directives (i.e. such as mandatory separation at source and collection[+3 +1 +4 M, BA, AL, LP, F] backstopped by disposal bans) is organic[M] and or CDD (i.e. construction, demolition & deconstruction recycling)[+7 +5 +12 SF, T, BA, AL] resource flows. In both cases there are readily available recycling options, which are cost effective, technically sound and environmentally preferable to disposal. Kick starting diversion by targeting organic and CDD material flows via

---

[136] NB: beyond just banning types of inputs, included in the framing of the word ban, are actual shut-downs and embargoes on the development of new landfill and incinerators.

simple regulatory stimuli has proven to be really effective in boosting environmentally positive and socially responsible informal sector and or, mainstream recycling businesses / organisations(+1 M, AL). In a developing context, the concept of landfill and incineration bans may be translated as, local ordinances banning / *outlaw* mixed waste collection, burning & semi-controlled dumping(AL).

3.6. Redesign the future through EPR/PS systems:

The described purpose of EPR/PS, is not just re-distributive, punitive, or even primarily recycling focussed, but rather has a long-term creative objective of seeking to inspire and incentivise the re-design of an new generation of greener products with a- minimal: toxicity, environmental footprint, packaging, end of life disassembly cost, recycling and residual waste footprint and b-maximum, reuse, repair-ability and in-use life-cycle(+1) or biodegradability(+13 T). Other value adding integrations which can be designed EPR/PS programmes are, for example, a requirement for environmental education, recyclate market development i.e. through bio-degradability(+12 SF) green procurement guidelines / regulations and or, R&D to create new material upcycling pathways, which ultimately ensures the journey towards zero waste and circular economy is more diversified, localised, resilient and financially sustainable.

3.7. Action EPR/PS priorities:

The following specific product types are identified and candidates for mandatory EPR (which in a New Zealand legislative context, under the WMA:2008, equates to *product stewardship* (PS)): electronics *(with mandatory EEE retailer take-back)(+4 +1 T)*, paint, mattresses, carpet / mattresses, batteries, pharmaceuticals, books, durable goods, mercury containing, other special & hazardous class products(+4) beverage containers, some types of packaging, disposable cameras and batteries(F). It is important to recognise that in the zero waste conception of EPR/PS this design inherently involves *advanced disposal fees* (ADFs), which transparently prefund the end of life recycling / treatment cost, within the purchase price, so that the drop-off is fee, or even incentivised as in the case of container deposit – refund schemes for packaging(+5 +3 F).

3.8. Ban hazardousness / toxicity and *design for disposal / dump*:

In order to curb the worst excesses of the 'throwaway society' zero waste also advocates for the outright regulatory intervention of first discouraging then more simply, banning hazardousness / toxicity in products and those 'designed for the dump' (i.e. those with obvious waste problems, poor recyclability, or which pose health or pollution risks. NB: the converse of this, promoting and underwriting the development of product standards / eco-labels)(+6 +3+2 F T) and or, actively dis-incentivising (read a tax, levy, or fee system, which relocates in the otherwise externalised environmental costs into the price) single-use, disposable products and or, packaging types (for example single use plastic bags (SUPB i.e. shopping bags), EPS drinking cups and food containers, bottled water, and takeaway coffee cups, etc)(+4 +2). A Taiwanese case study supports these directive regulatory interventions with assertive monitoring and compliance (i.e. super-markets are required to submit plastic packaging plans (with escalating reduction / recycling targets i.e. 15 to 25 to 35% over three years) and enforcement for non-compliance with submitting plans or achieving targets (i.e. fines USD $1-5k)(+3 T).

3.9. Tax waste → incentivise zero waste:

Zero waste fundamentally supports graduated national disposal levies / taxes on landfill or incineration(+4 F) as the most common overarching market-based economic instrument for driving change. Additionally zero waste advocates that taxes /levies be hypothecated to fund a dedicated lead zero waste agency, located within the government / relevant leadership structures and with the delegated authority to coordinate technical and financial re-investment in designing and driving the transition to a zero waste circular economy(+1 +5 NZ). Case studies illustrate government authorised, mixed funding / service provision and regulatory models for example(LP) where household recycling / composting services are funded by taxes, whilst business operate in a user PAYT fee based model based on the amount of waste produced i.e. regulations require street markets to operate separation at source programmes and hire a matching collection service.

3.10. Formalise and empower the informal sector:

The Buenos Aries case study provides an example of zero waste laws + regulations (2005) which reversed the prior 'Law 992' banning 'waste picking'. The zero waste approach replaced and reframed the negative conception of scavenging, with an *urban recyclers program,* which specifically required the inclusion and the strategic development 'grassroots recycler' cooperative(BA). Zero waste case studies from both developing and from highly developed socio-economic contexts(SF) illustrate how laws and regulations can be used to lock in community involvement and benefit. In the context of PS/EPR based container deposit / refund systems (CD/RS) as part of a state-wide *bottle bill* (i.e. deposits of 5-10 cent per container) the city of San Francisco[+3] legally mandates the role of non-profit type product stewardship / producer responsibility organisations (PSO/PRO NB: owned by producers, packers, bottlers, and recyclers) to run the city's CDS and specifically to provide an income source for the informal recycling sector. In this context, SFE is a government agency which formally integrates *community* into its recycling service provision models. The success of the SFE model is based on a consistent zero waste program budget ($USD $7 million pa) funding directly from PAYT waste disposal fees[+2] i.e. derived via *Recology,* the NGO / community based organisation's garbage collection revenue[+2].

3.11. Directive instruments and incentives for a responsible circular new *business as usual:*

The journey towards zero waste and a circular economy is described as re-engineering a revolution in the relationship between 'the people and their waste'[+1]. Zero waste methodology is by necessity politically directive and assertive. Central to this aspiration is intervention, to correct market failure (i.e. when it comes to environmental externalities markets are unlikely to be self-correcting, because ecological impacts are neither systematically evaluated nor factored in as production costs in the formation of market pricing). Fundamentally moving from wasting to zero waste requires intervention to reframe economic settings beyond the delusional free market ideal that a common environmental good will emerge without either, directly prohibiting environmental exploitation / pollution, or the requirement that these costs be fully internalised in market pricing. Zero waste is then a prescription for directive change to the *business as usual* model of publicly funded recycling programmes (i.e. which is in effect detached from the market economy) to extended producer responsibility (EPR/PS) models. In this sense zero waste can be seen as existing outside of the envelop of *business and usual*, in requiring change in the operational parameters of all production, products and packaging systems, so all environmental costs are internalised in market prices and responsibility models designated for producers. The design parameters for the *new future business as usual* is simply that, if it cannot be reused, composted, or recycled, it should not be produced in the first place. Such aspiration represents an explicit redesign of longstanding socio-political construct and dysfunctional free market ideals.

3.12. An innovation platform for new socio-economic models:

Zero waste is described as an innovation platform for new socio-economic models (employing for example, *reverse logistics and servicing* etc)[+3 NZ] which enable competitive market forces to drive change and environmental progress. In large part this assertion is based on the fact that the genesis of the zero waste movement's success occurred within the competitive commercial environment and contrary to appearance, rather than abandoning the market economy, zero waste just seeks realise this in a more pure and efficient sustainable form of *eco-market economy*. Zero waste seeks market reform beyond the tokenism and incrementalism currently deemed acceptable to the powerful vested interests, which make and manage waste. Zero waste endorsement of directivity and assertion, aka mandatory-regulatory approaches, is based on the accumulated real-world observations / evidence from case studies, that voluntary-only approaches are ineffective beyond a certain limits. Whereas all-inclusive level, playing field, mandatory approaches ensures that enviro-socially responsible businesses / industries are notes disadvantaged[NZ] and that *economies of scale* to work for, rather than against a circular zero waste based economy.

3.13. Zero waste change-making = reframing market-based economic instruments / Investments:

Many of the key tools evidenced in zero waste change-making = reframing market-based economic instruments[+1 NZ] and investments which reshape financial flows from negative, to positive environmental outcomes. For example, community investment in zero waste is equated simply as a phasing out and or, replacing investment in landfills or incinerators[+1 +2 F]. A simple example of rethinking investment is the option of diverting material (and the associated funding from disposal into circularity, is to shift to bi-weekly waste collections[+3 +1] and to then channel the savings into an alternative services of recycling collections. This investment shift concept would apply to both organic and or general recyclables. In the case of organics resources[+1] the benefit of achieving this cost saving is reinforced by the fact removing biodegradable material (i.e. which is diverted into composting), which means the residual waste is less problematic (i.e. less risk of smell, pathogens, flies rodents. This concept of virtuous investment (re)cycles, appears broadly supported by cost benefit analysis (CBA) / ecological economic perspectives, that the long-term, holistic. 'triple bottom line' (TBL) returns of zero waste and a circular economy, more than adequately repay and justify the initial set-up investment required for setting up zero waste programs.

3.14. The 'polluter pays principal' / *pay as you throw* (PAYT)

The 'polluter pays principal' / *pay as you throw* (PAYT)[+1 +14 NZ, F] are numerously endorsed as a critical market-based intervention to drive resource circularity. The polluter *PAYT* principle can be enacted in conjunctions a disposal levy / tax (i.e. on landfill or incineration and mandatory full cost accounting[+2 +9] to in effect, put an end to cheap disposal[+3]. This cluster of instruments collectively eliminate waste subsidies and the externalisation of environmental costs. This resets the economic calibration back to neutral, whereby under a long-term ecological perspective, a zero waste approach will out compete waste disposal(+3). Once the true, complete cost of waste is factored into the market calculus, disposal costs more, which encourages waste minimisation, reuse, repair, recycling and composting, as these resource conservation practices are more financially attractive. Zero waste movement recognises the inherent interrelatedness of it's activities, with the imperatives of addressing climate change, sustainable development and generating a circular economy. The financial rubric of zero waste is grounded in ecological economics and aims to attribute financial value to the public-environmental good outcomes of decreasing: natural resource depletion, GHG emissions, water usage, toxicity, pollution and ecosystem destruction, whilst conserving energy, and strengthening the local economy(+6). Valuing and including these shared public / environmental goods in a economic calculus makes zero waste a more realistic and complete market-based model than that which is currently conceived and applied.

In simple terms the combination of financial instruments and incentives advocated for and practiced by zero waste have been shown to work effectively in both developed and developing socio-economic contexts. For example:

- ✓ In Flanders where financial mechanisms are used by OVAM to discourage waste disposal (i.e. via landfill / incinerator *bury-burn* levies and selected restrictions(3), the result is 73% residential waste diversion, which is the highest in Europe. In this jurisdiction zero waste is essentially funded by a *universal annual charge* (UAC) which pays for: 1- organic recycling collection (i.e. USD $51pa for 120L bin) and 2- progressive citizen engaged home composting education and training (aka *compost masters*).
- ✓ Similarly, in San Francisco a combination of PAYT for residual waste, other incentives (i.e. Recology and the local residents and businesses are incentivised by rates setting to enhance recycling and composting(+4) and extensive public outreach has been applied, resulting in diversion of 77% now targeting 90% (2020). Specifically, the contracted zero waste service provider, Recology has consistent long-term landfill management contract, which significantly incentivises waste diversion and hitting zero waste goals(3). The Recology profit model involves 1- recycling and composting service contracts, 2- market sale of recycled resource streams and compost and 3- up to a USD $2 million bonus for exceeding diversion targets.
- ✓ In Hernani, Spain a PAYT fee-based door to door collection system (based on frequency and volume) applies for businesses and residents. This high quality, differential (i.e. differing materials on different days) model involves mandatory separation at source and is cited as achieving an 82% diversion rate. This model is reported as being less expensive than a large comingled MGB type container system, because of the higher income generated from the sale of recyclables. In this jurisdiction residents are also significantly incentivised to sign up to a commitment to home composting ,via a 40 % discount on the municipal waste management fee. The Hernani model provides a municipal case study where instrumentation is supported by education, i.e. home composting is taught and promoted via a package including free composting classes, training manual, compost bin and phone line offering technical advice and practical help from a home composting expert.
- ✓ The financial model in Pune, India involves SWaCH members as a zero waste service provider, having an income stream (i.e. approx. $USD $84-$112 / month + free reusables i.e. second-hand clothing, food, and access to water and toilets), based on 1- sale of recyclables and 2- user pays PAYT recycling service fee paid by residents(+3). This separation at source based model involves the informal waste-picker sector providing a door to door waste and recycling services and has resulted in lower contamination and sorting time /costs and a higher percentage of saleable materials and higher market returns(3).

It is clear from the above zero waste case study models that, in each individual context, a spectrum of genuine, market-based principles and economic instruments and incentives are applicable and these are interwoven with an expectation and actual experience in utilising effective regulatory tools. Depending on context zero waste models can involve intensive top-down government intervention in programme design and implementation. Alternatively, some exemplars draw value form a much simpler i.e. *resource not waste* reality, for example, separating and recycling organic waste, provides the baseline value proposition of removing the most problematic proportion of waste stream, with the benefit of making residual management much easier and less costly.

3.15. Socialising change from community education:

Normative public policy support and investment in community education(+6) for reducing and making resource consumption more sustainable through broad cultural and economic systems change(+3 +5 +4) is described as another critical interventions for re-directing the flow of resources from disposal into circularity. This form of socialised change-making in effect confronts and reverses the norm of advertising driven free-market, linear consumerism, which forms the basis of the throw-away society as a deliberate socio-economic (post-war) construction. Socially re-engineering consumption, creates a knowledge platform for consumers to support environmental sustainability designed (ESD) products, i.e. less toxic, hazardous and resource intensive and more durable, repairable, reusable and recyclable . An example of educational reform of prior socio-economic conditioning, is the rejection the *throwaway society* in favour of *universal social responsibility* actualising community-wide commitment to a zero waste effort[+3 +4]. Within this next enlightened worldview *wasting* no longer an acceptable social norm, this shift enables education and promotion to eventually be backstopped by compliance and enforcement i.e. in effect it becomes *anti-social* to not recycle and compost[+2+1]. Public (re)education is an instrumental and essential[+5] foundation for zero waste and literature promotes programmed publicly funded model, i.e. $2 pp / yr in phase 1, then increasing $3 pp / phase 2, and then increasing to $4 pp / yr in phase 3[SF].

3.16. Mutually reinforcing community education and enforcement:

In tandem with education (carrot), enforcement (stick) is designed to backstop the ideal of maximum participation in separation at source[+6 +2 BA]. For example a common imperative and focus of compliance is to reduce contamination in organic recycling. i.e. whereby if people repeatedly fail to correctly participate in conformance with programme rules, they eventually face a consequence for example a 'no sort - no pick-up' policy [+3 BA]. An example of a directive approach to drive resource circularity is provided by the Flanders case study, whose federal waste prevention regulation define products entering the market[+1]. This regulatory environment requires producers to minimise packaging (restricting the weight of boxes) and also, bans disposables (tableware at schools & government agencies) outright. Another example of even more directive circularity is the Taiwan case study, where in 2008, in order to reduce waste, the government asked stores and cafeterias to provide reusable chopsticks (i.e. not automatically give out disposable chopsticks with takeout food). This Taiwanese zero waste policy setting was backstopped by engaging consumers, and vai monitoring and compliance. For example, under the regulations non-complying vendors are potentially subject to fines equivalent to USD $2,000 - $10,000[T].

3.17. Meeting reformatted public expectation with transformed infrastructure and services.

In synergy with education, zero waste advocates for practical interventions to enable physically redirecting material flows towards circularity of resource flows. A key to reframing public expectation is having created it, to then not undermine this by failing to deliver functional zero waste services and infrastructure, which enable to communities to act out renewed environmental values and behaviours. Progress towards zero waste requires the public to have access to high quality, cost effective green / zero waste services via which, they can outwork a environmental ethos[+1 NZ]. A key aim of zero waste programmes is to design and implement directive / practical systems which enable the circularity of all 12 master categories of material resource / product types. San Francisco provides a case study where deliberate and directive intervention occurs in multiple ways and levels, based upon a three interrelated programme strands. Namely, 1- enacting strong waste reduction legislation, 2- partnering with a like-minded waste service provider / management company to innovate new programs and 3- working to create a culture of recycling & composting through incentive and outreach. In this municipal context 11 roles were employed working with business to focus on the goal of 80% separation at commercial sources by 2012 – once achieved, these human resource were then redeployed to focus on remaining 20%[SF].

Beyond focussing on the core 12 master categories of material resource / product types an important sphere of circularity is creating, expanding and promoting:

- ✓ reduce, reuse and repair[+2] (via for example resource recovery centres / park / networks, tool libraries and repair cafes to support the development of the 'collaborative economy') and also
- ✓ targeting *hard to recycle* items, via extended producer responsibility (EPR/PS) (i.e. *hazardous and special classes* of products[5 +1 F] *NB: specifically including: packaging, EEE + peripherals such as batteries & accumulators/chargers etc, EoL vehicles, printed matter, tires, lubricating & industrial oils, lighting equipment, animal & vegetable fats and oils, & medicines*[+4 +1] *and*
- ✓ specifically facilitating and incentivising *CCD/C&D* (inc. a system of permits / deposits) which enable CCD[+3] and
- ✓ establishing key pre-final- disposal infrastructure to intervene redirect resources for recovery and recycling. For example, MRBT-to-landfill model NB: which is cited as enabling diversion rates to make the challenging jump from 75 to 90%[+8 +2]

3.18. EPR/PS integration Zero waste = everywhere, all the time, easy / user-friendly universal recycling / co-located ZW/RR/*Green* centres, hubs, parks, zones and networks:

In summary, zero waste can be described as advocating for a universal recycling model[+5 +6]. These services can be co-located and facilitated in one convenient place as a, so-called zero waste park, which co-activates all six key zero waste facilities /

functions, i.e. a 1- recyclables/MRF, 2-organic recycling, 3- C&D/CDD, 4-reuse/repair, 5-CHaRM and 6- MRBT/residuals etc[+6 +2].

- ✓ In Buenos Aries, under the waste management legislation, similarly conceptualised *green centres* were built by the city government. These are serviced via a recycling contract offered exclusively to informal sector Cartoneros. This model is funded by a waste levy or *eco-tax* on those producing excess waste (i.e. >1,000 litres of non-recyclable waste per day[3]. This funding (NB: between 2007 and 2008 this increased from USD $300,000 up to USD $30 million) then underwrites the budget for the Cartoneros services, whose previously *informal* financial, environmental and social contribution was re-evaluated, *formalised* and compensated[+1].
- ✓ The Flanders case study illustrates a government led, highly directive focus on the various pathways with support the 3Rs as top priorities of the waste hierarchy, via the OVAM funded provision of 337 *recycling parks*, composting facilities and 2nd hand reuse RRC [+3 +3], *NB: 50% of which will only handle source separated residential MSW deposits[+1]*. This jurisdiction has also taken the step of applying the concept of EPR to the C&D/CDD resource stream *(NB the recycling processes for this material class can achieve a 90% diversion)*, alongside the more usual deployment directed at packaging and the special / hazardous class of products, etc. It is important to observe that the packaging EPR programme is funded by packagers, importers, and those who sell packaging & packaged products)[+5] and that the EPR scheme design involves incentives / support for future recyclate market development. Another interesting design element of EPR in this jurisdiction is the combination of aggressive product / recycling process standards, the intensity of the takeback / collection model, which includes door-to-door collection, drop-off centres, street containers, and retailer product take-backs (including the requirement that broken or obsolete products returned to retailers free of charge[+2]) and that EPR recovery targets are calibrated according to product type.
- ✓ The Taiwanese approach to EPR involves combining PAYT systems, mandatory reduction goals, voluntary agreements and incentives for businesses and industries[+1 T]. For example, in 2011 fast food, beverage, and convenience store chains were required by TEPA to reduce disposable cups. Zero waste recognises that *command and control* and *market-based incentives* and *educational encouragement* are not only all compatible but in combination provide framework for engineering innovation and success. The holistic rationale for progressing towards zero waste and a circular economy[+3 +1] is so comprehensive that it invites proactive, creative and long-term public sector intervention to exploit those benefits for the public good. For example, a low interest loan fund, R&D grants / tax incentives and new recyclate market development (i.e. to generate new uses, more material types and higher prices for recovered materials) to enable zero waste business development[+2 +1 NZ] to create green jobs & strengthen the local economy[+3] are all change-making mechanisms, demonstrated, recognised and advocated for in zero waste literature. Such interventions are particularly empowered when engaged within mandatory PS/EPR frameworks and when focussed on *upstream actions* (i.e. generating reduction as a top priority of the zero waste hierarchy) designed to maximise resource efficiency and waste prevention through product redesign engaged with green procurement programmes[+3 +1].

3.19. Enabling public, private, people partnership (PPPP) service delivery models:

Where insufficiently competitive private sector services and systems are absent of limiting, then the government has an obligation to intervene and either; 1- directly provide necessary services / systems, or 2- invest in PPPP to provide them *(NB: it is suggested that any such constructed PPPP models should have profits capped at 10%).* Two case studies from a developing socio-economic context illustrate this zero waste precept of government partnering with organisations (in this instance the informal recycling sector) to generate service provision models which deliver a more circular economy.

- ✓ In Alaminos, Philippines, 17 Barangays (village Councils) have established comprehensive collection systems (i.e. schedules and vehicles based around mandatory separation at source programmes[+2],) a working materials recovery facility (MRF) and the integration of itinerant junk / recyclables buyers injecting income into both the system and direct into participating households. In most cases this is funded by PAYT fees, which are set in agreement between Barangays and the residents who are paying the fees[AL].
- ✓ Similarly, in Mumbai, India PV cooperatives operate successful and growing commercial initiatives i.e. a snack bar, a recycling sorting operation, and biogas organics recycling facility. Whilst contributing to a zero waste goal, this PV model generates multiple value streams: a PAYT waste collection service, sale of recyclables, and generation of biogas or compost[+2] and additionally, the municipality saves considerable money in avoided waste transport & disposal costs.

In keeping with a balanced free market-based ethos, zero waste policies are strongest when they incentivise community participation and incorporate the interests of waste workers. The key elements of zero waste i.e. policies, programs, infrastructure all require robust, transparent and proactive community engagement. Zero waste advocates for consultation derived *vision plan* and programme design based on the concept of prioritising the *community interest (table)* ahead of the conventional and ultimately biased *stakeholder interest (table)*[+7 +1] as a mechanism for deliberately elevating *public* ahead of *private* benefit[+2].

4. Participatory Development / People and Community are an 'Appropriate Technology':

A5j part. dev. + A1j sep. Src + A2p non partisan + A1i pub v priv

4.1. Participatory community development of zero waste:

As a general principle zero waste endorses the concept and practice of participatory development and most specifically for the formation policies and plans, etc which are of reflective and effective for affected residents, households (which are viewed as the basic unit in national strategies[+1 NZ]) aka generically the *people / citizens / community*[NZ]. This emphasis on effective community participation in policy and programme development appears to exceed the general ethos that zero waste must be built in partnership with community / citizens - and the private sector / commercial interests - and government[+10 +4]. Zero waste advocates preferentially for the 'community table' / 'inside-outside partnership strategy', as modes of affirmative which quite deliberately disrupt the default to 'top down' development models dominated by industry and government. A strong premise within zero waste is that, deliberately disruptive / affirmative action platforms such the 'community table'[+8] (which elevate citizen advocates and or, zero waste champions[+5 +2] ahead of the normal default to vested industry / government) are critical for enabling community vision, in the development local zero waste plans[+4]. A key tenet of zero waste is that proactive community input is essential in igniting the kind of bold systemic change necessary to create genuine zero waste communities[+1] / outcomes, which achieve public / common good and *"sustainable prosperity"*[+9]. The zero waste NGO *Ecocycle* is an example of a local participatory learning & support hub[+3] (i.e. to enable citizen, business owner, student, government official or public staff member to become zero waste champions) which is emblematic of the zero waste commitment to local participatory development and action, but is also outworking this support and promoting this key zero waste driver globally.

4.2. Community *ownership* of / *responsibility* for waste and zero waste:

Zero waste is posited as offering (and where necessary requiring) a *revolution in the relationship between waste and the people* who generate and ultimately have to live with the consequence of this issue. In a zero waste worldview the presiding local authority / government is the guardian (Kaitiaki) of the necessary retention of *community ownership* of the waste stream[NZ]. Inclusion and respect for all social actors, especially the informal sector, in waste policy / programme formation is a critical foundation for zero waste success. Accepting that public / community and private / commercial sector interests are often in direct conflict this necessitates establishing neutral platforms for negotiating, mediating to resolve conflict and formulate progress within consultation processes. Zero clearly has *positive community bent,* however the purpose of this bias is about ensuring balanced and effective collaboration between citizens, businesses & govt collaborating[+2] - in parallel with the necessity of individual action and change[+3]. This balance might, for example be outworked via public/private partnerships and or via government viewing community / social enterprise as a new and alternative equivalent of private sector partners / service providers.

4.3. Deliberate programmed formalisation of the waste picker / informal sector delivers specifically targeted outcomes:

In both developing and more developed socio-economic contexts, the deliberate formalisation of the waste picker / informal sector (i.e. through the formation of cooperatives / federations sector and by enacting municipal regulations and investment), is described positively as part of the ethos of zero waste. The historical experience of zero waste sector / model development reported in San Francisco, in particular illustrates the potential end point of the recognition, inclusion and formalisation of the waste picker / informal sector, which is currently sought by zero waste in the developing country contexts. As discussed prior (ref. 9R) *Recology* which is the primary entity for delivering zero waste services, is the modern day end result of the formalisation and strategic development of former waste picker operatives (i.e. through affirmative action, such as preferential *green job /collar* opportunities, green procurement by government in order to deliberately underwrite recycling market development)[SF]. Recology illustrates not just that the informal waste-picker sector can be developed and grow from small beginnings to become big service provider, but also that these entities can be specifically programmed to for example: align with private waste management partners, offer good quality unionised employment, fulfil household and business recycling and waste disposal contracts in synergy with implementing zero waste diversion goals(SF). NB: it is important to recognise that the illustrated informal to formal is actually the generalised global recycling industry development pathway.

4.4. Centralised design, coordination and collectivisation in sync with de-centralised responsibility:

In the similarly high socio-economically developed context of Flanders, Belgium, ambitious decentralised regional policies, coordinated with highly efficient and effective local programmes focussed on waste prevention, as well as management(+2), have resulted in stabilising rates of waste generation and >75% material circularity, which is the best in the European Union. In addition, the government subsidises 2nd hand shops, reuse & recycling centres and requires standards based mandatory extended producer responsibility (EPR) programmes which actively seek to engage and benefit the community / NGO sector (i.e. managing take-back points). Flanders demonstrates a high-level government sponsored coordination and rationalisation incorporating and balancing public and private sector interests and capacity. For example, of the 308 Flemish municipalities handling MSW almost all have grouped themselves into 27 inter-municipal waste management associations to collectivise and collaborate in the provision of these services. The Flemish compost organisation, VLACO is a non-profit organisation constituted cooperatively by OVAM, the inter-municipal waste associations, private compost producers, and some independent municipalities in order to provide organic recycling service(2) funded by a dedicated universal annual charge (UAC). This funding model supports industry training, aka the *compost masters* training program as well as school and home composting demonstration sites integrated with gardening and environmental education.

4.5. Overarching symmetry and mutuality between zero waste and the key sustainable development platforms of participatory development and appropriate technology:

The presence and emphasis given to the zero waste programmes in developing socio-economic contexts indicates an overarching symmetry and mutuality between zero waste and the key sustainable development platforms of participatory development and appropriate technology. Phrasing such the *bottom-up / grass-roots / participatory community engaged* planning processes used to generate local village level zero waste plans(Al), further illustrates the zero waste ethos that communities can and must be have long term involvement and responsibility for solving their own waste management problems. This community involvement and responsibility can be supported and facilitated by, but not replaced or subjugated by *top-down local authorities private sector, or external experts*. Collectively the frameworks and mechanisms for formalising and incorporating the informal sector are cited as a critical opportunity for integrating, implementing and realising zero waste principles(+2 +2 M, AL). The direct benefits of formalising and incorporating the informal sector are cited as: improving social status / gender equality and increasing incomes / alleviating poverty (for example, in Mumbai zero waste NGOs offer woman waste pickers zero waste training in cooperative organisation, contract management (i.e. for multiple work strands inc. cleaning) and marketing support (600 women op in 150 diverse locations). The ancillary benefits of a thriving informal sector incorporated into and driving a zero programme is cited as: the development of a *recycling economy* not necessarily dependent on government intervention / regulation (hence lower risks of corruption / police harassment), improving the management of separation at source programmes (which reduces municipal costs) and increases the opportunity for stimulating direct reuse of recycled resources (i.e. the cited example of organic recycling via anaerobic digestion to produce biogas for cooking(+3 +1 M)).

4.6. Practice confirms and reinforces principle:

Some illustrative informal sector zero waste development models illustrated in zero waste case studies are:

- In Alaminos, Philippines, the technical consultation between involving Barangay villages councils, waste picker cooperatives and the resident community to create an agreed / signed zero waste plan, which once completed, enables local leaders to take ownership for the ongoing management and implementation. In this instance, the neutral zero waste technical consultation and brokerage is seen as non-partisan and apolitical, which functioned as a new enabler of consensus(AL) and progress.
- The waste management story in Buenos Aires is defined by the persistent commitment and wealth of experience of *Cartoneros*, aka grassroots recyclers (transformed into environmental promoters) was recognised and facilitated via legal and financial support from the city govt(+5). As per the pattern of other zero waste case studies, *Cartoneros* had been an integral part of people-based opposition protest against waste / landfill and allied with environmental networks in campaigning and political lobbying for zero waste. In this instance the formalisation matrix includes *Cartoneros cooperatives* becoming:
    - ✓ better organised, with improved working conditions (i.e. uniforms, health and safety, public liability insurance, developing regular schedules, child care facilities)

- ✓ offering increase levels of service (i.e. ringing the doorbells and undertaking public engagement)
- ✓ participating in environmental education whilst collecting and participating more generally in collaborations (i.e. with a university in BA)
- ✓ developing integrated contracts (i.e. in synergy with door to door collections) to manage *green / resource recovery centres* (RRC)(+3+1)
- ✓ having access to necessary technology (i.e. for sorting, baling and storage in order to enhance the sale of materials) and transport support (i.e. supplied via government funded investment)(BA).

- In the regional Spanish context off Herani, zero waste momentum also arose from anti incinerator groups(+1), which then focussed on the instigation of PS/EPR models, the formation of *citizens committees*, which provide monitoring, networked volunteer waste prevention (design, production & consumption) and sustainable recycling. In this context recycling collection services are provided by a public company called *Garbitania*, whilst the organic recycling system is operated by provincial consortium, which has been incubated by the governments of Hernani, Usurbil, and Oiartzun(H).
- In LaPintana, Chile organic (focussed on food waste) and general recycling programmes were developed, via the facilitation of not for profit (NfP) non-government organisations (NGOs) based out of municipally developed / funded network of *green points* alongside recognition, promotion of the informal sector (supported by the *National Recycling Movement of Chile* – MNRCH). In this context the municipality supports the recycling programme by supplying collection bins and via education and regulation i.e. requiring C&D material to be managed privately by producers. The collection of non-diverted residual waste of the city is 1/3 serviced by the municipality 2/3 by a private company(LP).

4.7. Community as an appropriate social technology:

Whilst the role of the informal sector is, for genuine reasons certainly identified and embraced in zero waste (i.e. transformational cost effective) the spectrum of organisations which have evolved in support of international zero waste programmes, illustrates a conception *community,* which is broader than just the informal /waste picking sector. In the zero waste context of developing countries, participatory development and appropriate technology can be seen as interrelated concepts, because the resident / community (as well as informal sector) participation in consuming sustainably, minimising waste, separation at sources, home composting and active implementation and monitoring of zero waste programmes is often the cheapest, most resilient, effective and hence, the most *appropriate approach / technology* (+1 M). In zero waste socialised conception of appropriate technology differs and is broader than the normal mechanical / hardware based framework. The zero waste conception of appropriate technology includes the human / software element, which coincides with *reduce* being the top priority of even the most conservative conventional versions of the waste hierarchy. In this alignment zero waste confirms the function of personal choice as an important, appropriate, yet under-utilised 'social technology' for managing the type of consumption which occurs, which can reduce waste generation at source as well as, for example through separation at source, improving all post-discard management options. The equivalence of *social vs hardware-based* conceptions of appropriate technology is a confirmation of the zero waste principle that waste is fundamentally a social - not just technological issue

4.8. Socially attuned programme design = beneficial outcomes:

Zero waste's preference for employing the human software element of the spectrum of all of what might be considered *appropriate technology* is based out of the reality that, genuinely engaging community and formalising, developing and incorporating the waste picker / informal sector can result in significant benefits. For example the reported benefits are:

- ✓ improved services (i.e. simple effective design aligned to grounded reality / community requirement),
- ✓ increased / improved employment(+1) (i.e. green jobs with an escalating skill requirement to higher-skill roles)
- ✓ potential for the benefits of *free-market* engagement (i.e. existing private sector itinerant buyers can collaborate with the WP/IS model(+2),
- ✓ more flexible service models and a variety of ownership structures for infrastructure (i.e. community / industry / government funded /owned)
- ✓ lower cost structures(+1)
- ✓ lower carbon footprint (i.e. less transport(+2))
- ✓ reduced risk of exploitation (i.e. by 'middle-men')
- ✓ increased and more stable recyclate materials supply / availability (inc. organic recycling – compost production, which has a positive resonance with supporting localisation of gardening and food security)
- ✓ improved community receptivity to other future environmental services and programmes (i.e. as in the sphere of organic recycling underwriting this diversion via developing landfill bans(+2 +1 AL, M).

4.9. Colonising and repurposing waste infrastructure:

A further permutation of the concept of *appropriate*, relative to future technological requirements is, rather than demolition and supplanting infrastructure, a reoccurring theme within zero waste of is to seek to build on, optimise and repurpose existing infrastructure, so as to avoid excessive waste and transition costs. One way to achieve this repurposing is through the formation of diverse models of zero waste / eco-industrial / symbiosis / resource recovery centres / parks / networks (i.e. RRC/P/N), via which both the reuse (i.e. *sharing /collaborative economy*) and recycling can be facilitated. It is observable that these facilities can provide an opportunity to cultivate the special / essential role of the community NGO / NfP section[(2)] and to incubate win-win, symbiotic (i.e. Recology -City, SF) public private people planet partnership models (PPPP)[(+1 +1)]. Another permutation of the diverse zero waste conception of *appropriate* extends to colonising and repurposing conventional waste framed (reverse) logistics / service models and transforming these into for example, flexible new franchise or, contract agreements (single or multiple haulers), municipal ordinance or government run trucks[(+1)], etc.

4.10. Product stewardship / extended producer responsibility as socially appropriate technologies:

Arguably the most profound alternative zero waste conception of *appropriate* is viewing product stewardship / extended producer responsibility approaches, for example container deposit systems (CDS), as a people centred socially appropriate technology. EPR/PS, can offset unnecessary infrastructure and service costs, can provide income for the waste picker / informal sector[(SF)], can enable viable roles for the not for profit (NfP) sector in managing drop-off networks in synergy with door to door collections and ultimately can enable permanently funded participation in *product stewardship / producer responsibility organisations* (PS/PRO) (created by producers, packers, bottlers & recyclers)[(H)]. This conception of community centred development and participation in product stewardship / extended producer responsibility systems, as socially appropriate technologies, is critical to realising the zero waste vision of user friendly / accessible / everywhere / normalised *universal* recycling models, *NB: whilst inherently also leveraging environmentally sustainable design to change the nature of future waste materials / problems.*

4.11. Debate dissent, myth-busting and reality checking the (zero) waste paradigm:

The key driver for the *appropriate* element of the zero waste conception and approach to technology, draws upon the alterative zero waste hierarchy in disrupting mythologies / assumptions which have built up within the waste paradigm. For example, that privatisation automatically equates to more efficiency, that more mechanical technology is always the answer and that the scale and complexity of waste management issues can only be resolved via, correspondingly large and costly interventions designed by experts. Zero waste theory (of which the zero waste hierarchy is emblematic) and practical experience promotes alternative perspectives and recognises that highly decentralised, people-powered models can ultimately be more successful, lasting and financially sustainable[(M)]. In simple terms this is because eliminating / reducing waste is cheaper and easier than having to manage, treat and dispose of it. Accommodating dissent, debate and campaign activism, especially in reference to the worse excesses and issues associated with waste, is a declared characteristic of the global zero waste community of practice. This characteristic can be regarded as inherent with the term zero waste functioning as an aspirational, unownable, innovation space, but as also giving rise to a grounded ethos of internal review, revision and evolution in the theory and practice of zero waste. Unsurprisingly contradictory observations exist withing zero waste discourse. For example such as that private sector motivations can directly conflict with public good focussed zero waste objectives, yet the informal waste picker sector are viewed as a positive, albeit disaggregated form of private sector deserving of preferential treatment (NB: often in competition with other large unhelpful private sector entities[(P)]. Large expensive techno-centric waste systems (particularly incineration) are sometimes only viable because of subsidies secured via vested interest lobbying lobbied and eventually these become fiscal 'black holes' (i.e. which suck the life out of alternative investment / innovation), yet zero waste calls for subsidies to be re-directed from waste to alternative zero waste business enterprises[(+3 T)], which may require long-term public sector support.

4.12. The change-making power of community starts with individual choice:

Arguably zero waste experience evidences the potential of seeking to recognise, balance and draw upon both public, versus private sector attributes and values[(+1)]. In short zero waste recognise the necessity of technical policies, programs and infrastructure appropriate to context[(+2)], but equally that to be socially, technically and cost effective these developments need to be driven out of robust community engagement[(+3 +1)] and might equally be centred around human capital. Zero waste is also cited as an affirmation of the individual ethic / principles of *power of one* individual mind-set and as encouraging of personal life affirming, change-making choices to live within our means on our one shared planet Earth. Collectively as it accumulates this revolution in consumer choice and behaviour becomes an incredibly powerful in shaping all future markets (and hence the production which feeds them) and what resource recovery, material cycling and residual disposal systems are then required to service these alternative circular market-based economy.

4.13. Separation at source a foundation for zero waste:

Maximising community based development and participation in effective *separation at source*[+16 +18] can be recognised as a ubiquitous and foundational precept, aligned and in synergy with zero waste's expansive conception of other key foundations such as *participatory development and appropriate technologies*. The benefits of separation at source processes can be drawn upon across a range of spheres of practical activity such as: reuse, repair and recycling of inorganic / general recyclables, as well as product stewardship / 'hazardous and special' classes of product / materials types and separate collection and reducing contamination of organic recycling programmes (i.e. covering composting to anaerobic digestion)[T, F, H, LP, AI, BA, SF, NZ].

In particular, building on from rudimentary wet vs dry[NZ] mode of source separation, which in addition to benefitting both general recycling and all forms of transitional residual waste management, *source-separated organics* (SSO) is essential for successful organic recycling, which is underwritten by the quality assurance (QA) of the inputs and outputs of production. Demonstrating tis criticality, in the context of enabling SSO, the government of La Pintana, Chile invests in the provision of 35 L collection bins and a processing network of *green-points*[LP] to support informal sector service provision of SSO. Another similar example of government recognition of the importance of separation at source[+2 +7] and the enabling of an informal sector role in supporting this, arises out of Beunos Aries, where exclusive recycling licences / rights are offered to the Cartoneros / waste picker cooperatives[+1]. The Cartoneros provide support for separation at source practices via education / training of the general public and large waste producers[+2]. Formalising the Cartoneros role in supporting separation at source has resulted in better access to better quality materials, improvement in both market returns and recycling rates[BA] (cited for paper, glass and plastics).

4.14. The importance of investing in separation are source:

Some jurisdictions have identified source separation / waste segregation as the *"most important activity"*, hence as a top legislative priority[+3 +2] and also that separation at source can enacted in synergy with banning biodegradable waste from landfill[M]. The practice and potential of separation at source can be applied by legislation to individual, household, public spaces / events, education, business and government sectors and at the holistic community / national scale[+4 SF]. However, even where assertive laws exist to clarify public participant responsibility, the outcome in such scenarios may still not be perfect and the informal sector / waste picker coops[+2] can be enabled to perform on-site rechecks / final sorting, as part of the collection process (in on cited instance providing to quality assurance of inputs for biogas[M]). Because separation at source inherently recalibrates and engages personal responsibility in support of a shared and agreed community / environmental outcome and is regarded by some as the single most important / necessary societal behaviour change[+2] required for zero waste. In this sense, zero waste supports public outreach / enviro education for separation at source in schools, businesses, households & events.

4.15. Policy synergies - accelerating the benefits of separation at source:

Separation at source can be supported and enhanced by economic policies such as *full-cost accounting*, regulatory approaches, such as *materials bans on incineration and landfill*[+1 M] as well as by, community education for long term social change across the spectrum of easy to hard product / material types. As such, separation at source is a essential platform for deconstructing and de-legitimising the pathology of wasting (aka reversing the norms of the *throw-away society*) and the necessary transition from voluntary to mandatory (NB: and then backstopping this with monitoring and enforcement, i.e. "no sort, no pick-up" policy (Lombardi & Bailey, 2015), so that ultimately in future there is *zero mixed / comingled trash*[5]), which enables traction to be generated around the various zero waste target / goal framings (i.e. 75%)

The evidence from across the global spectrum of socio-economic development, of the effectiveness of separation at source makes the application of this instrument a vital opportunity. The combination of separation and source and the involvement of the informal sector can increase the reach and specificity of all types of collection services. Separation at source can be instigated and supported by government, whilst also being be facilitated in conjunction with the waste picker / informal sector, for example, undertaking door to door collection and further sorting of general recyclables and or, whilst diverting organic waste for recycling (i.e. to anaerobic digestion to generate biogas[+2 +1 P, AI]. In the context of Alaminos, Philippines separation at source formed part of the rA9003 waste regulations[+7] which enabled and enhanced backyard and small scale, village-level composting and recycling collection and sorting programs / facilities, which serviced resorts / inns, hospitals / clinics and schools / universities. In this instance the government backed up this regulation with zero waste technology and programme investment, i.e. education of both community and tourists around the strict no-littering & waste separation policies(AI).

4.16. Environmental education → separation at source → community acceptance → success and proliferation:

Whilst government can drive separation at source enabled programme developments (i.e. government established door to-door general and organic recycling collections - with mandatory separation at source) evidence also shows that the impetus can come the community responding to waste issues. Irrespective of where the initiatives arises, separation at source can both be supported by and be a focus for environmental education and be enthusiastically embraced by residents and on the basis of demonstrating significant results (i.e. 80% waste diversion from landfill and 1.5% contamination rates(+3) spreads to other provinces / places(H). In the jurisdiction of Flanders, OVAM the designated government agency, promotes separation at source through environmental education, as well as backstopping this by making it mandatory in national and regional plans and subsidising the necessary recycling services and infrastructure(F), i.e. *"337 recycling parks"* (RRC/MRF) and organic recycling (i.e. composting + anaerobic digestion programmes. Whilst separation at source requires education (estimated and needing to reach a threshold of 80% household) this *environmental education* can be framed as simply as visiting and discussing programme requirements with residents and supporting this with for example green incentives i.e. tree planted locally(LP).

4.17. Separation at source – an appropriate (social) technology integrated with participatory (community) development:

By lowering the rates of contamination and hence the associated processing issues (i.e. damage to machinery), time and cost(+3 +1) separation at source increases the quality(+2) and resulting market value(+5 AI) of recycled resources (including in the context of organic waste and final compost products(P)). These outcomes positively influences objectives such as: achieving higher recycling / waste diversion rates, growing the local economy, via 'green jobs'(+3) and improving workers conditions(+3 AI) and service levels for the community and businesses. The underlying concept and benefits of separation at source as a decentralised appropriate (social) technology is, illustrated in the quote *"our state-of-the-art technology is the neighbours",* aka the community themselves, this context supported and monitored by citizens committee(H). The participatory and socially appropriateness technology attributes and associated outcomes of separation at source which can be implemented variously according to context across the socio-economic spectrum make this a flexible as well as powerful instrument. Various cases studies illustrates that separation at source can for example be instigated by government, in synergy with:

- Waste picker / informal sector integration and development programmes (i.e. directed via municipal contracts and pricing)(AL), supported by training (i.e. in collection and sorting systems, legal / regulatory requirements, business development and recyclate marketing, administrations of customer services and fees and practical operation of composting pits / biogas plants). The result of separation at source enabled by a *"thriving informal recycling economy"* can be, transitioning from disposal orientated waste management policies, to progressing zero waste KPIs, such as waste prevention(M). Buenos Aries provides another example of a city that, based on multiple positive environmental, social & economic benefits has accessed national government funding to formalise *(i.e. ref previous section)* the Cartoneros grass-roots cooperative's role in separation at source in support of recovery & recycling(+1) with the result of boosting the profile of the city relative to other international cities(+1+1).
- Various payment / funding models, such as simple user pays collection systems (i.e. *"no-segregation, no-collection"* - two warnings policies(AL)), aimed at progressing stated targets, such as increasing diversion, reducing open burning and dumping and banning certain products / materials from landfill and incineration(AI) based on the high costs and associated enviro issues(T).
- Differing modes operationalisation from more complex government led, hands-on programmes involving, for example, integrated door-to-door collection, drop-off centres, street containers & retailer product take-backs"(F). Alternatively, hands-off approaches can be facilitated, which deliberately seek to limit public sector involvement, by promoting privatisation. This model can provide a low-cost separation at sources system which can grow and evolved steadily overtime. A variety of legislative and programme approaches, reported examples are: the Taiwan 'Waste Disposal Act' frames the 'food Waste recovery & Reuse Plan(T), versus in Buenos Aires a new zero waste law (2005) which built on the preceding waste related 992 law(BA).
- Within zero waste *guidelines / documents*, separation at source is recognised as a critical as a policy instrument and opportunity to drive progress in zero waste programmes, which – *big picture* - it is argued are the 'fastest, easiest, most cost-effective' way to address climate change, prevent pollution and progress towards a circular economy and sustainable prosperity(+2). For example it is reported that reforming production, consumption and the disposal of

products and food provides an opportunity to address 42% of all U.S. GHG emissions. Because future resource scarcity vs the alternative of resources conservation, interfaces strongly with mining and zones of conflict and corruption, zero waste is cited as an opportunity to deleverage global / regional risk (aka zero waste is cited as a *peace movement*) and maximise the associated local social and environmental goals.

4.18. A broad conception of source and separation:

It is numerously attested that separation at source is an integral practice within the way zero waste envisions and practices participatory community development of and as, an appropriate change making technology. Zero waste's expansive conception and practice of separation at source, i.e. initially encouraged and then mandatory and enforced[+2] and applied across both collection (from door to door - right up to for example skip bin systems) and drop-off (i.e. from return vending to self-haul to transfer stations / systems) is foundational to delivering on goals / targets which are described as similarly instrumental to zero waste progress and success. For example, the priority identification[+1] and checklist for success[3] offered in the zero waste community roadmap numerously reinforces the importance of transparently monitored separation at source, as a driver of community engagement and progress[+2] for targeting 90% diversion articulated in three phases over ten years[+2].

4.19. Barriers / issues separation at source:

Separation at source can be recognised as a pivotal enabler, or alternatively if absent, a barrier to zero waste progress. In the context of Flanders the shift into mandatory separation at source is cited as resolving the quality issues and enabling the region's organic recycling programme to expand and achieve highest rate of waste diversion in EU[F]. Another experiential overlay emerging from zero waste literature is that securing a *legal right* to access resources greatly enhances the livelihood and lives of waste picker / informal sector, as well as enabling this sector to address critical practical issues, such as where separation at source requires face to face explanative / educational support and or the physical resorting and or, consistent monitoring, compliance and enforcement as a backstop[+1 +1 P, BA].

4.20. Deciphering the opportunity for govt vs private sector opportunities for progress:

Within zero waste discourse it is be recognised that catalysing and sustaining *social change* against the flow of the mainstream, embedded waste paradigm is fundamentally hard and can be problematic (aka *hit bumps in the road*). Anecdotally, it has been cited that zero waste benefits 90% of community, but the 10% of embedded *anti* mind-sets and current vested private sector interests can powerfully resist change[+2]. In recognition of this inequity, zero waste proposes a new approach based on reversing embedded imbalances and elevating the so-called *community table* ahead of the *stakeholder table*[+14 +9] in consultative engagement and decision making. In confronting barriers to progress, it can be observed from international experience that, delivering on the opportunity which exists for governments to exercise leadership and offer support varies considerably. This means that, potential pathways for progress are also quite asymmetric and variable. For example, in the EU context, government can be regarded as providing both direction and leadership, whereas in the absence of this in the US context, grass-roots, bottom-up agency is required for zero waste to progress. It can also be recognised that the private sector, with a vested interest in waste / recycling can be both, good at delivering defined services, as well as design and innovation, but equally can also block good ideas and undermine change[+2].

4.21. As an innovation space zero waste can catalyse new progress pathways:

The pre-conditional scenario of *government vs private sector awareness of opportunity and willingness to act on this*, precedes and adds to other foundational barriers / issues, i.e. such as establishing key platforms like community based participatory design and development, appropriate (inc. social) technology / infrastructure / services and separation at source. Zero waste positively accentuates the *public good* role of government in providing for the general welfare of the whole community and that, sometimes negotiating less controversial / middle ground consensus with vested interests, does not necessarily equate to paradigmatic level of change – or the best enviro socio-economic outcome, that is actually required[+2]. Whilst elements of the zero waste community might argue for highly managed, government led, interventionist approach to the economy, for example, where market competition is lacking, it is a public sector responsibility to step in to create / facilitated this[+2]. However, it is also important to recognise that equally experience shows that zero waste progress can occur via by-passing existing government / political tensions, rivalries, top-down issues (including corruption), fear of change, open hostility toward low status marginalise waste-picker communities, vulnerable grassroots zero waste cooperatives[+1 AI, M]. As an innovation space zero waste can catalyse ways to overcome systematic infrastructural issues i.e. limited space in multi house dwellings (MUD), past bad experiences / programme failures, such as low and problematic participation in organic recycling, slow, inconsistent and partial government support[+1 BA], which might otherwise hasten networked organisation, worker rights and occupational safety and health (OSH) improvements and the development of more financially sustainable models[LP, M] even in rapidly growing / developing, high density context / huge scale of megacities[M]. Embodying and communicating this kind of salient experiential learning within zero waste discourse is an important cognitive buttress in supporting people in persevering through the *ups and downs* of the often cited, *journey* towards zero waste.

5. Social Change:

A1g soc comtmnt PPPP - A5a ZW EfS behav change + A5b ZW enviro schools + A5c ZW ind. train / uni ed + A5e best prac advice + A5g Awards NB: in this next section SS & EPR are innately together as a collective action - in red extra non code to Int networks collaboration + agreements etc - ZW outreach only after programmes and infrastructure in place

5.1. Bottom-up / top down - public / private – community / commercial inclusion in programme development processes:

As discussed previously, the zero waste paradigm is premised in changing the relationship between waste and people, aka the community. One of the fundamental dimensions in this transition is for everybody to have a voice and be included and involved[+2]. This alternative zero waste planning model shifts the onus beyond just politicians and technical experts *(i.e. zero waste is not built by govt alone*[+3]*)*, so as to instrumentally include residents / the community / general public (of all levels of education and wealth) impacted by waste issues. Zero waste observes the fact that people / communities / everybody has the ability to work together to make change and resolve issues (aka *all hands on deck*)[+20]. For this reason zero waste is described as a *bottom-up* approach incentivising and involving all social actors, in the formation of strong and effective policies and programmes, alongside the private / commercial waste (especially the informal recycling) sector organisations. Zero waste recognises the value of including workers perspectives in programme development processes as their knowledge, skill and effort is essential required alongside that of the community in making systems work[+7].

5.2. Collective input =s collective ownership and success:

For example, a *bottom-up* planning process involving local officials and stakeholders in village / barangay level workshops was facilitated (over a period of 14 months) to develop zero waste plans, which were publicly signed by the entire Barangay council, with all residents in attendance[+9 AL]. Further demonstrating the concept of inclusion within this jurisdiction, a separate - parallel consultation process designed to expand participation in implementing rA 9003, is cited as involving: stakeholders from various city departments, city waste management workers, representatives from the reuse / 2nd hand sector, the tourism industry, the boat owners and operators association, hospital / medical health facilities, academia, business and various religious sectors. A key benefit of the collective and holistic involvement of the community in this consultation process, was greater appreciation for and participation in the resulting service provision, by all stakeholders - especially itinerant buyers.

5.3. Collectivising shared learning and experience for systemic change:

The expectations is that public officials, citizens and businesses can engage, learn from, collaborate with, and support each other on each step of a *zero waste planning journey*[+3]*,* with the long-term, interdependent aim of reversing pervasive thinking, behaviours and systems enabling the *throw-away society* and ultimately, eliminating the embedded concept and culture of waste[+7]. Zero waste recognises the importance of the *individual* in catalysing change, as well as the reality that, *groups of individuals* working in a coordinated way, have greater chance of creating the collective public shift from harming to healthy eco behaviours[+2] and generating transparent, measurable and accountable (aka the so-called *rates and dates*) progress towards zero waste. Zero waste is cited as one of the fastest, easiest, most cost-effective ways that any given community can address climate change. Whilst recognising a commonality of foundational principles (i.e. community engagement), policies, programs, infrastructural requirements, zero waste encourages that each community will forge its own pathway. Sharing this learning and success with others in the global zero waste movement, for example the Ecocycle online platform and roadmap)[+2], is a critical way of inspiring further innovation[+3]. Reforming a *throw-away, linear economic model*, into a zero waste based circular economy, requires *distributed intelligence of* multi-sector interdisciplinary innovation, extending beyond just the conventional waste management actors[+2], to include for example the materials processing technology and product design sectors. Rather than deferring to *centralized top-down, expert knowledge* (i.e. the power structures, which got us to where we are today), zero waste seeks to involve and unleash the creativity and energy of every sector and level of society and all businesses institutions and community agency in the pursuit of zero waste goals[NZ].

5.4. Practical case study experience reinforces collective responsibility / opportunity:

Illustrating this zero waste phenomena, the Mayor of Hernani, Spain declared, *"our state-of-the-art technology is the neighbours"* (i.e. community participation and responsibility expressed in the form of separation at source), which is available *"if only governments dare to lead the way and count on their citizens".* In this zero waste context, a deliberate process of dialogue was undertaken with citizens to explain and solicit input on the new zero waste system[+3] and as a result, this community-based waste management system is cited as producing impressive results in a short period[H]. In Flanders several cooperation agreements, which identify and appropriately attribute responsibility between the community and the municipal, regional and national levels of government have been signed for key waste reduction measures (i.e. mandatory separation at source and extended producer responsibility[+3] which require and rely upon collective action[F]. Similarly, in San Francisco the terminology of collective responsibility / opportunity is demonstrated in the reported partnerships between like-minded waste professionals[+2] to create a culture of recycling, composting and zero waste[+2]. The described symbiotic relational model involves SFE providing governance and oversight, etc and Recology providing the capacity for practical implementation[+2]. This approach to zero waste represents a unique synthesis of regulation, a long-term partnership (SFE, Recology and the community) and engaged community outreach, which has been extremely successful in altering the minds, habits, and culture of its citizens to accept and progress zero waste goals. A key to the world leading, San Francisco zero waste success story, is the celebration and promotion of this community's shared learning and milestones / metrics of success (i.e. alongside other empirical targets, achieving the millionth tonne of organic recycling).

5.5. Upending conventional power and control structures in order to release fresh energy and experience

This is arguably most explicit in the zero waste characteristic of, in developing socio-economic contexts, embracing and seeking to formalise and deploy the informal waste picking sector, as a critical actor for progressing zero waste goals. For example, the Cartoneros informal recycling /waste picking cooperative /sector's wealth of local experience is described as a zero waste asset and ally that the city government cannot afford to waste[BA]. Other jurisdictions report that the deliberate integration of the informal sector (i.e. KKPKP / SWaCH) as part of zero waste programmes, results in lower residual municipal waste collection volume /costs, with aligned benefit of improving the representation and status of the people involved[P]. Where human and financial resources are constrained solutions need to be both technologically and socially appropriate, i.e.be generated locally and be financially and practically sustainable. Despite being a very poor community, the Municipality in La Pintana, Chile, has demonstrated that robust analysis of the local context, setting clear goals, and engaging community alongside NGOs and the informal recycling sector, has enabled this community to move beyond just dumping / landfilling into the 3R practices which drive zero waste[LP]. Aside from prioritising democratic engagement, genuine consultation and strong community involvement in zero waste program design[+2] and creating active participation[2] in and monitoring of implementation processes, zero waste advocacy extends to supporting formal worker unions and informal sector cooperatives. Proactively recognising, protecting and empowering the *green collar* zero waste workforce conforms with the broader zero waste principle of informing and empowering the community for an essential participatory role.

5.6. Collectivised innovation and knowledge sharing structures and uniform best 3R practices:

Creating the new societal norms and changing collective public behaviour is one of the toughest challenges confronting zero waste[+4]. In terms of the top of the zero waste hierarchy i.e. *reduce – reuse*, zero waste advocates for policies which support a *sharing-collaborative economy*[+2] i.e. collectivising within community and family groupings the use of services and products, so as to make better use of resource intensive investments, i.e. owning a car vs ride sharing etc. One of the ways that new innovation and best practice can be generated, is via the establishment of a network of zero waste advisors / champions working in the community to enable the *inside - outside (govt - community) partnership* strategy to flourish[+4]. Such structural programmes are essential in order to move beyond the limitations of individual inspiration / power / influence (i.e. for change-making and sharing positive lifestyle choices) - into systematic collectivised community involvement in zero waste. Ultimately in practice zero waste manifests as a uniform best practices regime of: maximum participation in separation at source[+7] and *universal* general and organic recycling, *green* construction, demolition and deconstruction (CDD) practices and extended producer responsibility programmes[+14]. The overarching principles is that this regime is normalised in schools from early age[+5] and is a phased evolution i.e. moving from voluntary, to slowly introduce, at pace which the community understands and feels is fair[+6], a mandatory approach, which is then backstopped with monitoring and enforcement.

5.7. Repurposing and future proofing waste → zero waste service, technology and infrastructure systems:

The most effective way of future proofing the (re)engineering the services and infrastructure systems, so as to be able to receive and circularise the expected escalation of recycled material flows, is to acknowledge, repurpose and expand all existing waste services and infrastructure systems (i.e. to anticipate and fill future processing gaps) in a redeveloped framework directed at zero waste. In simultaneously reducing pollution, addressing climate change and progressing towards being a sustainable circular economy, zero waste can be regarded as an essential community service, which requires putting the public good / community benefit, ahead of profit centred private interests. Irrespective of socio-economic context, it can be accepting that there can be tensions between and often directly competing public vs private sector motivation and practices(P), in the provision services and infrastructure. Whilst accentuating public / community ahead of private sector consultative vision / value / goal setting and policy / programme design, monitoring and reporting, zero waste appears to acknowledge the potential benefit of and advocate for, a balance of both public and privatised ownership and operational models. Specifically, the *public private people planet (PPPP) partnership model* is identified as a positive approach(+5 NZ), particularly where the private component is a *social enterprise*, which is defined as a *mission-driven business (either for-profit or NfP*) whose business model is to use the power of the marketplace to achieve social and environmental goals.

5.8. Zero waste case studies present a spectrum of experience in collectivised service and infrastructure models aimed at *seeking innovation and advancing best practice*:

- In Pune, India, separation at source as a collective action supports SWaCH, in providing organic recycling within a service matrix alongside other public and private sector activity. In this context the Pune Municipal Corporation (PMC) enables the formalisation of the waste picker cooperative SWaCH, via a strong contractual working relationship for services and data support)(P).
- In San Francisco, a similar, now historic formalisation process has resulted in a modern equivalent of SWaCH, *aka Recology*, which originally began when waste pickers created loose federations, in order to be more competitive. From this formalisation, by the 1920's two cooperative companies emerged (i.e. the *Scavengers Protective Association* and the *Sunset Scavenger Company*). Latterly these merged to form the modern day *Recology*, which now supports unionised workforce(+5) and contractually provides zero waste services to the Municipality. Additionally today, because of a mandatory state-wide *bottle bill,* a new informal sector (i.e. of homeless and unemployed people) is thriving based on the income supports provided through street litter / recyclables collection into the container deposit system (CDS).
- In Alaminos, Philippines a partnership approach involving NGOs, village leadership and the government has established a zero waste strategy involving community based separation at source. At an overarching level this is supported by the rA 9003 zero waste legislation which established strong provisions against incineration and specifies how Alaminos will conduct public education and implement competitive recycling and waste collection systems(+4). As a result (zero) waste management systems have developed in the hospitality sector (as tourists were educated and reminded about the strict no-littering and waste separation policies) and hospitals, health clinics, schools and universities improved their waste segregation and composting practices(+2 AL).
- Similarly in Hernani, Spain a provincial consortium *San Marko Mancomunidad* operate door to door collection programs feeding recycling material flows to a MRF. This model is monitored by local *citizens committees / Zero Zabor* (i.e. zero waste groups which emerged from the precursory anti-incinerator movements) in order to quality assure the implementation of these collectivised zero waste services and infrastructure(H).
- In La Pintana, Chile, separation at source based general and organic recycling(+3) is provided via a network of 'not for profit' (NfP) NGOs servicing *green point recycling drop off centres* (built by the municipality) operating in synergy with and door to door recycling collections provided by the informal sector.
- In Flanders, Belgium, the government agency OVAM, signs agreements with municipalities for collectivised (zero) waste service provision, such as environmental educational campaigns(+3). For example organic recycling systems are provided by the *not for profit (NfP)* Flemish compost organisation (*VLACO*), which is constituted as a cooperative of inter-municipal waste associations, private compost producers, and some independent municipalities(+2) by OVAM the overseeing agency. Similarly, NfP NGO's also perform other important roles, such as managing product take-backs within a mandatory extended producer responsibility (EPR) programmes, developing educational resources for waste minimisation programmes, operating an online database (i.e. *MAMBO*, which is an inspirational collection of business case studies based on cleaner production and eco-design methods), a *green events programme* (i.e. a guide and online assessment tools for organisers to calculate and then reduce the ecological footprint), promoting tap instead of bottled water and sustainable consumption (i.e. adopting bulk purchasing and avoiding packaging, disposables / single use plastic bags (SUPB) and junk mail). In addition, most cities belong to inter-municipal partnerships and run collectivised (zero)waste management services cooperatively, employing a combination of inter-municipal associations and private or public companies, and a few operate independently, with no association(F).

- The Taiwanese zero waste case study provides an example of collectivised zero waste service provision via cooperation between residents, local governments, recycling businesses and the *Recycling Fund Management Board*[T].
- Through a persistent political commitment and collective action the grass roots Cartoneros recycling cooperatives in Buenos Aries won recognition, legal and financial support from the city govt[+2] for the operation of *green centres*. An agency has been created within government, which is dedicated to *Cartoneros* and the extension of alliances with local and international organisations and companies in support of zero waste.

5.9. Institutionalised integrated *whole of community* awareness raising, behaviour change and practical education:

Zero waste is numerously described as being revolutionary and disruptive in challenging the societal cognition and conditioning of the linear throwaway waste paradigm and the derivative service and infrastructure matrix which is pointed towards normative disposal. This makes community environmental education and behaviour change an indispensable part of an ongoing zero waste campaigning[+4]. Because zero waste is in effect integrated within the collective environmental ethos and technical science of resource management, circular economics, climate change and sustainable development[+2], the required educational basis' can be synergetic when combined in practice. However, specifically, as a preceding foundation for any subsequent compliance and enforcement activity, the local and national zero waste community education and behaviour change component requires: focussed environmental education, awareness raising, creating easy access to authoritative scientifically robust information[+1], practical public demonstration projects, outreach across all cultures and elements of society, so that programmes engages everyone in the community around how and why to participate in the quest for zero waste[+6 NZ, SF] (NB: in these cited contexts defined diversion goals of 90% by 2020).

5.10. Properly and permanently funded environmental education:

Because of the fundamental importance of community environmental education and behaviour change in enabling zero waste, a properly funded phased approach is strongly advocated and cited as $2 pp/yr in phase one, then $3 pp/yr phase two, then $4 pp/yr phase three[+19]. The spectrum of requiredzero waste educational knowledge areas needs to encompass: (zero) waste management theory *(i.e.5 to 16R versions of the (zero) waste hierarchy)* and practices, all material and product types, extended producer responsibility / product stewardship (EPR/PS), cleaner production, environmentally sustainable design (including detoxifying and reducing the hazardousness of all products and materials flows and less packaging), green procurement, sustainable consumption and the evolving international case study spectrum of government policy and programmes[+3] are all cited as important spheres of zero waste community education and behaviour change. It is also important to recognise that education and public outreach to citizens, households, businesses and all other institutions can and should be integrated with support, tools, and market based instruments and incentives designed to drive progress towards zero waste[+5].

5.11. Communicating real world success and progress – recycling good news stories:

Zero waste community environmental education and behaviour change outreach programs needs to communicate keys to success, cultivate citizen buy-in and guide correct participation, across a range of audiences i.e. basically *everybody everywhere* and specifically: homes, schools[+3 NZ], businesses, households, public space / *commons* / events, all levels of government organisation and initiative[+13], as well as vocational training for recycling (zero) waste workers (including occupational safety and health etc)[+2]. One reflection is that, rather than being interpreted as a *problem,* actually aiming for zero waste in all events and public spaces (i.e. our shared gathering spaces aka the *commons*) is actually an critical *opportunity* to reach many people in a common recreational educative space[+2] and to create a new cultural paradigm in the community i.e. where wasting is no longer an acceptable social norm[+3]. Similarly, public space engagement and zero waste event recycling and composting stations actually offer a really powerful community interface and educational opportunities.

5.12. Embedding and normalising environmental responsible:

Zero waste recognises a key role for schools and universities in modelling and normalising, as well as teaching and researching zero waste (and circular economic) theory and practice, as part of their basic education for sustainable development (ESD) curriculum[+3 NZ]. An aligned key opportunity, is for zero waste institutions (i.e. R&D hubs) to be developed within the tertiary education sector to, for example train and certify zero waste advisors / officers (i.e. to support: cleaner production and sustainable business development and to lead and facilitate the research, design and development of new green technologies, processes, products and materials[+3 NZ]. For example, *eco-design awards* provide an opportunity to canvas students and professionals to contribute design ideas for incubation and start-up investment to empower zero waste / circular economy innovation(+3). Taiwan recognises the critical need for more research to analyse and propagate key (zero) waste management and circular economy success factors and strategies.

5.13. Community education positively reinforce *outsider-in and insider-out* participatory development processes:

A positive outcome of zero waste community environmental education and behaviour change outreach programs is that the community can be kept in an active and informed dialogue with government staff and support will remain strong for each new phase and or, investment in what needs to be an evolving zero waste programme. Technical and environmental education in support of zero waste is an essential part of preparing and enabling the *community table* so that participants representing the broader community can perform this necessary leadership role and work effectively with the expertise offered by the professional *stakeholder table*(+3) in informing and implementing an plan for zero waste and a circular economy. A reoccurring theme across case study contexts is that zero waste campaigns often begin as *outsider-in* campaigns challenging authorities around the negative environmental issues associated with waste and then become, by degrees official adopted and incorporated *inside* municipal policies and programmes. Both *outsider-in and insider-out* projections of zero waste are strongly educative and focussed on catalysing positive change in environmental practice. *Insider-out* commonly involve informing and encouraging separation at source programmes to improve the functionality, quality assurance and cost effectiveness of general, organic (i.e. composting / biogas) and other recycling programmes offered to or required of residents and businesses(+4 P, SF). For example in Alaminos, Philippines where the municipality utilises outreach workers(+3) (i.e. mostly college graduates in environmental fields are hired specially for these campaigns) to conduct a door-to-door campaign to promote separation at source to both residents (i.e. over a 7 year period visiting 80% of households to provide information, reported *as much and as often as municipal education budgets allow*) and businesses(+8). Part of the strategy of this ongoing outreach and communication campaign, is to highlight benefits and incentives for resident's participation (i.e. new trees and public parks).

5.14. Prioritise – start small / immediately and then learn and grow through educational engagement with the community:

Municipally facilitated education programmes might begin with a simple singular priority focus, such as promoting home composting. For example, as in Hernani, Spain, where residents can sign up for a home composting class and receive a free instruction manual and compost bin(+2), as well as, utilise a phone line to get expert advice and or, have compost specialists visit households to provide practical assistance(H). In contrast, San Francisco supports a broad spectrum zero waste education and outreach system to support the rollout of new programmes and help create the corresponding recycling and composting habits within the recipient community, as soon as the new services and infrastructure are tolled place(+2). In this context (which is the most successful city in the world) education and outreach is deemed so important that large *green collar* teams of environmental / zero waste advocates (i.e. up to 20) are deployed to work in the business sector (i.e. waste minimisation and toxics reduction) and the wider community (including especially to the traditionally challenging marginalised communities and hard-to-reach audiences) to improve build participation(+8). Similarly, in Flanders, OVAM requires and also subsidises municipalities to provide a broad spectrum approach to zero waste education and outreach. This includes: public waste prevention campaigns, providing technical or financial assistance to citizens to reduce waste (i.e. home composting programs, promoting reusable nappies and school water fountains, etc(+6) and sponsoring specific campaigns for target groups, such as schools. In this context organic recycling is prioritised by educating citizens and schools about home composting via communication campaigns, composting demonstrations at community compost plants(+3). A "compost masters" program has been established to train citizens, who are then encouraged to work as volunteers training other citizens and assisting them to compost properly, aka promoting "cycle gardening"(+3). Also as part of the education and support framework, eco-efficiency assessments are offered to the business sector to evaluate the efficiency of small and medium companies, to identify interventions for reducing waste and increasing recycling(+2) improving energy and water efficiency.

5.15. Zero waste vocational training and professional / personal development of zero waste / recycling / informal / waste picking sector workers:

An important dimensions of zero waste community environmental education and behaviour change is to support the vocational training and professional / personal development of zero waste / recycling / informal waste picking sector workers, who in several contexts can then provide further training and support for: community recycling activities, practical trainings, consultancy / technical assistance and facilitating strategic planning workshops. In Alaminos zero waste education and awareness is offered in conjunction with barangay / village Council meetings to reinforce key technical messages from consultation and assemblies(+8). Barangay leaders were then able to visit and provide poster sized brochures to people in the community. In this context the NGO GAIA provided financial support for printing educational materials, as well as investing in processing equipment such as shredders for organics and plastics, awarding mini-grants for barangays to build eco-sheds and purchase vehicles to support collection and processing, etc.)(+2 AI). Similarly in Buenos Aries after a formalisation and organisational development process, *Cartoneros* cooperatives were equipped to provide education on the required *how to* of separation at source and the environmental benefits of recycling to residents and large businesses(+5). In this programme context the Agronomy School of Buenos Aires University also provides recycling training to citizens. In Mumbai the *Stree Mukti Sanghatana (SMS)*, has been training and organising women waste pickers since 1975 and latterly in 1998 SMS formed *Parisar Vikas (PV)* a comprehensive zero waste training and management program.

6. Rationale:

A1m integrated ZW CE CC SD - A1k cyclical material flows + A1f appld ecol econ + A1l precautionary principle + A2e plastics intrv - A1n Resource mngt focus - ref A3g trans to green jobs – [A2m Disaster WM]

6.1. Indicators of integration across environmental sustainability domain i.e. with the imperatives of climate change, circular economy and sustainable development etc (CC-CE-SD): ... *(ref Except ONE page 115)*

NB: 6. Rationale and the first Section 6.1. Indicators of integration across environmental sustainability domain i.e., with the imperatives of climate change, circular economy and sustainable development etc (CC-CE-SD) were selected for inclusion and more detailed examination and explanation in the Results Section 4.3. For this reason and because the Section is relocated as an excerpt in 4.3, at this point the content skips through to 6.2. Understanding rather than denying the big picture holist evniro-economic rationale / reality:

6.2. Understanding rather than denying the big picture holist evniro-economic rationale / reality:

A key economic rationale, which echoes the macro-level case for addressing climate change (Stern, 2006, 2009) is that the long term savings of zero waste dwarf the initial transitional investment(+1). Possible the most poorly understood, least priced and accounted for aspect of zero waste is the value of the *success factor* (good results in a short timeframe), which can shift social perceptions around what level of change is possible and create a positive receptivity to other actions designed to address climate change and environmental sustainability, etc. Alongside this intangible value in supporting the broader environmental mandate, by reducing or avoiding polluting behaviours and the associated risk to public and environmental health and the cost / harm which result, zero waste is associated with strengthening local economy(+5 +5) and with prosperous communities(+5). Alongside emphasising localised circularity(+2 LP), zero waste can be regarded as a key platform for enhancing local economic development(+1 H). As local and central government authorities grow in the understanding that discarded material flows are actually valuable resource, i.e. this an opportunity to exploit, rather than a problem to get rid of(+1 LP).

6.3. Enhancing the quantity and quality of employment:

Echoing the anecdote that there are 10 jobs in recycling for every 1 in waste *(i.e. wasting resources = wasting jobs / money)*, zero waste is reported as underwriting the creation of more *green jobs* than bury-burn disposal treatments. As much as any other claimed attribute zero waste recognises and projects the value proposition of investing in green jobs and enhancing the interests (i.e. a financially sustainable livelihood, improved OSH working conditions) of zero waste / informal sector waste pickers / recycling workers(+3) as a form of local sustainable business / micro-enterprise development. Zero waste is strong advocate of formalisation and transitioning up the value gradient from waste picker / scavenger communities up to high quality, diverse well paid roles, cooperative / union represented, safe / healthy, secure jobs(+6 SF). Recology in San Francisco is cited as exemplifying this value transition into an employee owned (via stock options) organisation. A key zero waste human resources / employment relations platform is to end exclusion, discriminatory practices and to respect and engage the community and all social actors involved resource recovery. Zero waste can be viewed as way of supporting the most marginalised and vulnerable elements of the populations and enabling their integration into society(SF).

6.4. Circularity - a key environmental rational:

Zero waste is described as a *path to sustainability*, a journey to top of hierarchy (i.e. from an end-of-pipe disposal focus - to a front-end design focus) and as a practical framework for respecting planetary ecological limits(+1). All three outcomes are the results of ensuring all resources are used to the maximum potential and when eventually discarded, materials are safely and sustainably returned to nature, or manufacturing(+4 F). Zero waste is about protecting the environment, enhance community wellbeing(+2 +2). In terms of providing additional agency for making change, zero waste provides as opportunity to move beyond the limitations of a linear waste mentality / management paradigm (i.e. just promoting (100%) diversion from disposal to recycling(+1 LP)), by brokering the big picture considerations of how a circular economic system can offset environmental and economic damage(+1 LP). Conceptually zero waste provides a holistic integrated, clustered framing of directive and mutually reinforcing policies and programmes, for example by rewriting all waste contracts as, *resource recovery* contracts(NZ) and backstopping this by taxing(+3 +8 +2) and or, banning (selected products and materials) from landfill and or W2E / incineration(+2 +6 +2).

6.5. Enabling the democratic objective and opportunity for people / citizens to be able to exercise environmental ethics and sustainable practices:

A key social and cultural rationale underpinning zero waste is to meet a democratic objective and opportunity for people / citizens to be able to exercise environmental ethics and sustainable practices(+1 SF), if they so choose, i.e. you can choose to waste in a zero waste system but you can't choose to zero waste if the waste system does not facilitate this. This doesn't negate the role of the individual (aka) the *power of one*, but recognises that cohesion between government and the people and collective action is critical in efficiently enabling future generations to build a safer and higher quality of life within in adaptive resilient communities(+11 +5 H, LP). Maintaining the *waste paradigm* described beyond the physical material construct and as being equally about wasting a positive opportunity for essential change(+4 +1 +1) to addressing critical / hard global / planetary environmental, socio-economic challenges(+9 +1 +7 +2) before tipping points are breached. Zero waste exceeds the fixation and limitation of traditional linear disposal orientated waste management, in being described as offering ecosystem design metaphor for the resource use(+2) over the entire socio-economic system(+5 +1 +3).

6.6. Humanity, values, faith and the virtuous cycle in choosing value over waste:

Zero waste is associated with epithets such being *life affirming, hopeful, joyful and as being a peace movement,* which inherently involves an opportunity of local action with global impacts(+1). Zero waste is essentially about value i.e. properly valuing rather than discounting, people (communities and the human resources / IFS recycling worker OSH etc), place (the local context) and more generally the planet and the future(+5). Everything society once thought of as waste, actually has value as a resource, we just have to make the leap of faith to choose to realise the opportunity of discovering and maximising(+2) this value. These values are reflected in the very strong recognition and emphasis community / resident / empowerment / engagement / participation(+4 LP, F, H), both in terms of programme design and development, as well as through the implementation practices, such as separation at source for general, organic and all other forms of recycling(+2 +1 LP, F). The incentives and outcomes of participation related to the phenomena of zero waste, are reported as resulting in a virtuous cycle of improved investment in neighbourhoods, public parks (trees planted), sport facilities, citizen quality of life and relationship with the environment. Zero waste can open up a high impact change pathway, despite barriers such as poverty / low socio-econ status, and this can provide a launch positive future yet to be anticipated opportunities i.e. next step programmes(LP).

The specific linkage between zero waste and the circular economy, climate change and sustainable development domains / movements is numerously evidenced in coinciding phrasing, such as the mutual identification of the *linear - take - make – waste*, extractive and wasteful, *earth to dump*, rhetoric, premised on excess consumption and the *throwaway society*(+2). As an alternative model, zero waste is described as seeking to capture all discarded product and material resource flows and to recirculate / recycle / reuse them back the production economy, thereby offsetting further virgin natural resource extraction. Both zero waste and circular economy models recognised and seek to preserve natural capital, resource value (intangibles + $) and to eliminate the concept (and material fact) of waste(+4) - and by circularising the material economy, move toward more sustainable, prosperous communities(+2). Both zero waste and circular economy models articulate the concept of *changing the rules* (i.e. economic policies and market based instruments and incentives) to reward resource recovery and stewardship over wasting i.e. *the cleanest greenest companies, not the dirtiest, reap the profits*(+1).

Brief Commentary re: Section 6. Rationale.

Justifying the use of the term *numerously,* within this data-set there were a total of 58 coded references conceptually and practically linking the collective resource / waste management focused zero waste and circular economy movements as related to and supporting the broad global imperatives of climate change and sustainable development. Beginning with: GHG emissions(+17 +9 +3 NZ, P, H, LP, M, F, T), -aka mitigating climate change /

impacts(+4), this result outlines 13 parameters, in descending order of confirmation, which the data-set cites zero waste practices as reducing. Similarly, beginning with the emerging new circular economy(+10 +6 +5 +1 LP, F) and natural / social capital, this result outlines twenty two parameters which zero waste practices are cited as enhancing. In each case the quant + QUAL(quant) write-up annotates the exact number of coded confirmations, the sources node which provide the confirmation and where it has been stated the real-world case location or content of the sources information (i.e. NZ = New Zealand).

Overall, as just one part of a whole result attributed to the parent node *Rationale* (sic. in support of the MZWM), this excerpt demonstrates the significant extend and detail of new information forming up and providing further comprehension around this result. Two minor but pertinent observations that are important to note are: in the final configuration of Figure 11 the child node *A2e plastics interventions* was ultimately relocated to be part of product stewardship / extended producer responsibility relational cluster under the *Empowering Policy* parent node. Making this re-association illustrates that abductive reasoning, analysis and iterative result formation continued right up to the point of finalisation and publication of the graphic result. Despite this being a growing issue impacting municipal communities, no corresponding data was coded to the node *A2m Disaster waste management,* from this selection of sources. Despite this omission in confirming this element of the coding framework in forming Figure 11 a judgment call was made to keep this inclusion in anticipation that confirmation will occur in time.

7. Services / Infrastructure:

A4b - amplified universal recycle - A4g - Syst pub space event recycle - A4c MRF networks - A4e OR / AD comp - A4d - C&D, C&I dirty MRFs / LMRF A4f - RRC RRP, EIP IE etc - A4h transition tech store/mono fills - A3e aligned ZWSD investment

7.1. A comprehensive universal *everything-everywhere*, source separation zero waste collections model:

Consistent with the declared intention of zero waste, a reoccurring aim is to establish a comprehensive universal, source separation based, collections model (i.e. which builds on from whatever current collections service / infrastructure exists as a starting point), to maximise the flow of recovered resources into localised(+1 NZ) reuse, repair and recycling processing systems, so as to minimise *recycle miles* and to maximise local economic opportunities. In simple conceptual terms this *universal zero waste community collection system* aims to recover *everything from everywhere*, i.e. home, work, school, public spaces / events, and the diversity of commercial and government / public sector organisational contexts and operation environments. The *everything – everywhere* concept is directly applied to general and organic (-via composting and or anaerobic digestion) recycling, construction deconstruction and demolition materials (CDD) reusable – repairable second-hand goods, special and hazardous (i.e. the so called PS/EPR class, aka CHaRM) of products and materials(+18 +26 +3). It is also important understanding this aspiration in the context of waste derived issues, such as plastic pollution, where a material may variously have negative of zero value as a recyclable resource and or, incurs a small associated cost as waste (i.e. collection disposal), but has the potential for exponential eco-impact costs over an extended period of time as degrading microplastic litter. The holistic zero waste *everything-everywhere* aspiration includes this big *value-cost-consequence* picture as part of the economic calculus, normally ignored, excluded and externalised from consideration within the conventional waste management paradigm. Within more complete coherent socio-economic and technical design settings (i.e. where producer responsibility is required over environmental externalises and economies of scale and efficiency work for not against environmental outcomes), the opportunity exists for zero waste resource recovery system to comfortably outcompete conventional waste management systems, in terms of visibility, profile, accessibility, user friendliness, convenience and full cost accounting and efficiency(+2 NZ).

7.2. Maximum recovery and circularity synchronised with the redesign of product and material lifecycles:

Whilst zero waste envisages a hyper accessible, multi material, *end of life* collection system, which pragmatically emphasises local processing and economic development, the synergetic *upstream*, environmentally sustainable design (ESD) conception within zero waste aims to maximise product / material use cycles, so as to extend the longevity of the resource life-cycle and forestall disposal for as long as possible. Aside from resetting economic parameters so that, a new durable design and production paradigm can outcompete the *throwaway society disposability model*, zero waste advocates for societal infrastructure and service network which empowers systematic: reuse, repair and sharing (i.e. community wide networks of tool libraries / repair cafes, online trade and exchange functions, second hand shops and resource recovery centres, etc) which maximises the utility of resources through extended and multiple product ownership phases(+8 +1). Acknowledging the essential need, accepting the leadership responsibility for identifying gaps in existing infrastructure and service matrix and then, developing and then promoting a more complete and systematic recovery and reuse, is the essential role of an, ideally government supported / integrated, zero waste leadership agency.

7.3. Public / private - profit / not for profit – ownership / operational models / motivations - overcoming barriers zero waste systems:

Whilst the aspiration of a zero waste collection model seems clear, the ownership and operational systems appears to be more sharped around what can deliver the best outcome based on the existing assets, opportunities and starting point. In developed socio-economic contexts, the legislative frameworks which have originated out of the *historical sanitary motive* associated with traditional waste disposal, appear to have been translated to modern day agenda of recovery and processing of resources. This means that a legal hierarchy of responsibility descending from central to local government, ensures that *government* will often presume a deep practical engagement in this work area. *NB: One of the key barriers to progress in this sphere the assumption that a waste mind-set and disposal orientated skillset , can be successfully applied to a zero waste and or a circular economy objective, which is distinctly different (albeit with some areas of correlation) socio-technical process. Additionally, it can be argued that waste and even more so zero waste is a really complex and difficult problem which is being approached with a limited, unresolved and outmoded conception of the complete disciplinary and training requirements for fully encompass the holistic issues and opportunities. Further, that what disciplines are understood as contributing, are engaged at less than the advanced level of inter → trans disciplinary synergy necessary, to catalyse breakthrough levels of innovation and inspiration to address (zero) waste issues and opportunities.*

7.4. Diverse development pathways, ownership / operational scenarios from a spectrum of zero waste contexts:

Whilst the latter day trend towards privatisation has diluted the automatic presumption of local government ownership and optional control, because this model can blend public good / service mandate with good business principles, effective local government involvement (albeit sometimes with private sector contractors) still features strongly amongst good zero waste success stories and expectation(+2 NZ). Zero waste case studies illustrate a variety of development pathways, ownership/ operational scenarios arising out of differing contexts:

- The relationship between SFE and Recology in San Francisco is a good example of how public / private and profit / not for profit models and motivations can be mediated and combined in support of zero waste objectives. This context is generating applied innovation via the worker owned cooperative *Recology,* which creates, tests and then manages services and infrastructure to collect and process trash, recyclables, and compostables(+2 +1 +1). In San Francisco the mandatory separation at source required of household / business, also applies to larger scale organic recycling and C&D activities(+6 +3 +1) as stipulated by the respective *Food Service Waste Reduction Ordinance (2007)* (NB: which includes mandatory restaurant use of compostable or recyclable take-out containers) and *C&D Debris Recovery Ordinance (2006)(+2)*\. The so-called *fantastic 3 program* relies on mandatory household / business source separation(+6 +3 +1) feeding into black, blue and green carts (i.e. MGBs) for waste, recycling and composting respectively(+2 +3 +2). This SFE / Recology collections model integrates waste and recycling in double-chambered back-loading collection trucks which cater for both material(+1) and smaller side loading trucks which pick up compostables(SF).
- Similarly, as part of a government *Food Waste Recovery and Reuse Plan* Taiwanese citizens and businesses / producers are required to source separate: 1- recyclables, 2- food organic waste and 3- residual waste directly to collection trucks(+2) as part of a three streams / bin system. There are clear similarities with this approach and the *fantastic 3 programme*, which was first pioneered in 1999 and the fully deployed to all San Francisco households and business in 2003.
- In Flanders the government actively promotes separation at source for households (and also for home composting and onsite organic recycling within the parks network) and public events (supported via a government developed *green event* assessment and guide)(+2 +5) and the associated collections model involves a combination of door-to-door collection, drop-off centres, street containers, and retailer product take-back sites. As is illustrated in the Flanders approach to organic recycling, sometimes the most localised and efficient recycling loop involves, where possible avoiding collection altogether by recycling on-site. This approach is also practiced for construction, deconstruction and demolition (CDD) in Flanders, whereby the policy, supported by legislation, is based on the principle of extended producer responsibility (EPR). In this context, the law requires all new construction projects (>1,000 m3 of debris) to develop and implement a

deconstruction plan. This *non-collection / onsite processing model* has, by 2010, resulted in 90% of CDD waste being recycled(F).

7.5. Mandatory *separation at source* / separate collections models - a common denominator in zero waste:

A common denominator running through all zero waste collections systems is the expectation that the community will sharing of responsibility for quality assurance in the form of decrees for and degrees of mandatory separation at source / separate collections model(+20 +29 +1 NZ, T, SF, F, H, P, LP, BA, AI, M) this mandate has been extended beyond just households and general recyclables to include all multi residential units (MRUs) and businesses / producers and organic waste and construction and demolition materials (C&D)(+17 +24 +1 SF, F, M) and has also extended to include residual waste sorting requirements(+2 T).

- Alaminos, Philippines provides another example which the zero waste collections model blends public / private and profit / not for profit models and motivations. In this instances the NfP NGO GAIA provided and awarded funding for printing educational materials to support community engagement and separation at source (NB: even tourists are educated according to the strict no-littering, waste separation at sources and composting policies'(+1)), shredding systems for organic and plastic recycling process, mini-grants for barangays to build eco-sheds and or purchase collection vehicles(+3). In this context 17 Barangays comprehensive collections model (NB: 15 of the 17 are based on an element of *user pays fees*), which includes localised *village-level* composting and small-scale eco-shed MRF sorting facilities. Overall, this collections and processing model services a network of resorts / inns, hospitals / clinics and schools / universities. This model supported by rA9003 legal framework, which make provision for a *no-segregation, no-collection* policy, sets a target for waste diversion and reinforces the national ban on incineration by declaring it a prohibited act(+2).
- Similarly, in several small cities of the province of Hernani, Spain(+2 +5) mandatory source separation ris integrated with door to door separate collection services for general and organic recycling services operate, The Hernani collections model achieved 82% diversion from landfill, after just one year. Each stream has a designated pick-up day, for example paper and cardboard are tied in bundles, or placed in boxes or bags, whilst organic recycling is collected via government is supplied bins(+4) and residual waste is disposed of in bags. In this setting collections are provided by the public company *Garbitania*. In rural areas, home composting is mandatory, whilst other recycling streams are either collected door-to-door or taken to drop-off centres(H).
- Similarly, in the City of Pune, India(+3 +3) mandatory source separation is integrated with door to door separate collection services for general and organic recycling. This service operates as a user-pays based collections model, which extends to households and institutions who sign-up(+4 +2) and is provided by the *SWaCH cooperative* of grass roots informal sector recyclers and is integrated into the Pune government's overall waste management system.
- Similarly in La Pintana, Chile, the government supplies residents with 35-litre bins to support a separation at source organic recycling collection and off-site composting programme(+2 +6) (NB: only fruit n veg waste - not meat or dairy products). Whilst this is cited as a poor community, similar to the Flanders and San Francisco models, C&D materials are required to and are managed privately by the producers locally on-site(F, SF).
- In Mumbai, India, informal sector waste pickers known as *Parisar Bhaginis* (aka *neighbourhood sisters*) have been trained in how to organise as worker cooperatives and negotiate contracts(+3) for delivering separation at source based zero waste collation and processing systems(+3 +1). This involves picking out, sorting, aggregating and selling dry recyclables (including Tetra Paks) from the waste stream. In addition, depending on the nature of the waste stream and the contract, the *Bhaginis* also offer a range of other zero waste related services integrated with buildings maintenance and grounds cleaning, for example in hospitals, institutional campuses and multi-family apartment complexes this includes dry waste collection and gardening / composting / biogas plant management.
- Similarly, in Buenos Aries, the informal sector recycling *Cartoneros* cooperatives, have been incorporated into the waste management system, via separation at source based collection contracts for: 1- wet organic recycling and 2- dry general recyclables. This zero waste collection models is supported by government leadership, legislation and investment in the form of: a public campaign to promote the requirement for citizens and businesses to separate recyclables (paper, cardboard, plastics, glass, Tetra Pak & plastic film) from food organics and from residual waste at source, for subsequent delivery directly to collection trucks(+2).

7.6. Localised materials processing to maximise community benefit:

Consistent with the previously discussed zero waste ethos of universal recycling (i.e. which aims to collect / recover *everything from everywhere*) the zero waste conception of materials processing aims to maximise local economic development opportunities, by localising reuse, repair and recycling processing systems(+1), which minimises *recycling miles*. Additionally, as previously emphasised, this model is premised upon recognition and integration of an *ethos cluster* of zero waste *essentials* i.e. authentic community engagement, separation at source / separated collections models, redesigning dysfunctional socio-economic and product design, re-setting the malign duplets of producer – consumer irresponsibility, excessive waste generation - disposal and externalising - ignoring the resulting environmental costs. The recent advent of international recycling / waste bans (i.e. China), *return to sender* shipments and the well documented issues with the application and monitoring of and compliance with the Basel conventional, has highlighted issues with general recycling, hazardous materials and ewaste. In particulare the lack of country of origin , actually the initial key localisation focus demonstrated in zero waste, is organic recycling (i.e. via home and commercial composting and anaerobic digestion(+8).

7.7. Integrated zero waste R&D, service, infrastructure, technology, education nexus (R&D-SITE):

This *ethos cluster* in zero waste literature, has manifests in a spectrum of conceptual and actual practical working examples of a green / resource recovery / zero waste / circular economy / eco-industrial ecology / urban metabolism – R&D innovation / incubator centres, hubs, clusters, complexes, parks and networks etc (i.e. ref. via iterations of the RRC /P/N acronym). In terms of locally / regionally strategically located infrastructure the key zero waste requirement is articulated as the following six key elements, which might all be configured in one location (i.e. centre, hub cluster, complex or park) or region (i.e. network). It is asserted that to reach 90% diversion within a 10 year period the a minimum necessary zero waste service matrix requires: 1- municipal recycling facilities (MRF), 2- construction, deconstruction and demolition (CDD) facilities, 3- organic recycling / recovery facility (ORF which might involves either of both composting and anaerobic digestion i.e. AD associated with super-efficient bio-waste to energy production), 4- *centres for hard to recycle materials* (CHaRM, i.e. hazardous and special product stewardship class materials), 5- reuse and repair facilities and 6- a 'material recovery biological treatment' (MRBT) system for what is left. This *hardware* model, is premised on being empowered by appropriate software i.e. investment in educational outreach(+7 +31 +4) and R&D for innovation and change-making.

7.8. A rationale for flexible, scalable and holistic (re)investment for zero waste:

This necessary nexus of zero waste hardware and software may include, where appropriate implementing advanced sorting recovery technologies with the overall aim that, any *transitional residual disposal* is restricted to essentially inert materials to landfill(+9). The prerequisite aim is that all other material resources are diverted to the best use, highest return and in the long-term to feed into detoxified and redesigned (aka circularised) reuse and recycling pathways(+5 +3). It is argued that, this six-element zero waste materials processing model is not reliant on having to invent new systems, as this conceptual model is based on using *off-the-shelf* technologies, with an established track-record and known construction and operating costs. This means that the zero waste materials processing model is in practice already achievable and the zero waste investment can and should be fundable on the basis of communities considering avoided existing landfill disposal costs and or, by the offset of potential future replacement landfill rebuild costs. Importantly, rather than being undermined by the zero waste ethos of encouraging communities and businesses to invest in reducing resource consumption / waste generation (i.e. via redesigning cultural & economic systems, for example, limiting non-recyclable products, etc) this commitment, is parallel and synergetic with the six-element zero waste materials processing model, because it provides a stronger basis for appropriately scaling / scoping the necessary level of investment.

7.9. Pragmatic, future proof strategic planning for (re) investment:

Emphasis is given to the strategic planning and location of, specifically MRF, but more broadly iterations of any given zero waste R&D, service, infrastructure, technology, education nexus (R&D SITE - i.e. including RRC / parks / networks, etc and or the six-element minimum zero waste materials processing model) with the aim of maximising the volume and efficiency material flows to appropriate new reprocessing facilities, recyclers, (re)manufacturers and the repair & reuse sector. NB: In a New Zealand context, this might for example include the Auckland Council planned and funded *resource recovery network (RRN)* of local RRCs and online models of personal (i.e. *TradeMe and free-cycle*, etc) through to industrial material exchanges based out of the concept and practice of industrial ecology)(+7 NZ). Another related strategic consideration in support of localised zero waste materials processing models (aka R&D SITE) is ensuring that all transfer station and landfill facilities have sufficient storage space set aside to enable the management of *last resort* resource recovery and storage. A related consideration is possibility requiring landfill practices for facilitate *mono / store-filling* of might in future become economically recoverable / recyclable resources to enable future extraction, via landfill mining, as technologies improve to enable this(NZ).

7.10. Symbiotic, multi-stakeholder, multi-faceted, PPPP ownership / operational models:

In more developed socio-economic contexts zero waste governments appear to, see it as their role to invest heavily in both materials processing systems (i.e. recycling infrastructure, MRFs and OR operations i.e. AD and or composting sites) and the accompanying educational outreach, research and development (R&D) and market development (for example increasing the value, volume, safety and performance of compost in local farms and gardeners) designed to optimise their performance[+3 +2 SF]. However, whilst zero waste governments / local authorities recognises a leadership responsibility this investment model also values and makes space for balancing the roles of business and community expertise and experience via for example the symbiotic PPPP model, for ownership of infrastructure and or delivery of services (i.e. *Recology, San Francisco* and *VLACO, Flanders* (a NfP PPPP established by *OVAM*).

- In the case of *Recology,* San Francisco, the PPPP zero waste materials processing model, is a market-based commercial mechanism. This allows the government to meet diversion and technology goals, such as increasing the market value of diverted materials and exploring non-thermal MBT (with AD) for residual treatment by 2020[SF].
- In Flanders, Belgium, the collectively owned zero waste materials processing model includes: 1- *VLACO* (which involves inter-municipal waste associations, private compost producers and independent municipalities) encourages organic waste prevention, certifies, promotes and provides expert support for organic recycling (i.e. of vegetable, fruit, & garden (VFG) material) at all levels, via either composting, or anaerobic digestion[+2] and also, 2- the *OVAM* subsidised general recycling, via a networked system of *recycling parks*, 2nd hand shops (which function as a network of reuse and recycling centres) and a network of 337 drop-off centres, which handle 50% of the materials returned as part of PS/EPR programmes.
- In Hernani, Spain the city government involvement and leadership in zero waste materials processing, is outworked via membership of and participation in *San Marko mancomunidad* (a free collectivised association of municipalities) which has been established to jointly manage waste and recycling. Functionally the materials processing is outworked via: 1- a MRF for sorting light packaging (i.e. paper and cardboard, which is sold to a nearby recycling company) and 2- four drop-off centres (i.e. for people who miss the *door to door* recycling collection) which accept bulky PS/EPR class materials[+2] and 3- a regional compost plant, operated by the provincial consortium[+3].
- Similarly, in order to encourage organic recycling nationally, the national Taiwan government intervenes and leads by offering subsidies to local government for education, promotion, and composting facilities[T].

In a developing socio-economic context, zero waste materials processing model can be recognised as demonstrating common elements, such as: formalising and enhancing the informal sector, government supported localised infrastructure to enable materials handling / processing and alongside general recyclables, an emphasis on organic recycling (which is a large % of the waste stream in this context), via appropriate localised technologies. For example:

- In Alaminos, Philippines the zero waste materials processing model involves, small-scale local decentralised *eco-sheds* providing (zero) waste sorting facilities[+5] (NB: including hazardous waste[+2]) which are enabling and serviced via a collaborative model involving Barangay villages councils, the resident community and waste picker cooperatives so that they can recover more materials, under better conditions and sell them for higher market prices[+2 AL].
- Similarly, in Pune, India, where separation at source is cited as being only 30% effective, waste pickers are involved completing secondary sorting (i.e. pulling out recyclable material from the non-recyclables). This materials processing service is operated within a network of 19 recycling sheds, which alongside other *formalisation support and enhancement initiatives*, have been provided by the government / *Pune Municipal Corporation* (PMC), for example providing shelter from the weather[+2 P] for the women WP workers.
- In Mumbai another Indian context, where the emphasis is on organic recycling, the decentralised zero waste processing model, similarly involves networks of cooperative waste pickers *Parisar Vikas* operating localised on-site, general recyclables and organic material sorting and processing operations. For example, the *Nisargruna* (100 kg to 500 kg /day capacity) biogas plant / facility provides a quarter of the host operation's commercial canteen's energy needs. In addition this operations produces a high-quality manure (fertilizer) which can be sold back to households, or local businesses[8]. The zero waste processing model is locally and technologically appropriate and is financially and practically viable, because of the support from separation at source, integrated with follow-up waste picker cooperative based sorting to remove contamination[+4 M].
- Similarly in Buenos Aries, the zero waste material processing model is based around the combination of formalised and enabled waste picker cooperatives[BA] being located resource recovery and recycling facility (so-called 'green centres' where sorting, baling, and storing of materials for sale is managed) which are built on government land[+3 +7 BA].
- Similarly in La Pintana, Chile, the municipal authority has built a network of *green points* where the *not for profit* informal sector entities (supported by the *National Recyclers Movement of Chile MNRCH*) process glass, plastics, tetrapacks and

metal which is dropped-off by the public. However, in this context the main emphasis is on organic materials processing, as this is largest % of the municipal solid waste (MSW) stream (i.e. fruits, vegetables & yard clippings). Recycling this organic material saves financially, reduces GHG emissions, whilst producing valuable compost[+4]. Once collected the organic recyclables are transported a 7,500 m^2 treatment plant made up of 1- a 5,000 m^2 composting operation (which is able to process 18 - 20 t/dy veg waste / yard trimmings) and 2- a 2,000 m^2 of vermiculture area (which is made up of 136 worm beds at 15m long which are able to process 18 - 20 t/dy of veg waste).

7.11. The motivation, justification and outcomes of zero waste collections and material processing model are variously described as an opportunity…: *NB: In order of strength of confirmation.*

- For improved recycling service levels and outright system performance: Summarised as *universal recycling* which is high volume, easy, convenient, highly visible / accessible and cost effective for everyone to participate i.e. *everywhere* (including multi-family units (MFUs), *everything* (i.e. all general, organic and CDD materials and PS class material recycling etc), *all the time,* socially equitable recycling systems. This model is premised on being supported a integrated framework of regulatory interventions and market-base economic instruments and incentives (i.e. unit-based pricing – *pay and you throw* (PAYT), product stewardship / extended producer responsibility (PS/EPR) systems, backstopped by both a shift to biweekly, *no-sort no pick-up* waste collection and landfill and incineration bans[+13 +25 +3 AL, SF, P]. Zero waste collections and material processing models can also result in and be reinforced by, lower cost and improved residual waste management services for residents i.e. less immediate problems i.e. contamination, hazards, social nuisances (i.e. flies, smell, rodents etc), landfill fires, as well as legacy issues such as ongoing groundwater contamination from leachate, GHG gas emissions and actual leakage / washout from future flooding / sea level rise. There can be synergy and municipal benefits and savings in the transition from waste to zero waste models. For example, in La Pintana existing collection routes were rescheduled in a way which enabled diversion (40 t/dy = 20% of MSW) without increasing the number of trucks or overall system cost[+5 +2 LP, M].
- For realising synergy between educational outreach for zero waste / circular economy and awareness raising and change making around climate change and sustainable development: For example, recycling and composting stations at eco-events, are a great opportunity to showcase the community's zero waste goals / commitments and to educate a large number of residents in one place. By engaging creative thinking and citizen committees / volunteers a perceived issue, i.e. contamination, can actually become a meaningful opportunity[+3 +12 +5 H, LP] springboard for overcoming barriers to participation, education and monitoring.
- For capitalising on the direct link between zero waste / circular economy and the interrelated challenges of addressing climate change and sustainable development: In simple terms zero waste collections and material processing realises the opportunity to reduce: transport, water, energy use, GHG emissions, pollution, pressure on natural resources[+9 SF, M, Al], litter / fly-tipping / dumping and open burning[F], which reduces pressure for new disposal infrastructure i.e. incineration / W2E which are costly and controversial.
- For prioritisation as both a general investment principle, but also specifically in respect of organic recycling, which is often prioritised on basis of: return on investment (i.e. because of the positive link to addressing climate change), as the largest and most problematic portion of MSW (i.e. organic waste is cited as being up to 70% of MSW) and if not diverted from landfill contributes to toxic leachate, bad odours, and the generation of methane, which is both a GHG emission and increases the risk of fire. Whilst there can be challenges with organic recycling technologies[P], the outputs of this recycling process provides sustainable, natural, low-impact sources of organic matter and nutrients necessary for the Ag / Hort sector. Organic recycling works across the socio-economic development spectrum and at both, large commercial scales (i.e. *VALCO*[F] and *Recology*[SF]) and small-scale, backyard / *home composting* and village-level composting operations, with numerous interrelated social and practical benefits[+16 +3 NZ, SF, AL, H, M, F]. Municipal authorities can actively and successfully promote: 1- home composting (i.e. via composting classes, learning resources, face to face or phone expert advisory / support line and by providing free or discounted home composting bins[H, F] and or, 2- anaerobic digestion (i.e. small localised appropriate technologies systems, which are cited as having a small footprint, lack of odours and providing a direct use of biogas for heating in a localised loop[M].
- For realising progress around high level aspirations for environmental and socio-economic system change: Together communities can eliminate the concept of waste (aka progressively make zero waste a reality) and move forward into a new cultural paradigm for developing sustainable, prosperous communities. This transition can be engineered by prioritising the top of the (zero) waste hierarchy i.e. *reduction*, by developing sustainable consumption, empowering the *collaborative / sharing economy* and the long-term redesign of production, products, packaging and service systems

(PPPSS) and promoting *green procurement* of better, less wasteful products[+9 +5 +2 NZ], which overtime increasingly incorporate circularised recycle material content.

- For community development and localising resource circularity and the associated socio-economic benefits: i.e. committing to systematically diverting resources from (burn / bury) disposal pathways, provides a more certain and *level playing field* eco- investment climate, which promotes zero waste business start-ups and the opportunity for catalysing new green jobs within the local economy[+4 +5 +1 NZ, M, H]. *NB: in combination with all other public benefits, these outcomes are cited as, more than justifying government leadership, intervention and investment*[+5]. This intervention needs to be facilitated by a zero waste leadership agency, with roles such as, policy development, administering selected economic instruments to structurally reverse waste subsidies, coordinating programmes, assessing and managing application processes for support grants / funding / concessionary loans collectively designed to animate socio-economic transformation and R&D (i.e. for new products *designed for the environment* / via *environmentally sustainable design* (DfE/ESD)[+4 NZ] principles.
- For progressing poverty alleviation, equitable social development and the UNSDGs: Zero waste collections and material processing models are based on the inclusion of waste picker / informal recycling sector, the improvement of working conditions and livelihoods and by enabling the recovery of more materials, in better conditions, at higher sale prices[+7 +1 P, AL, M]. These models are workable in even very poor communities, because clear ambitious resource recovery goals are set and cost-effective innovation and appropriate technologies are used to improve the local environment and promote residents' participation[+2 LP].
- For governments' to demonstrate leadership of a comprehensive and successful zero waste strategy: This is cited as having a positive resonance with, for example, in work areas such as: public good / PPPP investment / subsidy models for infrastructure and service provision for waste prevention, separation and treatment, implementing waste levies, *pay as you throw* (PaYT) systems and other market based economic instruments and interventions (NB: reported as counteracting some of the negative impacts of privatisation, waste subsidies and the externalisation of environmental costs), construction, deconstruction and demolition (CDD) programmes, separation at source and recycling collection (i.e. *the fantastic 3 bin system*[SF]) and processing services, organic recycling systems, PS/EPR, environmental education, resource recovery / drop-off centres (RRC), reuse networks (including online virtual warehouse /exchange facilitates) and affirmative green procurement[+2 +4 SF, AI, F] recyclate market development programmes. The capsity which is developed through these kinds of leadership programmes are cited as having a positive impacts on other important sectors of the economy i.e. health, hospitality and tourism[AL].
- For driving the achievement of (zero) waste - minimisation / diversion goals / targets: which underwrites the rationale for public sector leadership intervention investment and the necessary transition to mandatory approaches[+6] i.e. re separation at source which makes for example the *eco-shed* programmes viable[AI].
- For economic efficiency and financial benefits: i.e. by reducing waste collection, contamination and disposal costs (lower volume, transport) and increasing recovery percentages, long term socio-economic savings and other interrelated environmental benefits, which collectively and accumulatively eventually *dwarf* the initial kick-start investment[+2 +1 +2 NZ].

8. Market Development / Guidance: Instruments / Interventions to Circularise the Economy.

A2b - Recyclate market dev - A2h - Green procurement - A2i - Backstop recyc min content - A2n Backstop product QA - A2a - WM to ZW (3R) contracts - A2j - ZW RoI tender contract guides - A5f - eco enviro labels - A2k - Stds accreditation - A5i- Enable pub good consumer advocacy

8.1. Redirect subsidies / incentives from waste disposal / resource destruction – to the opposite zero waste outcome:

It can be recognised that there are multiple layers and types of direct and indirect subsidies supporting the mutual dependencies of *making and managing waste* (R Crocker & Lehmann, 2012). Sometimes these subsidies are so entrenched, invisibilised and normalised, i.e. environmental externalities of the global plastic packing industry (Ellen MacArthur Foundation & World Economic Forum, 2016), that they are barely noticed, or contested amidst our presumed conceptions of *business as usual*. Developing mandatory economic instruments, which internalise previously ignored and externalised environmental costs into market prices and mandatory regulatory instruments, which redirect subsidies away from waste disposal / resource destruction is an essential strategy for supporting a zero waste alternative i.e. maximum resource recovery, recycling[+18] and a circular materials economy. Waste subsidies impose significant and accumulating financial and environmental costs on communities, which makes for a strong value proposition for both, reversing them (i.e. reducing immediate disposal cost, extending the life of existing landfill investment[+1], whilst increasing green jobs / investment etc) and replacing them with more efficient and effective regulatory interventions. For example, backstop bans of disposable single-use products[+1], mandating product stewardship / extended producer responsibility systems and standards of environmentally sustainable design, production, product and packaging standards and eco-labelling.

8.2. Reverse the impact of waste subsidies

Employing economic and regulatory interventions, instruments and incentives which reverse the impact of waste subsidies (aka redeploy these funding mechanisms to catalyse / promote a circular economy aiming for zero waste) is reported as linking to benefit clusters such as: cleaner / safer production and end of life recycling processes, improved worker occupational safety and health, enhanced resource efficiency and resource recovery rates, more financially sustainable recyclate markets, detoxifying material flows, establishing strategic design programmes targeting product durability, reuse[12]/ the sharing economy, disassembly, repair, recycling and packaging reduction and green procurement[+4 +16]. Programmes and institutions which focus research and development (R&D) and innovation seeking targeting the strategic objective of circularising materials flows and the goal of zero waste[+6 +6] have been shown to:

- maximise societal material resource efficiency and recovery, whilst minimising processing residues and waste[+1] and delivering high quality materials / recyclate, in sync with efforts to cultivate upcycling (i.e. the highest market price and best, most sustainable use) within localised domestic recycling (secondary resource) markets[+11 +19 NZ].
- Support the implementation of PS/EPR systems and the associated inherent product redesign policies and platforms, which reinforce the previously outlines outcomes (above) and sustainable products, produced in a scenario whereby, the cleanest most environmentally sustainable companies (i.e. which don't systemically eternalise environmental costs), rather than the dirtiest, are able to maintain the highest levels of profitability[+4 +13].
- help businesses and manufacturers transition from wasteful / linear, into cleaner and more sustainable models of production, products and packaging (i.e. unless able to be effectively reused, composted, or recycled – then redesign) and to synchronise with corresponding government led policies which grow the demand for and promote the uptake of green / sustainable products / procurement by all government (i.e. public sector contracts), industry and community, individual consumers[+10 +19]. The culmination of these measures is to *tilt the market* so that, for example *economies of scale* work to reduce the cost of sustainable products and increase the income associated with sustainable business practices, which ultimately benefit the entire community.

8.3. Zero waste an essential community service / public good:

Programmes and institutions which generate progress towards zero waste and a circular economy can and should be conceptualised as an *essential community service / public good* (i.e. which is opposite outcome of subsidies, which entrench wasting, polluting and climate impacting practices and industries). Because these concepts and imperatives are still so peripheral, contested and contrary to the mainstream ethos and practice of *business and usual* (BaU), these regimes require new rules and socio-economic frameworks. For example, zero waste identifies opportunity in *public, private, people, planet (PPPP) partnership* models to pioneer the investment and innovation pathways, which can deliver the new generation of community first, future focused zero waste visions, plans and goals[+4] which elevate public, to at least equivalence with private interest[+1] and require the latter to serve and support, rather than undermine the former. Echoing the findings reported in section 4.3.3 'Zero Waste Leadership – Agency and Laws / Regulation', zero waste anticipates the role of government as mediating the common good / welfare on behalf of the general public, via rule setting, which guide and then requires the collective behaviour necessary for the welfare of the *whole of society*[+3]. The so-called *inside-outside partnership and community table*, are cited as examples as zero waste structural mechanisms for achieving this[+4].

8.4. Pivoting away from business practices and consumer behaviours which cause harm and endanger human and environmental health:

Zero waste represents a pivot, away from behaviours and business practices which harm and endanger human and environmental health, into those that enhance community good and public benefit. Whilst this shift in paradigm and practice can be initialised and enhanced by voluntary efforts, such is the acuity of this issues, if these do not achieve the necessary goals and trajectory of change, then new regulation and mandatory approaches must kick in[+4]. At an immediate, pragmatic level zero waste is described as necessitating a change in the socio-economic rules of engagement (i.e. the wording and objective of municipal waste and recycling collection contracts) so that policies and incentives require and reward maximising the 3Rs over wasting[+3 +13 NZ]. For example, in San Francisco the contractual model, which has enabled the push to 90% diversion, involve *Recology* operating in a service contract with baseline revenue and the option achieving a of million dollar bonus for exceeding targets for waste diversion [SF].

8.5. Resetting the socio-economic *rules of engagement* to drive progress towards material circularity and zero waste:

At a higher policy level, such rule setting might include establishing:

- enforceable zero waste goals / targets and requiring these to monitored and progressed,
- market based economic and regulatory instruments and incentive schemes (i.e. such as PaYT, directives for source separation and bi-weekly separate collection systems and backstop bury-burn bans[+2],
- transitioning from voluntary to mandatory PS/EPR.
- recycling facility[+2 NZ] / recyclate quality assurance (QA) standards / permits[+6 NZ],
- transparent and authoritative *recyclability index* / eco-labelling with the aim of increasing and enhancing the financial sustainability of recycling markets[+2 +3 NZ] and or,
- legislated minimum *recycled content*,

There are several case study examples of *rule setting* where the intention is to grow recycling markets and influence zero waste – circular economy outcomes. For example:

- ✓ In New Zealand zero waste advocacy focussed on the creation of guidelines and standards for *green building* design and normalised construction, deconstruction and demolition (CDD) of the built environment[+12 NZ].
- ✓ The city of San Francisco passed a succession of regulations promoting robust recycling markets. This framework included: rules for green procurement where state agencies lead by example in purchasing minimum post-consumer recycled content. This measure is cited as being part of has catalysing increased cardboard, metal and e-waste market prices, which in addition to underwriting zero waste programme objectives, has supported the informal recycling sector. Similar rule-changes occurred in 2007, where the *Food Service Waste Reduction Ordinance* required restaurants to use compostable, or recyclable take-out containers and in 2012, all retail stores were required to provide compostable, recycled, or recyclable bags[+3 SF].
- ✓ The city Alaminos, Philippines has outlawed non source separated mixed waste collection, as well as all open burning and uncontrolled and semi-controlled dumpsites. Alaminos is also reported as considering banning *single use plastic bag* (SUPB), as part of a changed *framework of rules* designed to drive zero waste and a circular economy. In conjunction with this, the city invests ($600 USD / mth) in recycling market development, via by green procurement of plastic pavers (i.e. plastics shredded, mixed with concrete in a 40/60 ratio)[AI].
- ✓ Some examples of rule-setting may be as simple as Taiwan's Waste Disposal Act, which requires the public to take their recyclables, food waste and residual waste directly to the collection trucks, thereby ensure the cost efficiency of zero waste collections.
- ✓ The positive reinforcement between market development and rule setting is demonstrated in Hernani, Spain, whereby, because of collection efficiency and higher returns generated by the sale of quality assured recyclable materials, a door-to-door source separated 3R collection system, cost less than the prior mixed container system[H].
- ✓ Similarly in Buenos Aries, because legislation formalises the inclusion of the *Catoneros* waste pickers the city's waste management system, the informal sector enjoy a safer work environment and improved access to resalable materials[+2 BA]. The rule-setting within this jurisdiction promote both market development and zero waste, by requiring producers to separate organic materials suitable for recycling from the waste stream. This requirement is then supported by government designed and constructed *green centres,* which function as resource recovery facilities i.e. separating, collecting, sorting and selling recyclables (i.e. including: paper, cardboard, plastics, glass, Tetra Pak and plastic film)[+2]. In addition, the government provides the operational equipment and recycling systems to empower the services provided by waste picker cooperatives[BA].

8.6. Resetting and coordinating societal software with rules-based hardware:

However, given that zero waste is essentially about enabling democratic public good outcomes, it is recognised equally that, *hard* rule-based frameworks, must also be developed in synergy with social investment in *societal software* i.e. the deliberate and directional community education[+8] to support, for example sustainable / collaborative consumption / sharing economy / zero waste purchasing (i.e. durable not disposable) and the promotion of reuse - repair facilities etc[+11]. Zero waste education initiatives should also inform and enable collaborative industry development in support of zero waste and a circular economy, such as engaging with the manufacturing sector to both:

- highlight opportunities implicit the advent of green procurement guides / regulations[3], R&D loans / grants / tax incentives and zero waste business accreditation / label / branding initiatives[NZ] - and or,
- resolving potential issues around regulations for 'environmentally sustainable design / design for the environment' (ESD / DfE) (i.e. initiatives seeking to catalyse a new generation of / standards in green products)[+2 +1] as these relate to conventional ISO quality assurance programmes[+1 +6 NZ].

8.7. Multi-factor market development case studies include:

Flanders provides an example of how social software frameworks can be reprogrammed, so as to drive progress towards zero waste. In this jurisdiction, in an effort to support both municipalities and the general public, the government agency OVAM has: 1- developed a web-based app to support environmentally preferable green procurement (i.e. hence recyclate market development)[+2 +1] and 2- created ESD/ DfE design tools, i.e. *Ecolizer and MAMBO*[F], which respectively promote clean production / sustainable design and calculate and reduce waste and environmental impacts[+2 +2]. In conjunction with and in order to underwrite and enable investments in *social software*, the Belgian federal government has also established an associated *hard rules-based framework*, which for example involved:

- Establishing the *Waste Decree (1981),* which regulated a requirement for the development of regional waste plans (revised every 4-5 years) to set new waste reduction policies and targets for municipalities to implement with the government / OVAM's support. The required new waste plans: 1- set municipal targets (i.e. for reducing overall residential waste generation and increasing home composting, source separation and separate collection) and 2- regional goals (i.e. for mandatory extended producer responsibility, via a system of advanced disposal fees (ADF) and free drop-offs) and 3- offer investment in growing a networks of resource recovery parks (RRP),
- Mandating a standards-based framework based of environmental and social criteria for products entering the market and then potentially contributing to waste and pollution issues[+3 +4], i.e. the *VLACO* compost certification[+3], which distinguishes *good from bad* biodegradable packaging substitutes.
- Legislating the *Polluter Pays Principle* which promotes sustainable production and consumption patterns. In this scenario the *"aggressive"* framework of standards and incentives for both individuals and businesses, meant that over time, waste diversion goals were met and then exceeded, allowing more ambitious waste reduction goals to be set, which ultimately resulted in the *"highest diversion in Europe"*[+5].

In Mumbai recycling market development is supported by:

- NGO supported *Stree Mukti Sanghatana* (SMS) provided zero waste based vocational / industry / IFS training, including in marketing for individual workers and cooperatives and
- establishing new and recycling contracts and reforming existing 3R contracts between the collector (SMS or the cooperative) and customers, so that these basic signed letters of agreement (annually renewable) include site / service specifics and important details such as documenting worker ID, staffing levels, hours and minimum OSH standards. The redeveloped and enhanced contract frameworks enable on-site IFS *Bhaginis* to collect dry recyclables and or, to manage an operation for a set fee[+3] NB: this service provision involves dry waste collection (inc Tetra Pak), composting from institutional campuses & hospitals, housing apartments, also buildings and grounds cleaning, and operation of small-scale biogas plants[M].

8.8. Up / down-stream, hard / soft-ware, voluntary / mandatory, paradigm / practice, inspire / invest, dualities / polarities – systems integration and interactivity:

It is important to observe that, whilst *hard and soft frameworks* can be separately identified, it appears it is the *interactivity between these elements*, which is critical. For example, in Flanders OVAM signs agreements with municipalities to carry out obligations for waste prevention campaigns, the provision of technical / financial assistance to citizens to reduce waste and to sponsor specifically targeted campaigns for key groups and organisations i.e. schools, etc. These agreements often include subsidies to finance public education campaigns, as well as things like, home composting programs, promoting reusable nappies, and school water fountains, etc[F]. In simple zero waste it is not just about programme elements / parts of a methodology, or the *sum of the parts*, it is also about the positive synergy and interactivity of these elements and understanding how all of the parts of any given zero waste programme work together to derived and accelerate results.

8.9. People, policies / programmes, operational systems, technology / infrastructure integration and synergy:

The magnitude of change envisaged by zero waste involves respecting and maximising community engagement[+5 +1], i.e. the inclusion all social actors, especially the informal sector (IFS) and getting everybody to work together (aka *all hands on deck*) to remake the *linear throw away* system into a new a socio-cultural paradigm, which strives to eliminate the waste, build a circular material economy and sustainable prosperous communities[+12]. Whilst recycling is important and inextricable within the imperative of zero waste, this requires moving beyond just *100% recycling* (as a preliminary objective) and involves a bigger picture conception of redesigning the entire system of resource extraction and use. Whilst zero waste advocates for a rapid enabled transition into *universal (i.e. everywhere, everything) recycling*[+15] based around investing in six key infrastructures *(inc. MBRT)*[+7] (NB: ultimately this culminates in making the *zero option*, easier and cheaper than the *wasting option*[+5]) and automates the benefits of both *avoided issues / harms* (i.e. associated with of disposal, landfills / incineration) and the accruing benefits of redirecting investment from levies / financial savings, new green jobs, instrumenting a fast cost effective way to address climate change[+3] all of which positively reinforce the momentum for zero waste)[+11].

9. Keys to (Re)Design and Innovation.

A3f - fundamental DfE / ESD - A1h - Design - innovation continuum - A4a - detox + Haz waste treatment

9.1. Waste as a failure of socio-economic design:

Design failure lays at the root of waste issues[F]. When the overlapping and interrelated literatures of sustainably waste management, zero waste, circular (bio-) economy, zero emissions, industrial ecology / symbiosis and urban metabolism, etc, reference human impacts on ecology / ecosystems and natural resources / environments, climate change and sustainable development, etc, the failure of socio-economic design is a recurring theme. Conversely, a corresponding call for a (re)design revolution encompassing all aspects of the way human society exists and interacts with our life support system, the Earth biosphere, is a similarly reoccurring theme. Within this construct, the theory and practices of the zero waste and circular economy movements are cited as offering a (re)design *principle*, (re)creative ideal and continuum of aspiration[+14]. Derivative and analogous with for example zero defects / accidents / suicide programmes, zero waste argues for radically reforming the way all anthropogenic systems use resources (i.e. from materials extraction, refining and production, through to inception in product design, manufacturing, packaging, transport, marketing, thought to ownership, consumption, use, storage, (re)gifting / reuse, through to *end of life* discard, recycling or treatment / disposal), with the aim of enabling the public / community exercise of social / cultural / environmental interest and responsibility, to prevent resource / biodiversity depletion and ecosystem destruction and to conserve energy / water, mitigating climate change, detoxify material flows, with the aim of eliminating pollution, emissions and waste[+15].

9.2. Engineering an assertive practice and paradigm shift enabling circularity:

Given this context and the future / food / resource security implications of failing to redress the decline in the Earth's essential ecosystem services, zero waste has been analogised as a *peace movement* and as, necessitating a *wartime* imperative, directed at rehabilitating our currently failing, waste management human systems. All of the progressive movements responding to the issue of waste within the framing of sustainability (Glavic & Lukman, 2007), to a greater or lesser degree, recognise the need for a revolutionary level of shift in paradigm and practice. This manifests in, for example calls to re-engineer the normative operational environment for business, whereby the economy's framework of incentives encourage clean – circular, rather than dirty – liner companies enjoy sustainable profitability[+8] based upon fully internalised environmental cost accounting and ensuring resources are cycled back into either nature (i.e. the bioeconomy) or into the industrial system (i.e. as technical nutrients) as part of a circular economy model[+20].

9.3. Redesigning production, products, packaging and service systems (PPPSS):

Institutions of any size and level which are engaged in innovation and R&D and committed to zero waste can, across the '*whole supply chain'* (i.e. amongst corporations and businesses / manufacturing / industrial and importer / disturber / wholesale / retail) and engage in (re)design to support sustainable production, products and packaging in line with a matched expectation for government leadership and provision of support, guidance and a level playing field requirement. Alongside seeking to universalise and maximise the recovery and (re)cycling of all material resource flows within the human economy *(aka beyond 100%),* zero waste prioritises (re)design, *up-cycling* and implementing a progressive policy / rule-based requirement for:

- resource use (i.e. less, more efficient and understood / evaluated / managed, via lifecycle analysis LCA),
- eco-standards for production (i.e. transparent and authoritative quality assured / social, environmental and OSH responsibility which is monitored / reported)
- products / materials / packaging (i.e. better functionality, which includes dematerialised, detoxed, durable, renewable, bio-degradable and with recycled content),
- consumption and ownership (i.e. eco-labelled, green procurement, extended custody / ownership and stewardship / responsibility i.e. voluntary to mandatory PS/EPR, servicising, sharing / collaborative / reuse economy),
- end of life (repairable, banning single-use / disposability - *aka design for the dump,* product and material disposal bans in favour of mandatory disassembly and recycling)[(+42 NZ, SF, H, T, F)].

9.4. Intentional, directional and sustained systems (re)design and leadership:

The predictive future focussed zero waste (re)design[(+14)] intention is premised on government agency and leadership (i.e. Taiwan – EPA, Flanders - OVAM, SFE, etc) establishing an investment platform for: providing R&D and *green* / ESD / DfE grants, loans, tax incentives and for trialling new technologies, materials and processes and for providing institutional training and certification for zero waste / sustainability advisors focussed on enabling innovation for zero waste and a circular economy[(+4 F)]. The zero waste (re)design conception extends beyond just physical / technical domain of materials and products into the cognitive domain of systems, policies and programmes. For example, given *whole of lifecycle* approaches and PS/EPR systems are an essential platform within zero waste[(+13)] the initial and ongoing design of these programmes, involves continuous review, analysis and evolution. Systems design is observable in the zero waste aspiration for:

- cycles of authentic community consultation (issue resolution) and strategy formation / policy development, as well as in
- target setting (based on actualising the prevention and
- reduction of waste through changes in design, production, and consumption—and
- recovering all materials discarded in a safe and sustainable manner – all in parallel and equivalence with all other normal inclusions to the waste hierarchy) to drive programme innovation and to inform backstop regulation which shapes the necessary transition from voluntary to mandatory approach[(+6 SF, H, T, F)].

9.5. Detoxing future and current material flows / upstream – downstream systems (re)design

The toxicity and in practice, un-recyclability of elements of the residual waste fraction, evidences the failures of product production and socio-economic systems design and conversely highlights the opportunity and necessity for quantum innovation and R&D focusing on (re)design[(+4)]. A common rhetoric within the idiom of zero waste (re)design is that, if a product can't be reused, composted, or recycled, then it should not be produced[(+4)]. The Earth bio-system and the entire human population now evidence pervasive chemicals and microplastic emitted from the economic systems of production and disposal (i.e. *making and managing waste* – latterly mostly via landfill and incineration)[(+4)].

9.6. Changing the future - systems (re)design interventions for production – consumption and end of life responsibility:

Detoxing and circularising material flows in the economy requires investment in both pre-emptive upstream design, which predestines the *nature of future* material flows, as well as responsive downstream interventions, to capture and mitigate the *existing nature* of current material flows. As discussed in the previous section, OVAM in Flanders, has created a suite of upstream, systems design inventions, namely:

- the *ECOLIZER* design tool, which helps designers calculate and improve the environmental impact of their products,
- the *MAMBO* waste cost calculator,
- publishing a database of cleaner production / eco design case studies,
- organising *eco-design awards* for students and professionals, in order to encourage innovation in waste prevention[(+2 F)].

The design and development of for example, the Centre for Hard to Recycle Materials (CHaRM[SF]) / Eco-shed[(AI)] type infrastructure / programmes are profiled as essential downstream zero waste interventions which integrate with PS/EPR processes (aka the *special / hazardous* class of products[(+2)]) Premised on a necessary transition from voluntary to mandatory approaches[(+5)] priorities candidates for the assertive and complete PS / EPR systems envisages by zero waste are: WEEE, paint, and mercury-containing products, carpet, mattresses, textiles, books, plastic packaging, pharmaceuticals and batteries.

9.7. Anti-disposal conventions backstop systems (re)design and reinforce *upstream - downstream* interventions:

As is discussed in section 16R the zero waste ethos of systems (re)design is backstopped by the baselines of - NO to incineration and W2E (NB: in Taiwan incinerator ash is recognised as a serious environmental liability, with insufficient safe storage and end uses) – and YES to MBRT and minimal residual landfill. These zero waste backstop conventions represent a boundary limitation for the mutually reinforcing *up-stream and down-stream* interventions (re)designed to avoid / eliminate pollution / detoxify (eventually ban) contamination and non-reachable materials from existing and future production, products and packaging[+6, T, NZ].

9.8. Educating consumers - changing consumption and embracing circular systems:

Another essential and mutually reinforcing element of societal systems (re)design is consumer education to change consumption habits and social behaviours and normalise the conception of zero waste and a circular economy. Within zero waste it is recognised that the most cost effective holistic approach involves overarching government leadership, agency and investment in concert with and rationalisation and moderation of individual free market business, institutional and NGO efforts. The ideal progression for government funded zero waste / sustainable education outreach is to, initially promote recycling messages and participation in community consultation and management processes (i.e. such as the *inside-out / commercial stakeholder table*[+2], then more targeted efforts / special initiatives that aim for impacts higher up waste hierarchy i.e. addressing waste reduction, materials reuse, hard-to-recycle materials, *fix-it clinics / repair cafes*, supporting environmentally sustainable industrial design, purchasing policies, collaborative consumption, and underwriting community support for gernally transitioning from voluntary to mandatory approaches and compliance[+4] - all in the context of addressing climate and sustainable development.

Appendix 12: Waste Hierarchy Background / Discussion

A draft journal article – working title

New Zealand background, perspectives and outcomes related to the waste hierarchy:

The combination of establishing the Ministry for the Environment in 1986, passing the Resource Management Act in 1991 and the instigation of a national waste policy in 1992 are cited[137] as initialising the focus on solid waste reduction and environmentally safe disposal in New Zealand. In particular, the national waste policy 1992 is credited with identifying the 'waste hierarchy' as a key policy component and in this, reframing conventional theory and practice, via the inclusion of priority and assertion based on environmental perspectives (D. Morris, 1997). A further catalyst for pragmatic change in waste management in New Zealand, was the Local Government Act (Amendment #4 1996), which required local authorities to develop waste management plans that were consistent with the waste management hierarchy (Stone, 2002).

Although the concept of a 'waste hierarchy' can be considered a ubiquitous emblem of waste policy, neither the precursor working group findings (MfE & LGNZ, 2000), nor the actual New Zealand Waste Strategy (NZWS:2002), entitled 'Toward zero waste and a sustainable New Zealand' directly reference, or offer a graphic illustration of this theoretical model. Instead the NZWS:2002 provides graphics illustration of the aspired 'linear vs circular' transition (MfE, 2002, p. 16. figure 2). The NZWS:2002 does however, outline the following criteria for prioritising action: *'volume and harm, achievability, public concern, cost effectiveness'* and on the basis of this a number of targets were established, namely: 7- waste minimisation, 5- organic waste, 1- special wastes, 2- C&D waste, 3- contaminated sites, 3- hazardous waste, 2- organochlorines, 2- trade wastes, 5- waste disposal.

Subsequently, various review/reporting initiatives document the actual outcomes of this environmental incline in ethos and rhetoric within New Zealand documented waste strategy. The 'Decade of progress' report noted that, "New Zealand has made significant progress in waste management since the last OECD Environmental Performance Review in 1996" (MfE, 2007c). In a similar period, the 'Review of targets in the NZWS:2002' noted, "some important steps along the journey towards zero waste… waste minimisation and management practices are still widely variable… areas where more needs to be done… priorities for future waste work…" *(MfE, 2007a).* In 2006 the Parliamentary Commissioner for the Environment (PCE) published the *'Changing Behaviour: Economic Instruments and the Management of Waste'* report. This report provided a comprehensive analysis of the potential to utilise a spectrum of economic instruments (EI) to address waste management issues (Hannon, 2018). The report examined barriers to progress, articulated a set of specific concerns and called for *"renewed leadership from central government"* (PCE, 2006).

Whilst the PCE report was constructive and curated a broad grasp on postie international experience, it also contained several strands of blunt critique. For example, because the NZWS:2002 *"was cooperatively developed"* limited implementation was articulated as a failure of leadership, which "*undermines the whole process of democratic engagement with government"* (Hannon, 2018; PCE, 2006). The subsequent publication of a 'Environmental report card' examining trends between 2002 and 2008, appaers, in decribing New Zealand's perfomance as '*mixed'* and in rating the international comparison as a neutral 'non smiley face', to acknowledge this lapse (MfE, 2009).

In 2008, recognising the fact that New Zealand's waste problems warranted urgent legislative action, Parliament passed the Waste Minimisation Act (WMA:2008), thereby enacting a framework for implementing key economic instruments, as recommended by the PCE. A cabinet paper from that period[138], outlines the background, the package of proposed new measures and the rationale, expectation and optimism associated with the pending WMA:2008 legislation (Hannon, 2018). Notably, in respect of the guidance offered in the PCE's 2006 *'Changing*

[137] Source https://teara.govt.nz/en/sewage-water-and-waste/page-6
[138] listed on the MfE website see: http://www.mfe.govt.nz/more/cabinet-papers-and-related-material-search/cabinet-papers/pol-07-132-towards-sustainable-new

Behaviour' report, section (5) makes explicit, the expectation that the package of measures making up the WMA:2008 represent: "a *change of focus for waste minimisation activities – from the current, largely voluntary approach, to increased use of regulatory back-up and price-based mechanisms"* and an empowerment of central and local government in order to offer a *"stronger lead on waste minimisation"* (MfE, 2007b).

The 2008 the election resulted in a change from a centre-left, Labour led coalition (1999-2008), to a centre-right, National led coalition (2008 to 2017) government, which coincided with sharp swing in the prevailing political ideology and waste / environmental policy. This political shift manifest in a significant reset in waste policy, away from the prior political endorsement of the ethos of zero waste and sustainability, in favour of a more free-market, non-interventionist stance (Hannon, 2022 in submission).

The next National waste strategy developed in 2010 noted that, *"while the 'zero waste' vision of the 2002 strategy was ambitious, many of its targets were unable to be measured or achieved. The revised Strategy enables a more flexible approach to waste management and minimisation through two high level goals: reducing harm and improving efficiency*" (MfE, 2010). In the NZWS:2010 also did not refence a 'waste hierarchy' and instead the concept of priortisation was outworked by a risk equation: which calculated the risk of harm, whereby *"likelyhood x consequnece = risk of harm to the environemtn and human health"*.

In 2017 the political pendulum swung back in favour of variously formations of centre-left Labour led coalition government (2017 – ongoing). On-going progress reporting and briefing documents to then, incoming minsters provide a window into examining New Zealand performance in addressing the issue of waste. Despite the implementation of enabling legislation (WMA:2008) and significant investment from the associated 'Waste Minimisation Fund' (est. 2009), today New Zealand's KPIs for waste disposal, indicate regression, rather than progress (Hannon, 2022 in submission; Hannon & Zaman, 2018; Hannon et al., 2018). Despite $192 million of the investment generated from the national waste levy, specifically targeting waste reduction, the opposite has occurred, with waste deposited at levied disposal sites, increasing by a nett 20.1% in the three-year period between 2014-17. When last reported, the per capita waste generation rate of New Zealanders' was cited as one of the worst in the OECD (MfE, 2017a, 2017b).

New Zealand's most recent national waste policy rhetoric now reflects the concept of a circular economy[139] and appears cognisant of the big picture potential that (zero) waste management offers for reducing pollution, addressing climate change and progressing into more environmentally sustainable forms of development[140]. Taken as a whole, the emergence for these indicators suggest that New Zealand is now both addressing the past lapse in waste management performance, catching-up with international good practice, scientific guidance (PCE, 2006) and re-evaluating the role of aspirational social movements (i.e. for circular economy and or zero waste) in driving progress (Hannon, 2018). Today, there is evidence globally of commonality, integration and recognition of a *generalised* vision of zero waste (EC, 2014; UNEP et al., 2013; Zaman, 2015), as well as converging global acceptance around the responses required to address waste issues and engineer a transition to a circular economy (CIWM, 2014; Cobo et al., 2018).

Locally, reference to the concept of a 'waste hierarchy' is inconsistent. The 2009 'Waste Management and Minimisation Plan' (WMMP) illustrated and utilised a 6R waste hierarchy (PNCC, 2009). Despite being cited as retaining the strategic focus areas of the WMMP:2009, the next WMMP:2012 did not include any form of waste hierarchy. The WMMP:2012 was based upon much improved data, having been framed around information from first official 'Waste Assessment' (WA) (D. Wilson, Eve, Yates, & Middleton, 2012), which was a requirements of the Waste Minimisation Act 2008. A 6R waste hierarchy reappears in the next and most recent WWMP:2019 (PNCC, 2019; D. Wilson, Eve, & Middleton, 2018), with the source of this graphic cited as being the New Zealand Ministry for the Environment www.mfe.govt.nz However, today using the the search term 'waste hierarchy' in the https://environment.govt.nz website yields 'zero results'. Both zero

[139] ref: https://www.mfe.govt.nz/waste/circular-economy
[140] ref: https://www.mfe.govt.nz/climate-change/zero-carbon-amendment-act

International background, perspectives and outcomes related to the waste hierarchy:

The earliest known application of the 'waste management hierarchy' is cited as being Ontario's Pollution Probe in the early 1970s. This hierarchy originated as the 'three Rs' — reduce, reuse, recycle — but latterly a fourth R – recovery, is frequently added (Hoornweg et al., 2012). Within the context of reviewing solid waste management globally, the World Bank reporting is that sector generally accepts the waste hierarchy and responding to financial, environmental, social and management considerations and as encouraging the minimisation /mitigation of GHG emissions (Hoornweg et al., 2012).

The waste hierarchy was first introduced in 1977 as part of the EU's Second Environment Action Programme (CEC 1977) and is subsequently identified as having been a key driver of progress in Europe's move away from disposal, towards the more sustainable options of reduction, reuse, recycling and energy recovery (D. C. Wilson, 2007). The waste hierarchy in combination with climate change is identified in the form of the EU Landfill Directive (CEC 1999) can be being driver assertion and, compulsion and enforcement of required progress in that it requires 'all member states to reduce the levels of biodegradable municipal waste landfilled, to 35% of the 1995 levels by 2020' (D. C. Wilson, 2007). A reciprocal benefit of these inclusions in firstly the precursor policy documents (EC, 1975) and then the full European Waste Framework Directive (WFD) (EC, 2008) was that the waste hierarchy has become a more globally prominent and accepted mechanism for ranking policy and programme options (Ekvall et al., 2013; Göran Finnveden et al., 2013).

Waste hierarchies are descrtibed as being used 'generally' to develop 'Integrated solid waste management' (ISWM) plans (G. D. Meyers, McLeod, & Anbarci, 2006) ISWM is described as involving the selection and application of appropriate techniques, technology and management programmes to achieve specific waste management objectives and goals (WA, 2001). A typical waste management hierarchy is said to be comprised in the following order: (i) reduce; (ii) reuse; (iii) recycle; (iv) recover waste by physical, biological or chemical processes; and (v) landfilling, incineration or other disposal method" (G. D. Meyers et al., 2006; WA, 2001).

In reflecting on the background impetus across EU OECD and developing countries (inc. China) for establishing the waste hierarchy, (Giusti, 2009) correlates national/federal governments responding to elevated public concern following a number of serious and highly publicised pollution incidents associated with hazardous and unsustainable waste management practices. The resulting new and improved legislative/regulatory frameworks included the waste hierarchy as normative of sound environmental criterion, aka favoring waste prevention/minimisation, re-use, recycling, and composting, ahead of all forms of disposal. seeking to control environmental and human health impact. Another interesting reflection on the impetus behind the formation of the waste hierarchy arises in an historical overview of the global development waste management (D. C. Wilson, 2007). Wilson observes that the waste hierarchy is actually a recognition of 'resource value' as an ancient and pre-existing driver of recycling moving from its scavenger / waste picker origins into today's global industry (2007; D. C. Wilson, Velis, & Cheeseman, 2006). The articulation and entrenchment of the waste hierarchy as policy mechanism, can in now be recognised as the catalyst for moving beyond the limited 'end of pipe' historical conception of managing 'waste', towards the more integrated concept of managing 'resources' (D. C. Wilson, 2007).

A recent statement in ISWA UNEP Globlal Waste Management Outlook report illistrates comtemtrprary global thinking around the waste hierarcy. The GWMO notes that, whilst LCA can be useful in detirmining preferred amoungst available management options for a specific type of waste, the waste hierarchy coninues to provide a simple and often referred to generalised 'rule of thumb' in prioritising waste management options and technical approaches. The prevailing wate policy imperative of tranistioning from lower to higher level of the waste hieararchy is, at least notionally, if not in practice, widely accpeted. The authors of the GWMO observe that a waste hierarchy can be, and as has been illustrated has been, articulated in many different formats and beyond generalised notions, the specifc conetent and orders priority remain "hotly debated". (D. C. Wilson, Rodic, et al., 2015a).

In other spheres of activity seeking to strategically influence global economic development the waste hierachy concept is variously referenced/influential. For example, the OECD programme advocating for 'Environmentally Sound Management' (ESM) of materials/waste, is communicated as being underwritten by and interrelated with the Waste Framework Directive (1975) and the Hazardous Waste Directive (1991) principles of environmental protection and the waste hierarchy, etc (OECD, 2007). However, in respect of this acknowledgment the OECD's position statement notes, it is unlikely that any single policy mechanism will be appropriate in all circumstances and therefore, a multi-pronged approach, applying a diversity of policies and policy instruments, is more likely to influence all relevant players than a *'one-size-fits-all'* approach. Accordingly, the OECD articulates a 'systems view' in terms pf policy frameworks seeking sustainable material management (SMM), which envisions flexibly weaving diverse policy mechanisms into combinations that reinforce each other can help to generate more effective, efficient and lasting outcomes (OECD, 2007; 2012b, p. 14. figure 4; 2016). *= integration same applies to shift from hierarchy to infinity continuum*

The U.S. EPA Sustainable Materials Management Program - Strategic Plan notes that EPA's waste hierarchy continues to provide guidance, highlighting source reduction/waste prevention & reuse over recycling and composting, energy recovery, and treatment & disposal (USEPA, 2013, 2015) key focus areas "Action Area 2: Promote opportunities across the entire food life cycle to reduce wasted food from landfills, with a preference for those approaches higher up on EPA's food recovery hierarchy..

The process whereby conventional waste management theorem becomes cognisant of and is re-orientated and re-languaged toward the future focussed lexicon of the circular economy movement (Cobo et al., 2018; Hannon, 2020), appears to embed rather than undermine the principles annotated in the waste hierarchy. Interestingly this work reflects the apparent resolution of semantic / definitional boundary issues highlighted by other researchers (Gharfalkar, Richard Court, Campbell, Ali, & Hillier, 2015; Van Ewijk & Stegemann, 2016). For example Cobo et al define waste prevention as being at the *"top of the waste management hierarchy, as a strategy to be implemented in the life cycle stage prior to waste generation that seeks to minimise the depletion of natural resources and its subsequent environmental burdens"* (Cobo et al., 2018).

If the analogy, overlap and potential synergy between this and other *'brands'* on dynamic spectrum of sustainability movements/disciplines[141] (i.e. ZW, ZE, CE, IES, UM, BE and CIWMs etc.) is recognised then this further bodes well for the future of the waste hierarchy. As all in this genre of activity are focussed on deriving new and transformational ways of addressing the issues and opportunity associated with waste. All such movement be conceptualised as part of a *change-making* transitional spectrum, which can be abbreviated/annotated via the encompassing extremities of: *waste* → *zero* waste, aka (zero) waste management (Hannon, 2020) and most simple understood and racing towards the top of the waste hierarchy.

Zero waste and the (zero) waste hierarchy:

Unsurprisingly, in outright zero waste framed policy discourse/guidance the waste and or zero waste versions of the hierarchy, are a pervasive feature - to the point of it not being pragmatic to cite beyond an indicative selection (Chandavarkar & UNDESA/UNEP, 2010; EC, 2014; Eunomia & Resource Media, 2018; Hogg & Ballinger, 2015; Hogg & Durrant, 2017; S. Kathiravale & Yunus, 2008; MED-Zero Waste, 2013b, 2013c; J. Morris et al., 2012; Thanawala & Seidel-Wassenaar, 2013; Zero Waste Europe, 2013, 2017; Zero Waste Europe & FPRCR, 2015) and LCA studies framed in this perspective endorse zero waste's focus on the upper echelons of the hierarchy (SRMG Inc, 2009). Strictly academic review articles undertake rigorous examination of the role and utility of the waste hierarchy (Favoino, 2020; Hestin et al., 2010; Kopacek & Schadlbauer, 2013; Pietzsch et al., 2017; Song et al.,

141 The emerging cluster of sustainable waste (aka resource) management movements, include several overlapping intellectual disciplines and associated spheres of theory and practice, which can all be variously interpreted responding to waste, as both an acute global environmental crisis (Mavropoulos, A.; Newman, D., 2017) and physical emblem of broad systemic failure (Popson, C.P., 2002). The milieu of respondents includes: zero waste (ZW), zero emissions (ZE), circular economy (CE), industrial ecology / symbiosis (IES), urban metabolism (UM) and bioeconomy (BE), which all identify in the commonality of seeking to actualise the ecosystem metaphor of infinite-perpetual resource life-cycles and naturalistic design principles (multiple citations + Hannon, 2020).

2014; I. D. Williams, 2013; Zaman, 2015). How that said, as with some keynote waste policy discourse there are some high profile guidance discussion documents which largely overlook the (zero)waste hierarchy (IPLA, 2011a, 2011b, 2012, 2013a, 2013b).

NB: Although none of three authoritative zero waste sources selected and utilised in this MMR – HCA – T-MZWM quant + QUAL(quant) visible presented an actual graphic illustration of a zero waste hierarchy as a preconceived pre-adhered policy-priority model. There however is an imbued assumption of the concept of prioritisation and a hierarchy of preference and numerous graphic arrangements of steps, phases, clusters, touchstones and sequences of actions in moving towards zero waste and shifting from linearity to circularity.

In the same way that a rhetoric – reality disconnect and be discerned in respect of the waste hierarchy at the national / New Zealand context the same appears true of the global context. Despite billions of dollars having been invested over +40 years to actualise the priorities expressed in the waste hierarchy, genuinely transformational change, remains elusive (Hannon, 2020; Hannon & Zaman, 2018). A systemic socio-economic design failure appears currently so entrenched in our *anthropogenic DNA* (Ellen MacArthur Foundation, 2013b). The result is that most material resources flowing through the global economy are preordained for disposal (Bartl, 2014b) and the issues associated with this waste, are described as a globalised public and environmental health emergency, necessitating an urgent, internationally coordinated, comprehensive, and effective response (Hannon & Zaman, 2018; Mavropoulos et al., 2017; Mavropoulos et al., 2015; D. C. Wilson, Rodic, et al., 2015a).

In summary, international waste data indicates that, after over four decades of significantly investing in the widely accepted principles of the ‘waste hierarchy, there are still significant barriers in realising the stated: top (reduce), middle (recycle), or even lowest (residual disposal) priorities. Whilst conventional waste management theory, distilled into the near universal rubric of the waste hierarchy, clarifies our priorities and can be seen as having catalysed a measure of progress, overall we are yet to globally actualise this principle and appear to be entangled/trapped’ in limitations of this paradigm (Bartl, 2014a; Hannon & Zaman, 2018; Pietzsch et al., 2017; Pollans, 2017; Van Ewijk & Stegemann, 2016).

The relationship between LCA and the waste hierarchy as mechanisms for prioritising policy:

Whilst the waste hierarchy fully provides a *“rough generalisation”* (Eriksson, Strid, & Hansson, 2015, p. 115) in ranking landfill as the least environment friendly alternative - hence all options to minimise this outcome are prioritised variously above this (EC, 2008; Laurent et al., 2014), life cycle assessment LCA must also be recognised as a critical opportunity for designing and directing effective waste policy options. Policy-makers are encouraged to consider that LCA studies, might support alternative ‘context-specific waste hierarchies’ (i.e. priorities that are adapted to local conditions, including consideration of site-specific waste composition, treatment efficiencies, local energy mix, etc) which may not be identical to the generic waste hierarchy (Laurent et al., 2014).

On the basis of a large number relevant/indicative LCAs, Ekvall et al report that, waste hierarchy is a “valid, as a rule of thumb”, for the environmental ranking of waste management options (Ekvall et al., 2013, p. 2; Ekvall, Assefa, Bjorklund, Eriksson, & Finnveden, 2007). The development of more sustainable waste management systems requires both, policy instruments which give effect to the top priorities of the waste hierarchy and which encompass the systematic complexity of (zero) waste management (Göran Finnveden et al., 2013).

There are currently only a few general policy instruments that support waste prevention and increased re-use and recycling, in order to promote the higher levels of the waste hierarchy. One example is the extended producer responsibility, but it includes only a limited number of waste fractions and it does not require any recycling above the target level. To comply with the waste hierarchy there is thus a need for new policy instruments. It can also be noted that waste prevention aims not only at reducing the amounts of waste, but also at reducing the hazardousness of the waste and the environmental impacts from treatment of the waste, which suggests that policy instruments, focusing on waste prevention, should not only address waste reduction. This implies, for instance, that policy instruments in the chemicals field may have important positive impacts in this regard (Göran Finnveden et al., 2013).

Generalised waste hierarchy principles can be used in combination with specific LCA or the generalised results from meta-analyses to adequately consider/quantify the environmental benefits of waste prevention options (Laurent et al., 2014). The relative strengths are that in less complex scenarios former may sufficient and save decision-makers the cost of commissioning data-heavy, time-consuming LCAs. Relying on the 4 ''R'' – reduce, reuse, recycle, and recover, in the decreasing priority order – is cited as often 'generally accepted' (Hoornweg et al., 2012) and equally that in some situations deviations form this principle should be considered on the basis of proper justifications via life cycle thinking (EC, 2008, 2018).

Material types / sector variations on the theme of the waste hierarchy:

Unsurprisingly given recognition of the rhetoric – reality gap in implementation and generating the outcomes targeted by the waste hierarchy. One of the key sphere where the waste hierarchy concept is being re-envisioned adapted and revitalised to be fit for purpose is in the sphere of organic waste/resource minimisation/management. When referenced against contemporary life cycle assessment (LCA) examining GHG emission/climate impacts, recent studies confirm the generic utility (albeit approximate) of waste hierarchy as a tool for prioritising management options for various organic waste material types (Eriksson et al., 2015).

Ref. Contested view European Waste Framework directive (WFD) obliges member states to encourage options that deliver the best overall environmental outcome from a life cycle perspective, even when this differs from the waste hierarchy. However, this creates debate as whilst for example addressing the GHG emission/climate impacts is a critical overall environmental impact/outcome factor, is it appropriate to just targets ahead of all others (Eriksson et al., 2015)

+ *Watkins 2013 ed review of WRF 2008 Newthinking is probably needed from both regulatory authorities and industry covering further development of EoW legislation, with special emphasis on more product-based and innovative approaches, as well as consideration of the* practical implementation of the waste hierarchy. *Ref. Distinguished imp from theorising*

Accepted variations might be introduced because of local context/conditions (i.e. waste composition or energy system) (Laurent et al., 2014) in developing countries factors such human health impacts from direct exposure to hazardous substances and pathogens (for workers, waste pickers and surrounding population) and indirect exposure via ingestion of contaminated water and food (Hoornweg et al., 2012) *(see Giusti, 2009).*

However increasingly and on numerous basis the simplistic rubric of the waste hierarchy is questioned (Laurent et al., 2014; Van Ewijk & Stegemann, 2016)

Ref. Focusing on organic waste

But because this model is general for all waste types more specific organic waste version and tailored instructions have been developed. For example Laurent cites, Dutch – 'Moerman ladder[142]' , US - 'Food recovery hierarchy' and the UK –'Food waste pyramid'

In examining food waste in an Australian perspective establishing an "appropriate waste hierarchy" was deemed "critical" in prioritising "actions and opportunities" several international examples were reviewed, but no "existing model of food waste hierarchy was identified" (Lewis et al., 2017)

Issues / opportunities with the concept and application of a waste hierarchy:

(Van Ewijk & Stegemann, 2016) observes that, despite prevention/reduction being attributed as the top priority of the waste hierarchy, neither the actual application of the waste hierarchy, nor the efficacy of notional priorities

[142] Source https://blog.mauritskorse.nl/en/2016/01/waste-hierarchy-explained/

are a given, in respect of the objective of dematerialising the economy. Analysing the original aims, the propensity for fulfilling those aims, and actual he uptake and implementation in policy/practice of the waste hierarchy concept identified key issues as: limited specification and implementation of the top priority (prevention/reduction), omissions in level choice guidance, and remiss in definition (for example open-loop vs closed-loop recycling) and consideration of inter priority relativities and unintended inter-sectorial impacts/consequences (Van Ewijk & Stegemann, 2016). The research findings challenge the current formation of the waste hierarchy as insufficient basis for either policy or action necessary to achieve absolute dematerialisation (i.e. economic throughput waste/resources). Consequently the authors call for a valorised conception waste and accordingly more international 'resource' collection/recovery systems and the adoption, achievement, monitor and enforced compliance of diversion targets from the least to most preferred levels of the hierarchy of resource material productivity/flow options (Van Ewijk & Stegemann, 2016).

An example of where the waste hierarchy concept potentially causes inter-sectorial issues, is in decision making related to biomass which overlaps both waste and renewable energy policy spheres. In this instance lifecycle analysis indicates that wood recycling and waste to-energy have essentially equivalent environmental attributes, in which case any pejorative political intervention in favour of the former (as might be considered under early iterations/interpretations of the WRF:2008) should be fundamentally questioned (Knauf, 2015).

Despite documented guidance and support by the DG Environment, DEFRA and WRAP UK, around key provisions of the WFD2008, including the 'waste hierarchy' confusion persisted around semantics/terminology, pragmatic interpretation,, boundary definitions and rationale (Gharfalkar et al., 2015). In an effort to support resource conservation, environmental protection and material use efficiency, an alternative 'resource use' hierarchy and associated gap-filling/clarifying 'definitions' (i.e. re waste prevention, reduction and recovery) were proposed to rectify perceived issues in the interpretation of WFD2008 in respect of actioning the waste hierarchy (Gharfalkar et al., 2016; Gharfalkar et al., 2015).

Ref. Legality In urging simplicity and effiacy in waste policy (Tromans, 2001) cites the guiding hierarchy of objectives as being that: waste should be minimised, that which cannot be avoided should be benefically used either by reuse, recycing of by converson into energy. Residues that cannot be treated in this way should be disposed of with minimal harm observing the precautionary priciuple. Whislt these priciples are simple they have give rise to EC law which is 'notoiously difficult' 'infuiating complexity' 'leads to obfuscation natioanl inconsiency and in practice a lack of progress'

Ref. Problem ZW perspective leack of enforability "The waste hierarchy and government guidance presume that recycling should take precedence over incineration. However, there is currently no credible set of mechanisms or incentives to ensure that this will always be the case. The trouble is that although policymakers insist that the hierarchy remains as environmentalists would want it, with prevention, reuse and recycling sitting above energy from waste, they have no means to ensure that this is how local authorities necessarily respond to their obligations to divert more and more waste from landfill. (J. Hill et al., 2006)

Ref. Notionality In observing that the 'waste management hierarchy', is a widely accepted model for deliberating between waste management options and that, this prioritises to waste minimisation (Pongrácz & Pohjola, 2004) identify and question the direct conflict of interest between two interpretations of the role of waste management, i.e. 'getting rid of existing waste' vs the ideal of waste hierarchy to in the first instance avoid waste generation.

Ref. Conflict --- The attitude of public authorities and formal waste management sector to informal recycling is often very negative regarding it as backward, unhygienic and generally incompatible with modern waste management systems. On the other hand it has been noted [25] that it would be ironic to eliminate already existing and well performing recycling systems trying to apply the waste hierarchy framework..... While there is no certain way for a successful waste management approach, there are things that must be avoided and they are presented in a Failure Receipt (Mavropoulos, 2010a, accessed 2014) *ref. Megacity*

Ref. Developing country context: “Current environmental policy is generally founded on the principles of the ‘waste management hierarchy’. The hierarchy is represented in many different ways; however, the general principle is to move waste management ‘up the hierarchy’, towards reduce, reuse, recycle (the ‘3Rs’) nearer the ‘top’, diverting waste away from disposal, which is situated at the ‘bottom’. The version of the hierarchy in Figure 4.2 emphasises that a necessary first step is to get on the hierarchy in the first place by phasing out uncontrolled disposal in the form of open dumping” (UN-Habitat, 2010).

Ref. Alternatives Hierarchy concept is analogous to the ‘landfill step ladder’ “Over the last 30 to 40 years, development of environmental controls over waste disposal has come to be seen as a series of stepwise progressions in controlling disposal i.e. improving from the low baseline of ‘open dumps’, progressive via: *“better operational control, containment, detailed engineering standards and minimising / pre-treating wastes”* (UN-Habitat, 2010, p. 109. figure 4.3; D. C. Wilson, 1993).

A globalised ‘glance at world’ of waste reports that the lack of definite regulation/guideline re the MSWM hierarchy is one of the factors limiting the effective MSW management in Nigeria (Cerminaram, 2014)

Ref. Barriers to ZW

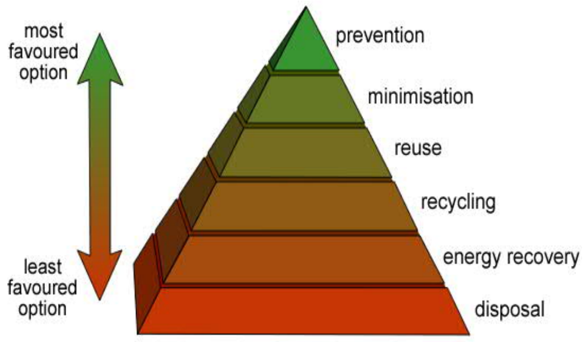
Re the advent of ‘lifeafterwaste’ and NZWS:2002 in the NZ context key concerns unitary (or “one-size-fits-all”) programme/change model and the conflicted relationship between key stakeholders i.e. government, business, consumers and non-governmental organisations which are likely to have incompatible missions “existing forces and strategies that are acting to maintain the status quo”. (Stone, 2002)

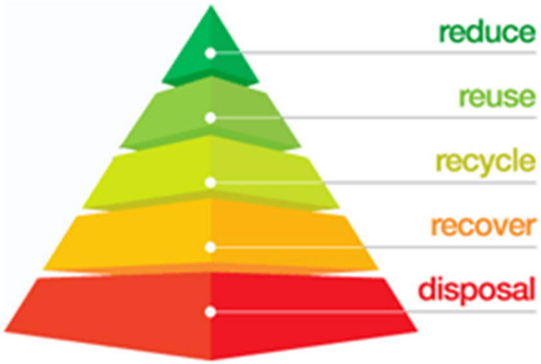
Barrier 1 – Government Subsidies Favor Extraction and Waste Barrier 2 – The High Cost of Waste is Hidden Barrier 3 – Producers Ignore Responsibility for Products’ Environmental Costs Barrier 4 – Inertia of Existing Viewpoints and Practices *Ref. GRRN*

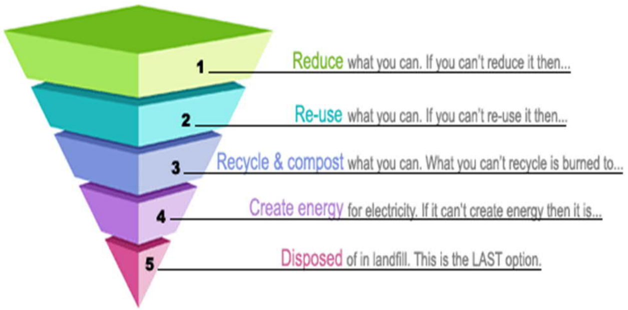
In examining international perspectives, it appears there is a degree of inconsistency in understanding, acceptance and promotion of the waste hierarchy concept. For example, the ‘top priority’ of the waste hierarchy i.e. reducing waste generation, is the obvious focus of research examining the concept of ‘peak waste’ (NB: which may not, at current socio-economic settings, be until 2100). However, the term ‘waste hierarchy’ does not rate a single mention in the associated article, despite being the key globally accepted conceptual model for prioritising reduction as distinct from disposal (Hoornweg et al., 2014). Similarly, neither a focused review of the evolution of waste management in the US context, nor a ‘world’ review of MSW generation, composition and management scenarios, utilise the term ‘waste hierarchy’ (Karak et al., 2012; Kollikkathara et al., 2009). Other authoritative indicators of future focus and trends in mainstream waste management thinking also omit to reference the waste hierarchy (Agamuthu, 2017; ISWA, 2017a). Such omissions, relative to stark findings of the consequence of apparently being yet unable actualise reduction as an essential global imperative, raise interesting questions around cognitive blind spot in waste discourse, around acknowledging the acute threat that the waste hierarchy represents in crystallising a visual appreciation of the stark and unresolvable conflicts which exist between environmental ethos/aspiration and the vested interest of those who profit from making and managing waste.

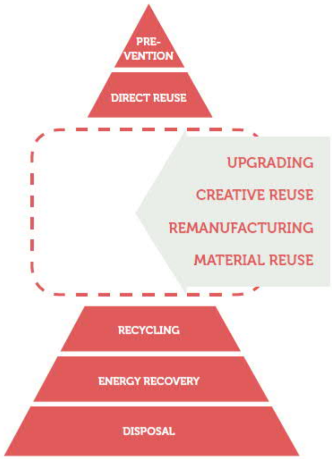
Recent studies confirm the environmental benefits from focusing on the upper parts of the waste hierarchy (Ekvall et al., 2013)

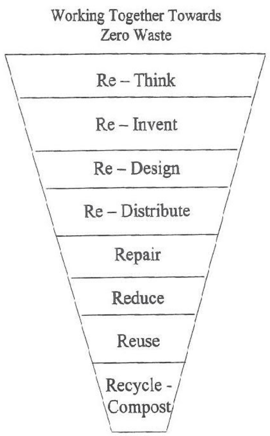
Appendix 1:



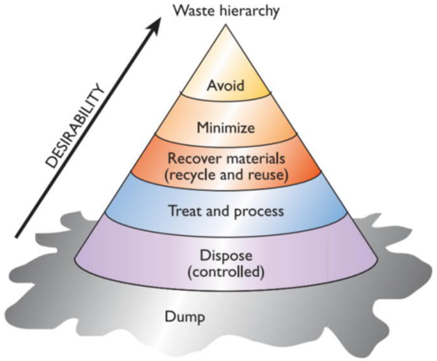


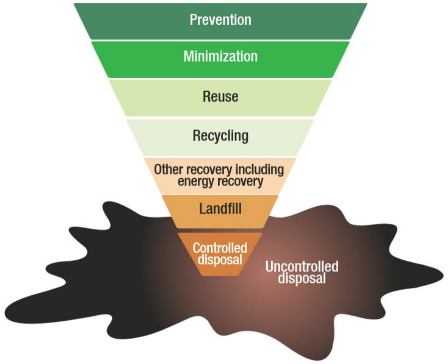


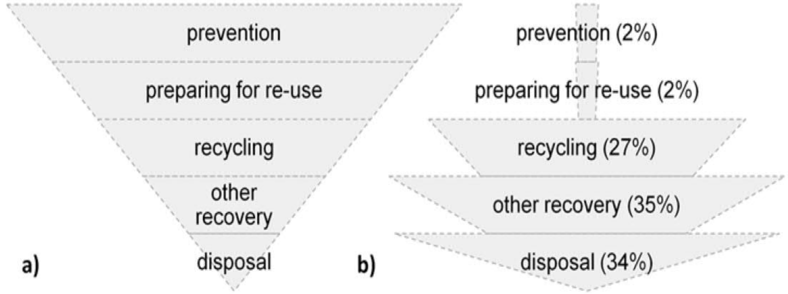




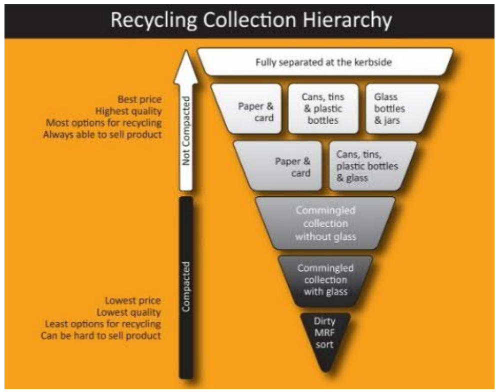
Top row: left to right- Wikipedia https://en.wikipedia.org/wiki/Waste_hierarchy#/media/File:Waste_hierarchy.svg + source: https://isustainrecycling.com/alternative-energy-solutions/waste-hierarchy/ Bottom row: left to right- Unknown + 'working tother towards zero waste' Unknown sources + ZWIA https://zwia.org/2013/06/zero-waste-international-alliance-adopts-zero-waste-hierarchy/ + Zero Waste Europe https://zerowasteeurope.eu/2019/05/a-zero-waste-hierarchy-for-europe/

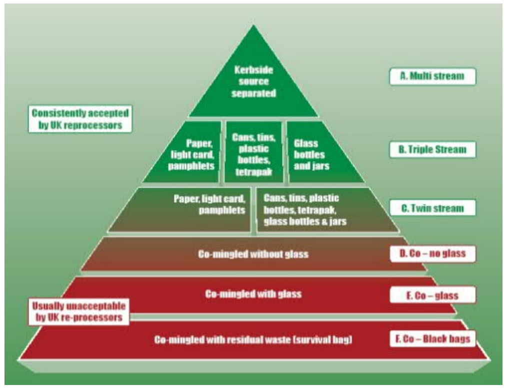


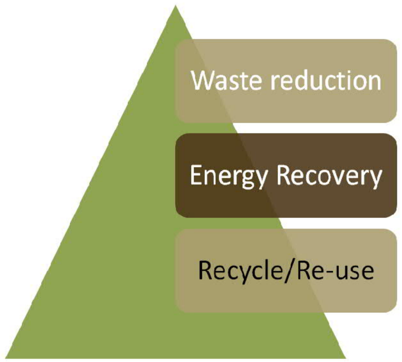


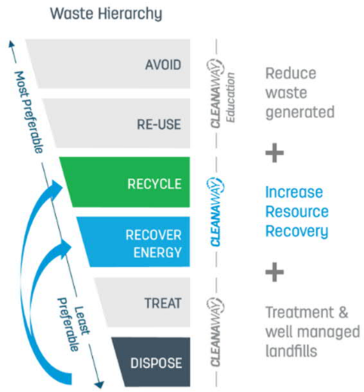


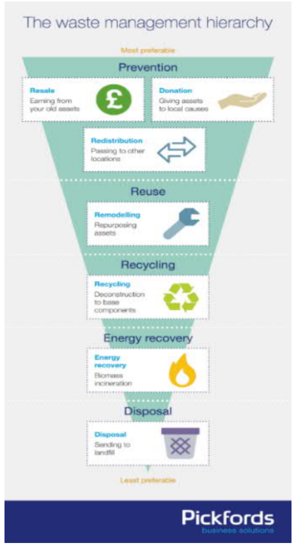
Top row left to right - 'Waste management hierarchy' (UN-Habitat, 2010, p. 105. figure 4.2; D. C. Wilson, Whiteman, & Tormin, 2001) + A later version of the hierarchy prepared for the GWMO with a sequence of steps is based on that agreed by the parties to the Basel Convention (D. C. Wilson, Rodic, et al., 2015a, p. 31. figure 2.4) NB: he applicability of this waste hierarchy has been questioned in a world where resource recovery involves global value chains, as it refers only to environmental aspects and not to public or occupational health, financial or other considerations such as materials criticality. Some current research efforts aim to supplement or replace it with more sophisticated tools. + (a) Waste hierarchy of solid waste management (Directive 2008/98/EC) and (b) Objects of investigation of the reviewed studies according to the EU waste hierarchy. (Allesch & Brunner, 2014, p. 446. figure 6 a&b) The allocation of the reviewed studies to the five steps of the EU waste hierarchy (without considering the categories of waste management system and waste collection) shows that waste prevention is not ranked among the top issues by the waste management assessment community (see Figure 6(b)). In only 4% of the reviewed studies, the main object of the investigations was waste prevention or re-use; however, approximately 25% assessed waste recycling systems.

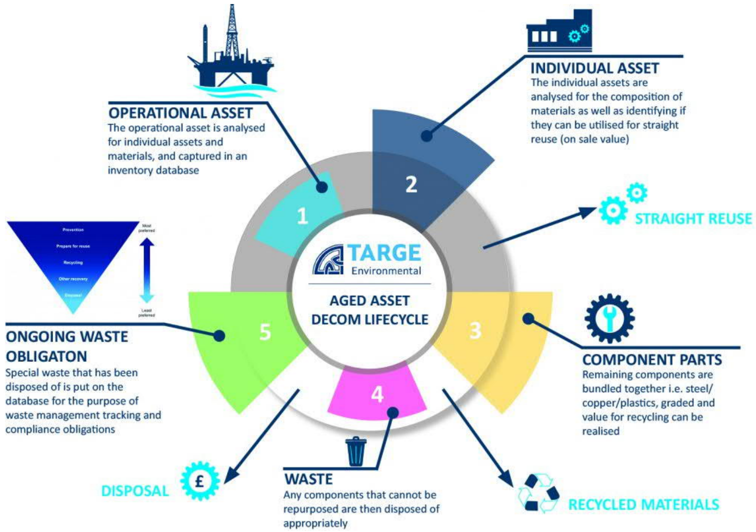




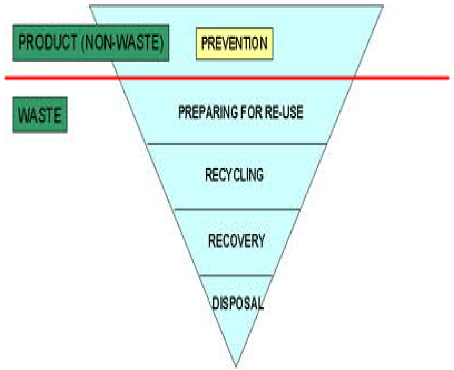


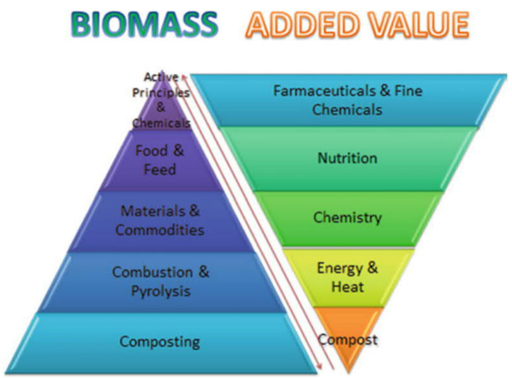


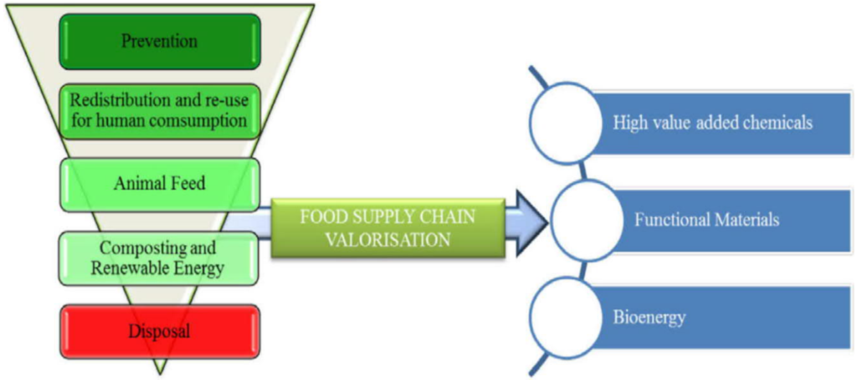


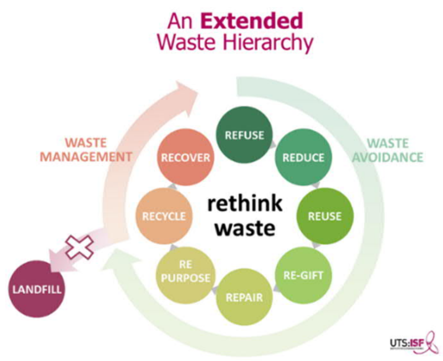


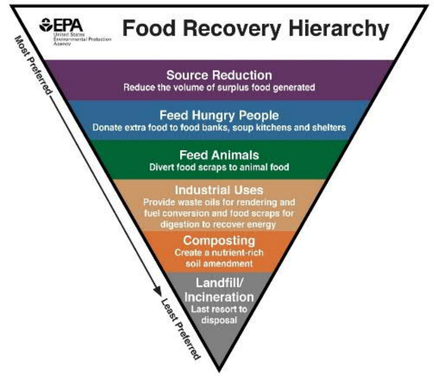
Top row: left to right- Two variations on the 'Real recycling' hierarchy see: https://zerowaste.co.nz/campaign-for-real-recycling/ + a zero waste to landfill https://elvenagri.com/zero-waste-to-landfill-2/ + 'The role of WfE in waste management' https://www.cleanaway.com.au/sustainable-future/why-energy-from-waste/ a commercialised hierarchy shaped around the service delivery model of a commercial service provider. Bottom row: left to right- 'Re-prioritising how furniture and IT is disposed when moving office, refurbishing or downsizing https://ecogreenlove.com/2019/02/23/waste-hierarchy/ + 'TAG waste hierarchy' https://www.targe-env.com/tag/waste-hierarchy/ source Targe Environmental re aged asset decommissioning + 'From Waste to a circular economy' re EUROSAI environmental auditing https://www.eurosaiwgea.org/documents/meetings/SS%20on%20Waste%20and%20Circular%20Economy/Waste-CircularEconomy_Report_0508.pdf



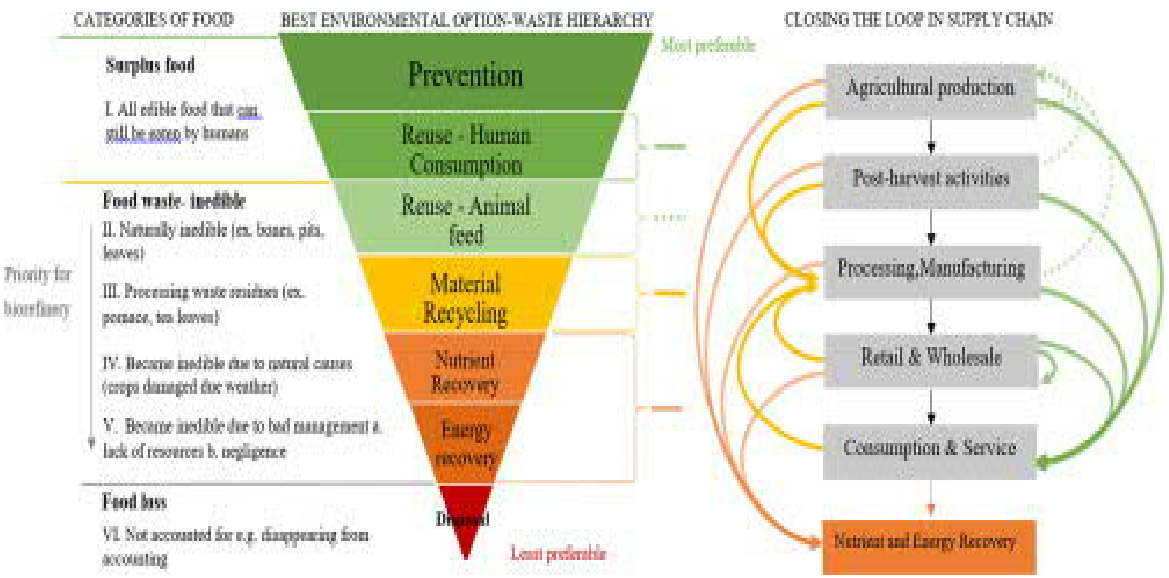


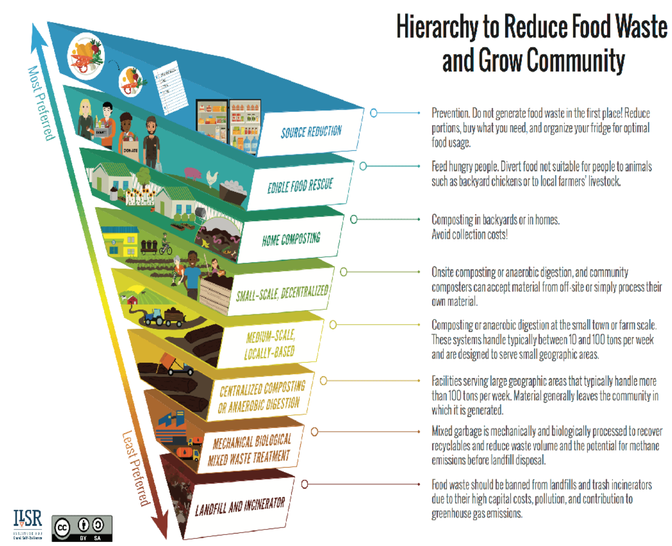


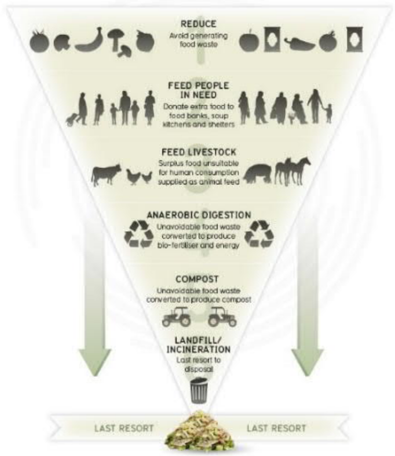


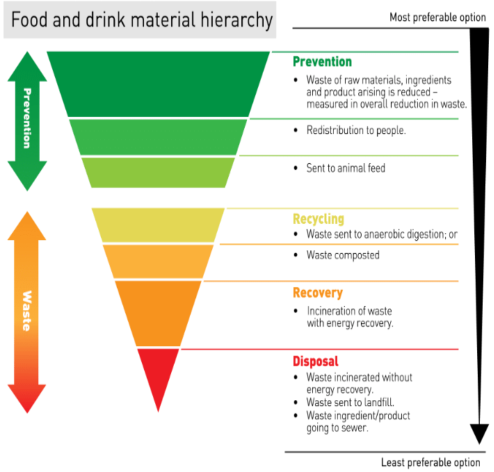


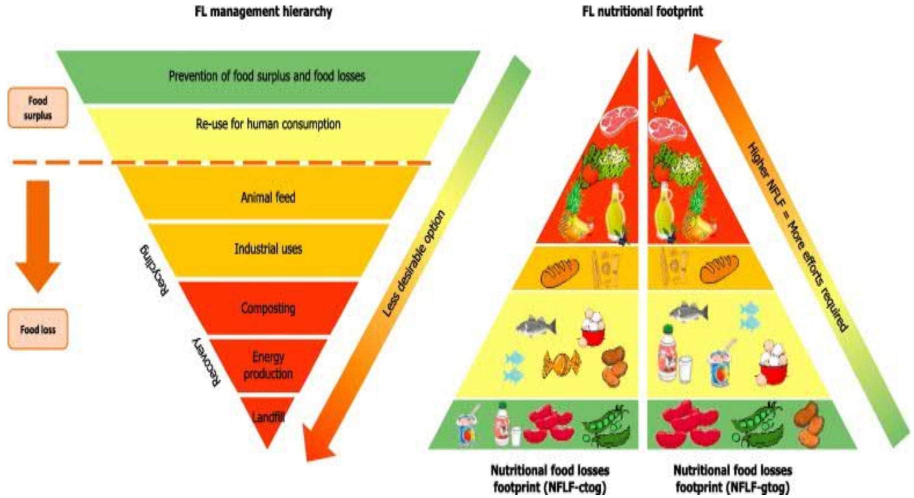
Top row: left to right: Waste Framework Directive 2008 (WFD, 2016). https://ec.europa.eu/environment/legal/law/6/pdf/02_aile_eU_waste_legal_framework_speakers_notes.pdf + from a bioeconomy perspective (Leao et al., 2017) + (Matharu et al., 2016). Bottom row: left to right- 'UTS:ISF' (Downes, 2018; Lewis et al., 2017) ZWIA + 'Recycling can be confusing, but it's getting simpler' 27th Mar 2018 Jennie Downes https://theconversation.com/recycling-can-be-confusing-but-its-getting-simpler-68063 + *'Food Recovery Hierarchy'* *https://www.epa.gov/sustainable-management-food/food-recovery-hierarchy*



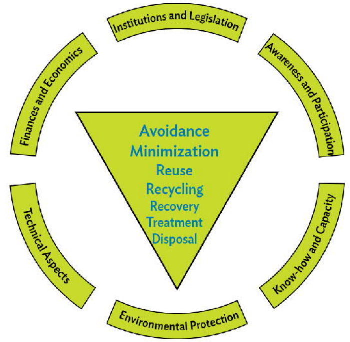


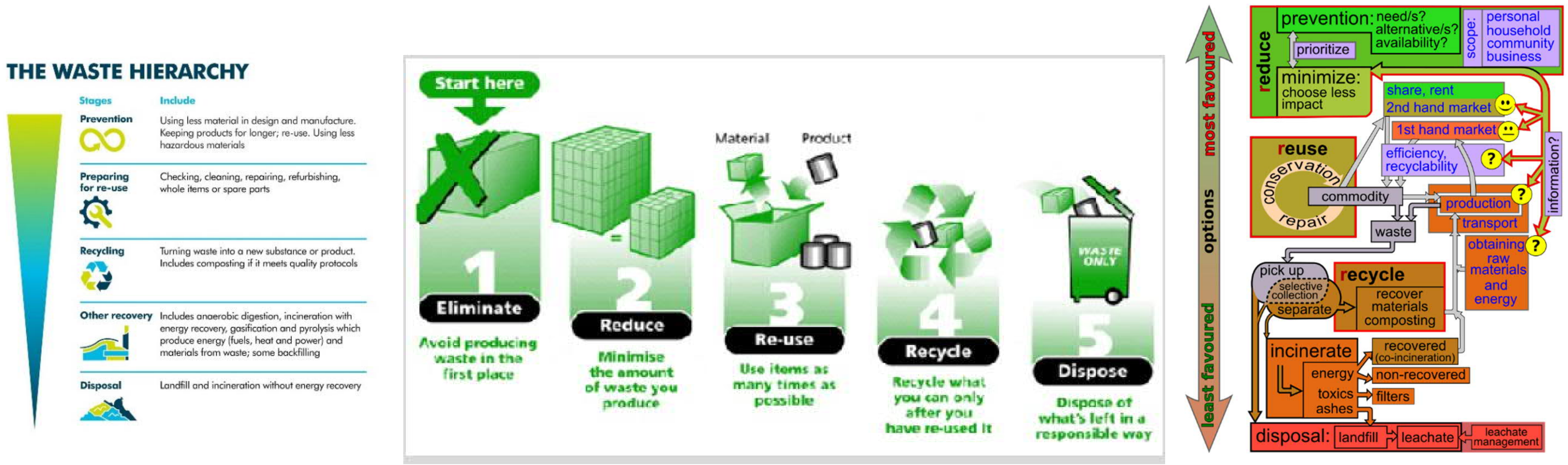






Top row: left to right – 'best environmental option waste hierarchy (Teigiserova, 2020) + 'food waste hierarchy' https://ilsr.org/food-waste-hierarchy/ Bottom row: left to right - 'Vision 2020 achieving zero food waste to landfill'https://www.vision2020.info/ban-food-waste/the-food-waste-hierarchy/ + (Caldeira et al., 2019) - *The food waste hierarchy is a model supported by a number of organisations, notably WRAP, The London Food Board and Feeding the 5000"* + http://www.wrap.org.uk/content/why-take-actionlegalpolicy-case and *https://www.researchgate.net/figure/Food-waste-hierarchy-obtained-from-WRAP-2018_fig1_338430585* (Garcia-Herrero et al., 2018) (Asian Development Bank, 2017, p. 6).

Figure 1: Waste Management Hierarchy




Top row: left to right - Source https://visual.ly/community/Infographics/environment/waste-hierarchy + '8R extended waste hierarchy diagram' for sustainable textiles https://buddhajeans.com/encyclopedia/8rs-waste-hierarchy/ + Waste Hierarchy: 'The Five Stages Of Waste Management' Williams, M. https://viablealternativenergy.com/waste-hierarchy/ cite also similar version http://feedbacklocal.co.uk/the-waste-hierarchy/ which cites *"The waste hierarchy is an EU initiative with the aim of reducing the waste produced across Europe. All UK companies should try to adhere to the waste hierarchy as often as possible. By reducing, and re-using waste, we aim to stop wastefulness in the community"*. Bottom row: 'Recycling pyramid' from https://www.ubqmaterials.com/resources/the-waste-hierarchy-what-you-should-know-about-it/ cites that UBQ™ is the most climate-positive thermoplastic material on the market, made from landfill-destined waste https://www.coryenergy.com/wp-content/uploads/2020/10/waste-hierarchy-1-scaled-e1602234424548.jpg + 'Zero Waste week UK/NZ' https://www.zerowasteweek.co.uk/zero-waste-week-new-zealand/ graphic originally from www.envirowise.gov.uk/ this has now become part of https://www.wrap.org.uk/ + possibly the most complex - integrated 'Waste hierarchy; diagram https://en.wikipedia.org/wiki/Waste_hierarchy#/media/File:Waste_hierarchy_rect-en.svg (source cited as Jmarchn & Nuria Vidal Rodrigo)

Figure 24: The full compilation of various examples of the concept of a waste and or zero waste hierarchy.

Appendix 2 Energy Justice Network - Zero Waste Hierarchy (Ref. http://www.energyjustice.net/zerowaste/hierarchy)

SHORT / SWEET VERSION:

- Reduce
- Reuse
- Source Separate:
- o Clean Compostables ⇒ Aerobic Composting ⇒ Non-food landscaping/agriculture uses
- o Recycling ⇒ Material Recovery Facility (MRF):
    - Recyclables to Highest-end, Most =Local Markets Possible
    - Research (to see what got this far and how to best avoid it)
    - Residuals ⇒ Waste (below)
- o Waste ⇒ "Dirty MRF" (a.k.a. Mechanical / Biological Treatment):
    - Additional Recyclables captured and marketed
    - Residuals ⇒ Anaerobic Digestion ⇒ Aerobic Composting ⇒ Landfill
- o Special Collections ⇒ e-Waste, Household Hazardous Waste and other special/dangerous materials to proper recycling option

MORE DETAILED VERSION:

- Redesign
    - o Make products durable, recycled and recyclable
    - o Use materials which are more environmentally sustainable
- Reduce Toxics
    - o Toxics Use Reduction
    - o Reduce amounts of toxic chemicals in production
    - o Replace toxic chemicals with less toxic or non-toxic alternatives
- Consumption Reduction ##Use less
    - o Buy less (reduce advertising)
    - o Buy stuff with less packaging
    - o Avoid disposables & non-recyclables
- Packaging Reduction
    - o includes polystyrene and PVC plastic bans and single-use paper/plastic bag bans and taxes
- Reuse/Repair
    - o Thrift stores
    - o Charity collections
    - o Dumpster diving
    - o Freecycle
    - o Paint blending
    - o Repair centers for bikes, computers/peripherals, furniture, appliances, etc.
- Recycle
    - o source-separation, not single stream or "one bin for all"
    - o seek the highest end-use and avoid "downcycling"; segregate office paper from lower paper grades and other recyclables, to keep quality high
    - o buy recycled; create market for glass so that glass collected for recycling is actually recycled, not dumped in landfills
    - o adopt a bottle bill / wastepicking
- Compost
    - o Curbside collection of organics (weekly), which can be done while decreasing the collection of trash and recyclables to biweekly (the smelly stuff in trash is the compostable stuff, so this encourages people to compost if they don't want trash smelling).
    - o Ban clean organics (not sewage sludge!) from landfills. Sewage sludge, even after being digested, does not belong on farm fields or in urban gardens.
    - o Clean compost from food scraps and yard waste can be used in landscaping and non-food agriculture uses.

- Research
    - On a regular basis, do a waste sort and see what remains in the waste and feed that into Extended Producer Responsibility campaigns, product bans and other measures to eliminate these residual materials from the waste stream, ensuring that they're dealt with further up in this hierarchy
- "Dirty" Materials Recovery Facility (MRF) for the remainder (a.k.a. the “Mechanical” part of Mechanical/Biological Treatment)
    - Pull out additional recyclable and compostable material. It's important that this not be a replacement for source separation and upstream recycling, as it will get people out of their good recycling habits and will degrade the quality of recyclables, lowering their value and ensuring less will actually be recycled.
- Anaerobic digestion followed by aerobic composting (a.k.a. the “Biological” part of Mechanical/Biological Treatment)
    - The remainder, which is largely contaminated organic material, should be digested in order to reduce the methane generating potential, then aerobically composted to dry it out, stabilising the waste for landfilling (avoiding having a gassy, stinky landfill)
- Monofill (landfill in separate landfill cells at existing landfills)
    - Ensure proper landfill management (don't mismanage the landfill by managing it for energy production) Minimise gas production: Do not manage the waste facility as an energy facility by stimulating gas production.
        - Keep out liquids
        - Cover the active face of the landfill to keep out rainwater, using a temporary structure
        - Do not recirculate leachate
    - Cap landfills with permanent synthetic covers and install gas collection systems in months, not years.
    - Maximise gas collection: ##Segregate organics in landfills for best gas collection
    - Maintain high suction on collection wells; do not damp down wells or rotate off the wells to stimulate methane production
    - Clean the gas prior to use
        - Filter toxins in the gas into a solid medium like a carbon filter; containerised and store on-site.
        - Do not send to carbon "regeneration" or "recycling" facilities [they simply incinerate the captured chemicals, polluting the air]
    - The purified gas can be used:
        - for heating purposes (burned in a high efficiency boiler), piped into gas lines, used to make alternative vehicle fuel, used in fuel cells, burned for electricity in a high efficiency turbine (less preferable to uses for heating), or the CO_2 and methane can be segregated and sold as industrial chemical feedstocks (but not for food industry use).
    - Landfill gas-to-energy should not be considered renewable (That allows it to undercut clean sources like wind and solar and puts source reduction, reuse, recycling and composting at a competitive disadvantage.)

The landfill management aspects are nuanced because it’s critical to ensure that greenhouse gas emissions from landfills are avoided, unlike how landfills are commonly managed today. For a full appreciation of the need for this type of landfill management, please review the materials at www.energyjustice.net/lfg/ .