IOP Conference Series:
Earth and
Environmental Science

PAPER • **OPEN ACCESS**

Construction industry classification systems: Defining the construction sector in New Zealand

To cite this article: An Thi Hoai Le *et al* 2022 *IOP Conf. Ser.: Earth Environ. Sci.* **1101** 042011

Construction industry classification systems: Defining the construction sector in New Zealand

An Thi Hoai Le, Niluka Domingo, and Monty Sutrisna
School of Built Environment, College of Science, Massey University, Auckland, New Zealand
E-mail: a.lethihoai@massey.ac.nz

Abstract. CanConstrucNZ is a partnership programme between New Zealand universities, government agencies, and professional bodies to develop a smart system that enables mapping future pipeline projects with the industry capacity and capability to advise the stakeholders whether the sector will be capable of delivering the proposed construction projects. Defining the scope of the construction sector itself is the first step of the programme that helps measure the construction sector capacity. This paper compares different definitions and approaches of the construction sector boundaries and discusses similarities and differences in the selected classification systems, usually used to define, collect, and generate data for measuring the construction sector. The findings highlight the need for a more comprehensive classification to help generate the correct level of data for measuring the construction sector's true scope and size, resulting in better policy initiatives, and informing changes in the industry. The findings of this study recommend future research to develop a customised classification system to represent the value of the New Zealand construction sector in a holistic manner.

1. Introduction

New Zealand's construction sector is a significant contributor to the nation's economy; it contributed to the national GDP as much as 5.7 % in 2015 and 6.5 % in 2020 [1]. This contribution worth around 11.2 billion USD in GDP, employing 5.8% of the nation's working population and was the fifth-largest sector in terms of GDP contribution in 2020. Infrastructure New Zealand revealed that around 90 billion USD, including private infrastructure, is expected to be spent over the next ten years from 2020 onwards on pipeline projects across the country [2]. National Construction Pipeline Report 2021 estimated that the construction activities grow steadily to about 33.2 billion USD in 2024, driven mainly by the high demand of the residential sector [3]. Lessons learned so far indicated that the New Zealand's construction sector suffers from skill shortages, poor productivity, high staff turnover, and lack of innovation that may prevent the sector from delivering successful projects in future [4, 5, 6]. In addition, construction enterprise survival rates in NZ have been decreasing in the last decade [7], and we are yet to observe the full impact of COVID-19 disruptions toward the typical boom-and-bust cycle of the sector8 [8]. Stemming from these, two critical questions from the Government and stakeholders need to be addressed: what is the capacity of the New Zealand's construction and where are the gaps in its capacity to deliver future construction projects in the country [9].

In response, the CanConstructNZ research programme has been established aiming at answering the two questions and solving the capacity and capability problems for the construction sector in New Zealand. The programme aims to create a comprehensive system

that enables users to map the capacity (e.g. workforce, plant, equipment, materials) against the proposed construction projects so that the sector will be able to resource the projected demands. The system intends to generate a set of capacity measurement factors that allows the Government, local authorities, public and private investors to understand what can realistically be delivered by the sector and, if capacity is insufficient, what changes should be implemented to ensure successful delivery of these future projects. Meanwhile, the construction sector is highly integrated across the national economy and intertwined with other industrial sectors such as mining, manufacturing and wholesale trade, and so on by a complex set of input, output inter-relationships [10]. Therefore, defining the scope of the construction sector and its components is crucial to fully understand the full extent of the sector's capacity. As a part of the CanConstructNZ programme, this study serves as a starting point to understand the holistic structure, scope, and components of the construction sector. The paper thus firstly discusses alternative approaches to investigating what are included/excluded in the definitions of the construction sector. Secondly, this paper compares existing construction classification systems, which are usually used to define, collect, generate data for construction statistics, to generate on the way forward to map the construction sector in a holistic manner.

2. Literature Review

The construction sector's structure, role, and scope are becoming a point of debate among researchers and analysts [11]. The typical view is called the "construction industry", which only covers the production of a new structure or facility [12]. This view typically consists of on-site assembly, including the construction of buildings and infrastructure, specialised construction activities such as site preparation, building installation and building completion [11]. On the other hand, Foulkes and Ruddock suggested that analysing "the construction" should be in "narrow" (construction industry) and in "broader" (construction sector) definitions so that construction statistics can capture the true scope of the construction activities [13]. Thus, the broader construction sector consists of the construction production, operation of the constructed assets, professional services and the supply-chain for construction-related products such as mining and manufacturing [13]. With this broader view, the construction industry can be seen as a subset of the construction sector. As CanConstrucNZ is going to develop a system to model sector capacity, it takes the broader definition, which encompasses construction production, professional services, and other related services involved in the entire life cycle of constructed facilities, from manufacturing materials to demolition and disposal at the end of its life cycle. The construction sector approach is a new framework for construction statistics [14]. According to Carassus et al., this approach creates new boundaries for the construction statistics, which is made of three groups of activities as below [12]:

- Group 1: activities concern the management of the existing stock of structures, including asset management, property management and facilities management;
- Group 2: activities cover service activities involving project management, implementation and assembly activities to create a new structure or facility;
- Group 3: activities are focused on material manufacturing and distribution, implementation and assembly activities of equipment and plant on worksites;

Measurement of the wider construction sector is typically challenging due to data quality and availability issues [15]. Traditionally, construction statistics follow the national industrial classification system, where construction is indicated by the narrow construction industry definition [13]. However, many researchers argued that the value of the construction sector is deeper in meaning and wider than its statistical representation. Carassus et al. applied the new approach and attempted to link other principal activities related to the construction industry, such as mining, manufacturing, and real estate [12]. The results show that the value of

the construction sector system can be as large as twice than the one of the construction industry as typically measured in the statistical terms. Carassus et al. compared the construction sector and the construction industry in terms of employment in nine countries and found that the construction sector's employment is also more than twice as large [16]. Interestingly, indirect contributions of construction activities to other parts of the economy is much greater than their direct contributions [14]. For these reasons, reviewing existing classification systems would be necessary to develop a more appropriate system for measuring the construction sector size and value.

3. Research Methodology

The integrative literature review was adopted to accomplish the research objectives. This type of review generates knowledge by building a conceptual model or framework that offers new ways of thinking about the literature and a research agenda that delivers questions for future research [17]. The integrative literature review is employed in research to generate conceptual frameworks and guide future research [18, 19]. In this study, comparing existing construction classification systems helps develop a conceptual model that categorises the related-construction activities using the broader construction sector definition. This result would enable a better understanding of the construction sector scope, providing meaningful knowledge about construction sector components for further research on measuring the construction sector capacity. The United Nation's classification system (ISIC), i.e. the national industrial classification systems in OECD countries have been selected as a starting point. For this purpose, the keywords "industrial classification" and the country name, such as "New Zealand", were used for the search engine. These documents were retrieved from governmental and organisational websites. Initially, 21 industrial classification systems were located. Four of the most relevant industrial classification standards are included here for reviewing different world parts. The International Standard Industrial Classification of All Economic Activities (ISIC) developed by the United Nations can be used for any country. The North American Industry Classification System (NAICS) has been used for the US, Canada and Mexico. The General Industrial Classification of Economic Activities within the European Communities (NACE) has been used for the European countries, including OECD's countries in Europe. And the Australia and New Zealand Standard Industrial Classification (ANZSIC) represents the Oceania regions.

4. Findings and Discussion

The industrial classification systems have been developed to reflect the structure and compositions of all industries within the national economy [20]. The United Nations has developed the International Standard Industrial Classification of All Economic Activities (ISIC) to guide countries in developing their industry classification standards [21]. Accordingly, national statistics organisations establish definitions, data requirements and collection methods to measure contributions of the construction to GDP and the economic growth. This paper examines the classification systems' overall structure and further analyses the construction-related activities to categorise them into three groups of activities using the broader construction sector definition.

4.1. The International Standard Industrial Classification of All Economic Activities (ISIC)

The latest version of ISIC Revision 4 was released in 2008 with the primary purpose to provide a set of activity categories that can be used for the collection and reporting of statistics according to activities [21]. According to the UN Statistical Division manual, ISIC was developed based on a production-oriented framework and producing units into detailed industries based on similarities in the economic activity. The classification is structured by the tabulation categories, identified by letters, called "sections", the 2-digit categories "divisions", the 3-digit categories "groups",

and the 4-digit categories "classes". There are 21 sections (from A to U) and 88 divisions and their groups and classes in ISIC, providing a framework for comparable data classification at different levels of detail. It is suggested that ISIC classes can be further subdivided for specific purposes [21]. The construction section, Section F, has three divisions, eight groups and eleven classes. The categories cover construction of buildings (division 41), construction of civil engineering (division 42), and specialised construction services (division 43). The repair is included in the specialised construction services. The renting of construction equipment with the operator is classified with the associate construction activity.

Section F presented in Figure 1 covers the production of the construction industry (Group 2), with the maintenance and equipment hiring included (partly Group 1 and Group 3). Other relevant construction activities are classified in other Sections in ISIC. Professional services such as architectural, engineering activities and technical consultancy are classified with Section M (Professional, scientific and technical activities), division 71. Furthermore, activities are carried out in operation such as asset management, property management and facility management are not classified within the construction section. Real estate activities such as buying, selling, renting, operation, and building projects are classified with Section L (Real estate activities), division 68. Regarding group 3, material manufacturing such as quarrying of stone, sand and clay is classified under Section B, division 08. Section C presents the classification of manufacturing; however, there is no separated division or class for construction materials and equipment. Similarly, supply chain activities are not classified within the construction sector. The construction distribution line is classified in Section H (Transportation and storage) or Section G (Wholesale and retail trade).

Group 1: Management of existing stock	Group 2: Project management and on site production	Group 3: Manufacturing and distribution
Section L: Real Estate activities Section M: Professionals, scientific and technical activities (partly) Section K: Finance and insurance activities (partly)	Section F: Building construction and civil engineering construction (maintenance and equipment hiring included) Section M: Professionals, scientific and technical activities (partly) Section K: Finance and insurance activities (partly)	Section B: Mining (partly) Section C: Manufacturing (partly) Section G: Wholesale (partly) Section H: Transportation (partly) Section K: Finance and insurance activities (partly)

Figure 1. ISIC construction sector

4.2. The North American Industry Classification System (NAICS)

The North American Industry Classification System (NAICS) revision 2017 was developed to provide a framework for collecting, analysing, and disseminating industrial statistics in Canada, the United States, and Mexico. NAICS is built on a production-oriented or supply-based conceptual framework [22]. The principle categorises producing units that use similar production processes into a group together [22]. As a result, NAICS taxonomy arrays the business economy into 20 categories at its highest level (2-digit code), 99 subsectors (3-digit code), 311 industry groups (4-digit code), 709 NAICS industries (5-digit code), and 1057 industries (six-digit code). NAICS classification system classifies an activity in an industry when its primary activity meets the definition for that industry. Therefore, NAICS provides a more detailed framework for the construction industry and related services than ISIC.

Construction is classified with category 23 and includes activities concern with erecting buildings and other structures (including additions), i.e. heavy construction other than

buildings. Construction works may include new work, additions, alterations, or maintenance and repairs. The construction category comprises three sub-sectors, ten industry groups, 28 NAICS industries, and 31 industries, covering activities in Group 2 of the construction sector framework. Subsector 236, Construction of Buildings, comprises establishments of the general contractor type and for-sale builders involved in the construction of buildings. The on-site assembly of pre-cut, penalised, and prefabricated buildings and construction of temporary buildings are included in this subsector. Subsector 237, Heavy and Civil Engineering Construction, comprises establishments involved in engineering projects; construction projects involving water resources (e.g., dredging and land drainage) and projects involving open space improvement (e.g., parks and trails) are included in this subsector. Subsector 238, Specialty Trade Contractors, comprises establishments engaged in speciality trade activities generally needed to construct all types of buildings.

Other components in the construction sector can be selected as those areas that contribute significantly to the construction sector, as illustrated in Figure 2. Group 1 comprises selected units in Sector 53-Real Estate and Rental and Leasing; selected units in Sector 54-Professional, Scientific, and Technical Services; sector 56, industry 5671: services to buildings and dwellings, including pet control landscaping services and other cleaning services. Group 3 includes activities that are primarily engaged in selling construction materials which are classified in Sector 42, Wholesale Trade, or Sector 44-45, Retail Trade, based on the characteristics of the selling units; construction material mining (Sector 21); manufacturing including prefabricated wood building manufacturing, architectural and structural metals manufacturing (Sector 31-33); and finance and insurance (Sector 52).

Group 1: Management of existing stock	Group 2: Project management and on site production	Group 3: Manufacturing and distribution
Sector 53: Real Estate and rental and leasing Sector 54: Professionals, scientific and technical services (partly) Sector 56: Services to Buildings and Dwellings Sector 52: Finance and Insurance (partly)	Sector 23: Building construction and civil engineering construction (renovation, refurbishment, maintenance and equipment hiring included) Sector 54: Professionals, scientific and technical services (partly) Sector 52: Finance and Insurance (partly)	Sector 21: Mining (partly) Sector 31-33: Manufacturing (partly) Sector 42: Wholesale trade (partly) Sector 44-45: Retail trade (partly) Sector 48-49: Transportation and warehousing (partly) Sector 52: Finance and Insurance (partly)

Figure 2. NAICS construction sector

4.3. The Australia and New Zealand Standard Industrial Classification (ANZSIC)

The Australian and New Zealand Standard Industrial Classification (ANZSIC) was originally developed in 1993 and then revised in 2006 and broadly aligned with the ISIC structure, using a similar principle but a shorter list of economic activities (ANZSIC, 2006). Similar to other classification systems, Division E, Construction, in ANZSIC only covers the narrow construction industry and clearly states what includes/excuses in each Division. Other sectors' components are shown in Figure 3. For example, architectural and consultancy services are not included in Division F; they are classified in Division M, Group 692. Offsite production of prefabricated buildings or building components are also excluded; they are included in Division C, group 222 Structural Metal Product Manufacturing. Also, quarrying sand, gravel, soil or filling activities are classified in Division B, class 0911; repairing and maintenance of building services such as plumbing, electrical, and fire alarm systems are included in Division S, class 9421 Domestic appliance repair and maintenance.

Group 1: Management of existing stock	Group 2: Project management and on site production	Group 3: Manufacturing and distribution
Division L: Rental, Hiring and Real Estate activities Section M: Professionals, scientific and technical activities (partly) Division N: Building cleaning, pets control and other support services Division K: Finance and insurance activities (partly) Division S: Other services	Division F: Building construction and civil engineering construction (repair, refurbishment, maintenance and equipment hiring included) Division M: Professionals, scientific and technical activities (partly) Section K: Finance and insurance activities (partly)	Division B: Mining (partly) Division C: Manufacturing (partly) Division F: Wholesale trade (partly) Division G: Retail trade (partly) Division I: Transport, postal and warehousing (partly) Division K: Finance and insurance activities (partly)

Figure 3. ANZSIC construction sector

4.4. The Industrial Classification of Economic Activities within the European communities (NACE)

NACE is the European standard classification of productive economic activities. The revision 2008 of NACE has been developed based on the fourth revision of ISIC [23]. Therefore, categories at all levels of NACE have been structured similar to ISIC categories with the fourth level of coding: sections, divisions, groups and classes. Each NACE code is assigned to a unit recorded in statistical business registers according to its principal economic activity [23]. Although NACE has the same structure as NAICS, the categorisation of divisions in the construction section still has similarities and differences compared to NAICS. The divisions in Section F construction are the same, which comprises the construction of buildings (division 41), the construction of civil engineering works (division 42), and specialised construction activities (division 43). Section F includes new work, repair, additions and alterations, the erection of prefabricated buildings or structures on the site. The renting of construction equipment with the operator is classified with the specific construction activity carried out with this equipment. The classification of the construction sector in NACE is illustrated in Figure 4.

Group 1: Management of existing stock	Group 2: Project management and on site production	Group 3: Manufacturing and distribution
Section L: Real Estate activities Section M: Professionals, scientific and technical activities (partly) Section K: Finance and insurance activities (partly)	Section F: Building construction and civil engineering construction (finance, remodelling, and equipment hiring included) Section M: Professionals, scientific and technical activities (partly)	Section C: Manufacturing (partly) Section G: Wholesale (partly) Section H: Transportation and storage (partly) Section K: Finance and insurance activities (partly)

Figure 4. NACE construction sector

NACE also has one more Division, 41.1, which is "development of building projects" by "bringing together financial, technical, and physical means to realise the building projects for later sale". However, architectural and engineering services and project management for construction is not classified in Section F; they are included in Section M: Professionals, scientific and technical activities, class 71.1. In addition, construction material mining such as sand, gravel

is not included in Section B (Mining); it mentioned that "usage of the extracted materials without a further transformation for construction purposes, see section F (Construction)".

5. Discussions

This study investigates national and international existing classification systems, including ISIC, NAICS, NACE, and ANZSIC, to understand the structure of construction analysis. The systems provide a basis for the standardised collection, analysis and dissemination of economic data on an industry basis, including construction. ISIC, NACE and ANZSIC use the same principle and coding structure with four-digit codes, while NAICS has a six-digit coding at the lowest level of detail. All standards above provide the classification for the narrow construction industry only, with three main sub-sectors: building construction, civil engineering construction, and specialised construction services. ISIC, NAICS, and ANZSIC include project management but exclude architecture and engineering activities in their construction section; meanwhile, NACE excludes both project management and architecture and engineering activities. All the standards include renting construction equipment with an operator is included in the construction section but exclude renting equipment without an operator.

None of the standards separates existing stock management, such as maintenance, refurbishment, and facility management. Repairing, maintenance, renovation or alteration of the structure and facility are included in the building construction and civil engineering construction, except repair and maintenance of building services in ANZSIC. Manufacturing and distribution relating to construction activities are also classified in other sections such as mining, manufacturing, wholesale trade, transport and warehousing. Finance and insurance are recommended as contributors to the construction sector in all groups. Although there are still other contributors to the construction sector, such as education and training, accommodation and food, and administrative, the comparisons of the above classification codes can help to check the degree of consistency across the standards regardless of the stage of development. However, because detailed data is unavailable, the actual comparison of the construction sector's valuation across the classifications was limited.

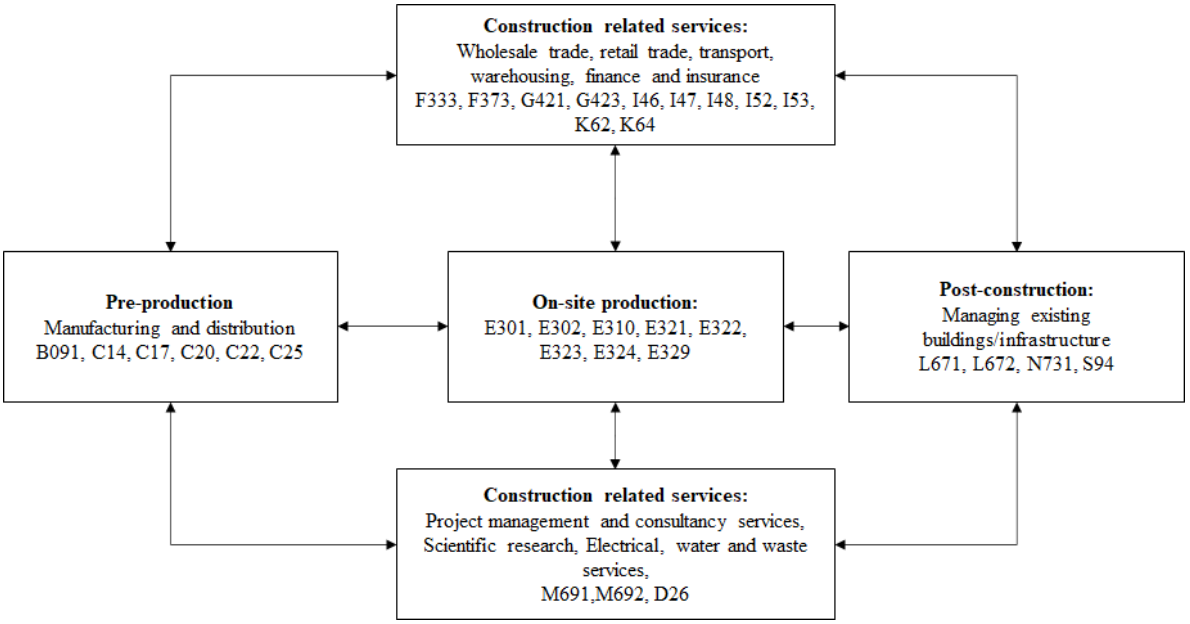

Figure 5. Construction sector proposed framework for CanConstruct

A construction sector framework for CanConstruct is suggested based on the findings, as illustrated in Figure 5. The proposed framework is in line with the concept of the construction value chain developed by Mariagrazia Squicciarini and Anna-Leena Asikainen [24]. The statistics data structured by this proposed approach can provide helpful information for strategic development for companies and the Government as it considers both the new builds and the existing stock. Repair, refurbishment and maintenance of such stock are important businesses in the construction sector in some countries, especially in developed countries [25]. For example, in Europe, new build represents annually less than 1.5% of the building stock of the non-residential construction sector [26], and in western Europe, repair and maintenance often represent half of the construction works [25]. In New Zealand, while only 20,000 new homes are built each year, 80,000 renovations occur annually [27]. In a report issued by the New Zealand Business Council for Sustainable Development in 2019, one of the biggest challenges in New Zealand building stock is that more than 1.6 million existing homes perform poorly due to 65% of current housing stock being built before insulation was required and over one-third of houses have ungraded cylinders that waste energy [27]. Meanwhile, the Government has committed to being Carbon Zero by 2050 by improving the operational efficiency of buildings and reducing the whole of life embodied carbon footprint of buildings [28]. Therefore, it is clear that sustainable refurbishment and renovation solutions should be targeted to achieve the goals. Hence maintenance and refurbishment work and facility management are the areas of increasing concern to both firms and public authorities. However, most current statistical data uses the narrow construction industry definition, so it is more difficult to measure the importance of asset, property and facility management activities. The proposed approach, on the other hand, includes new opportunities for refurbishment, maintenance and operation.

Furthermore, by considering relevant professional services, manufacturing and suppliers, the construction sector system approach will be beneficial for understanding innovation processes and improvement in the industry [16]. Performance of the narrow construction industry, using productivity measurements, is often seen as poor [29]. An essential part of the explanation for the low improvement of the industry is the failure to adequately measure the size and scope of the wider construction industry [30]. The last decades have witnessed the rapid development of additive technologies and smart systems in construction such as 3D printing, Building Information Modelling, virtual reality, augmented reality, robotics, drones, the IoT and so on [31]. The technological change also created various opportunities for higher performance in the construction industry. In addition, by moving from on-site to offsite manufacturing production or a controlled environment, the construction industry has strived for higher productivity [32]; however, the measurement of construction innovation is difficult due to discrepancies in classification [33]. Acknowledging of the importance of innovation, it is proffered that the capture of the contributions from professionals, manufacturing and distribution activities will be required to reflect the true scope and capacity of the construction sector. These advantages show that the new framework facilitates development in the construction sector through a fresh perspective of statistical analysis will have significant implications for industrial policy.

6. Conclusion and Future Research

This study shows similarities and differences in principles, structures and definitions of the selected construction classifications used by official statistics worldwide to measure the size and scope of the construction sector. However, none of the investigated standards includes material manufacturing and distribution, consultancy services, research and innovation in its construction section. Therefore, using the existing classification systems fails to capture the actual size of the construction sector, leading to a misunderstanding of the sector's capacity and performance. The construction sector framework will guide the development of a customised classification system for construction in further stages of the CanConstructNZ research programme. The customised

system is envisaged to generate data that improve the understanding of the sector value by linking the "core" construction and its "support" components and modelling interdependencies between firms in a production chain. This type of information can inform the Government, local authorities, investors and researchers and provide accurate measurements of the construction sector to assess the capacity and capability of the sector against future needs. A more detailed breakdown is suggested for the customised classification system to show which areas are the most important in the construction sector and/or where the gaps are in the construction capacity. The classification system will be tested using actual data to model the inter-relationships and propose policy initiatives. In New Zealand, local authorities are key stakeholders in policy reviews, data management, and stakeholder communication and it can be seen as a small scale mode representing the dynamic of pipeline projects in the country and its interaction with its construction sector. Therefore, the first stage of data collection in CanConstructNZ will involve local authorities in New Zealand for initial modelling and scenario testing of using the new construction sector framework for measuring construction capacity. Based on the data captured using the customised classification system, the CanConstrucNZ model can analyse the region capacity against the workload against their next three-year plan. Whilst the immediate results would enable the local authorities to prioritise investment to ensure successful delivery, the initial model can be further developed and scaled up to eventually model New Zealand construction sector.

7. Acknowledgement

The "Creating Capacity and Capability for the New Zealand Construction" research programme is funded by the New Zealand Ministry of Business, Innovation and Employment (MBIE) under MBIE Endeavour grant.

References

[1] StatsNZ 2021 Which industries contributed to your region's gdp? Report Statistic New Zealand URL https://www.stats.govt.nz/tools/which-industries-contributed-to-your-regions-gdp
[2] InfrastructureNZ 2019 Updated pipeline a sign of progress for infrastructure commission Report Infrastructure New Zealand URL https://infrastructure.org.nz/media/8104403
[3] MBIE 2021 National construction pipeline report 2021 Report URL https://www.mbie.govt.nz/dmsdocument/18150-national-construction-pipeline-report-2021
[4] Chang-Richards Y, Wilkinson S, Seville E and Brunsdon D 2017 *Engineering, Construction and Architectural Management*
[5] Ghodrati N, Wing Yiu T, Wilkinson S and Shahbazpour M 2018 *Journal of Management in Engineering* **34**
[6] Ayodele O A, Chang-Richards A and Gonzalez V 2020 *Journal of construction engineering and management* **146**
[7] StatsNZ 2021 Business survival rates in the construction industry in new zealand Report Statistics New Zealand URL https://figure.nz/chart/mBoxAr1YlOeOcshS-H7z5y5OrUYOZm5KF
[8] MBIE 2020 Construction factsheet Report Ministry of Business, Innovation and Employment URL https://www.mbie.govt.nz/dmsdocument/11600-construction-factsheet-july-2020.
[9] Sutrisna M, Wilkinson S and Cameron R 2020 *Build Magazine* **181** 72–73
[10] PwC 2016 Value of construction sector in new zealand Report Price Waterhouse and Coopers Lybrand URL https://www.pwc.co.nz/pdfs/CSG-PwC-Value-of-Construction-Sector-NZ.pdf
[11] Lewis T M 2008 Quantifying the gdp–construction relationship *Economics for the modern built environment* (Routledge) pp 54–79
[12] Carassus J 2004 The construction sector system approach: An international framework report by cib w055-w065 "construction industry comparative analysis" project group
[13] Foulkes A and Ruddock L 2007 Defining the scope of the construction sector *International Postgraduate Research Conference in the Built and Human Environment*
[14] de Valence G 2018 *Engineering, Construction and Architectural Management*
[15] Ruddock L and Lopes J 2006 *Construction Management and Economics* **24** 717–723
[16] Carassus J, Andersson N, Kaklauskas A, Lopes J, Manseau A, Ruddock L and De Valence G 2006 *International journal of strategic property management* **10** 169–184

[17] Torraco R J 2005 *Human resource development review* **4** 356–367
[18] Alcayaga A, Wiener M and Hansen E G 2019 *Journal of cleaner production* **221** 622–634
[19] Papastamoulis V, London K, Feng Y, Zhang P, Crocker R and Patias P 2021 *Recycling* **6** 61
[20] Lou E C W and Goulding J S 2008 *Architectural Engineering and Design Management* **4** 206–220
[21] StatsUN 2008 International standard industrial classification of all economic activities Report United Nations Statistical Division URL `https://unstats.un.org/unsd/publication/seriesm/seriesm_4rev4e.pdf`
[22] NAICS 2017 North american classification system naics Report US Office of Management and Budget
[23] Eurostat N 2008 *Office for Official Publications of the European Communities, Luxemburg*
[24] Squicciarini M and Asikainen A L 2011 *Construction Management and Economics* **29** 671–693
[25] Ruddock L and Ruddock S 2008 The scope of the construction sector: determining its value *Economics for the modern built environment* (Routledge) pp 99–113
[26] Establishment B R 2015 Sustainable refurbishment - how to better understand, measure, and reduce the embodied impacts. Report Building Research Establishment (BRE) on behalf of the BRE Trust. URL `https://www.bre.co.uk/filelibrary/Briefing%20papers/98660-Sustainable-Refurb-Briefing-Paper.pdf`
[27] NZBCSD 2019 Better performing homes for new zealanders: Making it happen Report New Zealand Business Council for Sustainable Development
[28] MBIE 2020 Building for climate change: Transforming the building and construction sector to reduce emissions and improve climate resilience Report Ministry of Business, Innovation and Employment
[29] Mellado F, Lou E C and Becerra C L C 2019 *Engineering, Construction and Architectural Management*
[30] Ruddock L and Ruddock S 2011 *Construction Management and Economics* **29** 1229–1239
[31] Silverio Fernández M A 2019
[32] Zhang Y, Lei Z, Han S, Bouferguene A and Al-Hussein M 2020 *Journal of Construction Engineering and Management* **146**
[33] Goulding J S and Rahimian F P 2019 *Offsite production and manufacturing for innovative construction: People, process and technology* (Routledge)