# Implementing Lean in a seasonal horticultural sector: Theoretical and practical suitability in the NZ pipfruit industry.

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Abstract

The New Zealand (NZ) pipfruit industry has recently set an ambitious target of more than doubling its export by 2022. However the industry has not performed very well in the past ten years with many growers averaging substantial losses. One key government action has been to deploy Lean thinking to improve production performance. The New Zealand pipfruit industry has not taken up this opportunity for unknown reasons. One reason may be that it is not known if the Lean paradigm will suit this seasonal industry which has a large manual labour component but pushes product into market, contrary to Lean principles.

Although Lean has been successfully implemented in a number of industries, there is little information about implementation in a horticultural context. Lean was not designed for pipfruit. The aim of this study is to research the concept of Lean and its theoretical 'fit' and practical applicability in a horticultural setting, specifically the New Zealand pipfruit industry.

A complex of methodologies integrates to find the answer. The literature review discusses transferability of common theoretical Lean themes to other industries. Consultants are interviewed to assess their views on the suitability of Lean for the pipfruit industry, while an industry-wide survey determines the current state of knowledge and Lean deployment within the industry, using a unique 'single-question-per-day' approach. Several case studies and action research studies then obtain rich data from organisations that have started with Lean implementation in recent times.

The inquiry demonstrates that Lean has many transferable elements and that the industry as a whole is not currently considered Lean. Data from action research and case studies demonstrate that Lean is largely applicable—leading to a measurable increase of Lean—supported by some positive financial indicators. The inquiry culminates in the development of a model and framework that can be applied in the future. In addition, orchards delivered some original interpretations of waste and developed a Lean assessment tool.

The inquiry edified that Lean substantially fits the different elements of the NZ pipfruit industry. This paper contributes to fill the gap in knowledge about Lean in a horticultural environment.

# *Acknowledgements*

This project was something that was on my mind; it had to be done by somebody. I ended up doing it—but only after considerable thought about the commitment required and the sacrifices to be made by family and friends. I took this step as 'mature student' out of curiosity and with an intent to make a difference, knowing that I had a lot of support. This support came from many corners and this page serves to acknowledge that support, never truly being able to do justice to it.

First and foremost, I must thank my wife Winnie for putting up with me, locked away in my office on numerous early mornings, late nights, days and weekends; that time was also your time and I can only thank you for showing as much determination to get through this as I needed. A time may soon arrive when I can talk about more than just Lean and the industry; it will probably be the 'jobs-to-do' list.

All our children, spouses and grandchildren have been short-changed with the little attention I could give them. It may have hurt to see me withdraw to my office or be deep in thought instead of joining in a cup of tea or playing with the grandchildren who give us so much joy. You have all been a source of sanity for me, luring me out of my hide-out regularly and showing me that there is life after study. I thank you for your patience and understanding.

Our friends and colleagues must have noticed the little time I had available and I thank you for your understanding. I will be back soon!

Then there are the people who live in this academic world and/or who stimulated me, encouraged me, and were food for determination. I may not mention all of you but thank you all, particularly Nigel and Jane for being creative and critical and encouraging in single sessions, but not forgetting Greg, Mark, Rick, Mike, Gary and others. It would have been hard without you. Massey University has been my university since 1988, and made it possible to study extramurally throughout my various study courses. For this inquiry, Massey University granted me a scholarship. I am very grateful for that assistance.

During the course of this study, a number of people were kind enough to spend time to communicate with me about the thesis. These included Professors Peter Hines, Paul Coughlan, Carol Cardno and Doctors Robert Camp, Martin Gooch and several practitioners such as Danie, Peter, Tony, Ian and others. I asked industry experts to proofread sections which needed verifying and I thank you for giving me your time and feedback.

This inquiry could not have been completed without the help of the research companies who sacrificed time and effort to participate. I cannot name you but you know who you are and I am grateful for your help and I hope that the inquiry will help the industry. Without you all, there would be no thesis.

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# 1. Introduction

This study researches the concept of 'Lean[1]' and its applicability in a horticultural setting, specifically the New Zealand (NZ) pipfruit industry. The New Zealand pipfruit industry comprises apples and pears and has an annual growing cycle of a perishable product. The study's focus is particularly on the theoretical 'fit' and practical implementation of Lean into a seasonal horticultural setting.

## 1.1. Growing world population; growth targets set by government and industry

The primary industries including pipfruit are gaining in relevance for New Zealand, nationally and internationally, both from the monetary perspective to increase NZ export trade and from the global perspective to provide food for the world's population. In an article in NZ Science Review, Ballard (2010) describes NZ as the land of milk and honey with its abundant natural resources. In a presentation to the NZ pipfruit industry 2013 annual conference, Carol Barnao, on behalf of the Minister for Primary Industries, presented data showing that the NZ primary industries account for 72% of New Zealand's total exports at $30 billion per year (Barnao, 2013). As a nation of 4.5 million people, New Zealand grows sufficient primary product to feed 40 million people.

With a world population rising from the current 7 billion to 8 billion in 2025 and 9.3 billion in 2050 (Marshall et al, 2012; Lutz et al, 2001), the sustainable and by inference 'Lean' use of land and water, and production of food will become increasingly important in the growing global environment. The NZ government and industry bodies have therefore set ambitious strategic performance targets that need re-thinking of 'the way we do things' (The Business Growth Agenda Progress Reports, 2012; Horticulture Industry Strategy: Growing a New Future, 2009; Pipfruit NZ annual conference, 2013) (Figure 1-1).

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[1] Throughout this document, Lean where it relates to the philosophy, processes and tools will be spelled with a capital to differentiate from any other meaning of the word.

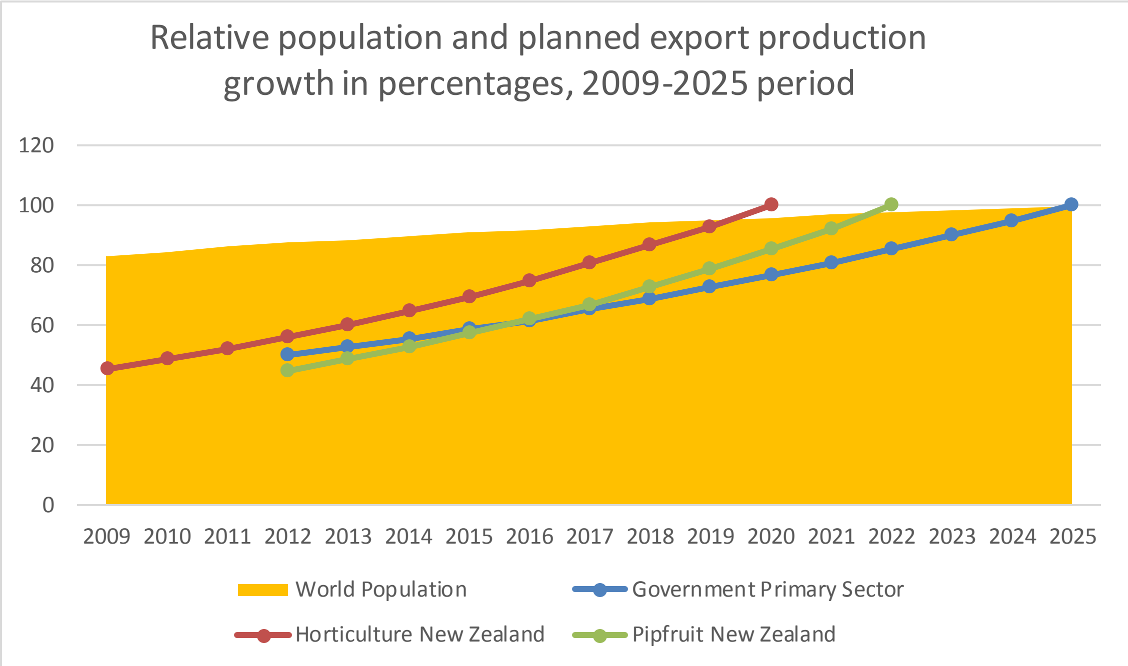



FIGURE 1-1: RELATIVE POPULATION AND EXPORT GROWTH PROJECTIONS WITH END-DATE TAKEN AS 100%.

In this growing world, the global competitive playing field is levelling itself. As faster and more complete information is becoming more accessible to everybody, more people than ever before compete and collaborate in real time on a more level footing than at any previous time in the history of mankind. Our world is changing. The world is becoming 'flat' (Friedman, 2006). And although the natural resource position of New Zealand (NZ) is enviable internationally, NZ has other constraints that require a targeted approach to service its customers.

## 1.2. The New Zealand pipfruit industry

The pipfruit industry is a challenging industry, particularly since deregulation in 2001. It has undergone numerous changes. Most challenges are based on market access issues, internal competition for supply between NZ based exporting companies, in-market competition between NZ based exporters and competition from other Southern Hemisphere countries such as Chile and South Africa. The industry has generated losses for grower stakeholders in a number of years and is not thriving (MAF Horticulture Monitoring Report 2011). Figure 1-2 shows the profit before tax of the New Zealand Ministry of Agriculture and Forestry (MAF)[2] monitoring orchards which represent a cross-section of the industry. Orchards have not been profitable businesses for a period of time, particularly in the Nelson area. The renamed MPI stopped monitoring the pipfruit sector beginning 2013 while re-designing the monitoring programme to address identified information gaps, provide relevant information and use MPI funding smarter.

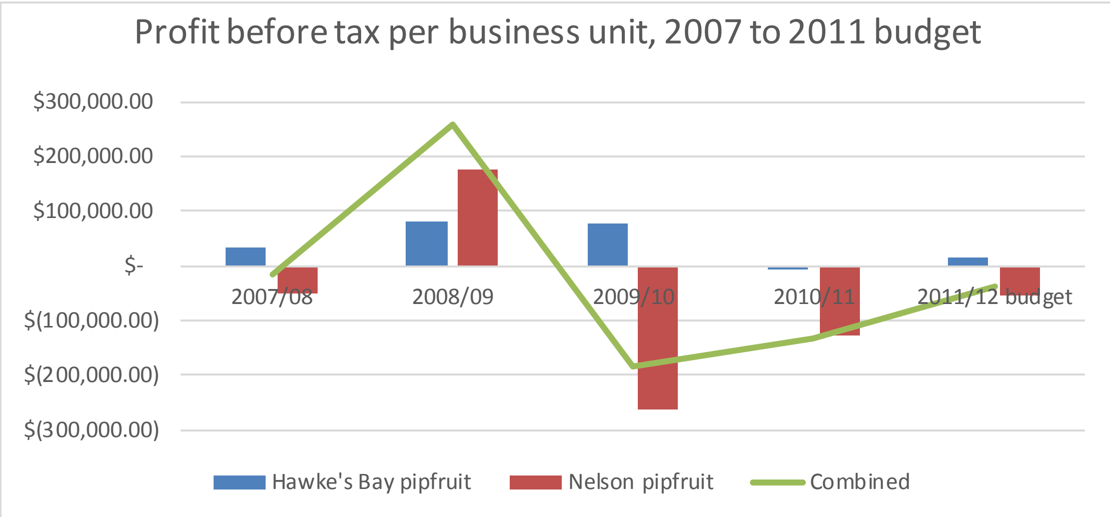



FIGURE 1-2: PIPFRUIT SECTOR PROFIT BEFORE TAX, 2007-2011 (SOURCE MAF HORTICULTURE MONITORING REPORT 2011 – PIPFRUIT SECTION).

## 1.3. NZ Government's response to support export growth - Lean

In its Business Growth Agenda, the NZ Government has set an export growth target of 40 % by 2025. In order to achieve such growth, the government is investing a further $100 million per year over the four years starting 2013 as part of its Internationally Focussed Growth Package. The government is already investing in business development with a number of programmes.

New Zealand Trade and Enterprise (NZTE), as the NZ government's national economic development agency, introduced several business improvement programmes including its 'Beachheads' programme, 'Better by Capital' programme, 'Better by Design' programme,

[2] The New Zealand Ministry of Agriculture and Forestry (MAF) has been renamed 'Ministry for Primary Industries (MPI) in March 2013.

‘Better by Strategy’ programme and ‘Better by Lean’ programme, as well as a number of other initiatives (e.g. ‘How NZTE can help’). Each programme targets specific business concerns, ranging from raising capital or arranging networks to improving performance.

Starting in 2005, NZTE initiated several programmes based on the Lean paradigm, including its Aichi programme, Lean Direct programme (Murti, 2009) and the current ‘Better by Lean’ programme. The expectation is that adoption of the Lean paradigm potentially offers advantages that will create a better fit for industries in the global drive for improved performance, eliminate inefficient processes and activities, and satisfy the customer in both production volume and quality. Since 2005, NZTE has supported the founding and coordination of regional Lean clusters—clusters of companies who implemented Lean and seek exchange of information to help them progress Lean (e.g. www.nzte.govt.nz).

## 1.4. Lean production and its transferability

‘Lean Production’ has been claimed to be the driving factor behind the growth of the Toyota Motor company (Womack et al, 2007). Toyota became the largest car manufacturing company in the world in 2008 and retained that position several years following (International Organisation of Motor Vehicle Manufacturers – OICA, 2008). In the classic book identifying Lean production, ‘The machine that changed the world’, the authors state that the principles of lean production can be applied equally in other industries across the globe:

> *“In this process we’ve become convinced that the principles of lean production can be applied equally in every industry across the globe and that the conversion to lean production will have a profound effect on human society – it will truly change the world”* (Womack et al, 2007, p6).

## 1.5. The problem

The NZ pipfruit industry has been unable to significantly introduce Lean or Lean thinking (Womack and Jones, 2003) as a paradigm. In October 2008, the NZ pipfruit industry’s governance body, Pipfruit NZ Inc. decided to acquaint industry stakeholders with Lean (Pipfruit NewZ, October 2008). Despite continued attempts to educate industry stakeholders, Lean is not embedded in the industry to-date. Although several companies are known to make some progress (e.g. Pipfruit NewZ, June 2013), the industry as a whole, has not been embracing Lean as a conceptual business improvement opportunity. The reasons for this have yet to be positively identified. Possible reasons are that Lean simply does not 'fit' the pipfruit industry and that the current industry culture is not conducive to adopting the Lean paradigm. Perhaps the industry is already Lean without calling it so. However we look at it, the industry suffers from relatively poor performance in a world demanding increased performance, and Lean has been identified as a very effective business improvement paradigm; the purpose of this study is to investigate how Lean can be made to work in a horticultural industry, specifically the NZ pipfruit industry.

## 1.6. Researcher position within the industry

It is relevant to summarise my personal position as researcher within the industry as this plays a role in the inquiry. I have been working in the industry since 2000, when the industry was still regulated and had a single desk export setup. Until 2008 I worked as operations manager at one of the larger vertically integrated pipfruit organisations, comprising orchards, packhouses, coolstores and exporting. From 2008 onwards, I worked as independent quality management, quality systems and market access practitioner, assisting a number of companies and the national pipfruit governance organisation (Pipfruit NZ Inc.) with their programmes. In addition, I have developed and annually deliver the industry's phytosanitary training programme. I also write regularly for the Pipfruit NZ newsletter with a focus on quality systems, quality management and recently Lean. This places me in a position where I have observed a number of organisations and how they operate. My personal knowledge and experience as independent practitioner allow me to provide a qualitative reflection on the industry which assists with the inquiry.

## 1.7. Aim of this inquiry

The aim of this study is to research the concept of Lean and its theoretical 'fit' and practical applicability in a horticultural setting, specifically the New Zealand (NZ) pipfruit industry.

The result of this study is to contribute original knowledge to the body of knowledge that exists in relation to 'Lean' and to horticulture in New Zealand, specifically the NZ pipfruit industry. The study's objectives are:

1. Identify common theoretical themes for the Lean philosophy, methods and tools, that are not industry or contextually bound and that may be transferable to the pipfruit industry.

2. Identify and analyse the current Lean deployment within the NZ pipfruit industry.

3. Analyse the applicability and any implementation approaches of the Lean philosophy, methods and tools within the NZ pipfruit industry.

4. Develop a conceptual Lean model for the NZ pipfruit industry and consider if the model is applicable to the wider horticultural sector.

## 1.8. Approach

Part one of the thesis introduces the problem and the aim of the inquiry.

Part two of the thesis includes a literature research that grounds the research project in available theory. The literature research includes the NZ pipfruit industry, Lean, its fundamental elements and its transferability and concludes with identification of observed gaps.

Part three of the thesis includes the selection of the research methodology, which is based on the aims and objectives of the inquiry and the literature research findings, and sets the scope and boundaries for the inquiry. The structure of the industry, its seasonal activities and the industry culture significantly determine the used methodology. The results of the practical research component include growing, packing/storing and exporting industry elements. The applied methodology uses volunteer companies for primary data collection; companies' identities may be commercially sensitive and are protected.

Part four of the thesis synthesises the data. The results of this original research are analysed and interpreted and combined to triangulate, and complement findings. The empirical results and analysis lead to the development of a model for the industry that links the analysed findings. The model precedes a conclusion, linking the findings and analysis back to the aim of the study and discussing the contribution to knowledge. The section includes limitations and recommendations. Table 1-1 shows an overview of the thesis.

TABLE 1-1: THESIS PARTS, CHAPTERS AND DESCRIPTIONS.

| ***Part*** | ***Chapter*** | ***Description*** |
|---|---|---|
| *Part 1: Introduction: Problem, aim, thesis overview* | Preliminaries: | Table of contents, List of illustrations, tables etc. |
| | Ch. 1: Introduction | Introduces the situation, the problem, the aim, objectives and format of the thesis |
| *Part 2: Background: Body of knowledge and underlying assumptions, current theory and practice* | Ch. 2: Background and literature review | Literature review of the NZ pipfruit industry and Lean incl. transferability; includes gap analysis based on review |
| *Part 3: Own work: Design of own study, research design, results.* | Ch. 3: Methodology | Research options, selected research method and motivation |
| | Ch. 4: Results | Reports on results of survey, interviews, case studies and action research |
| *Part 4: Synthesis: Contribution to knowledge, understanding of topic, examination of results, comparing results with others'* | Ch. 5: Discussion | Synthesis of results, linking to literature, discussion and limitations |
| | Ch. 6: Model | Development of a model for the pipfruit industry |
| | Ch. 7: Conclusion | Contribution to knowledge, future research and implications of study, development of a pipfruit model |
| | Additional information | References, Appendices |

# 2. Background and Literature Review

## 2.1. Introduction to the literature review

There is a vast body of popular and academic literature around the subject of Lean. In itself, that is testament to the interest that Lean has sparked since the inception of the term by Krafcik (1988) and the popularisation of the term by Womack et al (1990) in writing 'The machine that changed the world'. Since 1988 when Krafcik first used the term to describe the Toyota Production System, people in a number of industries have tried to make Lean 'fit' their industry, or have tried to take out of the Lean philosophy what suited their area of interest best. Over the years, Lean was adapted to suit a number of different sectors. The world has changed since 1988. Lean has been no exception.

In the same approximate period, the pipfruit industry has changed. The industry was centrally organised under a government controlled Apple and Pear Marketing Board (APMB) and later ENZA[3] until 2001. Just under 1500 growers were involved in the industry in 2000, and just before deregulation in 2001 (FreshFacts, 2002). Deregulation allowed the entrance of a number of export organisations into the industry. The direct and indirect consequences of deregulation are still felt within the industry. Growers and packers have consolidated substantially. The number of exporters has increased substantially. Although there is evidence of increased production per hectare, there is also evidence of an unsettled industry with much to learn (Doevendans and Wilson, 2011).

This section discusses the available literature on the development and workings of both the NZ pipfruit industry and Lean. A critical look at the NZ pipfruit industry will assist understanding how it can introduce Lean to improve performance. Similarly, a critical analysis of Lean will assist understanding how Lean can be used by the NZ pipfruit industry. A discussion and analysis of the literature concerning the NZ pipfruit industry and its processes is followed by a discussion and analysis of literature on Lean and its various developed forms.

[3] ENZA replaced the single desk APMB and was registered as a public company as a result of the Apple and Pear Industry Restructuring Bill of 31 August 1999.

## 2.2. The NZ pipfruit industry and its processes

The NZ pipfruit industry grows, packs, stores and exports fruit (apples and pears) predominantly for export to overseas markets (Figure 2-1). More than 75% of all harvested fruit ends up as fresh fruit in Northern Hemisphere markets. The balance ends up on local markets and is processed by juice plants.

This section describes the New Zealand (NZ) pipfruit industry. It briefly summarises the historical development of the industry, presents a picture of its place in the global pipfruit trade and describes the industry's economic hardship since deregulation. It continues with relevant fruit-technical details, seasonal aspects, market access and the role of people and science and technology within the industry.

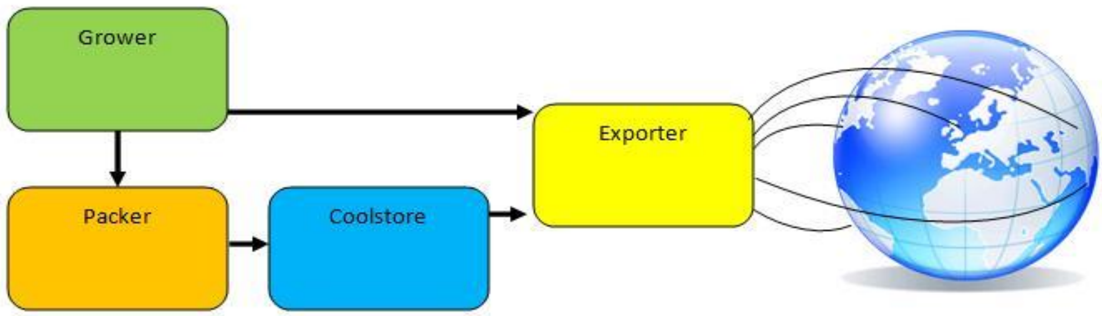



FIGURE 2-1: PRIMARY STAKEHOLDER SUMMARY PROCESS.

There is a lack of literature that attempts to describe the flows, mechanisms and processes within the industry. This may be attributed to the fact that, until 2001, all non-grower aspects of the industry were organised and controlled by ENZA. Deregulation led to within-industry competition to secure supply and consequently industry processes changed substantially as an increasing number of export organisations offered different service and cost structures. Emphasis was on fruit technical specifications and industry processes were largely ignored. Central organisation under ENZA was lost and no single organisation assumed responsibility.

Within the industry, there is a body of literature describing technical aspects. Pipfruit NZ, the national body, provides the Integrated Fruit Production (IFP) growing manual (2008) and numerous technical papers and tools. The IFP manual provides best practice information for growers, concerning pests and diseases, varieties, planting systems and production-, soil-, water-, weed- and shelter-management and spray technology. Pipfruit NZ also provides the Best Practice Guidelines for Production, Harvest, Cool-chain and Packing of NZ pipfruit; Industry Quality Recommendations (2012). This document provides generic growing information and quality specifications for various fruit types. It also contains recommended documentation templates.

Several packhouse/coolstore and export companies provide operations and quality requirement manuals. ENZA developed the original technical manual before deregulation and this manual forms the basis for all current manuals (e.g. ENZA specifications manual 2003). However none of these documents describes the different processes between organisations within the industry. A study of the NZ pipfruit supply- and value-chain focussed on financial aspects and industry supply and value chain assessment by internal and external industry stakeholders, and did not describe the processes involved (Doevendans and Wilson, 2011). In order to understand the industry, the following section discusses what is available within the literature.

### 2.2.1. Brief history of the NZ pipfruit industry

Pipfruit growing was established during the colonisation of New Zealand in the 1850's. Farmers, growing for their families, found markets in Wellington in the 1880's. This started a planting boom between 1910 and 1916 (Benzies, 1968, Monigatti, 1966). During the next eighty years, the growing of apples resulted in a flourishing export industry with the government's Apple and Pear Marketing Board (APMB) marketing all fruit overseas for a number of years. In 1963, the crop was extremely varied with 141 apple and pear varieties. Of these 141 varieties, a total of 109 made up 2% of the total crop (McKenna and Campbell, 1999).

During the early 1980's, a new levy system was introduced which led to 'the bitter years' (Mannering, 1999), and a newly elected Labour Government set out to profoundly change the political, social and economic thinking in New Zealand to one of pure neo-liberal economy (Kelsey, 1997). Growing concern with the single desk position was voiced in the early 1990's (Apple Fields Ltd. 1991). The single desk marketing monopoly continued until 1993 when the 1993 Apple and Pear Marketing Amendment Act deregulated the domestic market and provided for some semi-regulated niche export marketing. In 1999, the government introduced the Apple and Pear Restructuring Act and effectively separated the regulatory and marketing arms of the industry (McKenna et al, 1999). The short period following was fuelled by grower dissatisfaction over reclaiming of historical foreign exchange losses and court actions over export consents. In May 2001, the government announced that the industry would be deregulated per the 1st October 2001. Some further detail including some undocumented contemporary history of the NZ pipfruit industry can be found in Appendix 1: Reflective practitioner industry review.

### 2.2.2. Effects of deregulation on industry workings

Since deregulation in 2001, the NZ pipfruit industry has seen a reduction of the number of growers by 71.0 %, reduction of planted hectares by 38.85% and reduction of the number of packhouses/coolstores by 49.23% (FreshFacts, 2007; FreshFacts, 2013). During the same period, the industry saw an increase of exporters from one (and five export licenses) to ninety-nine exporters, some of which were quite small (Figure 2-2).

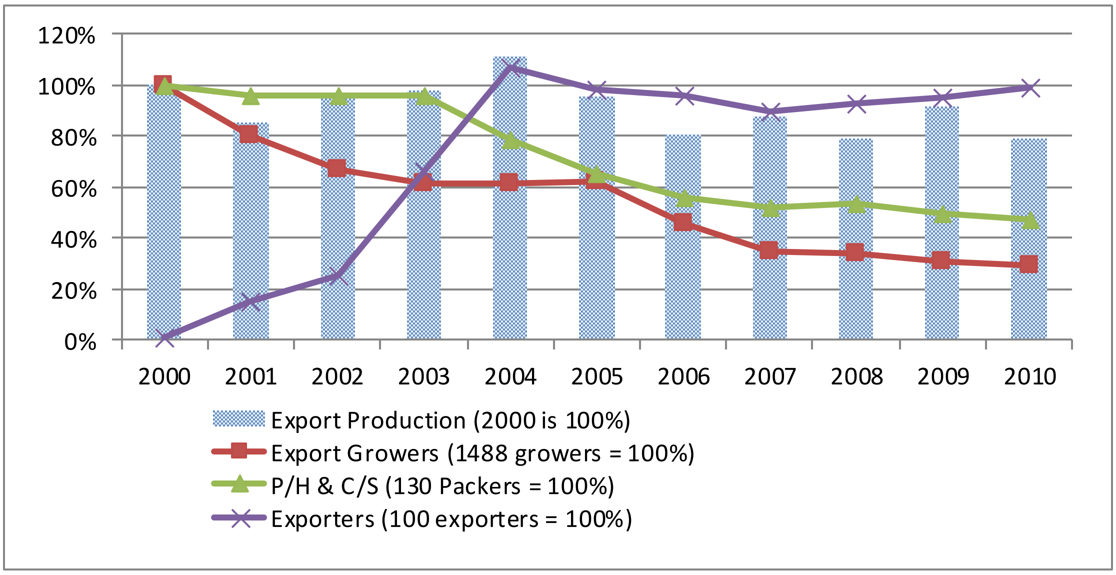



FIGURE 2-2: RELATIVE INCREASE/DECREASE IN STAKEHOLDERS SINCE 2000 IN RELATION TO PRODUCTION.

Organisations consolidated upstream and downstream, e.g. packhouses started growing and exporting and ENZA, formerly an export company, developed packhouse and growing capacity. Export production remained stable, averaging 305,335 tonnes over that ten year period (FreshFacts, 2007; FreshFacts 2013, and Pipfruit NZ, 2013).

### 2.2.3. Economic hardship in years following deregulation and sustainability

Immediately following deregulation in 2001, the New Zealand Pipfruit industry enjoyed several good years, soon followed by a poor 2004 result and a disastrous 2005 result (Pipfruit statistical annual 2006). This period was followed by years of moderate results, caused by frosts, several phytosanitary[4] market restrictions, some poor markets and unfavourable exchange rates. The industry and in particular the growers were having a hard time. In August 2005, the chairman of Pipfruit NZ wrote:

> *"There is no doubt that the industry cannot survive another year like this one has been. There is a clear need for us to start working together in a co-operative manner and introduce the necessary disciplines to minimise the infighting and maximise the value from the market. The orchard gate returns for growers must be sufficient to allow growers to reinvest in their businesses so the industry can continue to thrive"* (Pipfruit NewZ, August 2005, p3).

Interestingly, this statement reflected recognition of the 'infighting' that had started after deregulation, when exporters fought hard to secure fruit supply and in the process diminished more of the already fragile trust within the industry. Consequently, stakeholders communicated more about monetary trading returns than about effectiveness of operations. Doevendans and Ross (2011) examined the industry's supply and value chain, obtaining monetary data from a sample of ten export organisations and interviewing and surveying stakeholders. The study showed that monetary results varied significantly between export organisations, but reasons were not conclusively identified. Themes from interviews highlighted the lack of trust and the fragmentation of the industry. The researchers state that indirect stakeholders appear to understand the supply chain better than direct stakeholders. Further literature shows little factual evidence of anybody questioning the industry processes

[4] Phytosanitary relates to plant health, essentially fruit free from pests and diseases. Phytosanitary regulations are used by 177 countries that signed the International Plant Protection Convention (IPPC).

that had evolved over time; the 'in-fighting' between exporters is referred to at times, and Pipfruit NZ, the governance body of the industry tried to address exporter fragmentation by facilitating coordination meetings which focussed on market information (Pipfruit NewZ, December 2005).

### 2.2.4. Current position of the industry, nationally and internationally

#### *2.2.4.1. Relevance of the industry for New Zealand's exports.*

The pipfruit industry in New Zealand is a considerable export industry, contributing 24.94% to the total New Zealand fresh fruit export and 10.51% of total horticultural export income in 2010 (FreshFacts, 2011). Data released by Statistics New Zealand show that fruit exports make up 3.71% of the total New Zealand exports (Statistics NZ, 2011). New Zealand produces about 0.39 % of the world's apples but is largely export driven and captures 3.86 % of the global export trade (World Apple Review 2012).

#### *2.2.4.2. International competitive position of the industry.*

The World Apple Review considers pipfruit producing countries on the basis of 22 factors. Starting in 1996, the report shows New Zealand as leading a group of 28 countries between 1996 and 2002. Internationally, NZ was considered the most competitive country in the world. The 2002 review (World Apple Review, 2002) comments that New Zealand is both succeeding and failing in an attempt to become more effective as the food distribution system changes. The review mentions the 'old' marketing system being managed by one company (ENZA Limited), allowing the introduction of new premium apple and pear cultivars on the world market and allowing above average market returns which compensated for the long distance from major markets (World Apple Review, 2003).

Following 2002, the 2003 review report expresses the expectation that the industry may find itself in an awkward position because the government withdrew its funding for the involvement of HortResearch[5] into innovation of the industry. Since then, the NZ position has turned into a roller coaster ride with NZ dropping to second in 2003, dropping to third in 2009, to fifth in 2010, back to fourth in 2011 and to second again in 2012 (World Apple Review, 2002, 2003, 2009, 2010, 2012).

The 2013 OECD report on labour productivity levels shows NZ as a country lagging behind the OECD average in presented metrics (OECD, 2013). This contrasts with the NZ position presented in the 2012 World Apple review. It is not the intention of this document to criticise either review process, but the question must be asked how a country that believes the industry is hardly viable in 2005 can be placed second on the international competitiveness scale while economically being projected well below the average of the OECD indicators (OECD, 2013). It points towards a dichotomy between the different perceptions or towards an industry that performs better than the national average despite reports to the contrary. Future research may explain this phenomenon which falls outside the scope of this inquiry.

### 2.2.5. NZTE approach to introduce Lean to improve the industry's position

In 2008, New Zealand Trade and Enterprise (NZTE), following several discussions with Pipfruit NZ, offered the industry funding for those who intended to focus on Lean production. The NZ Government had already created similar opportunities for a number of manufacturers in 2005 (the 'Aichi' and 'Direct' Lean programme) through to 2008 (Goodyer et al, 2011). The uptake of the Pipfruit NZ initiative amongst pipfruit organisations was poor with only three companies participating in an expansion of the initial session, despite NZTE offering substantial co-funding of participation. In my personal conversations with the three organisations, none of the three claimed to have been successful with Lean implementation following the initial training (personal communication with stakeholders, May 25, 2012; May 30, 2012 and June 7, 2012).

[5] HortResearch (Horticulture and Food Research Institute of New Zealand Limited) was a semi-commercialised Crown Research Institute which became Plant & Food Research in 2008.

NZTE introduced Lean programmes, as have at least five other government departments (Wilson et al, 2008). The sustainability of these programmes has been questioned during a follow-up study, several years later with only one of eleven companies looking most likely to sustain Lean by having strong leadership and management commitment (Goodyer et al, 2011) and investing in 'below the waterline' enabling approaches (Hines et al, 2011a). The "Lean – Windshift" study (2011), also commissioned by NZTE, appears to be a commercial study without reference to a scientific foundation. The three studies show different pictures, ranging from enthusiasm (Wilson et al, 2008) to a critical look at sustainability (Goodyer et al, 2011) and 'on-the-fence-sitting' (Windshift" study, 2011). However none of these studies looks specifically at the horticultural sector which represents 7.8% of all NZ exports (FreshFacts 2013). In addition, Lean cannot be implemented thoughtlessly into a different industry type (e.g. Fillingham, 2007). These indicators imply that it is difficult enough to implement and sustain Lean, perhaps more so if Lean has not been tested in specific industry sectors. The Lean component of the literature review elaborates on the currently available knowledge base.

### 2.2.6. Pipfruit industry internal supply chain current state

Growers have relationships with packhouse/coolstore combinations and exporter/traders (Figure 2-3), each completing a number of tasks. Immediately after growers harvest, they will submit bins of fruit to coolstores to maintain storage-life and thus quality. At the start of harvest, coolstores may build up some stock to allow continuous packing by packhouses once packing starts. Packhouses pack product and store packed product (pallets) in coolstores to maintain quality. Packing typically starts mid-February and is often completed somewhere in June or July each year. Traceability will be maintained for food safety and quality (e.g. BRC Global Standard for Food), for regulatory requirements (e.g. MPI systems) and bill payments. Relationships within the intra-industry supply chain have a degree of complexity (figures 2-4 and 2-5).

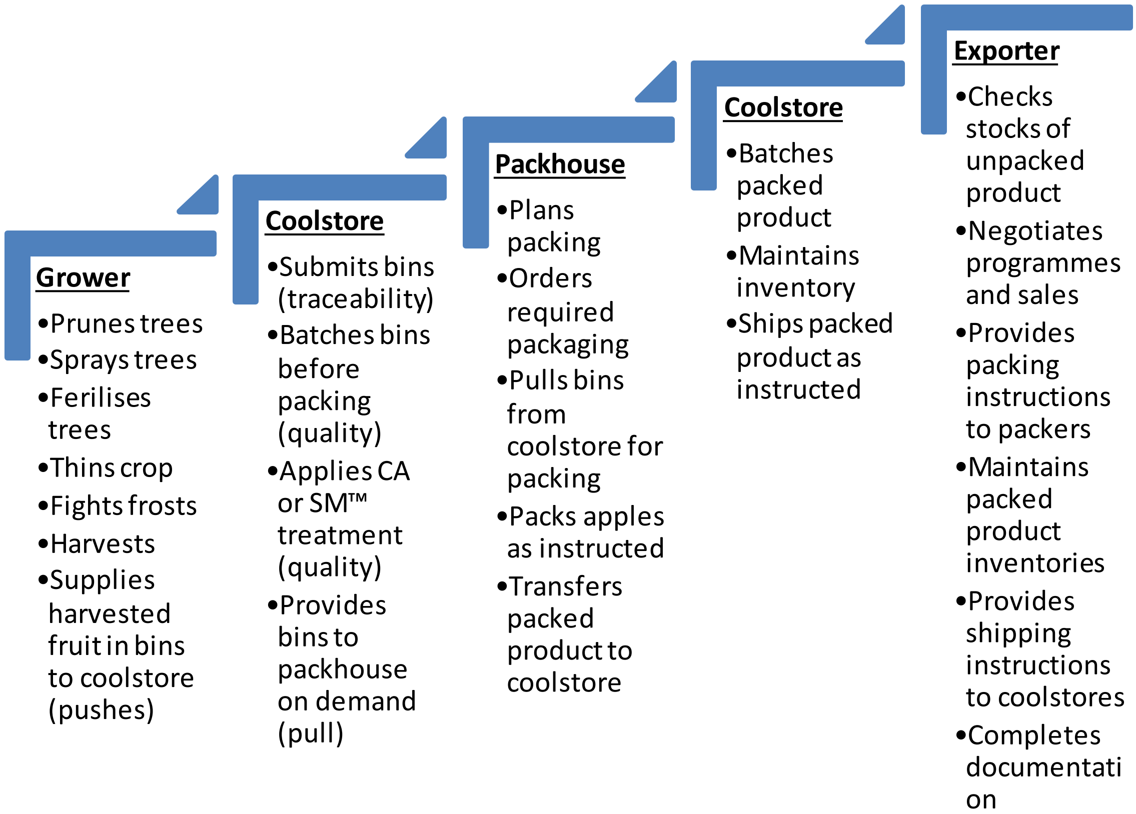



FIGURE 2-3: RESPECTIVE OPERATOR TASKS BY CHRONOLOGICAL ORDER (FOCUS GROUP REVIEWED).

Growers generally have little direct influence on where their fruit is going to be sold; in principle, growers will want to get the best price for their fruit and leave the marketing to the exporters. The exporter/trader will market the grower's fruit, provide storing and packing instructions to the packhouse and thus determine some of the costs that the grower incurs (The grower pays packhouse and coolstore bills). Some exporters pay for agreed extra packing/packaging/storing charges and generally recover these payments by charging the grower and deducting the costs out of the market returns. All this time, right up to the moment that the fruit is physically sold, the fruit is generally owned by the grower. This process is referred to as consigning or selling on consignment (Business Dictionary, 2013). It is rare that the exporter buys the fruit from the grower. This means that the grower runs all the risk while the exporter determines how the product will be packed, attempting to maximise value.

Depending on the fruit varieties that a grower produces, the grower may not fully control which exporter trades his fruit, e.g. in case of Intellectual Property (IP) fruit, the rights to which may be owned by a single exporter (Doevendans 2010).

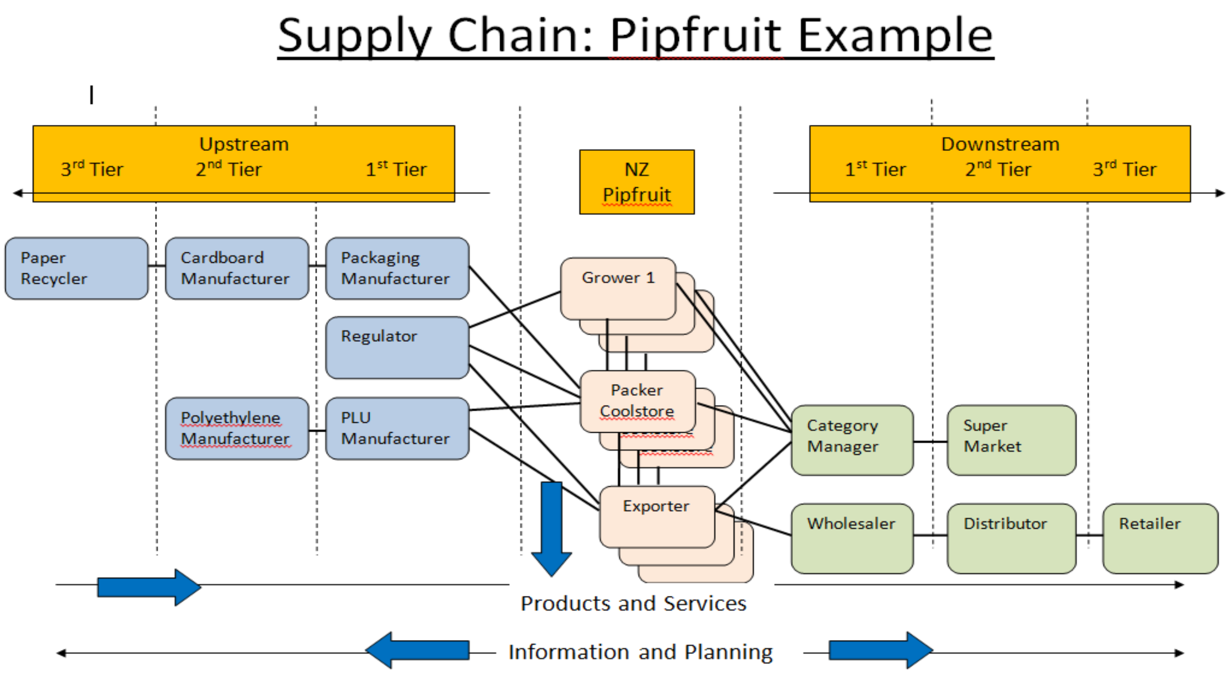



FIGURE 2-4: PIPFRUIT ACTUAL SUPPLY CHAIN EXAMPLE (FROM DOEVENDANS AND ROSS, 2011).

### 2.2.6.1. Complexity of customer requirements

Customers require apples and pears to be packed in a large variety of 'pack-types', e.g. 'Z-packs', RSTs (Retail Single Tray), RDTs (Retail Double Tray) and others. Each type of carton is manufactured in different sizes for different size brackets of fruit. In addition, each pack-type usually has different graphics for different exporters and end-customers. More than 200 different pack-types can be manufactured by a single packaging company.

Fruit is packed into cartons on moulded trays, manufactured from recycled paper. These trays are produced in different colours and a different tray is manufactured for each fruit size/count (the number of apples per carton by size); some counts/sizes have 'reversible' trays, trays that can be reversed for each layer of fruit so that fruit on the second layer sits partly in between the top of fruit of the first layer to prevent bruising. Other sizes have 'A' and 'B' trays as the trays cannot be reversed. As a complication, some trays are used for different carton types, e.g. 110 count 'A' and 'B' trays are used for a 120 count/size 'maxi-pack' cartons (a 20 kg pack vs an 18 kg 'Z-pack').

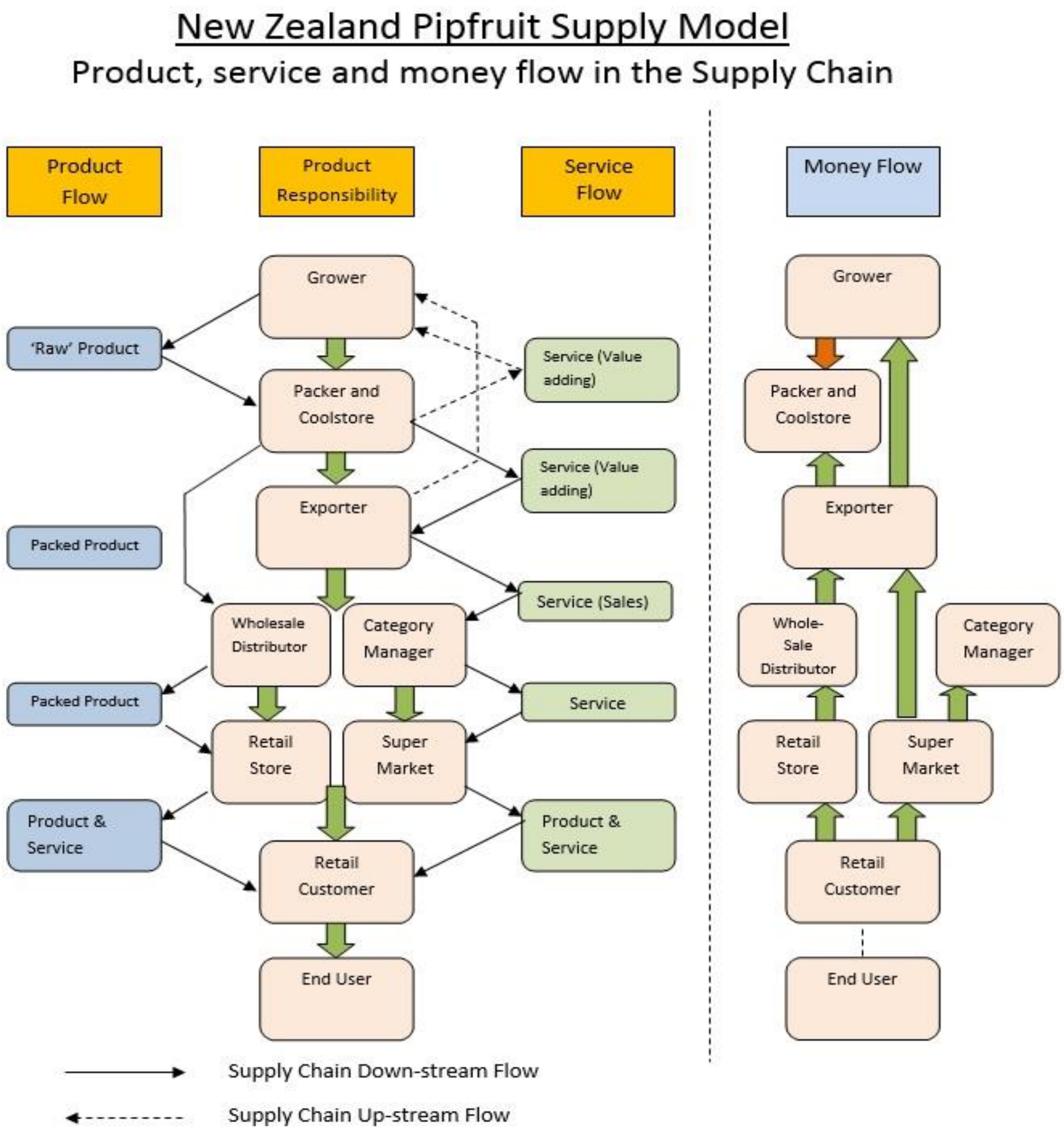



FIGURE 2-5: PIPFRUIT PRODUCT, SERVICE AND MONEY FLOWS (DOEVENDANS, 2010).

Product-Look-Up labels (PLUs) require similar production planning. There are different size PLUs for different size breaks of fruit and different brand PLUs for different customers. The

PLU manufacturer confirms that the range of PLUs approximates 300 (confirmed by email from the manufacturer on 10-10-2013).

Considering the complexity of the packing process where up to 20 different products may be packed simultaneously, the packing and packaging processes are complicated both in planning and execution.

#### *2.2.6.2. Convoluted relationship structure*

From the hereinbefore, it is clear that the relationship structure between grower, packer and exporter is convoluted as a result of the mixed information, instruction, product and monetary flows which have developed historically and are not well documented (Figure 2-5). As the industry consolidates further, there may be opportunity to provide straight-forward supply relationships and map a standardised supply chain. The current supply chain structure may not be conducive to a Lean supply chain.

### 2.2.7. Main attributes of the fruit, affecting supply to the customer

Fruit is a live, perishable product with a limited lifespan. In order to understand the impact of the product on Lean and vice versa, it is important to understand some of the idiosyncrasies of fruit and its production. To this end, some of the characteristics of the industry's products are described below.

#### *2.2.7.1. Varieties:*

There are a large number of varieties for both apples and pears (Appendix 2). The environment dictates largely what type of apple varieties can best be grown in specific areas. In 2013, 95.1 % of the NZ crop is represented by 11 varieties, while 3.3 % represents other apple varieties and 1.6 % represents pear varieties (National Pipfruit Crop Estimate 2013). From the moment that a decision is made to grow a certain variety, trees will not achieve full production until approximately seven or eight years later when they have achieved maturity (Wilson and Emms, 2009).

### 2.2.7.2. Count or size distribution:

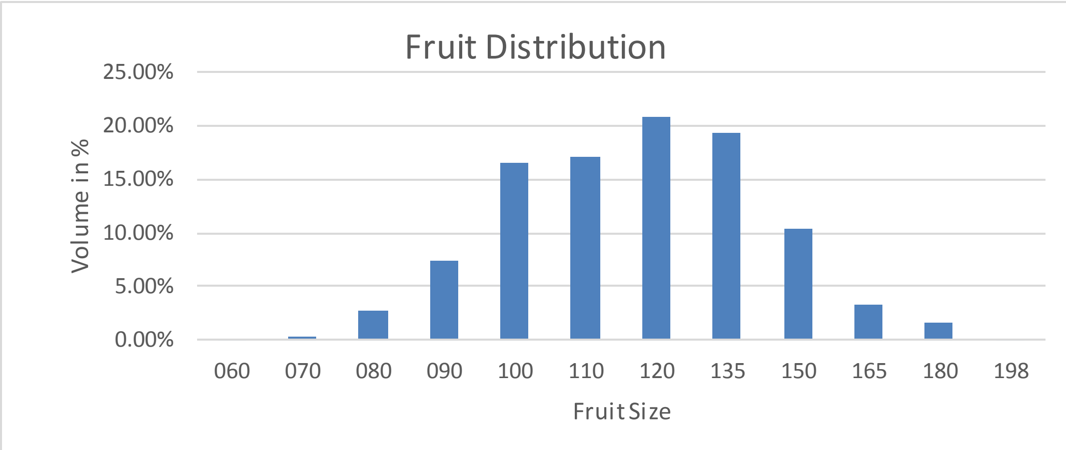



FIGURE 2-6: SAMPLE FRUIT DISTRIBUTION BY COUNT/SIZE (FOCUS GROUP REVIEWED).

Apples grow following a normal distribution. Figure 2-6 shows a typical size distribution. Size distributions vary for each variety. Customers in different countries typically prefer larger or smaller fruit. These trends are historical and well known; an example of typical export sizes to specific countries is attached as Appendix 3.

### 2.2.7.3. Colour:

Customers in different countries have different colour requirements. It is commonly known that Asian customers prefer bold red colours while European customers prefer striped coloured fruit or fruit with a 'blush'. Although colour is partly inherent to varieties, colour is also intensified by seasonal circumstances. Warm days and cold nights typically bring out colour in pipfruit.

### *2.2.7.4. Disassembly before assembly?*

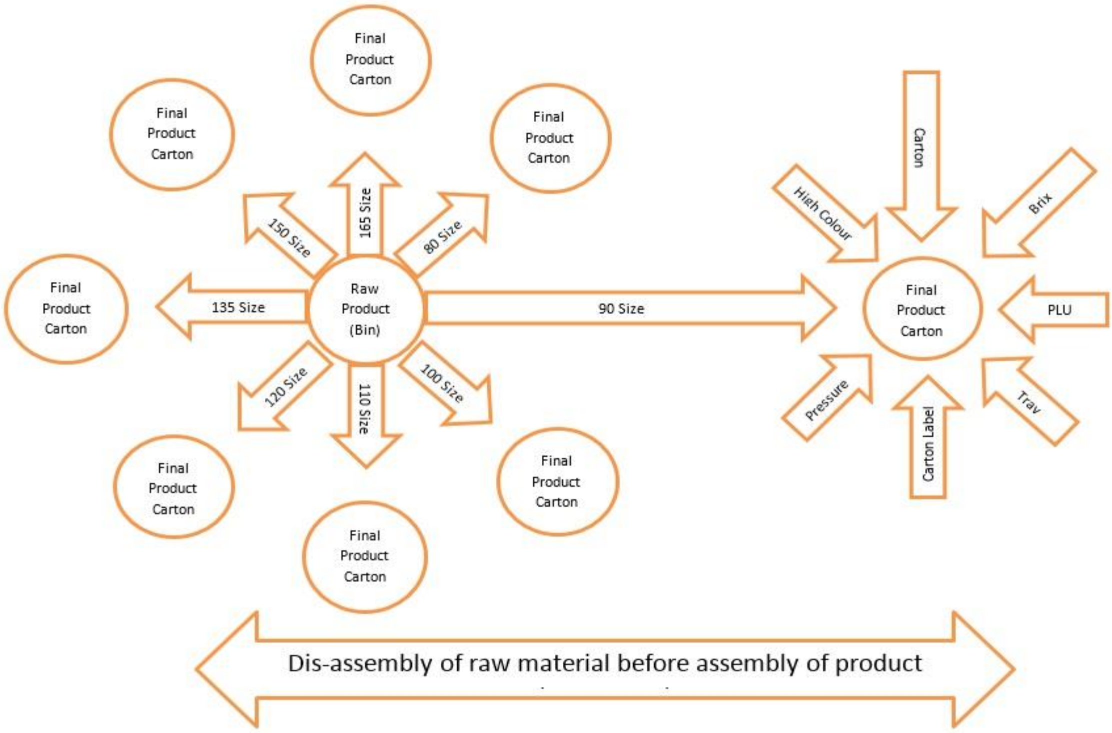



FIGURE 2-7: 'DISASSEMBLY' AND 'ASSEMBLY' IN PACKHOUSE (FOCUS GROUP REVIEWED).

The fact that size and colour can best be segregated in a packhouse means effectively that bins of fruit must first be disassembled into a number of size and colour combinations, before the customer product can be assembled into a packed carton (figure 2-7).

### 2.2.8. Seasonal 'push' of the industry

The conflict between Womack and Jones' Lean principles (Womack and Jones, 2003) and horticultural industries such as the pipfruit industry starts with the single annual fruit production cycle, culminating in a production process that is typically 'Push'. 'Push' and 'Pull' are characteristic elements of supply chains, as is the case with Toyota. Womack and Jones (2003, p71) as an example quote an operating doctrine that states:

> *"Don't make anything until it is needed; then make it very quickly"*

This operating doctrine typifies Lean production but does not fit easily with fruit production and only partly fits the packed product. The fundamental fruit supply chain components are typically 'push' as production cannot easily change. As customer demand can be more accurately forecasted, 'pull' strategies are more likely towards the customer end of the supply chain (Simchi-Levi et al, 2003). 'Push-Pull' strategies define the point where a transition between one and the other takes place (figure 2-8). Where packhouses 'pre-size' fruit, the fruit can be packed later to customer requirement and shipped as required ('Pull'). For the most part however, fruit is packed continuously to level the load on the packhouse, and subsequently stored until required to be shipped. This demands substantial storage facilities.

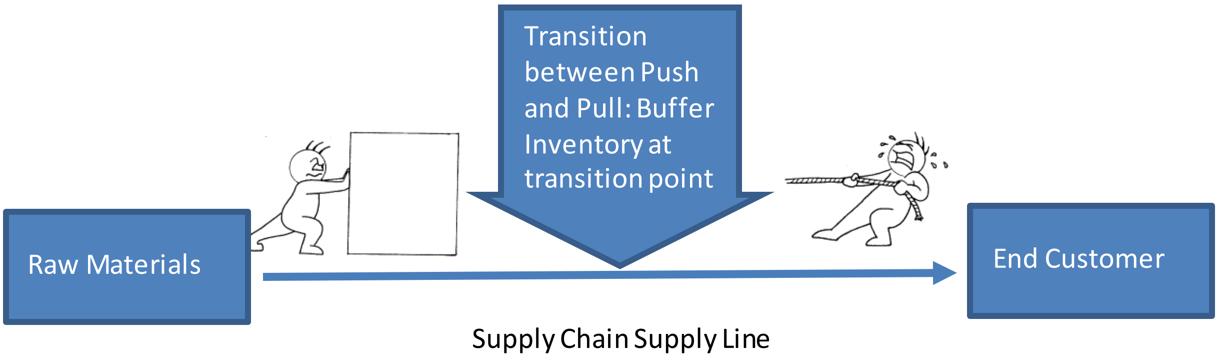



FIGURE 2-8: PUSH AND PULL ELEMENTS RELATED TO RAW MATERIALS AND CUSTOMER.

### 2.2.9. Market access constraints

Access to countries is regulated under the United Nations' Food and Agricultural Organisation (FAO). The FAO oversees the International Plant Protection Convention (IPPC), a treaty underwritten by 177 countries that secures action to prevent the spread and introduction of pests of plants and plant products, and promotes appropriate measures for their control (IPPC website: Retrieved 10-1-2013). MPI as the National Plant Protection Organisation (NPPO) provides country-to-country guarantees that New Zealand will not export product with quarantine pests and diseases. This effectively creates a body of regulatory compliance requirements and places substantial constraint on operations to achieve market access for their product. A number of specific programmes and procedures must be followed by operations, none of which add value for the customer. Pipfruit NZ recognises market access as Pipfruit NZ's number one priority (Pipfruit NewZ, June 2013).

## 2.2.10. The role of people and leadership

### *2.2.10.1. Manual labour requirements*

The last 100 years has seen major economic shifts. Birch (1987, in Zeithaml et al, 1990) reports that jobs in the agricultural sector in the US have dropped from well over half of all jobs to 2%. The shift from primary production and industrial activities to service delivery and data processing is substantial (figure 2-9). The pipfruit industry however still relies upon a substantial manual labour component. A sudden ten-fold increase in staff numbers during the harvest and pack season presents specific challenges (Grigg and Doevendans, 2011). Orchards spend more than 50% of their expenses on wages and salaries (MAF Horticulture and Arable Monitoring Report 2008 & 2009); packhouses spend more than 40% and exporters estimate their wage/salary bill to run between 58% and 65% of total expenditure (Doevendans, 2010).

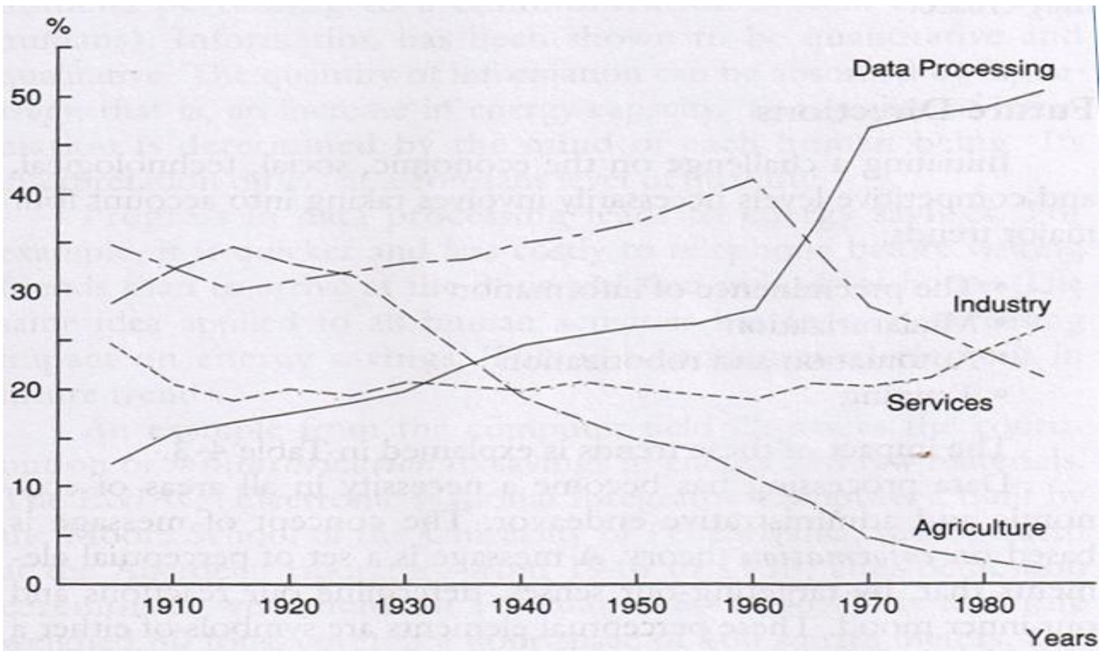



FIGURE 2-9: DEVELOPMENT OF LABOUR ACTIVITY TRENDS DURING THE LAST CENTURY (ADAPTED FROM PERIGORD, 1990).

#### *2.2.10.2. Leadership, general and within the industry*

A contemporary study into leadership in New Zealand businesses concludes that NZ owner/managers show an excessive focus on short-term goals and lack long-term strategy (Kennedy, 2000). The management style tends to be one of little empowerment with owners making most decisions (Green et al, 2011). Both Kennedy and the 'Management Matters in New Zealand' paper (Green et al, 2011) argue that NZ owner/managers are generally innovative but have limited leadership skills. Wilson et al (2008) refer to the Auckland 3 B's, the Bach, the Boat and the BMW, as a measure of success. Being successful makes owners hesitant to open up to new ideas because the evidence that the owner's approach is correct lies within their success (having the 3 B's). Masaaki Imai, in an interview (Jayne, 2010) argued that most of the change process is initiated by middle managers with limited jurisdiction. Owner/managers who do not accept initiatives by middle managers, will continue along the path of short-term production systems and continue to present a debilitating inward-focus. Business NZ (2006) finds that there has been an over-reliance on boosting production through longer hours and the use of cheap labour. It appears that leadership in general in NZ is in question.

Historically, many pipfruit organisations are family organisations or were borne out of family organisations. These organisations brought with them hard workers who left school early and had little formal training (Mannering, 1999). Doevendans (2013) discusses the importance of choosing a direction rather than maintaining heuristic non-directional models. Leadership within the industry is not robustly structured and internal competition does not contribute to strong directional development within the industry.

### 2.2.11. The role of science and technology

The industry has invested substantially in the development of science-based approaches towards growing better fruit with fewer diseases and affected less by seasonal and climatic conditions. In addition, the industry has invested in 'open-to-all' industry database systems, and a variety of equipment and other innovations. A number of these science based approaches are reflected in monitoring and spray programmes to combat fungi and pests with the lowest possible environmental and ethical effects. These have been well documented in the Pipfruit NZ technical library.

Technologies include the development of grading and sizing equipment of world quality. NZ equipment is used around the world and can accurately size fruit, distinguish between colour parameters and in recent years has achieved substantial progress in defect grading (e.g. http://www.compacsort.com/). Other equipment includes 'high volume apple washers' that clean pests off fruit, facilitating market access and thus making fruit available for the customer in specific countries. This technology is only documented as equipment requirements in MPI provided country specific programmes (e.g. MPI Phytosanitary Compliance Programme for the Export of Apples to Taiwan 2012-2013) but not as process-improvement technology.

#### *2.2.11.1. New fruit varieties*

The pipfruit production system is unsuitable for short term changes to either product attributes or production cycles (volume); production is partly opportunistic and partly based on long term trends. Varieties and volumes are largely dependent on the number of trees 'in-the-ground' and production density (density of tree plantings per hectare). To positively change a product volume in the pipfruit industry will generally take between five and eight years.

#### *2.2.11.2. New varieties and time-based pacing*

The approach towards development of new varieties likens time-based pacing (Eisenhardt & Brown, 1998) which has been identified predominantly as a strategic tool for introducing product change in a fast-changing environment. Considering the time required to develop new varieties, event-based pacing (Brown and Eisenhardt, 1997), a reactive strategy—if it could be qualified as a strategy—is a poor strategy for an industry such as the NZ pipfruit industry. Time-based pacing is a strategy for regular innovation in a fast paced environment. Time-based pacing may equally apply to time-consuming innovations–e.g. it may take a minimum of twelve years to develop a new variety in a slow paced environment (personal communication with Prevar's Chief Executive, September 20, 2013[6]); it may perhaps even be more applicable in that environment where, once a new variety is successfully launched by a competitor or competing country, it is likely to take a long period of time to catch up.

Time-based pacing as a strategy may need to be developed further for industries such as the NZ pipfruit industry where conventional development of a variety can take twelve to fifteen years, and commercialisation another ten years. The industry may require a continuing variety development programme—which it has in the form of Prevar Ltd—followed by time-paced commercialisation. Summarising, in order to produce a new variety for market, there is a twelve to fifteen year development period, followed by a commercialisation period estimated at ten years, which may or may not include a grower's period from planting to full production.

### 2.2.12. Industry processes

The sections above discuss a number of basic aspects of the pipfruit industry where these can be found in literature. Most of the reference material is not stemming from academic studies or research reports. Where data are obtained from industry or websites such as OECD, we can expect the data to be reliable. Similarly, several industry research reports have been scrutinised by industry and although not following the academic format per se, allow a measure of confidence in the accuracy and validity of these reports.

The fact that there is little literature researching industry processes other than technical processes is both curious and concerning. Frater e.g. observes that only 9.9% of articles in the national horticultural magazine relate to management subjects, of which 4.3% (a total of 0.43%) relates to Research and Development and a further 1.8% (0.18%) relates to innovations, patents and IP protection (Frater, 1999). Frater researches innovation management in the NZ pipfruit industry using survey and two case study trials, and finds that there is little familiarity within the industry with innovation practices (Frater, 1999). His findings are corroborated by Doevendans (2010) who uncovers low levels of total quality management awareness (TQM) within the industry. Interestingly, both writers are

[6] Prevar™ is an international joint venture and registered company established to develop and globally commercialise new apple and pear varieties and products. Pipfruit NZ is a major shareholder in Prevar.

professionals in their fields, and both express concern at senior management reactiveness and short term thinking when investigating industry processes.

This research project intends to fill part of that literature gap and contribute original knowledge to the fields of Lean and pipfruit. Having so little literature available was compelling in making the decision to describe minimal industry idiosyncrasies that enlighten the reader and assist with a holistic view of the industry.

### 2.2.13. Summary of key characteristics of the NZ pipfruit industry

The pipfruit section presented a number of idiosyncrasies of the NZ pipfruit industry as a whole insofar as these can be found in literature, and looked closer at a number of industry elements. The NZ pipfruit industry and to some extent horticultural industries in general can be summarised as follows (table 2-1):

TABLE 2-1: KEY CHARACTERISTICS OF THE NZ PIPFRUIT INDUSTRY.

| Customer / consumer |
|---|
| • Customers: Customers include category managers, supermarket chains and floor traders<br>• Consumers: End-consumers are people of all gender, ages and economic and social levels<br>• Taste: Consumer taste is substantially culturally bound |
| **Product** |
| • Product development: Development of a new variety can take between 12 and 15 years<br>• Commercialisation: Growing sufficient supply involves producing enough to cope with customer demand and can take a minimum of 10 years to build up<br>• Volume/cost relation: Pipfruit is a high-volume, low-cost product, satisfying basic human needs<br>• All year every-day supply: Customers and thus consumers expect to be able to supply and demand the product every single day of the year; note a northern and southern hemisphere aspect to be present<br>• Shelf life: Pipfruit has a forced customer life cycle of close to one year, provided quality cool-chain<br>• Variety: There are hundreds of existing varieties, mostly with subtle differences<br>• Variability: Seasonal and natural circumstances create variability in the product |
| **Processes** |
| • Main process: The growing process cannot be stopped once in progress<br>• Product change-over: Growing a new product takes a minimum of around eight years<br>• Seasonal processes: Processes are substantially determined by seasonal conditions<br>• Decision making: Many decisions are based on complex growing process and weather pattern combinations and thus challenging to standardise<br>• Assembly and disassembly: Product is grown, converged into a bin, disassembled and reassembled in a packhouse<br>• Just-In-Time: Does not apply to growing fruit but can be implemented at subsequent steps |

| | |
|---|---|
| **Resources** | |
| | • Infrastructure: Growing land and coolstores and packhouses<br>• Manual labour: Large temporary workforce, mostly unskilled<br>• Equipment: Variety of orchard, packhouse and coolstore equipment |
| **Logistics** | |
| | • Distance to market: Distance to market is substantial; all transport includes ships, costing time<br>• Push/pull: Supply and demand is both push and pull with relative predictability<br>• Inventory: Inventory building from ISO week 6 to ISO week 20-24, then gradually subsiding<br>• Market access: Regulatory restrictions determine where fruit can be shipped |
| **Seasonal influences** | |
| | • Forced actions: Seasonal component forces actions<br>• Activity periods: Different activity periods in different segments of the industry<br>• Weather: Weather has a significant impact on required actions, quality and quantity of fruit |

## 2.3. Lean

Lean was popularised as a paradigm in the book 'The machine that changed the world', in which the authors acknowledge that the term 'Lean' was first coined by their colleague John Krafcik because Lean '*uses less of everything compared with mass production*' (Womack, 2013). Specifically since that time, Lean has been extensively studied and described, both in popular and academic formats.

The following section considers various production improvement initiatives, summarises some historical developments around Lean, and discusses applications of Lean in the manufacturing and other industries. Lean successes and failures are examined as well as the identified reasons for these successes and failures. Lean philosophy and methods or tools are discussed and the availability and themes of existing pipfruit and horticultural literature in relation to Lean are discussed.

### 2.3.1. Enhancing productivity: Historical approaches, methods and techniques

During the past century, production has improved significantly, mostly through technological advancements. The world of science contributed to our understanding of the world and numerous scientists are considered to have contributed 'breakthroughs' that enhanced productivity. Although this process has gone on for thousands of years, it is only recorded history that facilitates tracking contributions to productivity improvement; in fact, the printing press –facilitating historical record keeping and dissemination and thus indirectly innovation-represents one of many technological breakthroughs. Since the nineteenth' century industrial revolution in the UK, productivity improved with most innovations being of a technological nature. Wells describes the period as if the world had been developing production equipment and saved deployment until just before the industrial revolution.

> *"The economic changes that have occurred during the last quarter of a century or during the present generation of living men have unquestionably been more important and varied than during any former corresponding period of the world's history."*
> *(Wells, 1889, pv)*

This technological drive has continued to develop at a continued acceleration, not seen before (Oram, 2012). The focus of this inquiry is however in the socio-technical field, a field that links people and technical knowledge and skills in order to manage supply variability, processing time and demand (Shah and Ward, 2007). It has a focus on how people and processes improve production.

#### *2.3.1.1. The world of socio-technical and related production improvement*

<u>The early pioneers</u>: An arbitrary point to start looking at manufacturing paradigms is the works of Gilbreth (1919) and Taylor (1919). Gilbreth and his wife, industrial engineers in the late 1800's, studied the bricklaying process in order to improve bricklaying output. Their time and motion studies focussing on 'flow' (1911) helped make numerous process improvements and increased productivity.

Taylor studied production from an efficiency perspective. His focus was on finding the best way to do a job through analysing the process steps and recognising that workers would only do the minimum required to keep their jobs. His introduction of piece rates and 'standard best practice' changed productivity markedly. Although his work became known as scientific management, Taylor originally called his work 'process management' ( Pryce, in Nelson, 1992)

Since Gilbreth and Taylor, a number of socio-technical system have been developed. Henry Ford developed a moving assembly line in which he created 'flow' by aligning manufacturing equipment at each assembly step to produce needed parts at a set production speed (Arnold and Faurote, 1915). Ford's multiple improvements in a time when mass consumption started to develop set the scene for years to come (Stamm et al, 2009). Mass production remained relevant until the 1970s, when the USA found that the Japanese were producing better products with more variety than the USA could produce (Vogel, 1979). It became the start of a mini avalanche of new production management systems, the most well-known of which are discussed briefly in the following section in a more or less chronological order.

Just-In-Time (JIT) and Toyota production System (TPS): During the 1950s, Ohno developed the Kanban system based on Toyoda's idea of Just-In-Time (JIT). The Kanban system is a practical method to order stock as and when needed. Sugimori et al (1977), regard JIT and 'Respect for Human' as pivotal to the Toyota Production System (TPS). The lack of natural resources in Japan led to a system where stocks were kept low as principle, leading to delivery 'just-in-time' for production to remain uninterrupted. Allowing workers to run and improve their own workshops through active participation was another main principle of the TPS. TPS is discussed in more detail later in this section. JIT was overtaken as approach by the more holistic Lean approach (which included JIT) which reflected the TPS.

Total Quality Management (TQM): The term Total Quality Management (TQM) has been attributed to Feigenbaum (1957, in Ishikawa, 1985) although Ishikawa (1985) makes the point that Feigenbaum adopts the western approach of having quality specialists, whereas in the Japanese philosophy all departments and all employees are involved to achieve an integration of quality control. TQM involves organisation-wide efforts to deliver high-quality outputs to customers (e.g. Deming, 1986) and became widely accepted as a production improvement paradigm in the early 1980s. Ishikawa makes the point that in broad terms, quality control means management control (1985). While there is no widely agreed-upon definition, Bounds et al (1994) argue that TQM involves people, management systems in a total management approach, customer satisfaction, lower real costs and extends horizontally and vertically, forwards and backwards through the supply chain. TQM efforts typically draw heavily on the previously developed tools and techniques of quality control.

Theory Of Constraints (TOC): Theory of constraints focusses on enhancing production by removing constraints from production systems, based on the axiom that there is always one constraint to achieving the end-goal of making profit, otherwise production would be infinite. By removing the constraint, the system improves and exposes the next constraint to be addressed in an ongoing cycle of removing constraints (Goldratt & Cox, 1986).

Six Sigma: Six Sigma was the result of a 1986 initiated improvement drive by Bill Smith and Bob Galvin, both of Motorola. Six Sigma uses a set of quality management tools to reduce the number of defects to a theoretical 3.4 per one million. It is a quality improvement initiative with a focus on decision making processes based on measurements (e.g. Linderman et al, 2003). Six Sigma is seen by some as a progression from TQM considering a number of similarities between the two (Näslund, 2009). Gershon (2010) argues that all of the Fortune 500 companies have implemented Six Sigma. Comparing a number of process improvement methods, he believes that Six Sigma encompasses all that TQM does and removes some of the TQM weaknesses such as management not participating, group project work not being promoted and the lack of implementation methodology. He believes that most paradigms fall under the TQM/Six Sigma umbrella with the exception of Lean.

Benchmarking: Benchmarking compares business practices with other company's business practices, often after comparing numerical measurements. Using a successful firm's practices that have led to the success in that area, the benchmarking company then learns what these companies do that makes them successful and initiates improvement of its own processes (e.g. Camp, 1989).

Lean: Lean developed from Toyota's inception as a car manufacturer in the late 1930s because Toyota identified that the market for their vehicles was smaller and more demanding than the US market in which Ford manufactured, requiring production on demand to customer variety. Lean developed as a management system where production was assisted by involving people, solving problems, introducing JIT, autonomation and supplier integration and many tools. Lean is doing more with less for the customer by focussing on waste reduction at all levels of product manufacturing. Lean focusses on reduction of variation, flow, inventory reduction through Just-In-Time, continuous improvement through people involvement and is people and process oriented (e.g. Womack and Jones, 2003).

Business Process Reengineering (BPR): In 1990, Hammer (1990) described how companies tend to use technology to mechanise old ways of doing business. Hammer believed that this was only speeding up outdated processes, based on unarticulated rules. He believed that processes had to be redesigned from scratch to improve production, ignoring the historical reasons for old processes because the environment has changed. Business Process Re-engineering (BPR) intended to make organisations re-think how they were doing things, simplify processes and reduce the waste in those processes. BPR soon became a 'fad' (Carson et al, 1999), used to reduce the number of employees, which was missing Hammer's point.

Agile: Agile manufacturing, 'the next logical step' (Hormozi, 2001), recognises that reaction time is an important competitive factor in meeting customer demand in a fast changing environment, and Agile's focus on manoeuvrability and responsiveness extends to the supply chain (Christopher, 2000).

Leagile or Leagility: A combination between Lean and Agile leads to the term 'Leagile' (e.g. Mason-Jones et al, 2000). Others, such as Ben Naylor et al (1999) make a case for the combination of Lean and Agile, using the strengths of each in a synergistic approach to a market environment: Agile Manufacturing is tailored to satisfy volatile markets, while Lean has a focus on eliminating waste and creating flow. Relevant in their discussion is the insertion of a decoupling point at the transition point between Lean and Agile.

Lean Six Sigma: Lean Six Sigma has been described as the latest improvement 'fad' to be discussed (Näslund, 2008), although Snee (2010) describes it as a natural evolution of business improvement methods. Schonberger (2007) discusses Lean Six Sigma without actually defining the concept while George and George (2003) summarise the use of Lean speed and Six Sigma quality in a combination of the two. Lean Six Sigma is said to provide the concept, methods and tools to change processes, many of which improve flow and involve human resources (Snee, 2010).

Material Requirement Planning (MRP) and Enterprise Resource Planning (ERP): Material Requirement Planning (MRP) is a time-phased planning technique that calculates and prioritises material requirements and schedules the supply of materials to manufacture products on-time with low inventories (Orlicky, 1975). Orlicky's system was re-developed into 'Manufacturing Resource Planning' (MRP-II) by Wright (1995) in order to include other concepts such as capacity planning and particularly to use software to assist businesses with their planning processes. A further development continued with Enterprise Resource Planning (ERP) software as a way to speed up the supply chain process, but the implementation of ERP as a system is complicated (Wang et al, 2014) and requires specialist involvement.

#### 2.3.1.2. Summarising productivity improvement initiatives

Table 2-2 provides a brief overview of several productivity improvement initiatives that emerged during the past century, referring to the driving factors leading to each initiative and the initiative's attributes.

TABLE 2-2: HISTORICAL PRODUCTIVITY IMPROVEMENT INITIATIVES, DRIVERS AND ATTRIBUTES

| Year | Paradigm | Driving Factors | Attributes |
|---|---|---|---|
| 1911 onwards | Scientific Management | Efficiency | Piece rate, process steps, standard best practice |
| 1910 onwards | Early Fordism | Consumption increase, price | Line flow, produce parts in-line as needed (Highland Park only), reduce waste |
| 1922 onwards | Mass Production | Mass Consumption, price | Line flow, batch and queue production |
| 1940 onwards | JIT, TPS, start of Lean | Consumer variation demand pulls production | Toyota Production System including JIT, respect for people and continuous improvement at all levels |
| 1980 onwards | TQM | Underperformance in the US | Organisation wide implementation of quality tools/culture |
| 1984 onwards | TOC | Productivity through systematic constraint removal | Maximise effectiveness of constraint; adjust all else to the constraint |
| 1986 onwards | Six Sigma | Quality drive to improve Motorola's performance | Tools/techniques for process improvement based on statistics |
| 1989 onwards | Benchmarking | Focus on best practice learning | Process improvement through comparison with best practices |
| 1990 onwards | Lean popularised | Produce to customer demand, enabling product variation | Focus on customer, using flow, pull, waste removal through continuous improvement |
| 1990 onwards | BPR | Importance of process re-generation as environment changes | Focus on completely re-designing processes to achieve the mission and rethink trend of buying technology |
| 2000 onwards | Agile | Response to rapid change in demand | Focus on quick adaptation in volatile environment |
| 2000 onwards | Lean and Agile ('Leagility') | Respond to fluctuating demand, reducing waste | Quick adaptation to volatile environment and achieve stable production |
| 2002 onwards | Lean-Six Sigma | Systematically reduce waste, using Six Sigma methods | Using Lean flow and speed combined with Six Sigma quality tools |

It is not in the interest of this inquiry to expand on the various production improvement initiatives, however some observations may be useful to share. As the pipfruit industry has a large human resource component (Grigg and Doevendans, 2011), any productivity improvement initiative has to take this into account. This is exacerbated by the fact that the industry is not a mechanistic producer of goods; it is subject to natural, i.e. uncontrollable influences; standards such as Six Sigma have not been designed for this type of industry. Similarly, the Agile concept is less suitable because trees take years to grow fruit while Agile responds to volatile market demands; this may be useful for exporters. TOC is largely unknown to the industry, as is BPR and some others such as Material Requirement/Resource Planning (MRP) and Enterprise Resource Planning (ERP), which span across the business and are not restricted to production. Some process reengineering takes place by individual companies, while others attend to some identified constraints; this happens organically and is not a focus on the paradigm or method. The intra-industry competition after deregulation prevented effective benchmarking. TQM had some intention in recent years (Doevendans, 2010) but remained ignored as paradigm by the industry.

Lean as a holistic approach to production improvement appears a reasonable fit for the industry considering its focus, its all-pervading approach and its wide application.

From the brief outline above, it is evident that there is no single best management or production paradigm. It appears more sensible to argue that although all improvement programmes share a number of common tools, it is the direction of the philosophy that leads the way for an organisation that intends to improve. Andersson et al (2006) agree that TQM, Six Sigma and Lean share many parallels, including methodologies, tools and effects. They opt for the simple suggestion that organisations could combine the three paradigms as they are partly overlapping and partly complementary.

There has been some discussion about 'fashionable' management methods. Carson et al (1999) comment on the life cycle of innovative management methods (fads) and discuss the transition point from 'fad' to permanent method. They discuss fifteen 'fads' ranging from the 1950s to the 1990s. Interestingly, neither JIT nor Lean are included in the list despite the fact that Lean was well established in the 1990s. In a different paper, Carson et al explore several psychogenic influences that drive leaders to move organisations into specific paradigms (Carson et al, 2002).

Because New Zealand has been placed low on the productivity index of the OECD over the past twenty years (e.g. OECD, 2013), both government and industries have engaged in Lean to improve productivity (Goodyer et al, 2011). As the New Zealand NZTE has endorsed and supported development of Lean production systems (Wilson et al, 2008), and several pipfruit organisations demonstrated an interest in Lean, this inquiry will focus on Lean as a paradigm for improving the productivity of the pipfruit industry.

### 2.3.2. Antecedents to the Lean paradigm

This section briefly touches on the early development of what today is called 'Lean'. Frederick W. Taylor and Henry Ford both produced seminal works which form a source where Lean elements are clearly identifiable. In order to exemplify the relevance of their work, it is useful to select several quotes from their work.

Although Lean as a word is ascribed to Krafcik by Womack et al (1990), the actual philosophy and paradigm appears to have been much longer in the making. As early as 1919, Taylor describes as purpose of his paper on scientific management the intention

> *"…to point out 'the great loss which the whole country is suffering through inefficiency in almost all of our daily acts"* (Taylor, 1919, p7).

In his influential work, Taylor examines the earlier motion and time and fatigue work of Frank and Lillian Gilbreth (1911 and 1919) to which he refers a number of times, each time analysing in detail Gilbreth's deductive steps. Important to note is that until Taylor developed his theory of scientific management, there was little interest in establishing management as a discipline (Slack et al, 2004). Taylor makes several fundamental statements indicating that, in the future, 'the system must be first', and that

> *'…the fundamental principles of scientific management are applicable to all kinds of human activities, from our simplest individual acts to the work of our great corporations.'* And……. *'that whenever these principles are correctly applied, results must follow which are truly astounding'* (Taylor, 1919, p7).

This last statement is strikingly comparable to the statement in Womack et al (1990) which was quoted in the introduction to this work. It may not surprise the student of Lean to read that the foundation upon which lean production principles were built as early as the late 1930s is based on Taylor's philosophy and approach (Shingo, 1992; Emiliani, 1998).

Similarly, Henry Ford describes how he could quite happily continue his current production system without changing it but how:

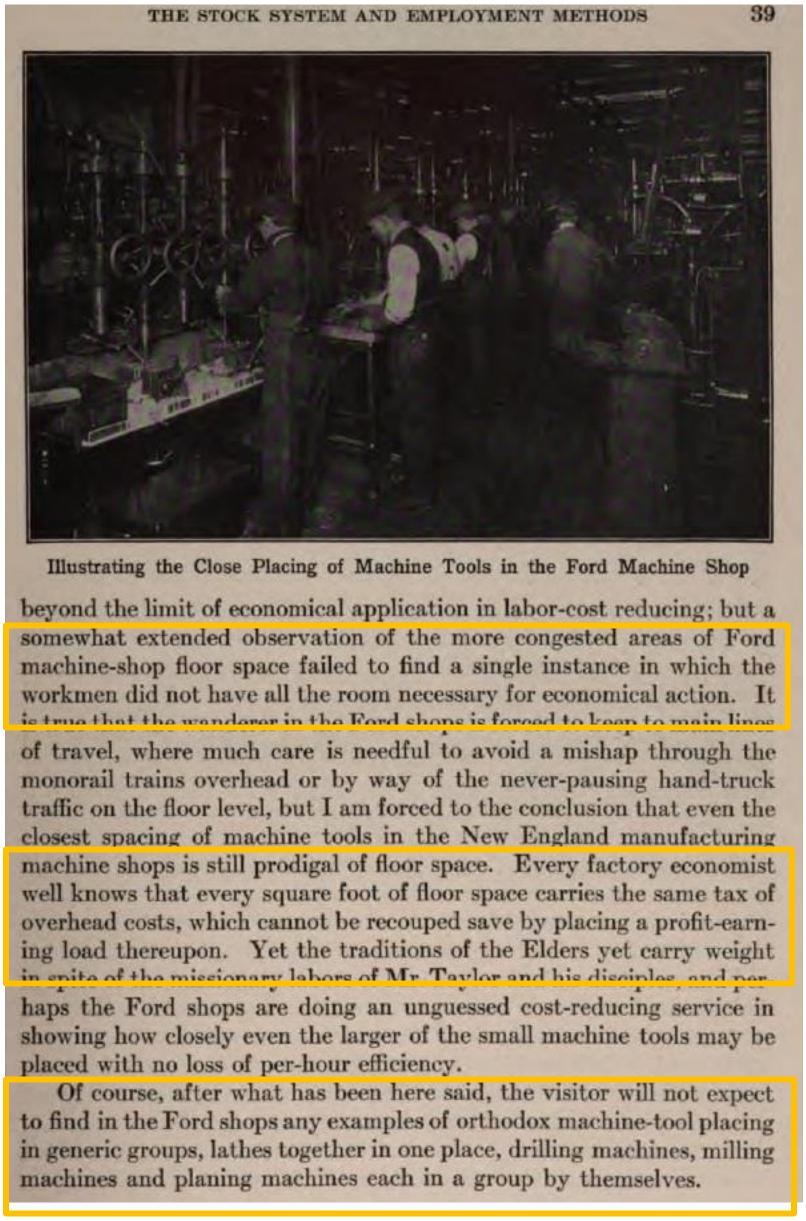
> *"The present system does not permit of the best service because it encourages every kind of waste—it keeps many men from getting the full return from service."* (Ford, 1922, p2).

Ford discusses waste motion, waste effort, waste weight, waste time and in general having eliminated a great number of wastes[7]. Ford also focusses on the customer when he states that

> *"There are always enough people ready and anxious to buy, provided you supply what they want and at the proper price—and this applies to personal services as well as to goods."* (Ford, 1922, p45).

Ford reports that the Plant at Highland Park has more machinery per square foot of floor space than any other factory in the world, quite similar to the way Womack et al describe the same for Toyota plants such as the NUMMI plant (1990). Arnold and Faurote (1915) describe the flow on the floor and explain that processes were brought to points where they were needed instead of being segregated in different departments (figure 2-10). This just-in-time principle appeared to have been developed intuitively by Ford.

[7] Ford mentions the word 'waste' or a derivative of 'waste' 87 times in his book 'My life, my work'.


THE STOCK SYSTEM AND EMPLOYMENT METHODS 39

Illustrating the Close Placing of Machine Tools in the Ford Machine Shop

beyond the limit of economical application in labor-cost reducing; but a somewhat extended observation of the more congested areas of Ford machine-shop floor space failed to find a single instance in which the workmen did not have all the room necessary for economical action. It is true that the wanderer in the Ford shops is forced to keep to main lines of travel, where much care is needful to avoid a mishap through the monorail trains overhead or by way of the never-pausing hand-truck traffic on the floor level, but I am forced to the conclusion that even the closest spacing of machine tools in the New England manufacturing machine shops is still prodigal of floor space. Every factory economist well knows that every square foot of floor space carries the same tax of overhead costs, which cannot be recouped save by placing a profit-earning load thereupon. Yet the traditions of the Elders yet carry weight in spite of the missionary labors of Mr. Taylor and his disciples, and perhaps the Ford shops are doing an unguessed cost-reducing service in showing how closely even the larger of the small machine tools may be placed with no loss of per-hour efficiency.

Of course, after what has been here said, the visitor will not expect to find in the Ford shops any examples of orthodox machine-tool placing in generic groups, lathes together in one place, drilling machines, milling machines and planing machines each in a group by themselves.

FIGURE 2-10: LEAN? CLOSE MACHINE PLACING AND FLOW CONCEPT AT HIGHLAND PARK (SOURCE: ARNOLD AND FAUROTE, 1915, P39).

And further on, Ford points towards continuous improvement when he states that:

> *"Hardly a week passes without some improvement being made somewhere in machine or process, and sometimes this is made in defiance of what is called "the best shop practice."* (Ford, 1922, p85).

As for keeping finished product stock, Arnold and Faurote state the following:

> *"No car is ever stored at the Highland Park plant for a single day, because this plant has absolutely no place to store its products save in railway cars…* (Arnold and Faurote, 1915, p31).

Both Taylor and Ford are original authors who report on their own work. Both appear to identify principle elements of what we call 'Lean' today. These great men discuss inefficiency, forms of waste, flow, team work, continuous improvement, standard processes and applicability of their principles to all types of firms, astounding results, and satisfying the customer with the right product at the right price. However, the early process-oriented production methods from Taylor and Ford have substantially collapsed into output-focused, short-term, results-oriented production systems that strictly dominate most of the manufacturing businesses in today's environment (Emiliani, 1998).

It appears that, unless we qualify Lean as something quite unique and specific, and despite the fact that Womack et al (1990) in their original work appear to propose that Lean was pioneered by Toyota in the twenty years after the end of World War II, Lean as it is recognised today was in fact substantially in existence in the early 1900s. Womack et al confirm that in an afterword to their 2007 edition of 'the Machine' in which they state:

> *"Toyota's achievement in creating continuous flow in conditions of high variety, market volatility and short product lives was truly brilliant, but it rested more firmly on Henry Ford's shoulders at Highland Park than we realized."* (Womack et al, 2007, p290).

There is sufficient evidence that generic best work practices lead to good results. Ichniowski et al (1996) and Pil and MacDuffie (1996), focus on actual and generic work practices rather than a specific holistic paradigm and point towards success as a result of those work practices. Fujimoto and Tidd (1994) and Scaffede (2002) also argue that TPS is not completely original, rather it is a system that mixed lessons learned from others such as Ford with inspired ideas.

It is apparent that there have always been work practices that lead to better performance. A name for a set of practices is in itself not necessarily relevant, although paradigms such as Lean tend to come with certain associations and focus the embracer's direction and approach, including focal points for employees.

### 2.3.3. Emergence of the Lean paradigm

During the decade before Lean emerged, several publications (e.g. Sugimori et al, 1977, Schonberger, 1982, Monden, 1983) described the Toyota Production system and Just-In-Time (JIT). Shah and Ward (2007) describe how, for a short period of time during the 1980s, JIT became the production system in the U.S. During this period of time, the US was already starting to realise that the Japanese production systems were superior. A 1979 book by Vogel, called 'Japan as Number 1' (Schonberger, 2007) and a NBC documentary called "If Japan can… Why can't we?", shown on television in the US in 1980 (Martinez-Lorente, 1998), detailed Japanese and US quality differences and aroused attention because it showed domestic production of inferior products and import of superior Japanese products (Martinez-Lorente et al, 1998). This may have been a pivotal point in the willingness to look at other paradigms.

The US had been comfortable for too long and grown complacent; it had become unable to change as rapidly as the environment, one of the prerequisite conditions to episodic change (Weick and Quinn, 1999). The national ego had been shaken and the identified crisis led to the US being ready for change (Gersick, 1991). Quality management and production systems started getting more attention in the US from 1980 onwards as is evidenced by the creation of the Malcom Baldrige awards in 1987 (Bounds et al, 1994) and the increased volume of Lean publications. Both Total Quality Management (TQM) and 'JIT', which soon became 'Lean' were two emerging paradigms in the US because the time was right. Schonberger adds a third area of interest as the area of employee involvement. He also points to the outpouring of articles during the early 1980s (Schonberger, 2007) as evidence that the US was looking for change. It is questionable if these paradigms would have been considered if the gap had not been that wide.

During the same 1980 period, Schonberger discussed 'frugal manufacturing' (Schonberger, 1987). His description of 'frugal manufacturing' substantially parallels the Toyoya approach as he describes that equipment replacement programmes are not necessarily the right answer. Schonberger is critical about the school of thought focussing on bigger and faster machines. Instead, his recommendation is to maximise conventional equipment effectiveness and focus on capability to modify and customise machines. Schonberger also made a case for continual modification instead of large scale automation projects (1987). Ohno himself stated as early as 1983 that TPS was born out of Toyota's efforts to catch up with the west '*without the benefit of funds or splendid facilities*' (Monden, 1983). Monden 'westernised' TPS with his

1983 explanation of the Toyota Production System and his seminal work made Lean more accessible to the manufacturing industries (Monden, 1983). All the prerequisites for the adoption of a new paradigm were present. It was just a matter of introducing a catalyst.

When Krafcik termed the Toyota production system a 'fragile production system' in contrast to 'robust production systems' (Krafcik, 1988a), it was because the Just-In-Time (JIT) process could easily lead to system breakdowns as opposed to conventional 'robust' manufacturing which was based on large stocks, long runs, large spaces and singly skilled employees. Robust production systems were presumed to be less likely to break down. Fragile required more investment in people and training for flexible multi-skilled staff. However, it was expected that the word 'fragile' would not sit well with business managers and during a meeting at Womack's office, the term 'Lean' was proposed by Krafcik and remained ( A chat with James Womack- 2013).

##### *2.3.3.1. Introduction of Lean*

'The machine that changed the world' (Womack et al, 1990), became 'a management classic' and one of the most cited references in operations management (Holweg, 2007). Realising this, the authors, in a 2007 reprint acknowledge the value of the exemplar work and decided to leave the original text as it was, adding a number of lessons learned since the original publication in 1990 in an afterword (Womack et al, 2007). The book and an earlier article by Krafcik in the Sloan Management Review (1988b) can be considered primarily responsible for the introduction and promulgation of the term 'Lean' and making Lean a trend or fashion. Benders and van Bijsterveld (2000) point out the relevance of fashionable management concepts. They believe that the impact of fashionable management concepts on actual organisations cannot be ignored. In their view, fashionable concepts trigger changes and may contain ideas that organisations find useful and can have a lasting influence. They also point out that fashionable concepts may be misinterpreted, and may be subject to corporate influences, possibly typifying mindless implementation of these without adaptation to new environments.

Forty years of Lean articles followed, with Lean being gradually tested outside the world of manufacturing. Stone refers to the emergence of Lean as the final part of the discovery stage, the first of five stages deducted from research in Lean over a period of forty years of literature (Stone, 2012). In his view, Lean was next disseminated, implemented at strategic levels, expanded to other industries and measured —a gradual progression of the new paradigm. He deducts these phases from a review of scholarly articles on Lean over a period spanning forty years. Stone's review shows that Lean as a paradigm was there to stay, and it is still quite relevant in many more ways than it was intentionally designed for.

### 2.3.4. Definitions, philosophy and tools

#### *2.3.4.1. Definitions of Lean*

It is interesting that Lean has conjured up a number of different attempted definitions and, interestingly, a number of non-attempts to define the paradigm. Stone (2012) believes that the term 'Lean' is ill-defined jargon, raising associations with 'meat' and to a person's physique. He probably has a following in that respect but the name of the paradigm has been set. Womack, when asked if he could rename 'Lean' today answered that he doesn't relive the past (A chat with James Womack, 2013). But that aside, it is important to define what it is that is encompassed by the word representing the paradigm. In Lean terms, a definition is standardisation. No definition means that it may be difficult to check that an organisation is actually Lean. In contrast, Hines et al (2004) move that Lean is still evolving and that it may be difficult to accurately define lean.

As the launchers of the term, Womack, Jones and Roos do not actually define the term; they define the identified steps involved in Lean (Womack et al, 1990), although Womack refers to the etymology of the word as a comment by Krafcik that it is:

> *'Doing more with less'* (Womack, 2010).

Shah and Ward (2007) point out that there is no common definition of Lean. They also point out that some substantive disagreement about what Lean production is, has led to confusion. Despite copious publications, there is still no precise and agreed upon way of defining (and measuring) lean production. Shah and Ward (2007, p791) propose the following definition:

*'Lean production is an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimising supplier, customer, and internal variability.'*

James-Moore and Gibbons (1997, p900) believe that Womack et al did define Lean as follows:

*• Integrated, single piece production flow, small batches, just-in-time giving low inventory;*
*• Defect prevention not fault rectification;*
*• Production pull not push with smoothed demand;*
*• Flexible, team-based work organization with multi-skilled workforce and few in-directs;*
*• Active involvement in root cause problem solving to maximize added value;*
*• Close integration from raw material to customer through partnership.*

They believed that one further ingredient had to be added, based on the work of Clark and Fujimoto (1991, in James-Moore and Gibbons, 1997, p900):

*• Greatly reduced overhead burden by the use of matrix teams, simplifying information flow and processing, enabling flatter organisation structures.*

This is not so much a definition as a set of features of lean. Interestingly, in this adopted definition there is no mention of customer focus or waste reduction, something so important that it was captured in the five principles of Lean. James-Moore and Gibbons (1997) go on to deduct a non-quantified vision of a Lean company as showing five characteristics: Flexibility, waste elimination, optimisation, process control and people utilisation. This view is relevant as they discuss the universal applicability of lean, something this research project strongly relates to.

A definition of Lean in the healthcare environment is proposed by Radnor et al (2012, p365) as:

*'Lean is a management practice based on the philosophy of continuously improving processes by either increasing customer value or reducing non-value adding activities (muda), process variation (mura), and poor work conditions (muri).'*

The attempted definitions above have some similarities but vary significantly and lead to confusion. Pettersen (2009) researched the twenty most cited articles quoting 'lean production' or 'lean manufacturing' and the therein identified most influential books, and concludes that there is no consensus on a definition for Lean amongst examined authors, despite efforts to do so. He also concludes there is no consensus on the characteristics that define Lean. He arranges all Lean characteristics identified by the authors in the selected Lean articles into a new set of groups, characterising Lean in an attempt to achieve some consensus on Lean characteristics, ending up defining Lean in operational terms (Pettersen, 2009). Pettersen (2009) also establishes that Lean is a concept on its own and not to be confused with TQM, using discriminant validity assessment.

It is apparent that there is confusion surrounding the definition of Lean. This includes the definition of Lean for other industries (e.g. Jørgensen and Emmitt, 2008). The lack of definition is concerning for several reasons. How can any scholar of Lean know that they truly understand Lean? How can any organisation that is trying to implement Lean know that they are on the right track? And, in the case of this thesis, how can we know that the intended research heads in the right direction?

The lack of definition highlights several important suppositions:

- Lean can be different things in different environments; there is no single definition.
- Lean is a fluid concept, changing as time goes by and we attempt to implement and adapt Lean to new environments (e.g. Hines et al, 2004).

The two suppositions above is what will, amongst others, drive the direction of this further research.

#### *2.3.4.2. Lean philosophy, methods and tools making up the paradigm*

The debate about Lean philosophy and tools has been ongoing for some time. A number of articles differentiate between the two; philosophy being the underlying driver of lean and tools being the practical and operational methods used to achieve the Lean position. Hines et al (2011a) discuss the 'Iceberg model', where tools and methods are visible, while the more permanent drivers of Lean are below the surface, i.e. invisible (figure 2-11).

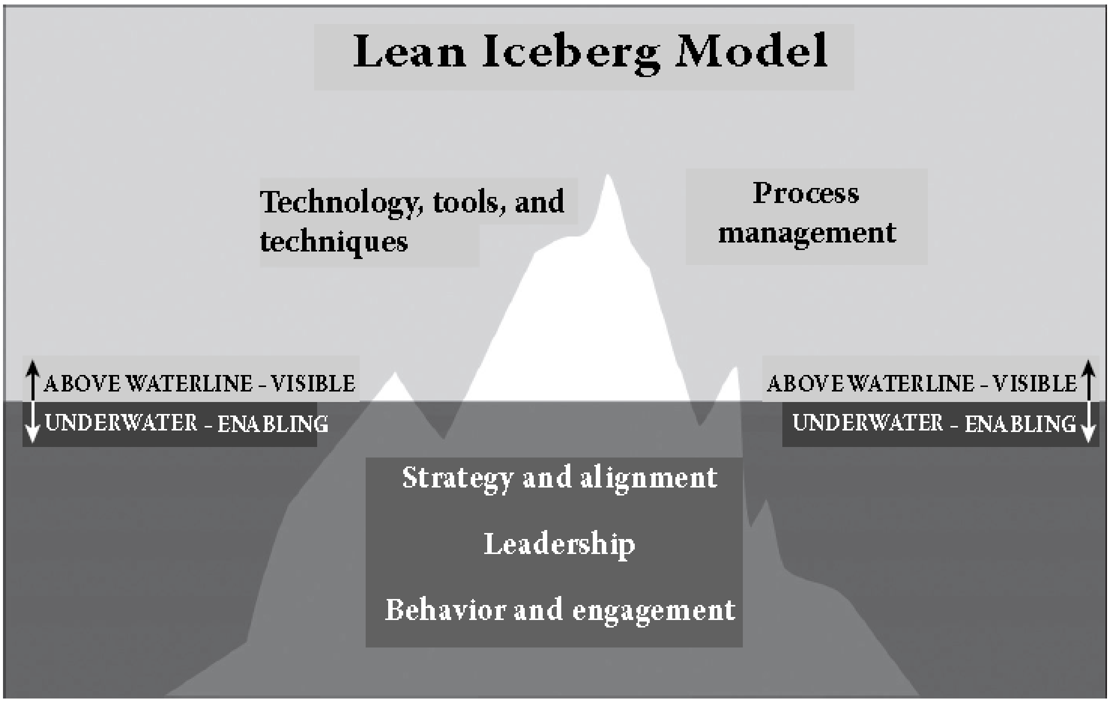



FIGURE 2-11: THE SUSTAINABLE LEAN ICEBERG MODEL. (SOURCE: HINES ET AL, 2011A, P16).

Pettersen (2009) identifies internal focus and external focus and although differences may be subtle, there is a marked difference in approach when internally focussing on cost reduction or externally focussing on customer satisfaction. Bicheno (2004) also points out that Lean is more than a set of tools, which is all the more interesting because his book centres on tools. Hines et al (2004) define strategic and operational dimensions in their model, while Shah and Ward discuss philosophical and practical dimensions (2007). Hines states that

> *'The secret lies in thinking about Lean less in simple cost reduction terms and more as a way of thinking, behaving and improving, impacting on every aspect of work inside a business'* (Hines, 2013).

It is clear that both philosophy and tools are important, one more for long term sustainable results in line with the organisation's vision, the other more for operational results. Philosophy appears particularly important as a foundation and direction indicator when considering the creation of a new area of applicability such as a horticultural context —

specifically tree crops—that are primary, seasonal and are logically significantly detached from assembly operations. Since new methods and tools may have to be identified or developed, these need a strong foundation as basis, and that is the philosophy. It is therefore the philosophical elements of Lean that will drive this study before methods and tools.

### *2.3.4.3. Lean models and model theory*

The literature produces several Lean models attempting to capture Lean. Hines et al (2011a) propose the sustainable Lean iceberg model where aspects such as strategy, alignment, leadership, behaviour and engagement are not visible but form most of the substance of the iceberg. Tools, techniques and process management are visible and above the water surface (Figure 2-11). The model is a symbolic way of highlighting that not everything to do with Lean is clearly visible; and that the tools and techniques that are visible do not necessarily indicate a Lean organisation. This view is similar to the 4-P model proposed by Liker (2004).

Liker (2004) studied Toyota for 20 years and captured fourteen principles in a pyramid model, dividing the principles into four groups, each starting with the letter 'P'. The 4-P model shows degrees of 'Leanness' and moves an organisation to a higher level of Lean as it climbs through the principles (Figure 2.-12).

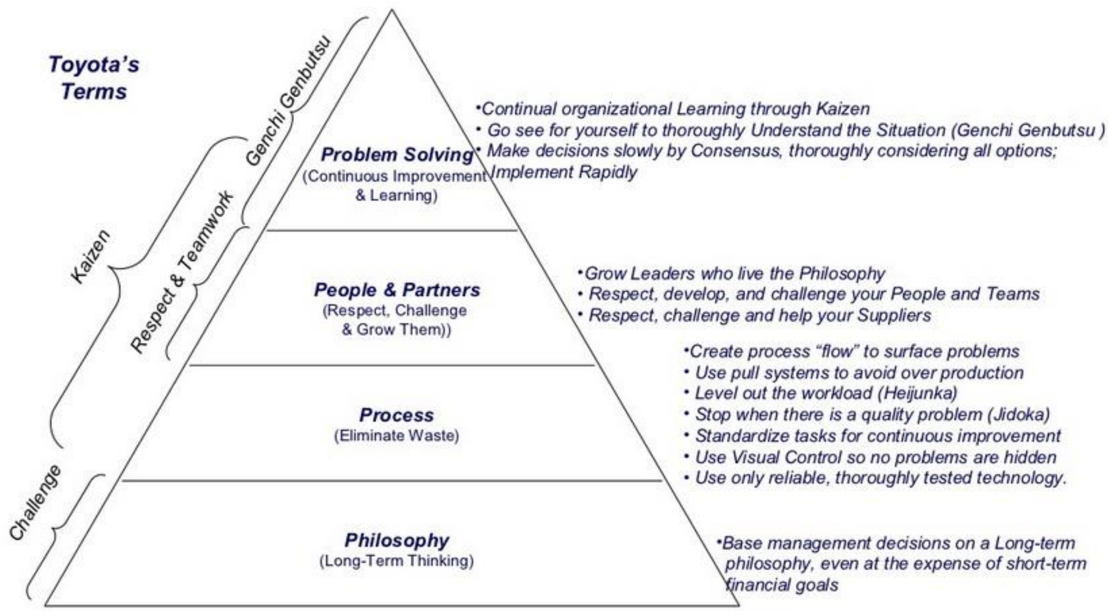



FIGURE 2-12: TOYOTA'S 4P MODEL (LIKER, 2004)

Sohal and Egglestone (1994) propose the core characteristics of a lean production model in a study of Australian organisations to be:

- *Team-based work organization with flexible, multi-skilled staff;*
- *Active shop-floor problem-solving structures, central to kaizen activities;*
- *Lean manufacturing operations, low inventories, JIT, jidoka;*
- *High commitment human resource policies, encouraging a sense of shared destiny;*
- *Close, shared destiny relations with suppliers, much smaller supply bases;*
- *Cross-functional development teams; and*
- *Retailing and distribution with close links to the customer and make-to-order strategy.*

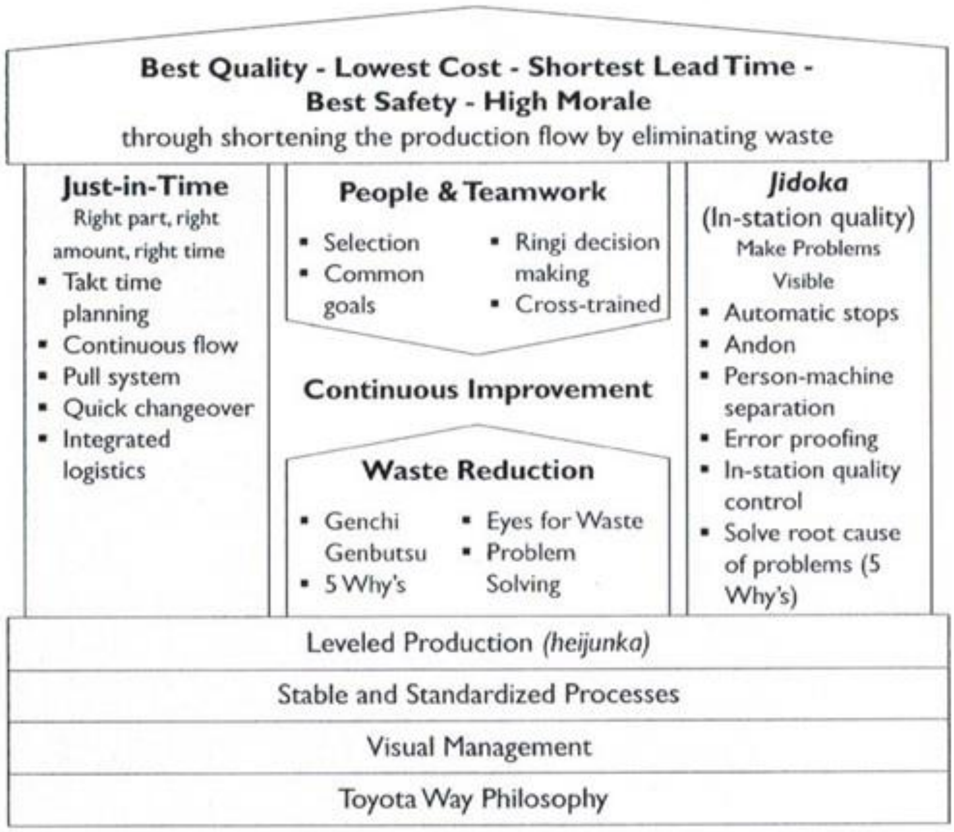



FIGURE 2-13: 'THE HOUSE OF LEAN', FROM LIKER (2004, P33).

Other models involve 'the house of Lean', developed by Fujio Cho to represent the Toyota Production System (TPS) as a system (e.g. Liker, 2004). Each element has its place to hold up the house and in addition, elements reinforce each other (Figure 2-13).

Finally, Krafcik (1988) describes Toyota's 4-M model (figure 2-14) as a model helping with problem solving. The 4-M model can be used at any level, from worker to entire organisation. In broad lines, the model looks at human factors and at hardware factors.

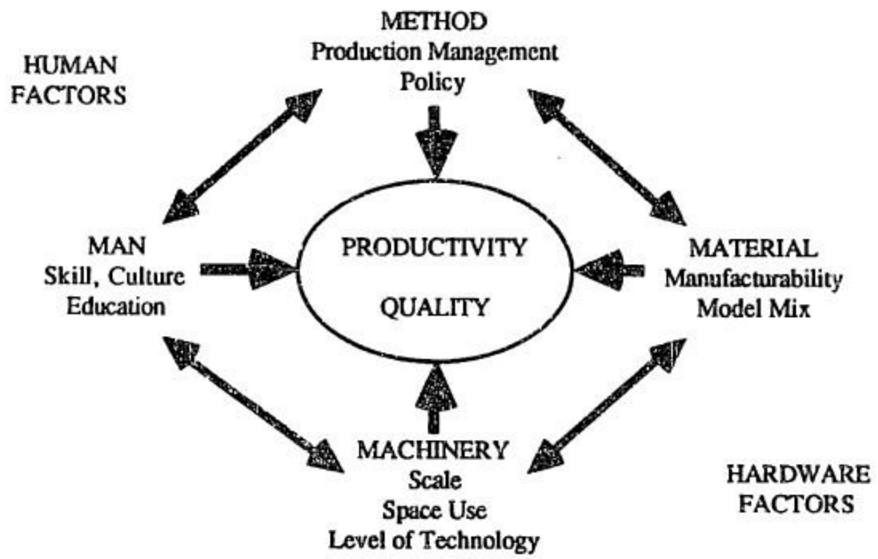



FIGURE 2-14: 4-M MODEL FOR PROBLEM SOLVING (FROM KRAFCIK, 1988, P15).

Each model attempts to identify in some form what happens in reality (i.e. Key Lean characteristics) and shows these in a way that is easy to understand and makes sense to the reader.

A summary of several Lean models is presented in table 2-3.

TABLE 2-3: SUMMARY OF LEAN MODELS

| Toyota 4P model (Liker, 2004) | Sohal & Egglestone (1994) | House of Lean (Liker, 2004) | 4M model (Krafcik, 1988) | Iceberg model (Hines et al, 2011a) |
|---|---|---|---|---|
| Philosophy (long-term thinking) | Team-based work organization with flexible, multi-skilled | Just-in-time<br>Takt time<br>Continuous flow | Hardware vs human factors | Enabling:<br>Strategy and alignment |

| | | | | |
|---|---|---|---|---|
| | staff | Pull system<br>Quick change-over<br>Integrated logistics | | |
| Process (eliminate waste) | Active shop-floor problem-solving structures, central to kaizen activities | Jidoka<br>Automatic stops<br>Andon<br>Person-machine separation<br>Error proofing<br>In-station quality control<br>Root cause problem solving | Man<br>Skill<br>Culture<br>Education | Enabling:<br>Leadership |
| People & partners (respect, challenge & grow them) | Lean manufacturing operations, low inventories, JIT, jidoka | People & Teamwork<br>Selection<br>Common goals<br>Ringi decision making<br>Cross-trained | Method<br>Production management<br>Policy | Enabling:<br>Behaviour and engagement |
| Problem solving (Continuous improvement & learning) | High commitment human resource policies, encouraging a sense of shared destiny | Waste reduction<br>Genchi Genbutsu<br>5 Why's<br>Eyes for waste<br>Problem solving | Machine<br>Scale<br>Space use<br>Level of technology | Visible:<br>Technology<br>Tools<br>Techniques |
| | Close, shared destiny relations with suppliers, much smaller supply bases | Continuous improvement | Material | Visible:<br>Process management |
| | Cross-functional development teams | Levelled production (heijunka) | Manufacturability<br>Model mix | |
| | Retailing and distribution with close links to the customer and make-to-order strategy | Stable and standardised processes<br>Visual management<br>Toyota way philosophy | | |

### 2.3.5. The focus of Lean

It is both interesting and concerning that the focus of Lean is not unanimously agreed by the numerous researchers that have studied the subject over the years. For this inquiry, it is relevant to summarise the dominant tenets of the literature. We have discussed the five principles espoused by Womack and Jones (2003). Ohno himself believes that there are two principles that formed the TPS: JIT and Autonomation (Ohno, 1988). Other writers have similar but discriminate views and identify more than two or different pillars, depending on the environment (e.g. Skorstad, 1994; Radnor, 2010, Barraza et al, 2009).

### *2.3.5.1. Focus on the customer and customer value*

Pettersen (2009) finds that there is little focus on the customer in all the articles and books he used for his attempt to find a universal definition for Lean. In his findings however, he does include the supply chain from supplier to customer as a focus point for Lean. In contrast, Total Quality Management (TQM) referred to both internal and external customer requirements as a constant theme. Schonberger (2007) discusses the shift from JIT and inventory reduction to quick response times to satisfy the customer, e.g. by reducing waiting times; Dell being a typical example. The quick response time was identified as adding value for the customer.

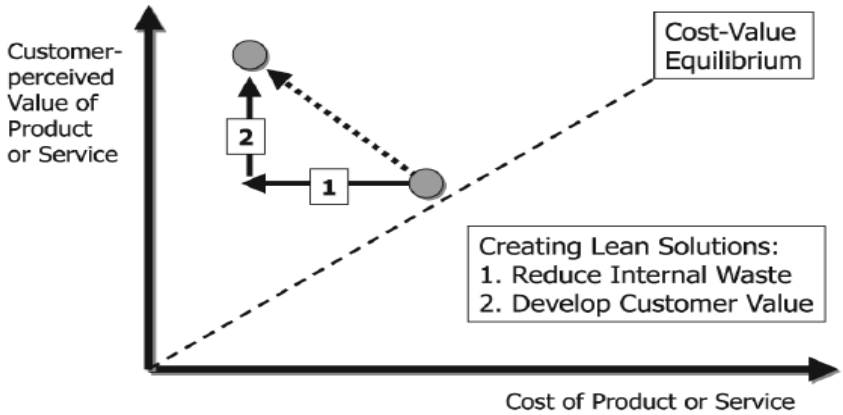



FIGURE 2-15: RELATION BETWEEN CUSTOMER VALUE, COST AND WASTE (SOURCE: HINES ET AL, 2004, P997).

Customer value in the Lean philosophy is the opposite of waste in the factory and, in fact, the entire supply chain (Hines et al, 2004). But Hines et al also point out that there is a risk in focussing solely on the removal of waste in order to create customer value. They point out that other tangible and intangible factors such as brand, image, environment and local production also play a role in the customer value proposition (figure 2-15). Jones and Sasser (2001) would agree with Hines et al, pointing out that only ‘totally satisfied customers’ make a difference; if the customers have alternatives, ‘satisfied customers’ will stray the very moment they are not completely satisfied; ‘totally satisfied customers’ will remain loyal.

Although the customer is of obvious importance, no matter what paradigm is adopted by the organisation, the customer focus in the Lean philosophy should not be seen in isolation. Instead, the customer value proposition forms part of the integrated value model.

### *2.3.5.2. Focus on removing waste*

Numerous articles reiterate Ohno's seven wastes (e.g. Hines & Rich, 1997; Jones et al, 1997; Schonberger, 2007; Hines et al, 2004), ascribed to Ohno and identified as waste in processing, time, defects, motion, overproduction, inventory and transportation. Over the years, these have been interpreted and several articles point towards an eighth waste, being human potential or knowledge (e.g. Womack and Jones, 2003; Kilpatrick, 2003; Liker, 2004). Others added a different eight waste, e.g. Emiliani and Stec (2004) who add 'behaviours that do not add value' as eight waste. Koskela (2004) makes a case for adding 'making do', i.e. doing a job despite the fact that not all prerequisite conditions are fulfilled, as eighth waste. Schneiderman (1988) places nine wastes identified by Ryuzaburo Kaku (Canon) next to Ohno's seven wastes: Kaku identifies wastes in rejects, parts inventory, indirect labour, equipment and facilities, expenses, design, human resources, operations, and waste in production (start-up) of new products. Hines goes one step further when he transforms the conventional wastes into 'green wastes' (Hines, 2009).

In a recent presentation to the 'New Zealand Lean Leadership Network' (NZLLN), Mark Powell, CEO of the Warehouse Group of companies, explained how retail has its own challenges and presented a table of ten wastes identified for the Warehouse Group. As an aside and in a personal conversation, Powell, whose thinking has been strongly influenced by his studies under Jones at the Cardiff Business School, confirmed that his thinking relates substantially to Lean principles, but that the retail sector had done very little in studying its applications in that sector. He prefers the term 'Value Stream Management' over the term 'Lean' (personal conversation with Mark Powell, CEO of the Warehouse Group, 25-10-2013). In order to contribute to knowledge, he undertook to present his views on retail value stream management academically (Powell and Childerhouse, 2010).

Table 2-4 summarises a number of different approaches from literature towards identifying waste.

TABLE 2-4: SUMMARY OF DIFFERENT WASTE PERSPECTIVES.

| Ryuzaburo Kaku, Canon (in Scneiderman, 1998) | Taiichi Ohno, Toyota | Hines (2009) | Koskela (2004) | Hines (2009b) | Womack and Jones (2003) | Hines and Rich (1997) | Emiliani and Stec (2004) | Powell and Childerhouse (2010) |
|---|---|---|---|---|---|---|---|---|
| **The Nine Wastes** | **The Seven Wastes** | | **Eight Wastes including 'making-do'** | **Eight Green Wastes** | **Lean thinking** | **Warehouse environment** | | **Retail environment** |
| **Waste in rejects** | Waste in processing itself | Over-production | Over-production | Greenhouse gases | Over-production | Faster-than-necessary pace | Over-production | Lost sales & customers |
| **Waste in parts inventory** | Waste of time | Defects | Defects | Eutrophication | Defects | Waiting | Defects | Excessive 'push' stocks |
| **Waste in indirect labour** | Waste of making defective parts | Unnecessary Motion | Unnecessary Motion | Excessive resource Usage | Unnecessary Motion | Conveyance | Unnecessary Motion | Excessive 'pull' stocks |
| **Waste in equipment and facilities** | Waste of motion | Unnecessary Inventory | Unnecessary Inventory | Excessive Water usage | Unnecessary Inventory | Processing | Unnecessary Inventory | Delay & waiting |
| **Waste in expenses** | Waste of overproduction | Inappropriate processing | Inappropriate processing | Excessive Power usage | Inappropriate processing | Excess stock | Inappropriate processing | Unnecessary transportation |
| **Waste in design** | Waste of inventory | Transportation | Transportation | Pollution | Transportation | Unnecessary motion | Transportation | Excessive movement & handling |
| **Waste in human resources** | Waste of transportation | Waiting | Waiting | Rubbish | Waiting | Correction of mistakes. | Waiting | Unnecessary processes or layers |
| **Waste in operations** | | Lost People Potential | Making-Do | Poor Health & Safety | Knowledge | | Behaviours | Defects, errors and poor process reliability |
| **Waste in production start-up of new products** | | | | | | | | Rigidity, the lack of flexibility & responsiveness |
| | | | | | | | | Unnecessary complexity |

It is fascinating that Ohno himself states:

> *"I don't know who came up with it but people often talk about 'the seven types of waste'. This might have started when the book came out, but waste is not limited to seven types. There is an old expression: 'He without bad habits has seven', meaning even if you think there is no waste, you will find at least seven types. So I came up with overproduction, waiting etc., but that doesn't mean there are only seven types. So don't bother thinking about 'what type of waste is this?' Just get on with it and do kaizen"* (Ohno, 2013, p175).

Essentially, it appears that the attempts at cataloguing waste have come about by not completely comprehending what Ohno had in mind when he came up with the seven so well-known wastes. From the attempts at grouping wastes in different environments, and from Ohno's own words, it is quite clear that any identified waste, any situation that does not add value and is unnecessary, can be categorised as waste and it becomes rather irrelevant how many waste groups there are. Regardless of focus on removing waste to increase customer value (e.g. Dennis, 2002; Bicheno, 2004), or removing waste to reduce costs (e.g. Ohno, 1988; Monden, 1998; Shingo, 1989), it is this approach that will further be adopted during the ensuing industry research.

#### *2.3.5.3. Focus on Just-In-Time*

A clarification of terms may be helpful to avoid a reasonably common confusion in terminology. The term 'Lean' will be used for the combined philosophies, methods and tools that are used to reduce waste and increase customer value. The term Just-In-Time (JIT) will be used for the method where the focus is on reducing wasteful inventory by delivering only what is needed, when it is needed and how it is needed (Ohno, 2013), with all the direct and indirect consequences.

Just-In-Time (JIT) was an early US adoption of Lean methodology but soon overtaken by the term Lean, rightly or wrongly. Shah and Ward (2007) point out that, for a period in the early 1980s, JIT became the production system in the US. JIT in today's terminology is not considered synonymous with the term Lean. It encompasses a substantial proportion of the Lean paradigm in that it focuses on small lot productions which then implies quick change-overs, kanban, low inventory, synchronised parts production, rapid delivery and a skilled and versatile workforce. JIT is not the same as Lean but it is however an important part of the Lean philosophy.

The JIT and consequent systems developed organically at Toyota. Cusumano (1994) and Ohno himself (Ohno, 2013) refer to the production of low volumes at a competitive price as a necessity at the time. We know from Womack et al (1990) that the system was considered 'fragile' in the 1990s as the lack of a single component could stop the production process. Ohno states that to get JIT introduced (the system was called the 'Ohno system' while being trialled) there was a significant mind-set shift required, and that shift in mind-set took time and persuasion to achieve (Ohno, 2013).

To indicate how important JIT was for Toyota, one only has to look at where it is placed by influential writers. Holweg refers to Ohno's description of autonomation and JIT as the two pillars of TPS (Holweg, 2007). Similarly, Monden (1998) described JIT as one of the two pillars of TPS; JIT eliminating waste in the process as one pillar and appreciation and utilisation of the worker's capabilities as the second. It is logical to conclude that JIT was one of the fundamental concepts of the Toyota Production System (TPS). Liker and Morgan (2006) refer to JIT and Jidoka as the two pillars of TPS, similar to Holweg. Their assertion is slightly confusing when considering other work by Liker in which he presents continuous improvement and respect for people to be the pillars of TPS (Liker & Hoseus, 2007).

It is interesting to note that there is some empirical evidence that higher levels of JIT employed by a number of companies confirm the hypothesis that higher levels of JIT lead to higher levels of profitability (Fullerton et al, 2003). It must be noted though that in their approach, JIT is fairly synonymous with standard Lean practices such as waste reduction through reduced setup times, uniform workloads and preventative maintenance. Fullerton et al (2003) also acknowledge that the part of the sample that was identified as JIT was precluded from random selection, which may affect the validity of their outcomes somewhat.

Although JIT plays a large role in the TPS, it remains to be seen what role it can play in an industry where not all activities require parts and where input of activity is weather dependent. The analysis and discussion of results will consider the role of JIT in chapter five.

### 2.3.5.4. Focus on respect for people

Toyota presents 'The Toyota Way' as a model based on two pillars, respect for people and continuous improvement (Liker & Hoseus, 2007; figure 2-16). Earlier, we saw that Monden also indicates respect for people as vital to the Toyota production System (Monden, 1998). The significance of the people becomes clear when Liker & Hoseus (2007) dedicate a whole volume to the Toyota culture as the heart and soul of the Toyota way. But respect for people doesn't mean to bow your head. Much like Deming (1986) argued that management should

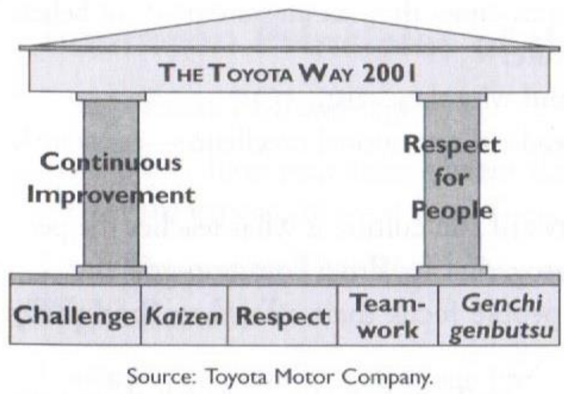



FIGURE 2-16: TOYOTA CULTURE (LIKER & HOSEUS, 2007, PXXVIII).

> *'Remove the barriers that rob people of their right to pride in their work'* (Deming, 1986, p24),

Ohno (2013) states:

> *'I think that it ruins people when there is no race to get each person to add their good ideas to the work they do within a company'* and .....
>
> *'the ability to add your creative ideas and changes to your own work is what makes it possible to do work that is worthy of humans'* (Ohno, 2013, p178).

Respect for people in this sense will provide people with motivation and satisfaction, two critical elements of human functioning (Lundberg et al, 2009). Imai (1997) agrees and differentiates between the role of management to support kaizen leading to a sense of pride in operators, and the role of management to control kaizen.

### 2.3.5.5. Focus on continuous improvement

Another element recognised as fundamental to sustainable Lean is the concept of kaizen or continuous improvement (CI). Lean is said to be a constant iterative process; people continue to learn as they continue to be engaged and improve their processes. Toyota presents 'The Toyota Way as a model based on two pillars, respect for people and continuous improvement (Liker, 2004). Womack and Jones (2003) recognise continuous improvement as the last link in the chain of Lean principles: 'Perfection'. It is the concept of continuous innovation or perfection that provides the Lean employer with an extra source of improving his organisation. It is often argued that western people prefer to have technological breakthroughs and innovations, while Japanese people are used to small incremental improvements (figure 2-17). Imai (1986) depicts quite clearly where innovation fits in relation to kaizen and that they can easily go hand-in-hand.

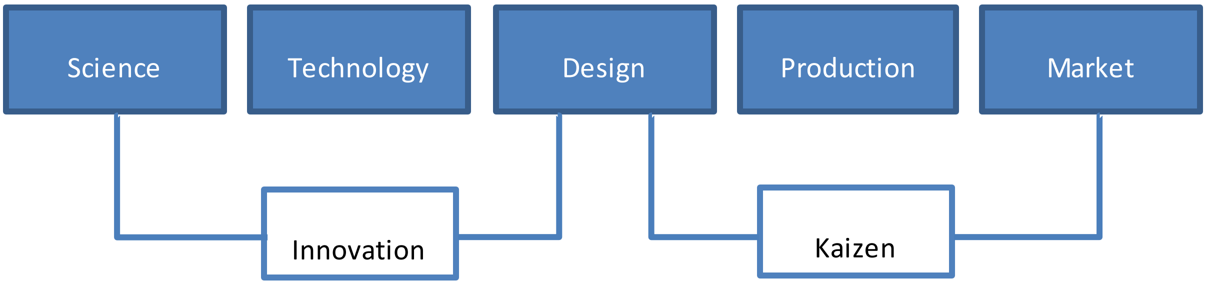



FIGURE 2-17: RELATION BETWEEN INNOVATION AND KAIZEN (IMAI, 1986).

Imai (1986) differentiates between the process of innovation and the process of Kaizen. Figures 2-18, 2-19 and 2-20 illustrate the difference between both processes.

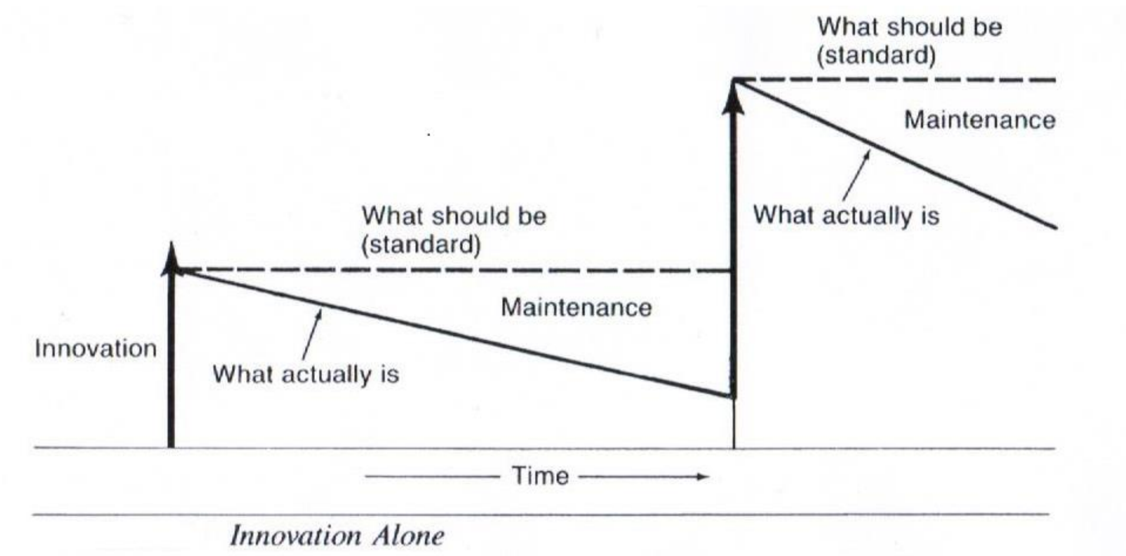



FIGURE 2-18: INNOVATION AS IMAI SEES IT (IMAI, 1986, P26).

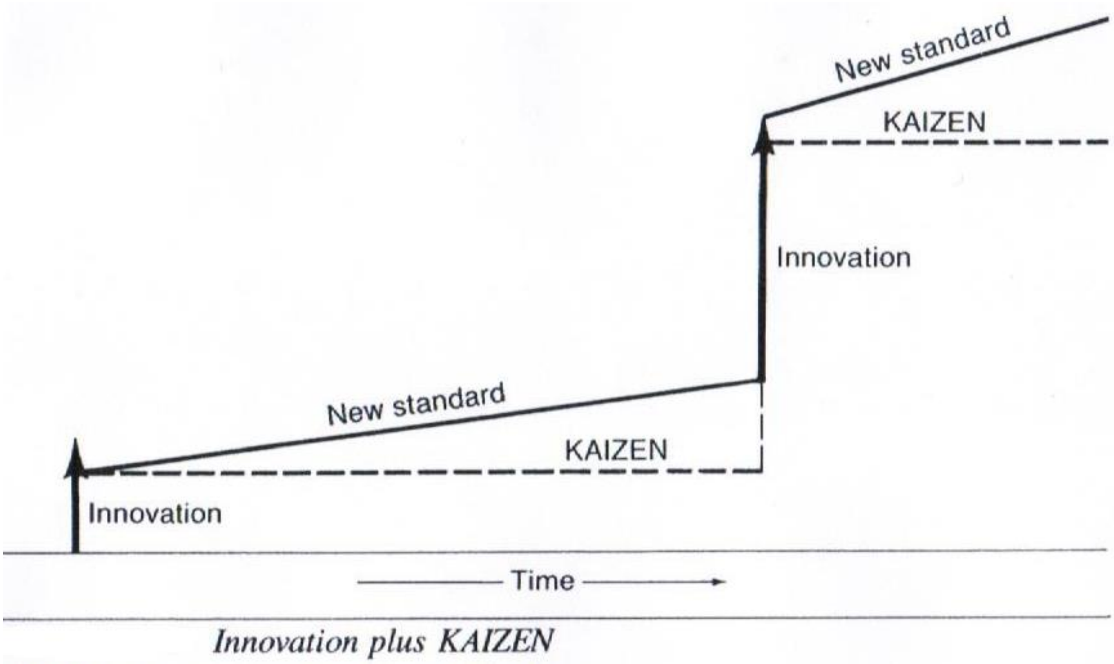



FIGURE 2-19: THE COMBINATION OF INNOVATION AND CONTINUOUS IMPROVEMENT AS IMAI SEES IT (IMAI, 1986, P27).

Ohno believes that kaizen ideas are infinite; each kaizen idea provides the basis for another. Continuous improvement should take place, particularly when times are good. Ohno warns against complacency and states that in bad times, all people can do is cut costs, most often by reducing staff; in poor times, people do not have the mind-set for continuous improvements (Ohno, 2013). Liker and Morgan (2006) believe that kaizen is rarely practiced in most organisations. Problems that surface are only valuable if the workers have the tools and are allowed and encouraged to deal with the problems themselves and then solve them at the root cause. Continuous improvement is therefore an endless journey of improvement and an essential element of any Lean culture. Particularly when we start attempting to develop a Lean approach in a new industry, it will be the people and incremental improvements that will add up to better results and a more prosperous sector.

### 2.3.6. A critical look at lean manufacturing

This section provides critical and alternative views on Lean to balance the view on Lean.

#### *2.3.6.1. Evidence for Lean*

There is a body of evidence that Lean works and works well. Womack et al (1990) present tables and numbers that demonstrate the successful impact of Lean. When they compare the traditional General Motors (GM) plant and the New United Motor Manufacturing Inc. (NUMMI) 'transplant' (a term used for US-based plants, driven by Japanese management paradigm) in Fremont, California, the numbers show staggering results such as in table 2-5.

TABLE 2-5: COMPARISON BETWEEN JAPANESE/US 'TRANSPLANT' AND US CAR ASSEMBLY PLANT (SOURCE: WOMACK, JONES AND ROOS, 1990).

| | GM Framingham | Toyota Takaoka | NUMMI Fremont |
|---|---|---|---|
| Assembly hours per car | 31 | 16 | 19 |
| Assembly defects per 100 cars | 135 | 45 | 45 |
| Assembly space per car | 8.1 | 4.8 | 7 |
| Inventories of parts (average) | 2 weeks | 2 hours | 2 days |

These numbers also demonstrate that Lean is not nationally bound, but is the result of a company culture and management system that is based on a different philosophy. In following years, Womack and Jones present multiple case studies of different medium and large manufacturing environments (Womack and Jones, 2003), and how these companies transformed into Lean companies. Byrne published several of his practitioner successes in which he explains how companies completed the transformation successfully (Byrne, 1995; Byrne and Womack, 2012). There can be little doubt that Lean can achieve excellent results, going by the numerous cases presented over the years.

#### *2.3.6.2. Success factors and pitfalls*

Several reports quote success- and failure-rates and causes, commonly for failures to implement Lean. The reasons for success and failures are often the same; e.g. projects partly fail through poor communication or partly succeed through effective communication. Liker and Rother (2013) quote the 2007 Industry Week survey that found that only 2% of companies that implemented Lean achieved their anticipated results. Bhasin (2012) summarises that less than 10 per cent of UK organisations have been successful in implementing Lean. Although the positive effects of a successful implementation have been adequately described (e.g. Womack and Jones, 2003, Byrne, 2012), it is useful to investigate the critical factors further.

Several studies identify success factors and pitfalls when implementing Lean. Scherrer-Rathje et al (2009) report how Lean can both fail and succeed in the same company. Their case studies indicate which factors contributed to failure at the first attempt and how the company succeeded the second time. Despite a number of internal successes, a first Lean project was terminated due to the lack of organisational support and a senior management re-organisation. The bottom-up approach suffered from lack of team autonomy, lack of senior management commitment and lack of communication in Lean. A senior employee also reported a degree of 'change fatigue' as the company had introduced a number of other changes before its attempt at Lean.

Nine years later, the company recognised the necessity to introduce Lean and management remembered the lessons from the earlier attempt. Despite not communicating the overall goal during the first six months, an initial pilot project headed for success and was soon followed by others. The recognition of the need for employee autonomy and the introduction of 'Just-Do-It' daily process meeting rooms facilitated the process. The company which originally failed to introduce Lean now reported a five-fold improvement in production. An important observation was that staff adopted a culture of improving themselves.

Bhasin and Burcher (2006) use mixed methods to investigate Lean implementation. After thorough discussion of Lean implementation and philosophy, they find that the philosophy must be embedded before successful implementation can be claimed. The low number of successful Lean initiatives is also linked to ineffective human resource management (HRM), with organisations often not understanding what 'respect for people' entails. In addition, they observe the need to have the supplier base included and –interestingly- also discuss the inclusion of accounting. A misalignment of accounting methods may eventually lead to dis-continuation of the Lean implementation effort.

Both the academic and popular literature provide a number of summaries of critical factors which may become pitfalls or can be used to assist the Lean implementation process. A number of these are summarised in table 2-6. Emiliani's list (Emiliani, 2012) is taken from a satirical ‘blog’, but he is a sufficient authority and to be taken seriously. Seddon’s work (2007 and 2010) has been taken from his writings as consultant, however he is considered to be both a successful practitioner and writer. Hines’s summary (2010) was taken from a white paper, however Hines is considered sufficient a Lean authority to be able to justify his findings. Liker and Rother (2013) also summarised their pitfalls on a website, but they too are considered sufficiently authoritative in the subject to be quoted. All other lists have been taken from academic papers. Kallage’s list (2006) is presented by the Fabricators & Manufacturers Association in the USA.

Several approaches group the critical factors. Common themes are the importance of an understanding of Lean, the commitment of senior management, the willingness to cooperate with change, the culture, the communication process, the implementation method or model, the monitoring and evaluation and the general approach towards the people in the organisation. Although it is helpful to have an understanding of the different views on success factors and pitfalls, one could argue that they are essentially the same, e.g. proper management commitment will contribute positively, while negative management commitment will endanger a Lean implementation process. For the purpose of this inquiry, there is little doubt that a number of the critical factors will be re-addressed during the discussion of the results.

TABLE 2-6: GROUPING OF CRITICAL ELEMENTS FOR LEAN IMPLEMENTATION.

| **Emiliani (2012)** | **Liker and Rother (2013)** | **Seddon (2007 & 2010)- Service industry** | **Pedersen and Huniche (2009)** | **Scherrer-Rathje et al, 2009) Implementation failure followed by success** | **Radnor et al (2006) Scottish public sector** | **Achanga et al (2006)** | **Hines (2010)** | **Lean failures Kallage (2006)** |
|---|---|---|---|---|---|---|---|---|
| ***Pitfalls*** | ***Pitfalls*** | ***Pitfalls*** | ***Pitfalls*** | ***Lessons learned*** | ***Pitfalls*** | ***Critical element*** | ***Pitfalls*** | ***Pitfalls*** |
| Ignorance of Lean | Fundamental misunderstanding what Lean is | Lack of understanding | Management: Lack of management awareness and support | Lean will not succeed without visible management commitment | Lack of resources to implement changes | Leadership & Management | Lack of clear executive vision | Management/Leadership: Insufficient Understanding of Lean and Its Elements |
| Short term thinking | Lack of skill to systematically and iteratively improve the process | Lack of flexibility | Resources: Insufficient resources (technical, financial, human) | Develop formal mechanisms to encourage and enable autonomy | Resistance to change from staff and management | Strategy | Lack of effective communication strategy | Management/Leadership: Poor Development of the Business Case for Lean |
| Zero-sum (win-lose) 'Fake Lean' | Ignorance of invisible purpose of tools | Blind application of tools | Communication: Poor | Openly disclose mid- to long-term lean goals | Post Rapid Improvement Event; lack of ownership of the activity | Vision | Failure to create & communicate a real sense of urgency | Management/Leadership: Communications: Too Little, Too Complex, Too Simple |
| Senior management ineptitude | Lack of skills to develop solutions | Managing activities as costs | Objective: Cost-cutting, layoffs | Ensure mechanisms are in place for long-term sustainability of lean | Lack of commitment to the change process | Funding | Poor consultation with stakeholders | Management/Leadership: Insufficient Focus and Involvement |
| Lean introduced to benefit the company at the expense of workers | Lack of routine to improve work | Fragmentation of the work | Link to strategy: Misalignment<br><br>Ownership: No ownership | Communicate lean wins from the outset | Slow pace of change in the public sector. | Organisational culture | Lack of structured methodology and project management | Management/Leadership: Poor Organizational and Leadership Development |
| Demand for immediate cost-savings | Lack of use of people's creative talents | No focus on demand | Employees: No buy-in | Continual evaluation during the lean effort is critical | | Skills & Expertise | Failure to monitor and evaluate the | Management/Leadership: Lack of Proper Metrics to Determine Performance and |

| Emiliani (2012) | Liker and Rother (2013) | Seddon (2007 & 2010)- Service industry | Pedersen and Huniche (2009) | Scherrer-Rathje et al, 2009) Implementation failure followed by success | Radnor et al (2006) Scottish public sector | Achanga et al (2006) | Hines (2010) | Lean failures Kallage (2006) |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | outcome | Isolate Challenges |
| Management not trusting workers | No focus on learning ability and attitude of people | No focus on processes | Need for change but Change more an obstacle than Lean | | | People & soft issues | Failure to mobilise change champions | <u>People issues</u>: Lack of Middle-Management Buy-in |
| Lay-offs stymie improvements | | Too great a focus on tools | <u>Competencies</u>: lack of change management | | | Productivity improvement | Failure to engage employees | <u>People issues</u>: Not everyone is a leader |
| Lack of 'respect for people', employees, customers, suppliers etc. | | Lack of learning to resolve problems | <u>Staffing</u>: poor change agents and improvement teams | | | Resource availability | Absence of a dedicated and fully resourced implementation team | <u>People issues</u>: Management or Employee Capabilities are Lacking |
| Lack of root cause thinking | | Loss of focus on waste | <u>Time Plan</u>: Slow pace of change | | | Willingness to learn | Lack of sympathetic and supportive HR policies | <u>Deployment Methods</u>: Failure to Learn proper CI Methodology—Reliance on Kaizen Blitzes. |
| Assigning blame culture | | | <u>Competence building</u>: Inadequate training | | | Technology development | | <u>Deployment Methods</u>: Reliance on a Single In-house Champion or Expert |
| | | | <u>Rewards</u>: Recognition & rewards missing | | | | | <u>Deployment Methods</u>: Insufficient or Inappropriate Training |
| | | | <u>Culture</u>: culture change required | | | | | <u>Deployment Methods</u>: Weak Deployment Strategy |
| | | | <u>Dominant mind-set</u>: Silo thinking | | | | | |
| | | | <u>Knowledge transfer</u>: lacking | | | | | |

#### *2.3.6.3. Criticism on lean.*

There has been criticism of Lean by a number of authors. This should not be surprising as Ohno, in his introduction to Monden's work (1983 and 1998), expresses his interest to see if the TPS works for other companies and countries. In his view it was developed solely by Toyota for Toyota, and even Japanese companies had trouble picking it up. Cusumano (1994) agrees with the restrictions to the TPS and tables a number of limitations to Lean. He quotes e.g. the Japanese government's efforts to reduce the effects of JIT-caused traffic congestion, and observes issues with the integration of suppliers and lack of blue collar workers. Cusumano clarifies that what is good for Toyota is not necessarily good for others (1994). Schonberger (2007) reports on longitudinal research data that are based on inventory trends and provide insight into diffusions and uneven results by the Japanese Management Systems (JPMs). Evidence of confusing system lapses and disappointments, both amongst Japanese and Western companies, raise questions about the sustainability of Lean, as well as some of its changed manifestations. An area of weakness is argued to be the lack of design recommendations for capturing and analysing implications of customer value (Piercy and Rich, 2004).

Emiliani (2012) uses a different approach and goes so far that he publishes a mock report of Lean Failure at an undisclosed company. The report has several blank spaces in which the reader can complete the company's name, as Emiliani expresses the standard reasons for failure to be the drive to cut costs, leading to 'zero-sum' outcomes (Emiliani, 2012). Seddon (2007) makes the case that often organisations implement tools and that this rarely results in changes to the system. His view is that the system needs to change and then the tools will follow. Lewis (2000) provides a critical look at Lean and concludes that Lean does not necessarily result in improved financial performance. In addition Lewis (2000) considers that there is a radically shifted power distribution once a company goes Lean.

Seddon too is quite rigorous in his condemnation of the standard use of Lean in different environments (Seddon, 2010). In his view, Ohno warned against codifying his system because that would remove all flexibility and turn it into the use of a set of tools without learning. In fact, Ohno did state that we are 'walking misconceptions' (Ohno, 2013). Seddon makes an interesting case for 'failure demand', demand caused by the failure to provide correct service the first time (Seddon and Caulkin, 2007). Liker and Rother (2013) quote Robert Miller, executive director of the Shingo Prize, who in 2010 stated that a large percentage of the prize Shingo Prize winners over the previous 19 or 20 years had not been able to sustain Lean and had regressed to implementing tools rather than embedding the culture. So, despite the fact that a 2007 study by Industry Week in the US showed that 69.6 % used Lean manufacturing as improvement methodology, there is a question about its sustained success.

It is evident from the literature, as it should have been from Ohno's own assertions (Monden, 1983), that Lean is not the omnipotent panacea for manufacturing. Lean has to be moulded and shaped to fit and suit the environment into which it is introduced, and it requires philosophical changes that are difficult to fit into a short-term profit thinking environment. It is this criticism that may be helpful moulding pipfruit industry organisations into 'Lean-readiness'.

##### *2.3.6.4. National and organisational culture*

It is by now clear that the right organisational culture is a prerequisite for successful Lean implementation. The question may be asked if national or societal culture affects organisational culture. Womack et al (1990) deal with this briefly when they compare the results of the NUMMI plant with the results of other US plants. The NUMMI plant in Fremont was substantially manned with ex-employees from the de-commissioned General Motors (GM) plant. Despite the fact that these workers were predominantly US born, the NUMMI plant outperformed all other US car manufacturers and, by inference, the result could not be tied to the Japanese societal culture. Krafcik concludes the same for several other plants in the US and points at production management policy as having a greater bearing than Japanese parentage (Krafcik, 1988a).

Wagner explored group cultures in implementing continuous improvement (CI), and found that new initiatives such as CI became meaningful to workers depending on the individual's perceptions (Wagner, 2011). In his view, societal culture was strongly linked to organisational culture similar to Jung's theory of groups (Jacobi, 1973), where people can belong to many groups, each influencing the person's ego awareness and behaviour but still displaying separate group cultural norms and values. This may not be the case where a 'foreign' organisational culture is introduced in a national or societal context in which case the different cultural contexts may precipitate conflicts (Mwaura et al, 1989), or where managerial adaptation is required to fit the organisational culture into the societal culture (Newman and Nollen, 1996). As Hofstede argues, national or societal cultures are a given, while organisational cultures can be managed up to a point (Hofstede, 1994). Wagner (2011) concludes that the individuals' participation in continuous improvement (CI) was largely based on self-motives and a feeling of self-worth.

This last observation relates to Maslow's hierarchy of needs (e.g. Inkson and Kolb, 2003) and transcends national and societal boundaries. Culture can therefore be influential but there is no reason to assume that it is the Japanese culture that made Lean a successful manufacturing paradigm.

#### *2.3.6.5. Universal applicability of Lean*

It is interesting that one of the founding fathers of TPS (Ohno, in Monden, 1983) believes that that even in Japan, it was difficult for people of outside companies to understand TPS. Ohno expresses the expectation that it must be even harder for 'foreign' people, and that includes westerners. Since 1983, however, a lot has changed in societies around the world. We have already seen earlier that the US was ready for a philosophical change in quality and production systems in the early 1980s. Cusumano (1994) points out that even in Japan, Lean is not the same for the users. He points out that Honda and Toyota had unique historical and geographic settings that facilitated Toyota's JIT and Honda's product development system. Nissan discovered in the early 1970s that Toyota's kanban system did not work very well in urban areas with traffic congestion and found different solutions. According to Lewis (2000), individual firms tend to follow a more or less unique Lean implementation trajectory. Although the TPS tools may not be universally applicable to all sectors and industries, there is a body of evidence that the Lean philosophy, principles and tools can be adapted sufficiently to other environments to help improve performance. The following paragraphs discuss some of these.

### *2.3.6.6. Low-volume high-value goods*

Lean production was typically designed for a relatively high volume environment where different products are produced. There are also products of which only few are produced with high levels of customisation. Jina et al (1997) discuss the question of whether Lean principles can be applied directly or in adapted form to High Variability Low Volume (HVLV) producers. They observe that it is evident that the type of methods and tools used in such a firm when attempting to be Lean will depend on the product and its environment. Aircraft producer McDonald Douglas is reported to implement fundamental principles specifically to their development and manufacturing arms (Jina et al, 1997). James-Moore and Gibbons (1997) refer to these as Super Value Goods (SVG) and investigate an aircraft manufacturer. They conclude that the general Lean principles have distinct applicability in a SVG industry but that only some 65 % is used. They also conclude that certain areas of SVG industries need to adapt those Lean principles, or adopt fundamentally different approaches.

The specific research into HVLV or SVG goods points towards the question whether production and variability of product are drivers for different Lean principles, tools and implementations. The definitions of high and low volume and high and low variability would need expanding before some clarity could be created. It is however not in the scope of this inquiry to develop a model for goods categories based on volume and variability (e.g. figure 2-20). Such an exercise would immediately result in more and different categorisations, e.g. relating to the physical or service aspect of the product.

| | **High Volume** | **Low Volume** |
|---|---|---|
| **High Variability** | Clothing retailing | Advertising, custom engineering, ship, design-and-built house |
| **Low Variability** | Stationary, e.g. paperclips, grocery items | Power poles, car trailers |

FIGURE 2-20: HIGH AND LOW VARIABILITY VERSUS HIGH AND LOW VOLUME.

### *2.3.6.7. SMEs and Lean*

In the context of this research, it is relevant to establish if pipfruit organisations must be related to Lean research in Small and Medium Enterprises (SMEs). SMEs are defined slightly differently in different parts of the world, but in New Zealand SMEs are defined as enterprises with fewer than 20 employees (table 2-7). These organisations include micro organisations and account for an average of approximately 31% of all employment in New Zealand over the past ten years (SMEs in New Zealand, 2011). European SMEs are taken to include 'Micro-Enterprises and Medium sized Enterprises have a maximum number of 250 employees (EU Commission Recommendation 2003/361/EC).

A problem with the NZ data is that they are taken in February each year and may or may not include seasonal workers, skewing the SME status of the organisation. Doevendans (2010) reports that responses to his survey indicate an average of 21 permanent employees and 147 seasonal employees. However, this survey was targeting a segment of each of small, medium and large companies defined by turnover, and a closer look reveals that 55% of respondents fall into the NZ SME group, while all respondents fall into the European SME group. Consequently, SME research is considered to apply to the NZ pipfruit industry.

TABLE 2-7: NUMBER, PERCENTAGE, AND CUMULATIVE PERCENTAGE OF ENTERPRISES BY SIZE IN FEBRUARY 2010. (SOURCE: SMES IN NEW ZEALAND, 2011).

| Employee Size Group | Number of enterprises | Percentage of all enterprises | Cumulative percentage |
|---|---|---|---|
| 0 | 323,935 | 68.9% | 68.9% |
| 1-5 | 97,888 | 20.8% | 89.7% |
| 6-9 | 19,571 | 4.2% | 93.8% |
| 10-19 | 15,980 | 3.4% | 97.2% |
| 20-49 | 8,420 | 1.8% | 99.0% |
| 50-99 | 2,489 | 0.5% | 99.6% |
| 100-499 | 1,739 | 0.4% | 99.9% |
| 500+ | 324 | 0.1% | 100.0% |
| **Total** | 470,346 | 100% | - |

There appears to be a relatively small body of research specifically focussing on Lean in SMEs, as most research involves larger organisations (Achanga et al, 2006). Similarly, McAdam (2000) finds that most re-engineering research is dominated by large companies. In a different field, Wong and Aspinwall (2005) observe a similar situation in relation to the research of knowledge management. A number of critical success factors for successful implementation of knowledge management, re-engineering and Lean are identified and quite similar and presented in table 2-8 (Wong & Aspinwall, 2005; McAdam, 2000; Achanga et al, 2006). SMEs in the UK appear sceptical about the benefits of Lean and show resistance to providing useful information and data. In their research, Achanga et al (2006) observe that by default, most SME leaders are owner managers with knowledge gaps and a lack of strategic drivers. SMEs then typically focus on managing a continuous string of short-term crises, while the implementation of Lean is often subject to 'continuous postponements'. Shah and Ward (2003) find a clear positive relationship between plant size and Lean implementation. It appears that independently managed SMEs are far more responsive and promise far greater ROI potential than owner-managed SMEs (Achanga et al, 2006).

TABLE 2-8: CRITICAL SUCCESS FACTORS IDENTIFIED IN THREE DIFFERENT BUSINESS IMPROVEMENT PHILOSOPHIES.

| **Wong and Aspinwall (2005)** | **McAdam (2000)** | **Achanga et al (2005)** |
|---|---|---|
| **(Knowledge management)** | **(Re-engineering)** | **(Lean)** |
| Management leadership and support | Resources | Leadership & Management* |
| Culture | Markets, environment and strategy | Strategy* |
| Strategy and purpose | Leadership | Vision* |
| Resources | Flexibility and change orientation | Finance** |
| Processes and activities | Structure | Organisational culture** |
| Training and education | Methodology | Skills and expertise** |
| HR management | Measurement | People and soft issues** |
| Information technology | | |
| Motivational aids | | |
| Organisational infrastructure | | * denotes important |
| Measurement | | ** denotes secondary importance |

The general conclusion that many business improvement studies focus on large organisations does not mean that Lean does not suit SMEs; researchers report it partly to be due to the lack of available resources within SMEs. Lean may be different for SMEs, but the Lean philosophy is equally relevant to small organisations, particularly considering the percentage of the economy they represent.

### 2.3.7. Assessing Lean in organisations

An intriguing issue arises when we start to examine assessment of the Lean state of organisations. Traditionally, assessment in business is aimed at standardisation (e.g. engineering) and performance (e.g. operations and finance). Drucker has been quoted to say that 'If you can't measure it, you can't manage it' (Hesselberth, 2008). Perhaps atypical and in contrast Deming, cited in Graff (1991) states that "It is nonsense to say that if you can't measure it, you can't manage it". Deming quotes an example of productivity measurement and makes the case that productivity measurement does not improve productivity (Deming, 1986). This appears quite contrary to his philosophy of measurement. Deming was after all a statistician and promoted statistics to improve quality and performance (Deming, 1975). The apparent contradiction does not devaluate Deming's statements to the scholars of his work and are quite reconcilable.

A brief preamble on the use of the words 'measurement', 'assessment' and 'evaluation' may clarify the use during this brief discourse. It is accepted that 'measurement' is often but not exclusively used in an accounting context, where 'assessment' and 'evaluation' are more often used as an appraisal of non-financial indicators. For the purpose of this section, this common use is mostly maintained, however there may be some cross-over between the terms where they relate better to original texts or appear more appropriate.

In the true Lean philosophy it may not be important to assess how Lean the organisation is as long as it continues to improve the system and its processes to create value for the customer. In reality however, business managers like to know where they are. Neely provides ample reason for performance measurement (1999) in a rapidly changing world. Evaluation of Lean and indeed, if a company measures as Lean, is no guarantee that the business performs. There may be correlational and even causal effects that need addressing. Bourne et al (2000) and Kaplan and Norton (1998) assert that measurement results serve as a tool to assist refocusing on the organisation's strategy. The principle for performance measurement should be based on the philosophy that improvements in non-financial measures drive financial performance, while financial performance indicators are 'lag' indicators, reporting on the past (Kaplan and Norton, 2001).

A simple truth is that businesses generally tend to assess the annual or quarterly bottom line, and that is quite harmful to Lean transformation (Maskell and Kennedy, 2007). Maskell and Kennedy (2007, p63) quote Fiume and Cunningham, both CFOs of effective lean manufacturers, who state that

> *"The average recipient of a standard cost-based profit and loss statement does not understand the document in his hands. It communicates nothing. Worse still, for those few that do understand it, these statements fail to give meaningful information about what is really happening in the operation."*

The reasons for the failure of conventional measurement are exquisitely summarised by Bhasin (2008). Because financial statements tell the story too late, we need to address Lean measurement. Lean assessment intends to give regular information on what is really happening. Mahidhar (1998) emphasises the importance of properly designed measurements to support Lean enterprise transformation.

A number of philosophies and tools have been developed over the years. Bhasin (2008) believes that organisations must adopt more holistic performance assessment systems as Lean benefits are not always obvious. He looks at several different assessment systems and combines these into a Dynamic Multi-Dimensional Performance (DMP) model which considers success dimensions and balanced scorecard dimensions in four different time perspectives from very short term to very long term. He follows this up with a table representing both technical and cultural elements (Bhasin, 2008), without transforming the table into an actual tool. Shah and Ward (2007) develop a multi-dimensional model of Lean, using three underlying constructs (supplier related, customer related and internally related) as main groups for a restricted number of defined Lean elements. They too develop a model but do not transform it into a usable instrument.

For organisations that are adopting the Lean paradigm, it is important to have regular indications of being on the right track. It would be futile to wait for the end-of-year financial performance or even regular financial performance numbers. These organisations need assessment methods that are readily observable and can be made visual on very short terms

to affect employees' behaviour. Although non-financial measures are difficult to establish (Allio, 2006, in Bhasin, 2008) and there is a lack of established and validated instruments for measuring 'leanness' within an organisation (Grigg et al, 2010), there are several useful instruments to assist the organisation.

Kobayashi developed '20 Keys to Workplace Improvement' (1995) which combines twenty inter-related areas that impact quality and costs for organisations and provides descriptive and five-point rateable steps within each of the 20 keys. The keys are based on his 'Practical Program of Revolutions in Factories' (PPORF) and the book itself provides useful recommendations to move from one level within a key to the next. Although the 20 keys have been designed as very practical steps, Kobayashi emphasises the need for a broader base and commitment within the whole organisation. An example of the model is found in figure 2-21, while Appendix 4 provides a relational summary of all 20 keys.

CHECKSHEET: KEY 1: CLEANING & ORGANISING TO MAKE WORK EASY

| No. | Category | Level | Evaluation Criteria | Judgement Calls | |
|---|---|---|---|---|---|
| 1 | Putting away unneeded items | 2 | No unneeded items lying around. | There are no cigarette butts, pieces of scrap paper, tools, files, machines, materials and parts that are not used for months or years. | |
| 2 | Floor cleaning | | Cleaning equipment is stored neatly / everything has its place. | Cleaning tools are stored near the shop floor. Brooms are hung properly so that the edges are not touching the floor. | |
| 3 | | | There is no garbage, dirt or paper on the floor. There is no danger of slipping and no trash in floor wells. | The floor is clean of iron scraps, water and oil so that the operators do not have to walk in the dirty areas. There is no danger of slipping. | |
| 4 | Display boards | | No outdated, torn, or soiled announcements are displayed. Papers are straight and neat. There are no torn corners or tape marks left over from old displays. | There are no outdated, torn or soiled announcements on the display board. All announcements are clearly displayed. | |
| 5 | Emergency access | | Nothing is obstructing the access to fire extinguishers and water hoses. Nothing is in front of emergency exits or corridors. Location and use of switches and breakers are posted. Zebra marks are painted on safety risk areas. | Nothing obstructs access to fire extinguishers, water hoses, emergency exits, walkways and crossings. Fire extinguishers can be seen from 20 metres away. Use of switches and breakers are indicated. There are no foreign objects in electrical switchboards, ashtrays or garbage cans. | |
| 6 | Items on the floor | | Work-in-process and tools are not placed directly on the floor. | Operators do not have to bend over to load up materials on the cart to go to the next operation.<br>Large materials are placed on pallets. | |

FIGURE 2-21: SAMPLE OF KOBAYASHI KEY WITH LEVEL AND JUDGEMENT CRITERIA

Another useful instrument was designed by Tapping Luyster and Shuker (2002). They created ten groups, much like Kobayashi, and provided descriptive criteria which are scored on a 5 point (0 to 4) scale. An example of commercial application of the scale is found in figure 2-22, while the ten groups can be seen in summary table 2-9. Figure 2-23 shows an example from the CD accompanying their book on value stream management.

# LEAN ASSESSMENT

## 2. WORKPLACE ORGANISATION & VISUAL MANAGEMENT

| | QUESTION | SCORE | | | | |
|---|---|---|---|---|---|---|
| | For each statement please circle the score that best represents the observed frequency in the plant and indicate the rationale for your assessment under Score Justification. For scoring use the following: *0 = Not found anywhere; 1 = Only found in some areas (25%); 2 = Commonly found but not in majority (50%); 3 = Very typical, some exceptions (75%); 4 = Found everywhere, no exceptions (100%).* | | | | | |
| 1 | The Plant is generally clear of all unnecessary materials or scrap and isles are clear of obstructions. | 0 | 1 | 2 | 3 | 4 |
| | ***Score Justification:*** | | | | | |
| 2 | Lines on the floor clearly distinguish work areas, paths, and material handling isles. Signs clearly identify production, inventory staging, and material drop areas. | 0 | 1 | 2 | 3 | 4 |
| | ***Score Justification:*** | | | | | |
| 3 | All employees are considerate of housekeeping and operators consider daily 'clean-up and out away' activities part of their jobs. | 0 | 1 | 2 | 3 | 4 |

FIGURE 2-22: EXAMPLE OF LEAN ASSESSMENT BY TAPPING, LUYSTER AND SHUKER, 2002.

### Step 5: Lean Manufacturing Assessment

**Just-in-Time**

| MASS | ORDER LEVELING | LEAN |
|---|---|---|
| Batch manufacturing exists throughout the value stream. | 1 2 3 4 5 N/A | Order leveling used to reduce variations in production valume and variety. |
| Product control releases multiple orders on the specific value stream without knowledge of true throughput lead time. | 1 2 3 4 5 N/A | Heijunka box is loaded based on production volume and variety. |
| No takt image. | 1 2 3 4 5 N/A | Takt image is understood by everyone, and pace is kept by utilizing a runner or material handler. |

FIGURE 2-23: TAPPING ET AL (2002) REVIEWED LEAN ASSESSMENT EXAMPLE (SIC.).

Another Lean assessment tool was initially developed by MIT and the Warwick Manufacturing Group under auspices of the UK and US Aerospace Initiatives (Nightingale & Mize, 2002). The tool is primarily aimed at organisations intending to transform to a Lean organisation and can be used as a guide and assessment simultaneously. Although comprehensive, the tool appears complicated to use for smaller organisations that do not have dedicated specialists to administer the tool (figure 2-24).

**SECTION I: ENTERPRISE TRANSFORMATION/LEADERSHIP**

*Definition:* Develop, deploy, and manage enterprise transformation plans throughout the organization, leading to: (1) long-term sustainability, (2) acquiring competitive advantage, and (3) satisfaction of stakeholders along with a continuous improvement in all three outcomes.

| | | | | | | |
|---|---|---|---|---|---|---|
| **I.A. Determine Strategic Imperative** - The decision to pursue an enterprise transformation is strategic in nature and affects all organizational practices and processes in the enterprise. The enterprise is continually striving to eliminate waste and enhance relationships with all stakeholders. | | | | | | |
| Diagnostic Questions | | • **Are enterprise leaders familiar with the dramatic increases in competitiveness that many companies have realized as a result of transforming?**<br>• **Are enterprise leaders fully aware of the potential opportunities (i.e., growth, profitability, and market penetration) that can be realized within their own organization as a result of transforming?**<br>• **Has a suitable strategy been identified to use resources freed up by improvements?**<br>• **Does "stakeholder value" strongly influence the strategic direction?**<br>• **Has full leverage of the extended enterprise stakeholders been incorporated into the strategic plan?**<br>• **Has a common vision been communicated throughout the enterprise and within the extended enterprise?**<br>• **Has a compelling case been developed for transformation?** | | | | |
| **EP #** | **ENTERPRISE PRACTICES** | Capability Levels | | | | |
| | | *Level 1* | *Level 2* | *Level 3* | *Level 4* | *Level 5* |
| I.A.1 | **Integrate Enterprise Transformation into Strategic Planning Process**<br><br>*Transformation is a key enabler for achieving strategic objectives* | Enterprise transformation efforts are ad hoc.<br>C D | Enterprise transformation is relegated to lower levels of the enterprise and application is fragmented.<br>C D | Enterprise transformation plans are formulated, but not integrated into the strategic plan.<br>C D | Coordination and synergistic relationship exists between transformation and strategic planning.<br>C D | Strategic plans leverage the results of transformation improvements to achieve enterprise objectives.<br>C D |
| | *Indicators (Examples)* | • Enterprise transformation implementation is included explicitly in the enterprise strategic plan.<br>• Strategic planning makes allowance for anticipated gains from transformation improvements. | | | | |
| | *Evidence* | | | | | |
| | *Opportunities* | | | | | |

FIGURE 2-24: LESAT LEAN ASSESSMENT TOOL DEVELOPED BY MIT AND LAI (P7).

The Manufacturers' section of Business New Zealand has a web-based programme called 'Leanstep' (http://www.leanstep.org.nz/) that can be used by operators to complete a Lean self-assessment. The instrument (figure 2-25) is simple to use and automatically generates reports such as the score per section, a graphical presentation of the results and a list of recommended improvements.

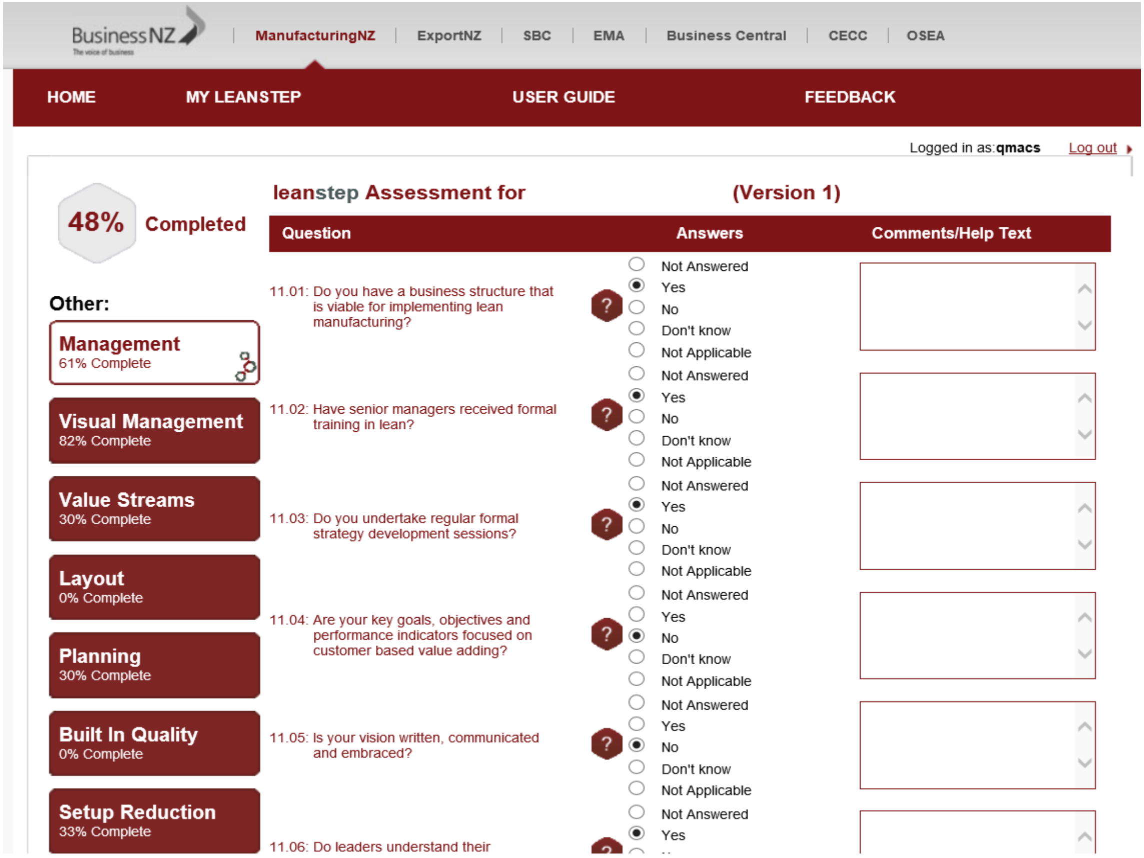



FIGURE 2-25: MANUFACTURING NZ'S LEANSTEP PROGRAMME.

Summarising, there are a number of Lean assessment tools available. Organisations that intend to transform to a Lean paradigm may have to make an arbitrary decision to select an instrument that can be understood and used by non-specialists or have restricted time available. Although the Manufacturing NZ's assessment is simplest in form, it does not point in any specific direction until completed. For that reason and because of its simple form, this research project considers that the first version of the Tapping et al Lean assessment form would be useful for starting converts.

TABLE 2-9: COMPARING LEAN ASSESSMENT CRITERIA.

## Comparing Lean measurement instruments

| | Kobayashi 20 keys | Tapping Luyster and Shuke | Shah and Ward (2007) | Bhasin (2008) | Bhasin (continued) |
|---|---|---|---|---|---|
| 1. | Cleaning & organising to make work easy | Cultural awareness | Supplier Feedback | Financial | Process (continued) |
| 2. | Rationalising the system/Goal alignment | Workplace organisation & visual management | JIT delivery by suppliers | • Profit after interest and tax<br>• Rate of return on capital employed<br>• Current ratio<br>• Earnings per share | • WIP inventory<br>• Finished goods inventory<br>• Stock turnover |
| 3. | Small group activities | Standardised work | Supplier development | | |
| 4. | Reducing work-in-progress | Flexible operations | Customer involvement | | |
| 5. | Quick Change-over technology | Continuous improvement | Pull | Customer/market measures | |
| 6. | Kaizen of operations | Error proofing/Poka Yoke | Continuous flow | • Market share by product group<br>• measures Customer satisfaction index<br>• Customer retention rate<br>• Service quality<br>• Responsiveness (customer defined)<br>• On-time delivery (customer defined) | |
| 7. | Zero monitor manufacturing/production | Quick change-over/set-up | Set-up time reduction | | People |
| 8. | Coupled manufacturing/production | Total productive maintenance | Total productive/preventative maintenance | | • Employee perception surveys<br>• Health and safety per employee:<br>• Accidents<br>• Absenteeism<br>• Labour turnover<br>• Retention of top employees<br>• Quality of professional/technical development<br>• Quality of leadership development |
| 9. | Maintaining machines and equipment | Material control/Pull | Statistical process Control | Process | |
| 10. | Workplace discipline | Level production | Employee involvement | • NPD lead time<br>• Cycle time<br>• Time to market for new products<br>• Quality of new product development and project<br>• management processes<br>• Quality costs<br>• Quality ratings<br>• Defects of critical products/components<br>• Material costs<br>• Manufacturing costs<br>• Labour productivity<br>• Space productivity<br>• Capital efficiency<br>• Raw material inventory | |
| 11. | Quality assurance system | | | | |
| 12. | Developing your suppliers | | | | Future |
| 13. | Eliminating waste | | | | • Depth and quality of strategic planning<br>• Anticipating future changes<br>• New market development<br>• New technology development<br>• Percentage sales from new products |
| 14. | Empowering employees to make improvements | | | | |
| 15. | Skill versatility and cross-training | | | | |
| 16. | Production scheduling | | | | |
| 17. | Efficiency control | | | | |
| 18. | Using information systems | | | | |
| 19. | Conserving energy and materials | | | | |
| 20. | Leading technology/site technology | | | | |

### 2.3.8. Lean in other industries and areas: Several examples

While Lean was mostly restricted to the operational manufacturing area in early 2000s, Lean has since extended to other disciplines such as economics (e.g. Stone, 2012), human resources (e.g. Holton, 2003), product development (e.g. Womack et al, 1990; Holweg, 2007), marketing and sales (e.g. Piercy and Morgan, 1997), service (e.g. Arbos, 2002; Seddon and Caulkin, 2007), construction (e.g. Jørgensen and Emmitt, 2008), health (e.g. Joosten et al, 2009; Aronsson et al, 2011), IT (e.g. Staats et al, 2011), government (e.g. Seddon and Brand, 2008; Krings et al, 2006), supply chain (e.g. Holweg and Pil, 2001; Aronsson et al, 2011), aerospace (e.g. Financial Post, 1999) and accounting (e.g. Hines et al, 2004). Lean as a concept had evolved significantly since its origins with the older concepts around shop-floor improvement in the car industry (Hines et al, 2004).

It is relevant to look at implementations of Lean in other industries and areas. For the purpose of this paper, not all industries and areas can be discussed, but some selected elaborations may further clarify the context within which the inquiry takes place.

#### *2.3.8.1. Lean in the health industry*

Hines et al report that research into Lean for the public sector is still in its infancy (2008). The public health services can be considered part of the wider public services and offers numerous studies and articles on implementation of Lean. These range from Lean in emergency departments (e.g. Dickson et al, 2009), histological laboratories (Buesa, 2009), healthcare (Radnor et al, 2012) and more. Lean healthcare emerges more frequently in articles in recent years. Generally, health care has been under scrutiny across the world, and it appears that health sectors understand that they must deliver more of a quality product while budgets are restricted. This also supposes that implementation of Lean is partly in response to potential crisis; possibly not the best reason to look at improving your organisation.

In all healthcare, there are two critical deviations from the assumptions in Lean: The customer is the institute commissioning the health care facility, and healthcare is capacity led instead of demand led (Radnor et al, 2012). The differentiation between the paying customer (e.g. the government) and the consumer (the patient) must bring with it the inference that the customer knows what is best for the consumer. This can be likened to the confounding relationship between exporter, packhouse and grower in terms of information flow, ownership and product flow in the pipfruit industry. Radnor et al (2012) also consider the traditional seven wastes and translate these into a health care environment in an attempt to 'Lean up' health care. They conclude that if these deviations from Lean suppositions are not addressed, they could severely impact on the implementation effect of Lean in the industry.

Laboratories are also service providers. Buesa (2009) looks at adapting Lean for use in histology laboratories. She describes the process and identifies the work flow as one of the areas where improvements can be made, including re-arrangement of instruments. Simultaneously, she recognises that not all Lean principles can be applied per se. In her view, laboratories that have 20,000 or more tasks benefit more from her approach. The repetition of small improvements in the process flows in laboratories can improve the organisations, but do not necessarily make these Lean.

Dickson et al (2009) focussed on Lean implementation involving front line staff after a process of education, Emergency Department (ED) observation, patient flow analysis, process redesign, new process testing, and full implementation. Value Stream assessments visualised processes and waste. Dickson et al report that the changes made were not special but made good sense. Changes included visuals (improved signage), alignment of processes avoiding duplication, re-defined job descriptions, early involvement of laboratory tests, X-rays and other services. Staff accepted changes readily because the proposed changes came from staff; Dickson et al (2009) indicate that staff were involved and empowered. Comparison of value based and operational data before implementation with post-implementation data from 2006, resulted in improved patient satisfaction despite a 9.23% increase in patients (37,000 patients).

Lean theory is assessed by Joosten et al (2009), who adopt a more careful approach in that they believe that a 100% positive message is not correct, and that Lean depends on a variety of issues surrounding the health sector. Improvements are mostly operational and not socio-technical. They clearly indicate that managers should focus on developing and improving their workforce—creating synergies that lead to otherwise impossible results—not on making the improvements themselves.

Kim et al (2006) report a number of successes and also tabulate some of the challenges for the health industry in two categories: Culture and practical. Cultural elements include a silo mentality, a fear for lay-offs, and the argument that people are not cars. In their view, health care shares the challenge of producing high-quality products (clinical outcomes) within an environment of restricted resources, while managing a complex business operation and maintaining the safety and satisfaction of workers and customers with manufacturing.

A number of studies have been completed in healthcare. It appears that reports are mostly project based. There is little mention of boards endorsing or positively promoting Lean other than on projects basis. This may be a useful approach as it at least generates success stories that may be replicated elsewhere, leading to step-wise improvement of the healthcare system. It may be too early to expect sustained Lean results in the healthcare industry.

#### *2.3.8.2. Lean in accounting*

Accounting can be seen both as a service industry as well as a professional activity. This section approaches accounting mostly from the professional point of view, however it clearly impacts on the state of accounting as a service industry whilst organisations opt for Lean change.

It is commonly accepted today that the way in which companies work and produce results for their customers has changed more rapidly in recent years than ever before as a result of how the world is changing (e.g. Friedman, 2005; Womack and Jones, 2009). Theories such as agile (e.g. Mason-Jones et al, 2000) and time-based pacing (Eisenhardt, 1998) are built for the fact that environments change rapidly and organisations need to keep up. It should therefore not be surprising that traditional accounting systems developed in different times should change with the current times and demands (Kennedy & Brewer, 2006). In his seminal work called ‘Relevance lost: The rise and fall of management accounting’, Johnson (1991) finds that accounting practices well established in the early 1900’s need revising because they were no longer relevant to the way businesses were run in the 1990’s. Kaplan was also quite critical of traditional accounting and in an attempt to provide a more holistic view, added several dimensions to the financial perspective including customer, internal business processes and innovation and learning (Kaplan and Norton, 1998).

Accounting can be understood to denote the reporting on financial performance of an organisation, or the reporting on management control systems; two different interpretations (e.g. Maskell, 2004; figure 2-26). Johnson (2006) describes financial accounting as a regulatory requirement and not 'waste'. In his view, it is management accounting -the setting of targets to control and drive actions- that is wasteful. Maskell and Kennedy (2007) describe management accounting as the control, measurement and management processes to support operations and as the type of accounting that must change when undertaking a Lean transformation. It is the management accounting that must be adapted to a Lean philosophy for Lean companies.

Johnson (2006) claims that traditional accounting control systems are the number one enemy of sound operations management. His personal experience is that Toyota's operations are not using accounting control systems, something unthinkable to western managers. In Activity Based Costing (ABC), cost information becomes misleading. In his view, western managers lose sight of reality by focussing on quantitative data and not focussing on what creates those numbers. ABC calculates costs on fragmented information, the proportion of labour and machine costs per item.

| | | 13-Jun | 20-Jun | 27-Jun | 4-Jul | 11-Jul | 18-Jul | 25-Jul | 1-Aug | 8-Aug | 15-Aug | FUTURE STATE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Operational | Units per Person | 15.18 | 15.63 | 14.70 | 15.91 | 15.90 | 16.59 | | | | | 20.70 |
| | On-Time-Shipment | 100% | 100% | 100% | 100% | 100% | 100% | | | | | 100% |
| | Dock-to-Dock Days | 6.00 | | | | | | | | | | |
| | First Time Thru | 80% | 80% | 80% | 85% | 85% | 85% | | | | | 85% |
| | Average Product Cost | $343 | $337 | $362 | $338 | $337 | $325 | | | | | $262 |
| | AR Days | 42 | 42 | 42 | 42 | 37 | 37 | | | | | 37 |
| Capacity | Productive | 29% | 29% | 29% | 28% | 28% | 28% | | | | | 40% |
| | Non-Productive | 54% | 54% | 54% | 52% | 52% | 52% | | | | | 33% |
| | Available Capacity | 17% | 17% | 17% | 20% | 20% | 20% | | | | | 27% |
| Financial | Revenue | $470,900 | $484,750 | $455,942 | $490,050 | $487,910 | $525,635 | | | | | $576,375 |
| | Material Cost | $172,085 | $175,385 | $178,685 | $181,935 | $184,685 | $187,010 | | | | | $189,160 |
| | Conversion Cost | $119,584 | $119,584 | $119,584 | $119,584 | $142,584 | $152,584 | | | | | $158,084 |
| | Value Stream Gross Profit | $179,231 | $189,781 | $157,673 | $188,531 | $160,641 | $186,041 | | | | | $229,131 |
| | ROS | 38.06% | 39.15% | 34.58% | 38.47% | 32.92% | 35.39% | | | | | 39.75% |

FIGURE 2-26: EXAMPLE OF A BOX SCORE USED FOR WEEKLY VALUE STREAM REPORTING. SOURCE: MASKELL, 2004, P8).

Maskell and Kennedy (2006) do not quite agree with this interpretation. In their view, some companies use ABC for process costing, and that is coming close to costing the value stream. Ohno is quite explicit in his explanation about cost accounting when he discusses 'the misconception that mass production is cheaper' (Ohno, 2013). He condemns cost calculations based on isolated thinking. Maskell (2013) tables a number of these, including labour efficiency, machine utilisation, purchase price variance and overhead absorption variance. He argues firmly that the focus of Lean accounting must be on the value stream. Kennedy and Brewer (2006) agree; in their view, decision making is assisted by analysing the effect of the proposed changes on the profitability of the value stream as a whole, not the individual products.

Kennedy and Brewer (2006) present the view that traditional accounting was designed to support mass production type management with top-down command and control, a departmental cost approach and a focus on shareholder value. When the philosophy changes away from mass production, they believe that the accounting has to change as well. They argue that traditional accounting systems can create organisational behaviours and attitudes that are not synchronised with Lean thinking, a parallel to Emiliani's 'fat behaviours'. Emiliani (1998) believes that increased competition during the late 20th century has led to a fixation on data and performance measurements, resulting in a neglecting of 'lean behaviours', behaviours that promote flow between people. Johnson and Kaplan (1987) in Ezzamel et al, 1990) and Grasso (2006) believe that management accounting lost relevance because of the increased competition and fast economic changes in the late twentieth century. It is clear then that Lean transformation requires a management accounting transformation.

A number of observations point at resistance to change from traditional management accounting. Grasso (2006) argues that resistance to Lean accounting is primarily caused by resistance to management system change. He goes as far as stating that management accounting is still a barrier to implementing Lean. Bhasin (2008) finds that a new philosophy will fail without an effective change management policy. Resistance to change is common (Kotter, 1995). Most managers do not realise that change involves a process. So what is that change that is required?

| PRINCIPLES | PRACTICES | TOOLS OF LEAN ACCOUNTING |
|---|---|---|
| A. Lean & simple business accounting | 1. Continuously eliminate waste from the transactions processes, reports, and other accounting methods | a. Value stream mapping; current & future state<br>b. Kaizen (lean continuous improvement)<br>c. PDCA problem solving |
| B. Accounting processes that support lean transformation | 1. Management control & continuous improvement | a. Performance Measurement Linkage Chart; linking metrics for cell/process, value streams, plant & corporate reporting to the business strategy, target costs, and lean improvement<br>b. Value stream performance boards containing break-through and continuous improvement projects<br>c. Box scores showing value stream performance |
| | 2. Cost management | a. Value stream costing<br>b. Value stream income statements |
| | 3. Customer & supplier value and cost management | a. Target costing |
| C. Clear & timely communication of information | 1. Financial reporting | a. "Plain English" financial statements<br>b. Simple, largely cash-based accounting |
| | 2. Visual reporting of financial & non-financial performance measurements | a. Primary reporting using visual performance boards; division, plant, value stream, cell/process in production, product design, sales/marketing, administration, etc. |
| | 3. Decision-making | a. Incremental cost & profitability analysis using value stream costing and box scores |
| D. Planning from a lean perspective | 1. Planning & budgeting | a. Hoshin policy deployment<br>b. Sales, operations, & financial planning (SOFP) |
| | 2. Impact of lean improvement | a. Value stream cost and capacity analysis<br>b. Current state & future state value stream maps<br>c. Box scores showing operational, financial, and capacity changes from lean improvement. Plan for financial benefit from the lean changes |
| | 3. Capital planning | a. Incremental impact of capital expenditure on value stream box-score. Often used with 3P approaches |
| | 4. Invest in people | a. Performance measurements tracking continuous improvement participation, employee satisfaction, & cross-training<br>b. Profit sharing |
| E. Strengthen internal accounting control | 1. Internal control based on lean operational controls | a. Transaction elimination matrix<br>b. Process maps showing controls and SOX risks |
| | 2. Inventory valuation | a. Simple methods to value inventory without the requirement for perpetual inventory records and product costs can be used when the inventory is low and under visual control. |

FIGURE 2-27: PRINCIPLES, PRACTICES & TOOLS OF LEAN ACCOUNTING (SOURCE: MASKELL & BAGGALEY, 2006, P37).

Lean accounting is strongly based on the value stream as part of Womack and Jones' (2003) five Lean principles. Kennedy and Brewer (2006) state e.g. that performance to budget is a traditional metric while performing to customer demand is the lean metric. Similarly, traditional management oversees people, based on information provided to those managers, while Lean accounting manages processes by providing real-time information to the people who manage the processes. This is expressed in techniques such as Visual performance measurement, continuous improvement, value stream costing and target costing (Maskell and

Baggaley, 2006). Maskell & Baggaley (2006) offer a clear and concise table (figure 2-27), setting out what entails Lean accounting in their view.

From the above, it is clear that a number of writers are critical about traditional management accounting, especially where companies have decided to transform to the Lean paradigm. This necessary transformation has consequences for both the accounting service industry as well as the accounting profession, as both have to move with the times and be prepared to present a different form of management accounting to their customers. This new professional accounting requirement, combined with the described difficulty of adapting to change in type of management accounting may well present a hindrance to those companies that embark on a Lean transformation journey. They are nevertheless essential in promulgating Lean in transforming organisations, including horticultural and pipfruit organisations.

#### *2.3.8.3. Lean marketing and supply chain*

Although marketing and sales are not per se a separate industry, there appears to be a relatively important development that affects other industries implementing Lean, including the horticultural sector. The two areas have been treated as separate entities for too long and the interface between marketing and manufacturing has been discussed by a number of researchers. Hausman et al (2002) conclude that inter-functional harmony appears to have a strong influence on either section's morale. Piercy and Morgan (1997) believe that marketing has reacted poorly to new paradigms such as supply chain management, TQM and BPR and that there is urgency required to address responsiveness to Lean thinking. They believe that marketing will be subjected to a major test by the introduction of Lean thinking, including Lean supply chains.

Both in the US and the UK, main supermarket supply chains participated in the Efficient Consumer Response (ECR) programmes which apply Lean supply chain principles to the retail business. This was the result of a number of conditions, including complex invoicing systems to deal with complex deals; unacceptable high levels of damaged and unsalable goods; excessive inventories and others. Claims are that between 5 and 6% of the costs can be taken out of the supply chain using ECR strategies (Piercy and Morgan, 1997). The adoption of Lean in marketing and sales and the wider supply chain is proposed to improve the competitive position of that supply chain.

In the past, there have been similar claims to improved efficiencies through paradigms such as TQM (e.g. Deming 1986), BPR (e.g. Hammer and Champy 1993) and JIT (O'Neal 1989), all suggesting that the elimination of unproductive waste and resources in organisations are the basis for sustained competitive advantage. Lean authors propose the logic that the retailer should collaborate with suppliers to produce the products required by customers and that the retailer should remove waste by collaboration with suppliers to create the products necessary to keep customers satisfied, based on purchase data collected at retail level (Piercy and Morgan, 1997).

Dewell (2007) observes a shift from focus on individual IT systems to enterprise wide views of marketing function and associated processes. He defines Lean marketing as

> *'a systematic continuous improvement process that will eliminate waste and inefficient processes, speed up production cycles and increase the professionalism of the people in every aspect of marketing. The emphasis is on process with supporting technology instead of technology led improvement.' (p24).*

He believes that Lean marketing is only just emerging (Dewell, 2007).

If marketing consist of the four 'Ps' (Product, Packaging, Price and Promotion), it is almost inescapable to look at the supply chain. Vargo and Lusch (2004) argue that marketing is no longer restricted to the 4 Ps, but argue that the focus has shifted from tangible resources, embedded value and transactions (goods-centred model of exchange) to intangible resources, value co-creation and relationships (service-centred model of exchange). Service provision rather than goods is fundamental to economic exchange; it is customer focussed and market driven (Vargo & Lusch, 2004). In their view, the shift moves from the provision of goods to the provision of the competency or value of the goods.

Piercy and Rich (2004) argue production efficiency alone is not enough to arm the organisation with tools needed to differentiate its business from its competitors at times when supply chain management has developed organisationally to 'come of age' and traditional marketing is in 'mid-life crisis'. In a time when traditional marketing is losing corporate influence, there are opportunities to bring together the successful qualities of marketing and operations approaches to form innovative, organisation-wide approaches to value chain management. They argue that the positive comparison between Lean and traditional manufacturing stimulated interest in copying the Lean model over and above the technical contingencies of car production and in moving the model from East to West. Piercy and Rich (2004) also maintain that there is a vacuum between operational management and meaningful marketing involvement during the design of the Lean business system. They point toward the SERVQUAL instrument (Zeithaml et al, 1990) as identifying key dimensions of service that far exceed the lean definition of quality. They give an excellent example through James Womack who mentioned becoming a 'lean realist' when, after leaning up his custom-made bike factory, the custom made bikes could be produced inside two days, severely affecting the value perception of the customer.

They propose to take the superior aspects of marketing (i.e., customer analysis, understanding) and the superior aspects of the lean enterprise (i.e., process-quality improvement) and form a lean value chain which promises organisations a substantially superior position in terms of the marketplace. They go on to produce a list of marketing and production issues and combine these into general Lean solutions in eight areas varying from capacity planning and long term forecasting to after-service.

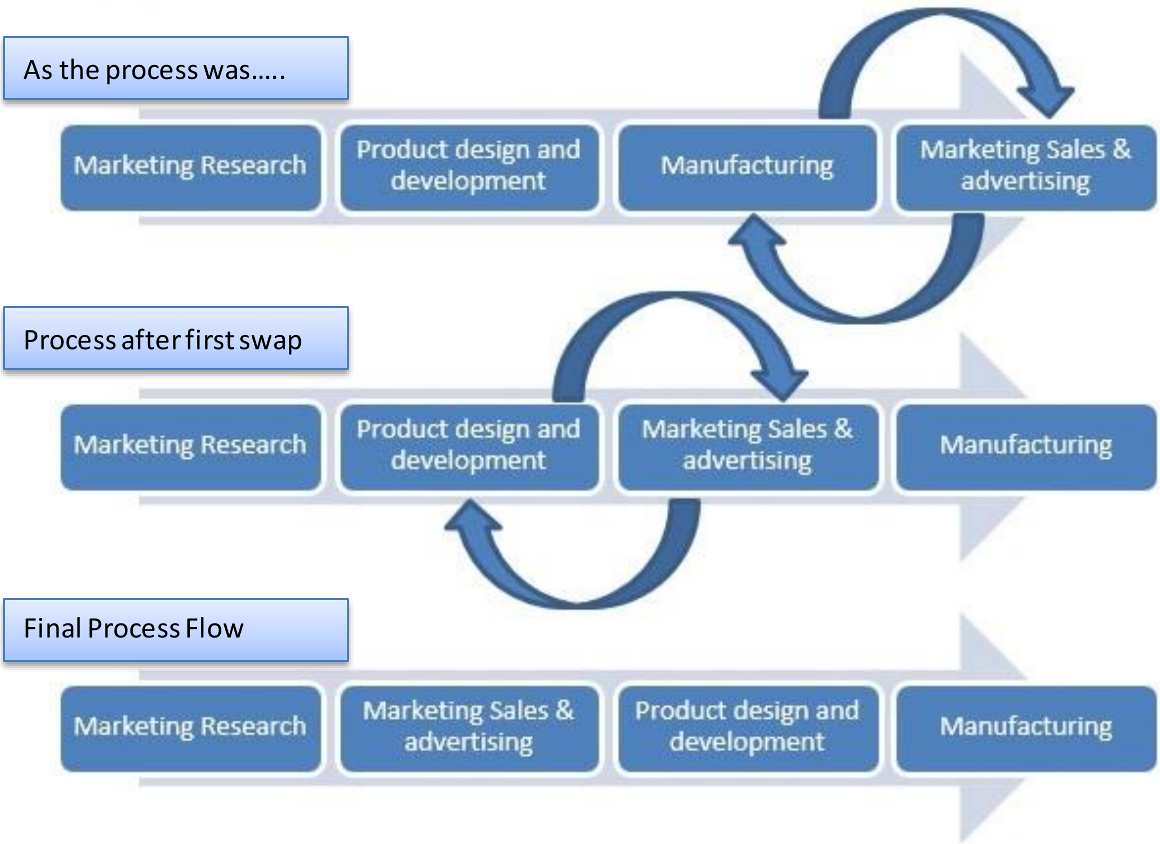



FIGURE 2-28: PROCESS SWAPS TO FACILITATE BUILT-TO-ORDER.

Sharma and LaPlaca (2005) propose a shift from the traditional business sequence to a more-Lean concept in a Build-to-order (BTO) approach (Figure 2-28). They propose to build as a last process and move design and marketing forward. Such a move should improve both customer loyalty and marketing efficiency. Like others, they argue that future companies will thrive if they have an intimate understanding of their customers. The practice of BTO has little relevance to the inquiry at hand, however the marketing and supply chain section demonstrates that there are many sides to Lean, all of which deserve consideration when adapting the current system to a new environment.

#### *2.3.8.4. Lean and the Process Industry*

King (2009) finds that the one area where Lean is lagging behind in being applied is the process industries. This group includes consumer goods, food and beverage, canned foods, frozen foods, pulp and paper, plastics, chemicals and so on. King quotes others who believe that there is constant flow in these areas or that Lean simply does not fit—that process industry processes are too different from manufacturing and assembly.

King's work is not academic; his reference section spans 1½ pages and offers some of the traditional works. Nevertheless, his work at DuPont gave him a long period of experience in world class manufacturing and knowledge of process industries, and he writes with practitioner's authority on the subject.

King quotes as the basis for his findings the five principles espoused by Womack et al (1990) and Ohno in saying that the basis for TPS is the absolute elimination of waste and the two pillars of the house are JIT and autonomation. He goes on to describe fourteen tools and later in his work he describes how these tools may work in the process industry. In his view, manufacturers produce parts and components, while process industries are characterised by processes including mixing, blending, extrusion, baking and so on. Umble and Srikanth (1995) differentiate four process groups in manufacturing:

1. Basic producers use natural resources as inputs and process these into products used as inputs by other segments;
2. Converters transform materials into end goods or end items;

3. Fabricators produce consumer goods or parts or components for assemblers;
4. Assemblers combine parts and components to produce finished goods.

Although the differentiation makes sense, it does not quite describe primary production where the natural resources are the inputs.

King believes that there is a significant lack of literature on application of Lean in process industries and this may be one of the reasons why people may assume that Lean does not apply (King, 2009). He covers several distinguishing characteristics of process industries in order to understand the application of Lean better. These include:

- *High volume, variety and variability*
- *Capital intensive versus labour intensive*
- *Throughput limitation through equipment rather than people*
- *Large and difficult to relocate equipment*
- *Processes are difficult to start and stop*
- *Product changeover issues are complex*
- *Finished product inventory versus WIP*
- *Hidden WIP*
- *Material flow processes converge versus diverging in processing plants*

King largely follows the standard Lean theory and tries to link process industry features to the Lean theory. He takes e.g. the seven wastes and describes what these would look like in the process industry. King also introduces a section describing Lean tools that may need a different approach. These include bottlenecks (caused by equipment in the process industry and by people in manufacturing) for which he recommends the Theory of Constraints approach (Goldratt and Cox, 1986). Using virtual work cells for cellular manufacturing, using product wheels instead of Heijunka cells for planning, postponement combined with Finish-to-Order. He refers to 'A' and 'V' type processes where the 'A' type process typically is assembly or conversion of parts and 'V' type is the reverse, a typical divergence of raw product. This is representative of a packhouse situation. Packhouse processes include divergence and assembly, and there are differentiation points which become critical because incorrect decision making results in unwanted product and thus waste (King, 2009).

Melton (2005) discusses Lean in the process industries. He summarises the Lean domain by trying to highlight the most salient components. Melton too tries to capture Lean components and give process industry examples, e.g. the seven wastes and a Lean toolkit. He continues with a small case study, highlighting a value stream process. His paper, presented at the 7th World Congress of Chemical Engineering, is more a summarised account of how lean could be implemented and the theoretical advantages. It has little significance for horticultural industries.

Pool et al (2011) differentiate between lean in discrete manufacturing and semi-process industry as caused by the resource characteristics of each. They believe that in most semi-process industries there is a transformation point where process production turns into discrete manufacturing. Downstream of the transformation point, Lean can be implemented in a straightforward way, but upstream requires a more liberal interpretation. The case study concerns a Sara Lee plant redesign where both process production and discrete production take place. A cyclic scheduling process is designed, improving production regularity, simpler planning, apparent yield, quality and energy-use numbers.

Mahapatra and Mohanty (2007) discuss why Lean has not been implemented more than it is around Mumbai and Eastern India. They differentiate between continuous process (CM) industries and discrete manufacturing industries (DM). They produce tables showing different ratings by DM and CM organisations for various tools. They produce tables showing the impact of various tools on maintenance, production, quality, materials and inventory and product and process design with production and quality being affected the most positive. Unfortunately the selection of participants is not discussed. It appears that a survey has been responded to by Lean manufacturers while the introduction states that there is a low level of acceptance.

Abdulmalek and Rajgopal (2007) describe how lean, particularly value stream mapping was implemented in an integrated steel mill. They also describe that there are few applications in the process industry. They used simulation to convince managers of gains to be made and indicate that this is a useful tool (Abdulmalek & Rajgopal, 2007).

Borbas (2011) produces an article focussing on a Lean change-over project for a bagging machine in a fresh salad packaging plant. Although the project takes place in a process environment for a horticultural product, it is primarily a standard Lean change-over improvement process with positive results.

Xu looks into the Lean and Agile paradigms in a supermarket environment (Xu, 2006). He argues that Lean and Agile can combine in an effective hybrid approach to the supply chain. Xu (2006) and Jones & Towill (1999; figure 2-29) focus on the different groups of products and proposed floating decoupling points in a virtual product pipeline for the various groups of products. Agile supply relates more to volatile markets with high product variety and short life cycle, high profit margins and high marketing costs (Mason-Jones et al, 2000).

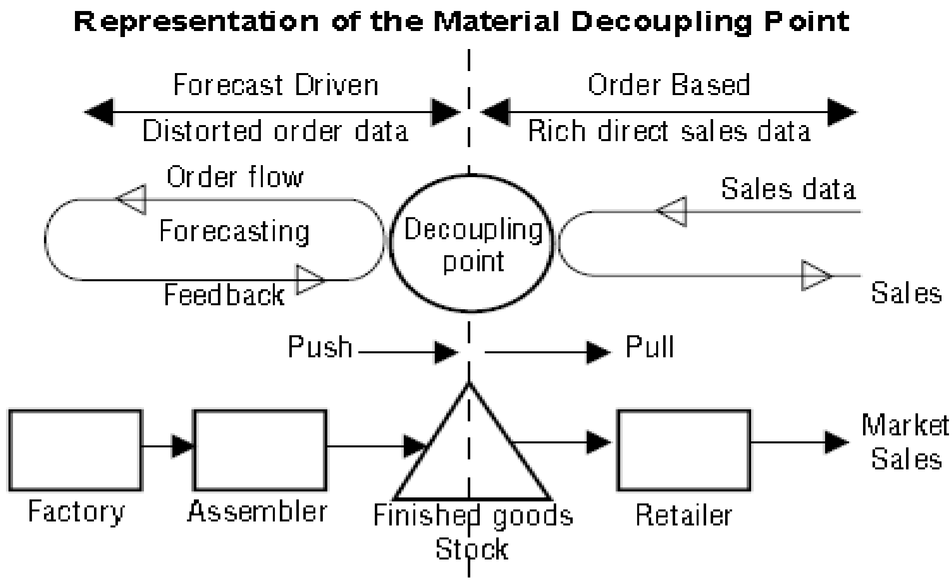



FIGURE 2-29: REPRESENTATION OF THE MATERIAL DECOUPLING POINT (SOURCE: MASON-JONES & TOWILL, 1999, P17).

All of these studies relate to the process industry which has not much in common with the pipfruit industry or the wider horticultural industry. Some interesting questions can be raised when discussing continuous manufacturing (CM) versus discrete manufacturing (DM). Are orchards either one or the other? Where do packhouses fit in? It is the researcher's contention that orchards are neither CM nor DM. Orchards do not have raw material available all the time; growth cycles mean that they have variable activities that lead to a short period of harvesting (production). Packhouses provide a seasonal packing service and coolstores provide a seasonal coolstore service, and neither can be compared to any form of processing or manufacturing. This is the approach that will be taken forward into the research section.

#### *2.3.8.5. Lean in the horticultural industry*

A variety of articles describes lean in horticultural settings. The Food Chain Centre in the UK's vision is '*to create the most efficient UK food chain supported by the most effective flow of information'* (www.foodchaincentre.com). Research in partnership with Cardiff Business School and the industry forum leads to published guides about Lean in the dairy, red meat and fresh produce industries. The publications are easy to read and aimed at the person in each industry.

TABLE 2-10: PROPOSED COMPARISON BETWEEN LEAN MANUFACTURING AND LEAN AGRIFOODS (FROM HINES ET AL, 2011B).

Comparison of characteristics between traditional lean environments and agrifood industry.

| Characteristic | Traditional lean environments | Agrifood |
|---|---|---|
| Product type | Standard engineering products | Often non-standard agricultural products |
| Product characteristics | Designed, engineered within tolerances | Naturally occurring, high variability |
| Operations | Highly standardised and automated | Often low standardisation |
| Scale | Medium–very high | Small–high |
| Seasonality | Low–medium | Medium–extreme |
| Supply chain | Tier one/two | Upstream raw material |

There is no referencing. Some significant claims are made such as the horticultural industry can save around £400 million annually (Applying Lean Thinking in the Fresh Produce Industry, 2007). Guides discuss waste, Lean principles and pilot cases from which data were taken to produce the guides. A similar guide describing an apple packhouse claims savings of £28,000 annually by removing a simple wasteful exercise (Saving Money by Better Workplace Organisation, 2007).

Hines et al (2011b) research contingent approaches to quality based pricing within the agri-food industry by two parallel case studies (imported canned pineapple and local potatoes) and note that the industry is typically featuring trading activity and is subject to commodity pricing. Three of the four factors identified as hindering intercompany pricing are mitigated by stabilising input costs, improving supplier Quality, Cost and Delivery (QCD) performance and encouraging collaborative approaches from a supplier group on the basis of withheld power. Although the paper has a focus on quality based pricing, Hines et al produce an interesting table (table 2-10) comparing traditional Lean environments with the agri-food industry environment, pointing at some of the challenges that agri-food faces when implementing Lean.

The Value Chain Management Centre of the George Morris Centre in Canada produced a guide to Food Waste in Canada (Gooch et al, 2010), in which it referred to some Lean elements, including a table (table 2-11) translating the traditional seven Lean wastes into Food wastes. The focus was on food waste and not on Lean elements, but Lean features in the guide as a way of looking at and reducing waste. Gooch et al (2010) produce a cause and effect fishbone diagram from Cranfield University (figure 2-30) in which they identify a number of causes of waste in the food chain.

TABLE 2-11: GOOCH ET AL (2010, P4) TRANSLATION OF TRADITIONAL WASTE INTO AGRI-WASTE.

The seven creators of waste

| Factor | Types of waste that occur as a result |
|---|---|
| Overproduction | *too much production and/or poor flow of products through the chain, often resulting in the need to discount in order to flow products through the system before they spoil* |
| Defects in products or equipment | *poor quality products, poorly operating equipment, communication errors, shortened shelf-life, poor delivery* |
| Unnecessary inventory | occurs at any point along the chain, including in households; creates *excessive delay, poor customer service, long cycle times, excessive spoilage* |
| Inappropriate processing | *incorrect procedures or systems, often when simpler approaches would be more effective* |
| Excessive transportation | *excessive, often complex and costly movements of products or information* |
| Waiting | *long periods of inactivity result in poor materials or information flow, long lead times, and increased spoilage* |
| Unnecessary motion | *poor design of any link or workplace along the chain, or the overall chain itself, often leading to lost or damaged items* |

In New Zealand, Scarrow discusses Lean in an orchard context, specifically related to Kiwifruit in New Zealand (Scarrow, 2010). Scarrow relates Lean to Deming's 'ten Kaizen principles', believes that the positive productivity shift is caused by continuous improvement as presented by the Deming PDCA cycle, and tables a number of questions relating to choices made by the orchardist. The focus of his article is on customers, continuous improvements, openly dealing with problems, creating cross-functional teams and informing and enabling employees. This is not a robust narrative but rather a scrambled collection of Lean and quality management maxims with the intention to convince readers that Lean works but without the benefit of empirical evidence.

A further Canadian research report quantifies customer satisfaction and effectiveness of current industry practices of the Ontario Pipfruit, stonefruit and grape industries ( Gooch et al, 2009). The study is not specifically focussed on Lean but found that orchard, post-harvest, and grading/packing practices often negatively impact the quality and value of fruit from customers' and consumers' perspectives. In addition, grower and packer practices in particular incurred unnecessarily high costs that affect their own and the whole value chain's profitability.

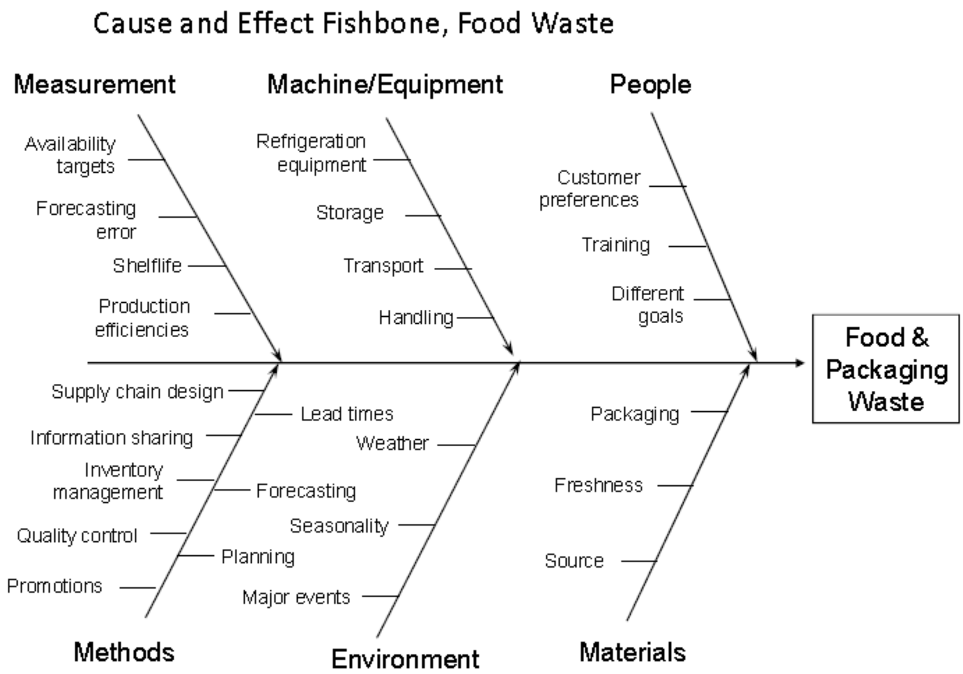



FIGURE 2-30: CRANFIELD UNIVERSITY FOOD WASTE ISHIKAWA DIAGRAM (GOOCH ET AL, 2010, P9).

A value chain map shows the process from orchard to customer but levels of waste are not indicated. Nonetheless, in their approach, they have created a list of recommended actions to improve the value chain, and linked these to three practitioner considerations: Implementation difficulty, Cost of implementation and Return on investment. Figure 2-31 shows a section of this table which may be useful from a practitioner's viewpoint, as it allows the horticultural operator to make decisions, based on some form of prioritising.

| VC element | Recommended actions | Implementation Difficulty | Cost of Implementation | Likely ROI |
|---|---|---|---|---|
| Grower level | | | | |
| Crop Production | Set orchard husbandry standards | Medium | Low | Medium |
| | Manage orchards by variety and age | Medium | Medium | Medium |
| | Keep records for analysis | Low | Low | High |
| | Encourage producers to transfer to intensive production | High | High | High |
| Management | Implement methods to increase growers' business skills | Low | Low | High |
| | Provide growers with management support and coaching | Low | Low | High |

FIGURE 2-31: APPLE VALUE CHAIN RECOMMENDATIONS FOR ONTARIO. VINELAND RESEARCH REPORT, GOOCH ET AL 2009, P156).

### 2.3.9. Core themes within Lean literature

The literature review shows that Lean, as a socio-technical system (Shah and Ward, 2007), is typified by basic themes. These include characteristics from various definitions from the literature review, as well as characteristics considered to be critical for successful Lean implementation. The literature from the review was coded manually, using keywords that link to Lean, were repetitive, or appeared significant, to create a table of Lean characteristics. Table 2-12 captures, and broadly groups the identified Lean characteristics into themes, asking the question 'what thematic construct captures the differences between Lean and not-Lean for the identified characteristic?' The themes range from what Hines determines to be below the waterline and 'enabling' such as leadership, strategy, alignment and engagement (Hines, 2011a)—similar to the philosophy 'P' in Liker's model—to the more practical system and process group, including processes, technology, tools and techniques.

TABLE 2-12: CHARACTERISTICS OF LEAN, GROUPED IN THEMES AND REFERENCED BY AUTHOR

| Themes | Characteristic | Reference: |
|---|---|---|
| Environment | Changing environment | Hammer (1990); Hormozi (2001); Mason-Jones et al (2000); Hines et al (2004) |
| | Different environments | Radnor et al (2012); Skorstad (1994); Hines and Rich (1997); Powell and Childerhouse (2010); Seddon (2010) |
| **Customers** | Identify customer value | Womack et al (1990); Radnor et al (2012); Sohal & Egglestone (1994); ; Seddon (2007) |
| People involvement | Active involvement | James-Moore & Gibbons (1997); Ohno (2013) |
| | Behaviour | Hines et al (2011a); Emiliani (1998) |
| | Change | Radnor et al (2006); Pedersen and Huniche (2009) ; Kallage (2006) |
| | Communication | Pedersen and Huniche (2009); Scherrer-Rathje et al, 2009) |
| | Culture | Liker (2004); Krafcik (1988) ; Pedersen and Huniche (2009); Achanga et al (2006) |
| | Defect prevention | James-Moore & Gibbons (1997) |
| | Engagement | Hines et al (2011a); Ohno (2013) |
| | Flexibility | James-Moore & Gibbons (1997); Sohal & Egglestone (1994); Seddon (2007) |
| | Improve continuously | Womack et al (1990); Radnor et al (2012); Hines et al (2011a); Sohal & Egglestone (1994); Ohno (2013); Imai (1986); Ohno (1988) |
| | Leadership; management commitment/support | Hines et al (2011a); Liker (2004); Emiliani (2012); Pedersen and Huniche (2009); Scherrer-Rathje et al, 2009); Radnor et al (2006); Achanga et al (2006); Kallage (2006) |
| | Multi-skilling | James-Moore & Gibbons (1997); Sohal & Egglestone (1994); Krafcik (1988); Achanga et al (2006) |
| People involvement | Reduce poor work conditions | Radnor et al (2012) |
| | Respect for people | Liker (2004); Sohal & Egglestone (1994); Ohno (2013) ; Bhasin & Burger (2006); Emiliani (2012); Achanga et al (2006) |
| | Root cause problem solving | James-Moore & Gibbons (1997); Liker (2004); Emiliani (2012); ; Seddon (2007) |
| | Shared destiny | Sohal & Egglestone (1994) |
| | Shop-floor problem solving | Liker (2004); Sohal & Egglestone (1994) |
| | Socio-technical | Shah & Ward (2007) |
| | Team-based | James-Moore & Gibbons (1997); Sohal & Egglestone (1994); Liker (2004) |
| **Systems and processes** | Autonomation | Sohal & Egglestone (1994); Liker (2004); Ohno (1988) |
| | Create flow | Womack et al (1990); James-Moore & Gibbons (1997); Liker (2004) |
| | Eliminate waste | Shah & Ward (2007); James-Moore & Gibbons (1997); Radnor et al (2012); Liker (2004); ; Seddon (2007); Ohno (1988) |
| | Identify Value stream | Womack et al (1990) |
| | Integrated | Shah & Ward (2007); James-Moore & Gibbons (1997); ; Seddon (2007) |
| | Just-In-Time (JIT) | James-Moore & Gibbons (1997); Sohal & Egglestone (1994); Liker (2004); Ohno (1988) |
| | Process control | James-Moore & Gibbons (1997); Radnor et al (2012); Liker (2004); Krafcik (1988); ; Seddon (2007) |
| | Pull | Womack et al (1990); James-Moore & Gibbons (1997) |
| | Reducing variability | Shah & Ward (2007); Radnor et al (2012) |
| | Supply/value chain | Pettersen (2009); Hines et al (2004); Holweg and Pil, (2001); Piercy and Rich (2004) |
| | System | Shah & Ward (2007) |
| | Tools & techniques | Hines et al (2011a) |
| | Suppliers | James-Moore & Gibbons (1997); Liker (2004); Sohal & Egglestone (1994) ; Bhasin & Burger (2006) |

| Themes | Characteristic | Reference: |
|---|---|---|
| | Visual management | Liker (2004) |
| Belief System | Vision | Achanga et al (2006) |
| | Strategy | Hines et al (2011a); Achanga et al (2006) |
| | Quality | Liker (2004) |
| | Philosophy | Radnor et al (2012); Hines et al (2011a); Liker (2004); Bhasin & Burger (2006) |
| | Long term thinking | Emiliani (2012); Scherrer-Rathje et al, 2009) |
| | Principles | Womack et al (1990) |
| | Alignment | Hines et al (2011a); ; Pedersen and Huniche (2009) |

#### *2.3.9.1. Defining a mature Lean organisation*

The applications of Lean in multiple industries that produce a variety of products and product groups leads to the recognition that:

- The relevance of what is produced is relatively low; non-Lean organisations can produce exactly the same product as highly-Lean organisations; and conversely that
- The relevance of how a product (including service) is produced is relatively high where it concerns people and processes; organisations that produce identical products can be highly Lean or not at all.
- The relevance of how technologically advanced a product (including service) is produced is relatively low; organisations that have modern technology can be 'un-Lean' while organisations with low technology can be highly Lean (e.g. Schonberger, 1987).

Although customer themes and output product are important, the relevance of both lies in how the organisation views and uses customer value and how it delivers that value in output product (a service is considered to be a product). It is the functioning organisation that makes the difference. Lean is not a final state; it is an evolutionary concept that can never fully be achieved as there is always something to improve. Organisations can however achieve a level of Lean maturity, indicating that the attitude, knowledge, experience and responsibility of the organisation has developed from the initial stage to advanced or grown-up; the ideal state is illusive.

This leads to the extraction of the following definition of a mature Lean organisation as:

- Having a holistic, integrated approach to production of goods and/or services,
- starting with vision and leadership, and pervading the organisation from top to bottom and into the supply chain/value stream to achieve common goals in a shared destiny,
- involving and empowering people to continuously improve the processes they are involved in to eliminate unevenness, overburdening and all other forms of waste to the customer, endorsing positive change,
- creating smooth production flow, substantially based on what needs to be produced and when, able to absorb variable customer demand,
- producing quality products (value) to customer demand,
- using the tools they have learned,
- and creating an adaptive sustainable culture to continue doing so in an ever-changing environment.

### *2.3.9.2. Lean as a viable organisational system*

Organisations are conceptually 'alive', continuing their existence by interacting with the environment and continued adaption to their customer requirement e.g. through continuous improvement in producing customer value; this applies particularly to Lean organisations.

A broad comparison can be drawn with Beer's Viable Systems Model (Beer, 1979). The viable systems model is based on three interacting constituents, the organisation's environment, the organisation's meta-level and the organisation's operational level (figure 2-32). The system responds to the environment by having a thinking 'meta-system' (vision, philosophy, principles and strategy) and an operational system that 'executes' (people involved in systems and process execution). The meta-system includes three different thinking levels that steer the operational activities from hierarchical functions

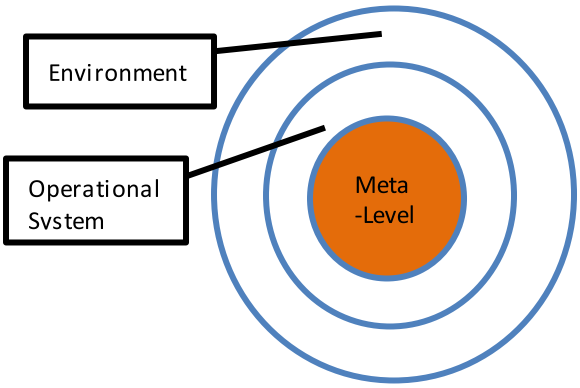



FIGURE 2-32: ESSENCE OF BEER'S VIABLE SYSTEM

of policy (vision and philosophy), below which there is strategy and adaptation/planning aimed at the outside world and an internal optimisation level (systems and process thinking). A fourth level communicates from and to the operational (fifth) level. The system is recursive, meaning that there can be systems within systems, following the same model. Importantly for the discussion of the model, Beer argues that the meta-system (vision, philosophy, principles and strategy) belongs inside the operational system, which is surrounded by the environment (Beer, 1979).

### 2.3.10. Synthesising a Lean model from the literature

The models from the literature review do not clearly express the lessons learned from the review. As an example, Krafcik includes machines and material, while it appears that neither machines nor material impact on how Lean an organisation is. This section attempts to consolidate the learnings into a different model. Taking the data from the literature review, a model of Lean can be conceptualised, based on the themes that emerged. The five themes (i.e. environment, customers, people involvement, systems & processes, belief system) identified from the literature review each form part of the model. Each interacts with other parts as follows:

Although not specifically discussed, the changing and different environments influence the customer to develop a need for a specific product (arrow 1 in figure 2-33). The customer develops a product 'value expectation' (Zeithaml et al, 1990), influenced by the environment (arrow 2). As with Beer's model, the elements of the value expectation in figure 2-33 are pictured separately to show how the elements interact.

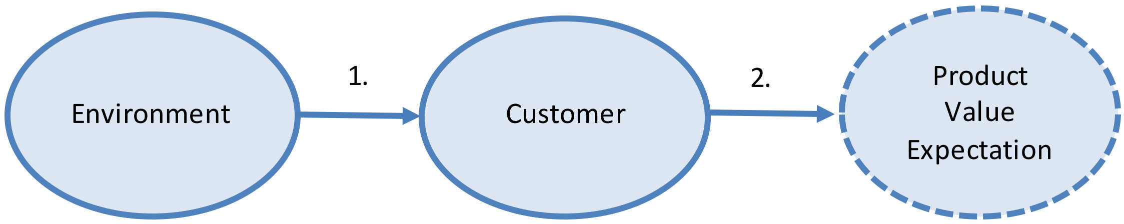



FIGURE 2-33: DEVELOPMENT OF CUSTOMER VALUE EXPECTATION

In a more real sense, the customer should logically be surrounded by the environment (figure 2-34). The customer is shown with a dotted line to symbolise the accessibility to influences from the environment, represented by arrows from the environment into the customer. The product is only a concept at this stage and is shown with a dotted line; it has not been produced yet. The arrows indicate the effect of one element on another. Each arrow can present information, communication, movement or outcome.

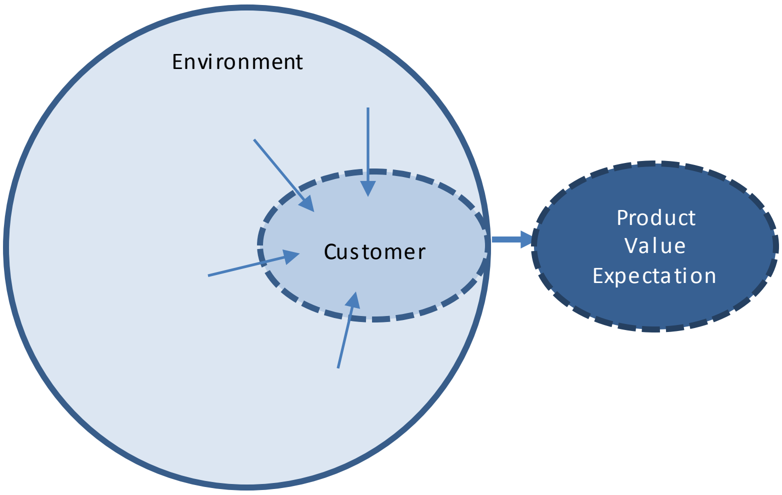



FIGURE 2-34: ENVIRONMENTAL INFLUENCE ON CUSTOMER PRODUCT VALUE EXPECTATION

Within the organisation, the model looks as follows: The belief system encompasses the vision, philosophy, principles and strategy of the organisation. Analogous to Beer's model, the vision and philosophy are the higher elements that make the policy, while the principles and strategy connect to the environment as well as the operation and facilitate adaptation of the organisation. Both the principles and strategy guide actions and keep the organisation on track to fulfil its purpose. At a lower level, the belief system regulates the organisation itself, creates synergies and optimises it at an internal level.

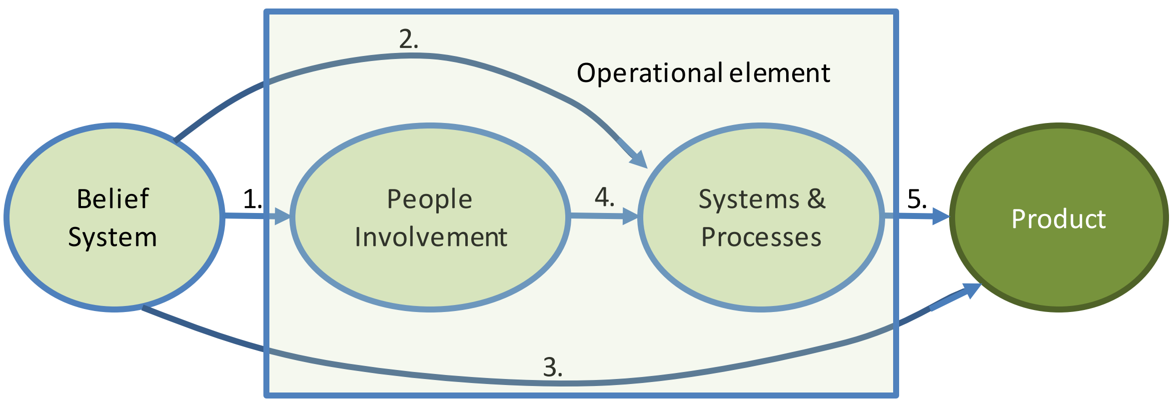



FIGURE 2-35: DEVELOPMENT OF THE VALUE CREATION

It is the belief system that is critical to the integration of the themes; the people involvement, systems and processes that produce the product (arrows 1, 2 and 3). The people, systems and processes form the operational element, the element that creates the product. Within the operational element, it is the people that create the processes, based on the philosophy and principles of Lean (arrows 4 and 2). As a result, the product is created (arrow 5). The whole of this is the organisational value creation (figure 2-35). Themes are pictured separately in figure 2-35 to show how the elements interact.

The materials and machinery have been deliberately omitted from the model as these do not affect the maturity state of the Lean organisation. The product is drawn with a solid line as this represents the actual output product; i.e. the value created for the customer. The product as an outcome, i.e. the value creation, is significantly influenced by the Lean belief system that influences the people involvement and the systems & processes that produce the product.

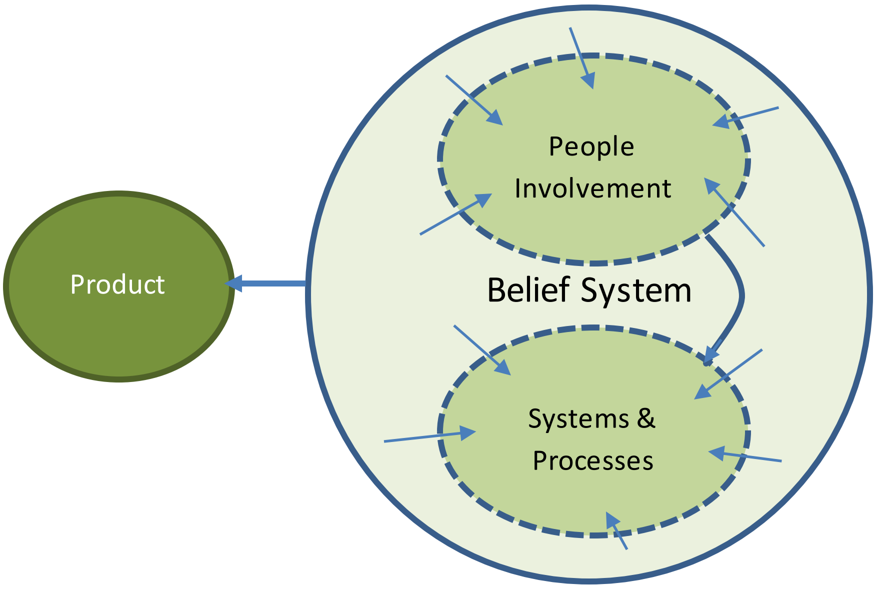



FIGURE 2-36: BELIEF SYSTEM AFFECTS PEOPLE INVOLVEMENT AND SYSTEMS AND PROCESSES

Here too, the arrows indicate the effect of one element on another. Each arrow can present information, communication, movement or outcome. The belief system pervades the organisation in that it enables the people involvement, focusses on systems and processes and their improvement and drives towards a product outcome that matches the customer expectation as in figure 2-35. In a more real sense, the people involvement and systems and processes should logically be surrounded by the belief system (figure 2-36) and are pictured as dotted lines to symbolise the effect of the pervasive belief system. The belief system is pictured as a larger font to indicate its relevance to the Lean organisation.

#### *2.3.10.1. Integrating the value expectation and the value creation*

Integrating the customer value expectation and the organisational value creation then leads to the following conceptual model of Lean (figure 2-37). In figure 2-37, the environment influences the customer who develops a product need and expectation —the value expectation (in dark blue with dotted blue outline).

The organisations' belief system pervades the people involvement that creates systems and processes that lead to product creation—the value creation. Similarly, the value expectation has a bearing on the people and processes that they develop to create the product to expectation. For clarity, the product expectation (dotted line in dark blue) and created product (solid line in dark green) are deliberately shown as not overlapping in figure 2-37 for clarity, however in the model of the mature Lean organisation, the value creation would overlap the value expectation completely. The two arrows pointing upward indicate the matching of the value expectation (dotted line and dark blue) by the value creation (solid line and dark green).

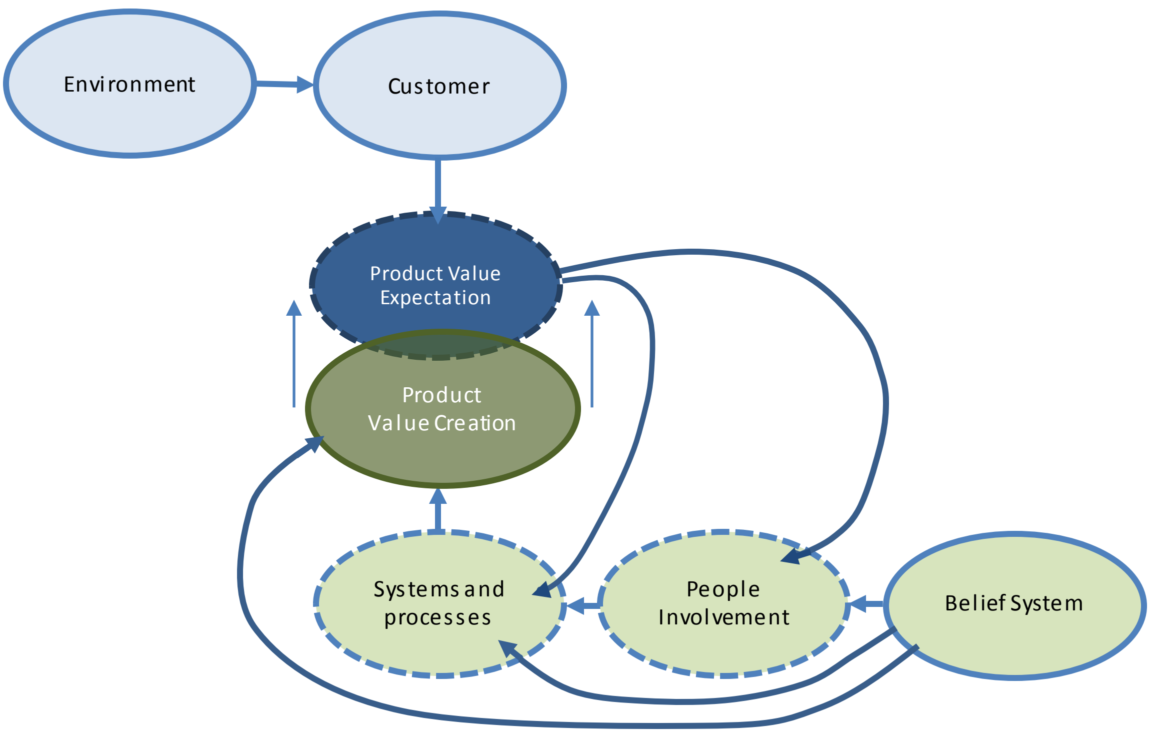



FIGURE 2-37: CONCEPTUAL MODEL OF LEAN, SHOWING VALUE EXPECTATION BEING MATCHED BY VALUE CREATION

The model in figure 2-37 can be depicted as an integrated model by placing the customer within the environment and placing the people involvement and systems and processes within the belief system (figure 2-39). Arrows indicate the influence of the environment on the customer's value expectation and the influence of the belief system on the people involvement and systems and processes that facilitate the value creation. An arrow between the people involvement and the systems and processes indicates that effective systems and processes are created through people involvement. Although it could be argued that the organisation is surrounded by its supply chain, the model displays the connection to the supply chain as included in systems and processes theme, referring to table 2-12.

Customer value expectation and organisation value creation connect in the product. The product is depicted as dark green with a solid line to represent the product value creation, while the line is coloured blue to symbolise the value creation (dark green) embedding the product value expectation (dark blue in figure 2-38).

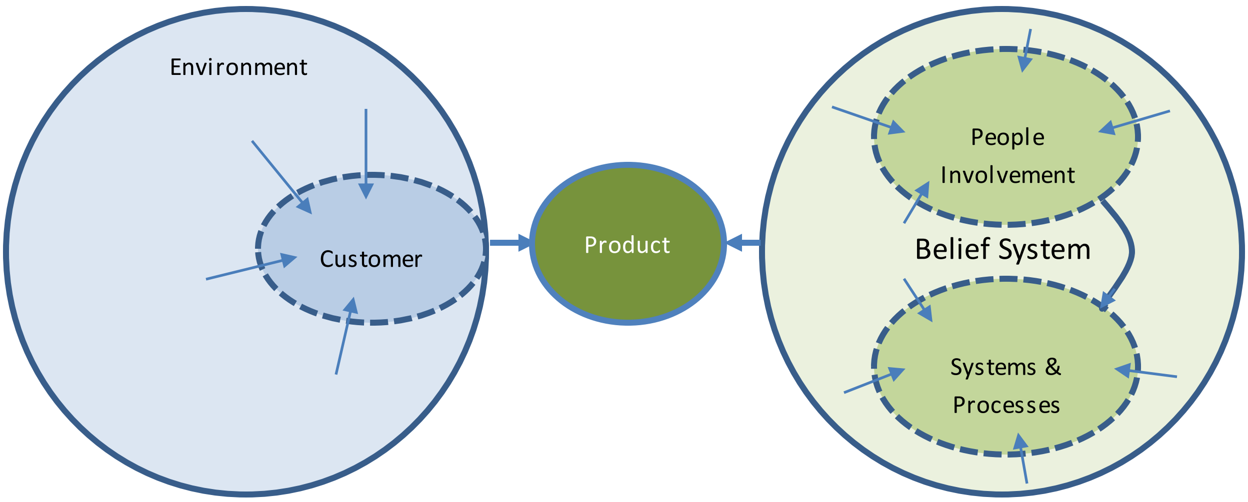



FIGURE 2-38: WHERE VALUE EXPECTATION AND VALUE CREATION MEET: THE PRODUCT

## 2.4. Literature conclusion

During the past century, a number of productivity improvement paradigms, methods and techniques have been described and used. Several of these are socio-technical and substantially include the human element that is so prevalent in the pipfruit industry. These are more suitable to the industry and include Lean as a reasonably logical preference, also considering NZTE's interest in spreading Lean to the NZ pipfruit industry.

The literature research shows that particularly little scientific material has been produced that focuses on the implementation of Lean in the horticultural sector and specifically the NZ pipfruit industry. Interestingly, there appears to be no explanation for this lack of literature, i.e. the literature research did not uncover evidence of failed attempts to introduce Lean in a seasonal horticultural setting. If there would have been a small body of evidence, empirically satisfying that Lean does not fit seasonal horticultural industries, research could look at different improvement methodologies or paradigms for this sector. However, little evidence could be found that serious research has been attempted in this area. The few government papers that were written for the wider public do not satisfy the academic need.

The reason for the lack of Lean implementation in the industry appears to be a combination of pipfruit and general industry related circumstances. Within the pipfruit industry, the literature review uncovered:

1. The dependence of growers and packers on ENZA—before deregulation in 2001;
2. The small to medium owner/operator composition of many businesses within the industry, often led by:
    a. Hard workers (Mannering, 1999) who left school early with little formal management education or training;
3. Fragmented industry with infighting, and a focus on short-term annual monetary returns—after deregulation;
4. No stakeholder supply chain involvement and therefore knowledge until limited involvement started to develop well after deregulation;
5. The lack of similarity between early Lean principles (Womack et al, 1990) and the pipfruit industry which had no manufacturing flow and was a 'push' industry.

NZ businesses in general, including the pipfruit industry were reported to:

6. Lack leadership, commitment and abilities, education or training and culture (Goodyer et al, 2011);
7. Have trouble with change strategy and the change management process (e.g. employee resistance), possibly through adoption of the '3-B' approach (Wilson et al, 2008);

8. Be weak in understanding customer value, particularly when getting closer to the shop floor (Goodyer et al, 2011);
9. Focus on short term goals and lacking long term strategies (Kennedy, 2000; Green et al, 2011).

Some of the possible reasons for a lack of Lean implementation in the pipfruit industry align themselves with table 2-6 (Grouping of critical elements for Lean implementation) as well as some of the common themes that emerge from the literature review. These common themes are general in nature; they relate to both applicability and success/failure factors for Lean implementation. Themes include major and minor themes. Major themes (significant but broad concepts or ideas) include:

- Lean is fluid and adaptive to its environment; different forms of Lean apply to different industries, organisations, locations and times (figure 2-39);
- Lean is challenging to implement. There are numerous cases of failed implementation: Critical factors that lead to success or failure have been identified;
- There is an apparent thematic continuum from general to specific, general being less perceptible and tangible, while specific is more perceptible and tangible:
    - The general theme includes vision, leadership (including support), philosophy, strategy, behaviour, engagement;
    - The specific theme includes methods and tools (best practices) such as 5-S, training, visual management.

Minor themes (frequently recurring meaningful elements) across most industries align with principles of the philosophical elements of the definition and include:

- Identifying customer value;
- Integration of production;
- Reducing waste;
- Reducing stressing of the system;
- Evening of flow;
- Producing small batches;
- Reducing inventory through just-in-time;
- Defect prevention;
- Production pull;

- Smoothing demand;
- Flexibility, multi-skilling and team work;
- Problem solving—going to the root problem.

The literature review shows that there is an issue with the NZ pipfruit industry and points at a gap between the NZ pipfruit industry and Lean; this gap may be attributable to some or all of the factors mentioned in this summary. Lean may offer an opportunity for the NZ pipfruit industry to improve operations. But as there is no standard template for introducing Lean in the pipfruit environment, the applicability and transferability of Lean must be studied. This void is of considerable concern and it is the pivotal driver for the research presented in this thesis.

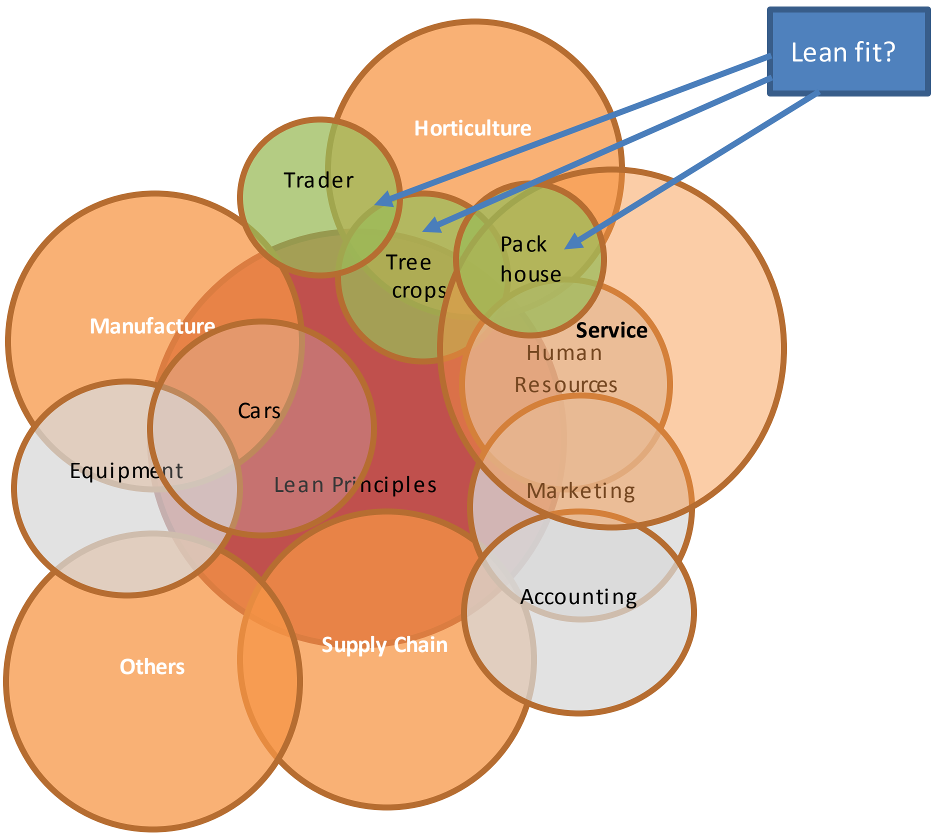



FIGURE 2-39: DOES THE LEAN PARADIGM SUIT A SEASONAL HORTICULTURAL INDUSTRY SUCH AS THE NZ PIPFRUIT INDUSTRY?

# 3. Methodology

## 3.1. Introduction to methodology

Chapter 1 of this thesis discusses the aim of this inquiry as *'research the concept of Lean and its theoretical 'fit' and practical applicability in a horticultural setting, specifically the New Zealand (NZ) pipfruit industry'*. The aim determines the scope for the inquiry. It also sets the boundaries: There is no primary interest in business improvement paradigms other than Lean. Similarly, there is no primary interest in other agricultural or industrial sectors. It is noted that, although the fourth objective considers the applicability of a conceptual pipfruit model for the wider horticultural sector, this is deemed to be an objective of secondary relevance.

This methodology chapter details how the aim and objectives from chapter 1 are intended to be achieved. The selected methodology guides the researcher throughout the inquiry. The chapter first describes some general methodology theory, followed by a description of the elected approach for each of the four research objectives, including strategy, population and sample selection and data collection methods. It then discusses the proposed data analysis methods, summarises the research design and completes discussing issues of trustworthiness and ethical considerations. The chapter is completed with a conclusion justifying the appropriateness and relevance of the proposed methodology to achieve the objectives of this inquiry.

## 3.2. Methodology: An overview

The following paragraphs deliberate on some elements of general theoretical research approaches and discuss briefly how these research approaches are considered to best suit the inquiry and methodology design.

### 3.2.1. The nature of knowledge: Ontological and epistemological footing

Knowledge is an abstract construct that lies at the root of human development. Philosophically, the very root questions are questions such as 'What exists?' or 'What is real?'

to lead to shared understanding (Uschold and Grunninger, 1996). Ontology asks what is existing; what is real ('onto' meaning existence or being real, and 'logia' meaning science or study). In a more academic context, ontological questions are relating to what exists specifically within a pre-determined subject area and includes questions about relationships and hierarchy, describing parts and processes to understand structures that affect that subject area. Poor ontology leads to poor communication (Uschold and Grunninger, 1996).

The ontological question in this inquiry becomes then how real Lean is as an idealistic concept (however with materialistic consequences) and if it can exist in the pipfruit industry. What parts and processes can be described that help us understand the structures affecting pipfruit organisations in their productivity? How do the people experience Lean?

The next question is how we can learn about Lean in the pipfruit industry. The epistemological paradigm concerns itself with the theory of knowledge ('episteme' meaning knowledge or understanding, and 'logia' meaning science or study). Similar to the philosophical and non-philosophical distinction within ontology, epistemology can also be viewed in a philosophical and non-philosophical context where the latter concerns itself with the formal identification of how we know that something is true (e.g. using empiricism or rationalism) while in the current inquiry simultaneously focussing on the human and social aspects of knowledge (Creswell, 2002). This is appropriate as the literature review identified Lean as a socio-technical construct, involving people in their production environment.

### 3.2.2. The need for tailored research; discussing the research options

The spectrum of research options offers a wide range of methodologies. Conrad and Maul (1981) rank quantitative and qualitative methods according to the level of control that each method is seen to exert through the researcher (Figure 3-1). Each method has different construct, internal and external validity and reliability. Each method however is described as an isolated approach towards answering a specific research question or hypothesis.

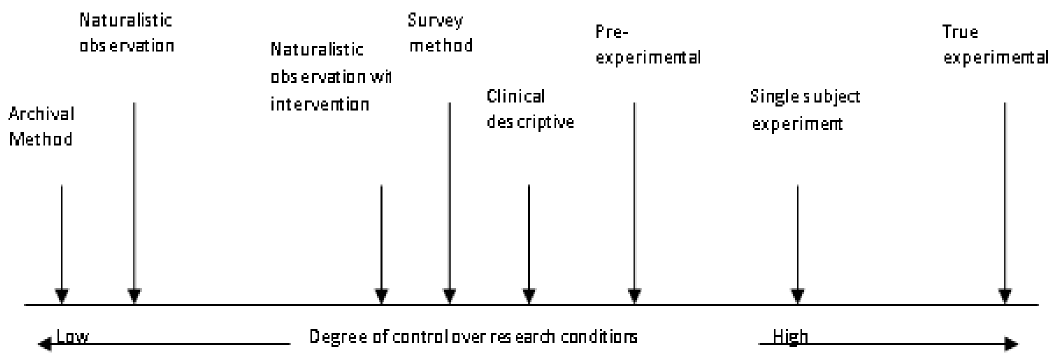



FIGURE 3-1: RESEARCH OPTIONS BASED ON DEGREE OF CONTROL (CONRAD AND MAUL, 1981, SIC.).

Saunders et al (2011) present research as 'an onion' with different layers, each layer having to be 'peeled' before the next. In their model, layers respectively include research philosophy, approaches, strategies, time-horizons and data collection methods (Figure 3-2).

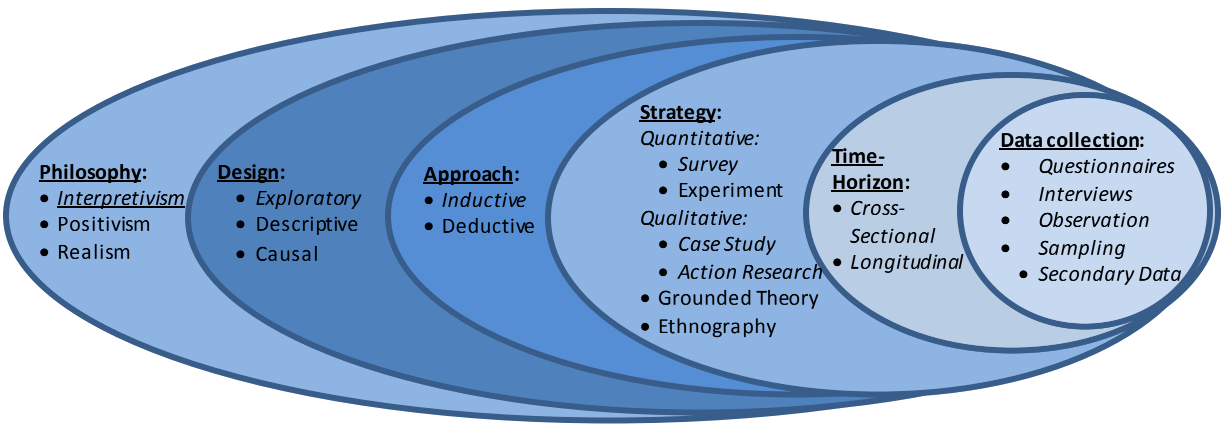



FIGURE 3-2: RESEARCH PROCESS STRATA (MODELLED AFTER SAUNDERS ET AL (2011) AND GHAURI AND GRØNHAUG (2005).

Neither Conrad and Maul (1981) nor Saunders et al (2011) discuss the structuring of the specific research design. In order to formulate the research model, there is the additional need to clarify if the research is exploratory research (unstructured), descriptive research or causal research (both structured) (Ghauri & Grønhaug, 2005). Similarly, Yin (2012) uses the terms exploratory, descriptive and explanatory. Creswell (2014) offers four philosophies instead of the three offered by Saunders et al (2011). These include Postpositivism (quantitative, based on empirical observation and measurement), Constructivism (often combined with interpretivism and making sense of historically or socially shaped meanings of others, inductively developing meaning), Advocacy/Participatory (a practical and collaborative change-oriented empowerment) and Pragmatism (problem-centred focus on what works). Inquiry paradigms are not mutually exclusive as Patton (1990) and Saunders et al (2011) clearly state; they provide options to researchers.

Considering the uncertainty around the subject area, it is relevant that the research methodology is structured by the ontological and epistemological questions mentioned at the start of this chapter and by the research strata presented in figure 3-2 to guide the researcher in the design of his methodology. These include the ontological question how real Lean is; the epistemological position that Lean exists as knowledge and is empirically proven to exist, while the current inquiry focusses on the socio-technical aspects of this knowledge along a constructivist/interpretivist approach. This approach appears justified as the literature review showed that Lean is people orientated; in order to study Lean in the industry, the researcher must embed himself into the industry and listen to peoples' views of their reality, rendering positivism as an inappropriate paradigm. This approach is then leading to an inductive route because of the many unknowns. It is considered appropriate when considering Lean as a socio-technical construct, involving people in their production environment.

### 3.2.3. Linking research strategies to objectives

The following sections discuss for each of the objectives the strategies deployed to achieve the research objectives, the data collection methods and the population and sample.

## 3.3. The first objective: Strategy, method and sample.

The first objective of this inquiry is to *'Identify common theoretical themes for the Lean philosophy, methods and tools, that are not industry or contextually bound and that may be transferable to the pipfruit industry.'*

### 3.3.1. Strategy to achieve the first objective

In order to identify common theoretical themes that are not industry or contextually bound it appears logical that a substantial body of literature must be researched as it is impractical to attempt collecting data from field work in a number of different industries or contexts. Too much time would be involved in collecting that data. There is a substantial body of academic work concerning Lean in different environments available. This makes a literature review a logical and primary source to search for common theoretical themes that are not industry or contextually bound.

A literature review is innate to most forms of inquiry. Ghauri and Grønhaug (2005) propose that a literature review helps to:

- Frame the problem under investigation
- Identify relevant concepts
- Position the inquiry

An additional method to obtain such data could be to find out if there are consultants practicing Lean implementation in different industries. Such consultants may have identified common themes across industries and contexts that may be transferable to the pipfruit industry. Consultants can be surveyed or interviewed to complement findings from the literature review.

### 3.3.2. Literature review method

The literature review took place prior to other elements of this inquiry and focused on the NZ pipfruit industry and on Lean. Throughout the literature review, the researcher concentrated on the identification of developing themes for the Lean philosophy, methods and tools across different industries and contexts. These themes are summarised to help assess the transferability to other industries such as the NZ pipfruit industry.

### 3.3.3. Consultant method

A primary reason for approaching consultants was to complete a very early and basic assessment to indicate the 'Lean state-of-the-industry' and determine if consultants believed that Lean could fit the pipfruit industry before setting out on a substantial body of field work. Consultants and practitioners generally have experience with a reasonably broad range of industries. This potentially provides consultants with a body of rich data. A contribution of data from consultants is therefore considered to offer additional value in that it may complement the literature review to achieve the first objective. The initiative to include consultants to contribute to the first objective is therefore considered justified. The consultant interviews took place during the first year of the inquiry.

#### *3.3.3.1. Consultant population and sample*

The population of Lean consultants was established with the assistance of NZTE, Pipfruit NZ and a web-based search for Lean consultants in NZ. This resulted in a list of twenty-six consultants operating across New Zealand, i.e. the population. Considering the relatively low number of consultants and the relative simplicity of this complementary component of the inquiry, it is justified to survey all consultants. The list of consultants is presented as appendix 5.

#### *3.3.3.2. Consultant interviews or survey?*

The number of consultants in New Zealand is relatively small, and a survey through interviews is practically possible. Interviews offer the interviewer the option to adjust questions and react to data provided by the interviewee. Although questionnaires are a possible data collection approach, questionnaires do not offer the plasticity that interviews offer to adapt the learning experience during the interview. Consequently, a decision was made to attempt interviewing all consultants, using a questionnaire that could also serve as a survey for those that could not be interviewed.

#### 3.3.3.3. Constructing the questionnaire

The purpose of the consultant interview is descriptive, rather than analytic, i.e. the interview is attempting to find out from consultants what experience they have with Lean implementation, in particular in horticulture or pipfruit (Ghauri and Grønhaug, 2005). Interviews can be unstructured, semi-structured or structured. DiCicco-Bloom and Crabtree (2006) argue that semi-structured interviews provide basic protocol consistency, but allow in-depth elaborations. They observe that semi-structured interviews are the most widely used interviewing format in qualitative research. Structured interviews would not allow probing for additional data and were rejected as instrument. Unstructured interviews would not allow protocol consistency, leading to a decision to elect the use of semi-structured interviews.

The questions were developed during the literature research and collected minor demographic data, followed by open-ended questions concerning four typical horticultural characteristics that ostensibly appear to be conflicting with Lean philosophy and principles in the literature review. These characteristics were identified as push, seasonality, perishable goods and consignment sales (not knowing the customer). Additional questions inquired about familiarity with academic work and asked consultants to estimate the level of Lean companies in New Zealand and in the horticultural industry.

The questionnaire was discussed with supervisors and not tested further prior to the interviews as the semi-structure would allow the researcher to adapt the line of inquiry during interviews. A copy of the semi-structured interview guideline is attached as appendix 8.

## 3.4. The second objective: Strategy, method and sample

The second objective of this inquiry is to *'Identify and analyse the current Lean deployment within the NZ pipfruit industry.'*

### 3.4.1. Strategy to achieve the second objective

The literature review demonstrated that there was no evidence of pipfruit organisations that had engaged in Lean. Three organisations had attempted Lean in 2008, but personal conversations with all three organisations in 2011 evidenced that none was pursuing Lean.

As the second objective relates purely to industry organisations and can only be determined by investigating the industry itself it is axiomatic that primary data must come from the industry. The industry consists of approximately 400 growers, 65 packhouse and coolstore combinations and approximately 90 exporters; a total of approximately 555 direct stakeholders (FreshFacts 2012). This population size is unsuitable for observation or interview as the size of a representative sample would become impractical. Instead, a survey method appeared suitable to obtain primary data from industry stakeholders and was elected as first method of the strategy.

A personal conversation with Pipfruit NZ in November 2011 led to the supposition that no companies within the industry were Lean but that there might be some elements of Lean that could have developed organically. This conversation confirmed that there was no literature about any organically developed Lean elements within the industry and the researcher decided that his experience in the industry would merit the writing of a reflective practitioner review which could contribute to the objectives by documenting some of the unrecorded observations. The practitioner review was added as second method of the strategy.

In addition to the primary survey strategy, the consultant interviews might provide data that could be converged with the survey data, providing the third method of the strategy.

The literature review and the three methods involved in the strategy to achieve the second objective (survey, consultant interviews and practitioner review) combine into the first phase of this inquiry.

### 3.4.2. Stakeholder survey: The first method for objective two

#### *3.4.2.1. Data collection through stakeholder questionnaire*

Several studies (Manfreda et al, 2002; Sheehan, 2006) show that long and web-based surveys have lower response rates than traditional methods. A sample questionnaire was composed in relation to Lean implementation. The questionnaire included several sections including organisation demographics, a descriptive appreciation of how each organisation currently operates using the 20 Kobayashi keys (but requiring no specific Lean knowledge from the respondent); and an appreciation how familiar each organisation is with common Lean tools. Each question provided a 5 point Likert scale for the respondent to use. Data collection took place towards the end of the first year of the inquiry.

#### *3.4.2.2. Building the questionnaire*

A number of Lean assessments have been discussed in the literature review. The instruments are similar and have common themes but show different presentations. One instrument was arbitrarily selected for use in the questionnaire. The Kobayashi criteria were selected as a suitable instrument because they integrate 20 areas in an organisation and provide a step-wise programme for achievement. This was considered potentially helpful for participants post-inquiry. Considering that the complete Kobayashi criteria would be too long and onerous for respondents to assess, the researcher created summary statements with elements of each of the five levels for each of the Kobayashi keys. The logic was that truly Lean companies would have implemented all levels of each key, but the opportunity needed to be given to non-Lean respondents to identify some of their actions as Lean. In addition, the researcher selected twenty common Lean principles, methods and tools with the intention to explore familiarity and use within the industry. These were taken from the literature and both the Japanese name and the English name were detailed.

The survey was discussed with supervisors and several industry stakeholders to ensure that the content would provide an industry baseline. The survey was then sent to a small pilot group with a request to complete the survey. This was followed up with a phone call to elicit responses to the use of the instrument. Responses from the pilot group indicated that the survey was too long and took considerable time to respond to. This led to an original and unique approach to increase response rate through what the researcher called a 'perceived diminished participant effort' approach (PDPE). This consisted of the researcher emailing a single question or statement each working day to the sample, allowing a response within a minute. Responses were collected daily and recorded. On completion of the survey, the researcher provided feedback to each respondent, including any 'missed' questions, offering the opportunity to complete those and increasing the response rate. Appendix 7 includes a copy of the industry survey.

### 3.4.3. Population and sample

#### *3.4.3.1. Establishing the population and sample for the questionnaire*

All elements of the industry, i.e. growers, packers, coolstores and exporters are forming the population, a total of approximately 555 direct stakeholders. The assistance of the industry's governing body (Pipfruit NZ Inc.) was asked to provide a database with email addresses of their members and select 150 of those members to represent the strata of growers, packhouse/coolstore combinations and exporters. The resulting stratified random sample (Saunders et al, 2011) included several suppliers and customers to the industry who were also ~~are~~ a member of Pipfruit NZ. The sample of 150 was reduced by 4 double-ups (two stakeholders of one organisation in the database) and 6 members asking to be excluded from the questionnaire. The sample was confirmed as follows:

TABLE 3-1: DISTRIBUTION OF SAMPLE BY INDUSTRY ACTIVITY.

| **Membership position** | **Number** |
|---|---|
| Grower (dedicated) | 71 |
| Packhouse/coolstore | 2 |
| Grower/packhouse/coolstore | 24 |
| Packhouse/coolstore/exporter | 3 |
| Grower/packhouse/coolstore/exporter | 14 |
| Exporter (dedicated) | 18 |
| First tier supplier | 5 |
| First tier customer | 3 |
| **Total** | 140 |

This stratified sample size and mix (table 3-1) was considered sufficient and representative of the industry population for the purpose of the survey validity.

### 3.4.4. A practitioner review: The second method for objective two

A number of developments within the NZ pipfruit industry have not been documented. As independent practitioner, the researcher has reflected on the industry from his professional perspective and this reflective review is added as appendix 1.

### 3.4.5. Complementing consultant interviews. The third method

The consultant interviews were considered potential contributions to establish how Lean the pipfruit industry currently was. At the time of the research design, it was unknown how many consultants had experience with the pipfruit industry or the wider horticultural industry. The consultant interviews have been presented under the first objective and it is considered unnecessary to reiterate the method, population and sample.

## 3.5. The third objective: Strategy, method and sample

The third objective of this inquiry is to '*Analyse the applicability and any implementation approaches of the Lean philosophy, methods and tools within the NZ pipfruit industry*'.

### 3.5.1. Strategy to achieve the third objective—quantitative or qualitative?

In order to obtain data that would help with the third objective, it was axiomatic to research organisations within the industry. The lack of literature prevented a grounded research approach which was excluded as methodology. The researcher was fortunate that synchronously with the start of this inquiry, several pipfruit organisations started implementing Lean. As the lack of Lean organisations at the start of this inquiry precluded a quantitative method, the methodological options were restricted to qualitative methods. This suited the inquiry, as Lean is probing intangible aspects of organisations such as vision, leadership, engagement and culture. These elements are difficult to measure and a qualitative approach was decided to be more suitable to obtain rich data without requiring a large sample. A qualitative inquiry obtains a deeper understanding, and the small number of companies engaging in Lean suited the selection of a qualitative methodology to achieve objective 3.

#### *3.5.1.1. Options within qualitative research methodology*

Relatively few options are available within qualitative research; these include grounded theory and ethnography, as well as case study and action research. Ethnography was not considered a practical solution as it would engage the researcher wholly, while grounded theory was considered possible but impractical due to lack of data. One of the problems encountered was that at the very start of this inquiry, no known organisations engaged in Lean. For this reason, the only option to research Lean in the pipfruit industry appeared to be action research, where the researcher can engage with a willing organisation that intends to adopt a new paradigm. Two such organisations were found, one being an orchard group and one being a packhouse. The emergence of two packhouse organisations that had unbeknown to the researcher started to implement Lean at the time of start of the inquiry offered the researcher the opportunity to engage with these two companies as case studies. It appeared therefore that action research, combined with case study would offer the best opportunity to collect rich data from different implementation methods to achieve the third objective. These two options are now expounded after discussing measurement instruments and the protocol.

#### *3.5.1.2. Measurement instruments used*

Because the action research orchard and packhouse—as well as the two case study packhouses—started implementing Lean at the start of this inquiry, it offered an opportunity to measure progress during the course of the inquiry. The researcher considered the measurement instruments from the literature review and selected the Tapping et al (2002) instrument as applicable and reasonably easy to understand by the research companies. The research companies were asked to complete a self-assessment at the start of their Lean programme; again after one year and again at the end of the second season which was the end of the research period.

During the course of the investigation, the research orchards and packhouses expressed curiosity about their standing in relation to the industry and asked to complete the industry survey at similar intervals to relate their position to the wider industry. This would add data and was promptly added to the protocol.

#### *3.5.1.3. Researcher embeddedness inside the research*

Lean as a socio-technical system involves people in their environment. The researcher was in a unique position, knowing both the industry and being a student of Lean. As Lean is significantly people-oriented, involvement of the researcher in studying Lean by engaging with the people attempting to adopt Lean was imperative.

Accordingly, the researcher recognised the possibility of active and passive bias (Onwuegbuzie, 2003), respectively the effect of the researcher on the people being researched and the reverse. Miles and Huberman (1994) called this 'Bias A' (the effect of the researcher on the participants) and 'Bias B' (the effect of the participants on the researcher). Researcher bias is a very common threat to legitimation in constructivist research because the researcher usually serves as the person (i.e., instrument) collecting the data (Onwuegbuzie and Leech, 2006). Guba recommends insulating the researcher e.g. by double blind procedures (Guba, 1981), however this was not a possibility. Instead, the researcher used standard methodologies to ensure that the research was not contaminated by bias; these included the protocol design, offering transcripts to participants for feedback and discussing discoveries with participants. Safeguards to mitigate researcher bias are discussed in the trustworthiness section and the effect of the embeddedness of the researcher is repeated in the limitations to the inquiry.

#### *3.5.1.4. The protocol; providing guidance and consistency*

Case study requires strict protocols in order to provide robust research results (Yin, 2009). Stake (2013) and Yin (2009) observe that use of a protocol ensures accuracy. The case study protocol follows a number of considerations. Yin (2009) emphasises the importance of researcher preparation and protocol design before the actual data collection phase starts. In case of multiple researchers, the protocol gives guidance to each researcher and will result in reliable findings across researchers based on consistent research questions and aims. In addition, and particularly in case of a single researcher—as is the case in this inquiry—a protocol ensures that the researcher stays 'on track' and firmly focuses on the research questions and the way in which his research will be analysed and reported (Yin, 2009). The protocol for the case study phase of the research project provides guidance for the following:

1. Basic information: Establishing the case study questions and propositions including validity and reliability considerations.

2. Data collection procedures: Identification of research subjects and decisions such as who to interview, an interview guideline, what to observe, and the evidence, documents and artefacts to collect.
3. Proposed analysis and method: Establishing the units of measurement and analytical techniques to link data to propositions.
4. Proposed report structure: Organising data and analysis while collecting data.

The protocol used for the case studies is attached as appendix 9

### 3.5.2. Action research as strategy

Action Research is a form of applied research, typified by researcher involvement. It follows a typical pattern of action, review, reflection and planning of the next step (figure 3-3), similar to Shewhart's PDSA cycle (Deming, 1986). The purpose of action research is not only to understand, learn and gain insight, but also to effect change. Analysis is therefore a continuously present activity during the inquiry in order to continue achieving improvement. Iterative cycles—circular and repetitive—can be long or short with smaller cycles embedded into larger cycles (Cardno, 2003) (figure 3-4).

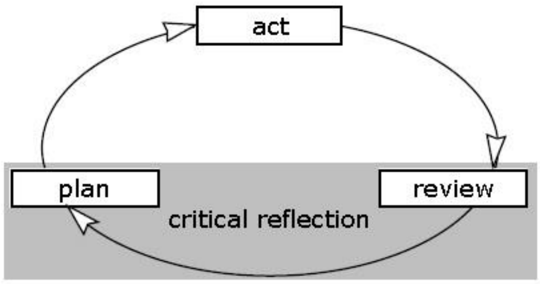


FIGURE 3-3: ACTION RESEARCH CYCLE (DICK, 2002, P4)

Cardno finds that action research has become paradoxically simple, yet complex. It aims to investigate and improve but has a reputation of being messy and have low rigour (Cardno, 2003). For the area of organisational development, Argyris and Schon (1996) also point out that action research involves a double burden, namely affecting change and researching. This leads to a conflict between rigour of the research and relevance of the research.

Westbrook states that action research is a variant of case study with the difference lying in the method of observation – from within or from outside (Westbrook, 1995). Similarly, Dick (2011) discusses case study of action research. The two methods, although different from the level of researcher involvement, are in fact closely related.

In addition Westbrook (1995), like Coughlan and Coghlan (2002) and Bjørn and Boulus (2011) argue that action research leads to theory building, while Stake (1978) and Eisenhardt (1989) argue in favour of case study assisting theory building.

Both action research and case study have theory building as a fundamental element of the methodology.

Action research is appropriate as Coughlan and Coghlan (2002) point out, whenever the research question relates to describing an unfolding series of actions over time in an organisation as is expected to be the case in this inquiry. The action research approach was therefore proposed, involving a grower—in this case an orchard organisation with several orchards—and a packing organisation to:

- Involve several industry sectors;
- Better understand issues around Lean implementation;
- Improve organisational practices during the course of the study.

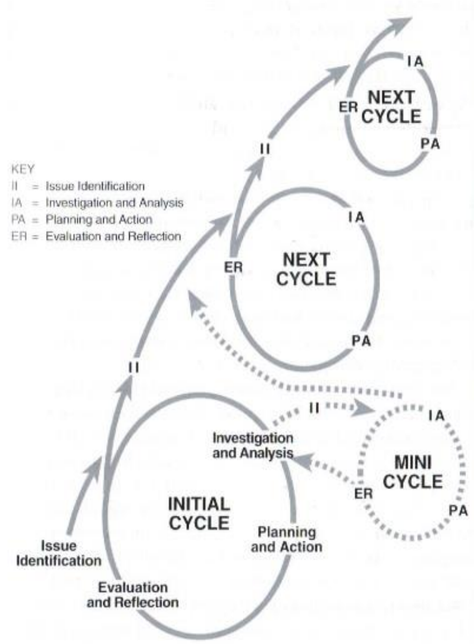



FIGURE 3-4: THE SPIRALING EFFECT OF CONTINUOUSLY BUILDING ITERATIVE CYCLES (CARDNO, 2003, P13).

### 3.5.3. Case study as strategy

Case study research has consistently been one of the most powerful research methods (Voss et al, 2002). Yin (2012) identifies exploratory, explanatory and descriptive case studies and this inquiry intends to explore. Similarly, Voss et al (2002) believe that case studies can be used for different types of research including exploration, theory-building, theory-testing and theory extension/refinement. As such, case study is an appropriate tool to analyse the applicability of the Lean philosophy, methods and tools within NZ pipfruit industry. Eisenhardt (1989) considers case studies a source for grounding and building of theories and the formation of a Lean model (the fourth objective of this inquiry) suits her arguments.

Fewer cases gives greater opportunity for depth of observation (Voss et al, 2002) which is preferable. Insofar it concerns Lean and the pipfruit industry—where there is limited information due to a lack of literature — the selected cases must however cover the industry and the number is therefore partly determined by the objectives of this inquiry.

### 3.5.4. Data collection for action research and case study

Data collection took place during a 20 month period, the researcher visiting each research company on a number of occasions and interviewing management, supervisors and floor staff while recording multiple observations. Evidence was collected throughout the process. This included but was not restricted to forms, meeting notes and photographs. Notes were kept by the researcher from these meetings and interviews. These notes were generally transcribed in situ as a combination of descriptive and verbatim records and were presented to the sample organisation for feedback in order to eliminate researcher bias.

Because orchard managers could not always get together, several visits were restricted to the technical manager who would then put new approaches in place with the assistance of the individual orchard managers. As the Lean theory knowledge of the orchard managers was low, sessions would regularly include explanations of Lean principles and methods, often followed by a discussion on how this might apply to the orchards (e.g. figure 4-7). Regular smaller iterative cycles were completed, complemented by end-of-season reflective cycles. The distinct iterative cycles related to the main activities during a one year season. These were pruning, spraying, thinning and harvesting with several associated lesser activities.

The data collection in the action research packhouse was similar to the action research orchards, completing several iterative cycles relating to identifying waste, visual management, leading, and staff involvement. Here too, transcripts were presented to the sample companies for feedback in order to eliminate researcher bias.

### 3.5.5. Population and sample

The established population included approximately 550 organisations, however finding volunteers for the research project proved problematic. Although the study was announced by email in 2011, and again in the industry's monthly newsletter in April 2012 (Pipfruit NewZ, April 2012; Appendix 6), the number of companies that volunteered for participation in the research project was low with only seven companies responding. Several of these withdrew participation within months from the initial expression of interest. In addition, none of the volunteers was an exporter, the third important industry segment.

#### *3.5.5.1. Establishing the sample for action research and case studies*

One orchard and one packhouse volunteered for participation without having any prior interest in Lean. These two organisations were selected by default for action research and were committed to participate.

Two packhouses volunteered for case studies. One packhouse had engaged a consultant to assist with lean implementation. The other packhouse had hired a manager with Lean experience, specifically to implement Lean in the organisation. Both packhouses were distinctly interested in participation and were selected as case studies.

The developed protocol required a representation of the industry; exporters presented a relevant component of the within-industry supply chain and were missing in the sample. In May 2013, the situation was discussed with Pipfruit NZ, and a decision was made to approach a number of suitable and representative exporting companies directly. Several of the top fifteen exporting companies which had not replied earlier were shortlisted and approached using emails, phone calls and personal meetings to explain the purpose of the research and attempt to diffuse any concerns that might exist. Most of these exporting companies did not answer or declined. Reasons for not participating were quoted as being too busy and not wanting to share information. One exporter agreed to restricted and conditional participation and one exporter granted an interview with follow up. These two exporters are considered mini case studies but have been included to provide some entirety to the inquiry.

## 3.6. The fourth objective

The fourth objective of this inquiry is to '*Develop a conceptual Lean model for the NZ pipfruit industry and consider if the model is applicable to the wider horticultural sector'*.

### 3.6.1. Strategy to achieve the fourth objective

Converse to determining the requirements for the model, lessons will have been learned during the inquiry that may be useful in order to build a model as in the fourth objective. For this reason, both inductive and deductive reasoning is used to arrive at an industry model. Inductive reasoning establishes the requirements for the model while deductive reasoning establishes what can be used from lessons learned during the inquiry to build new theory (Mintzberg, 1979; Eisenhardt, 1989), where a new model is considered new theory (Figure 3-5).

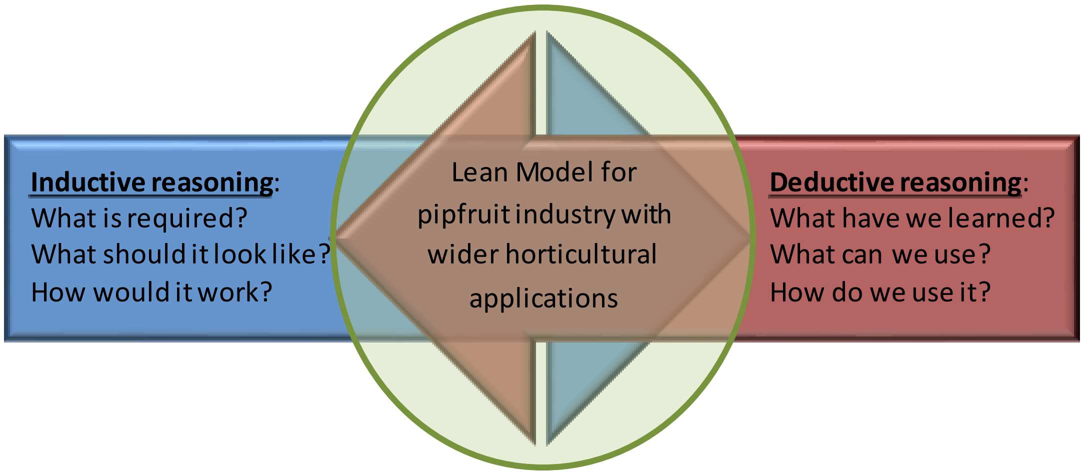



FIGURE 3-5: INDUCTIVE AND DEDUCTIVE REASONING TO LEAD TO A MODEL.

Findings from the literature review were used to build a conceptual Lean model which can be aligned with the inquiry's empirical findings (figure 2-38). The findings of the inquiry will assist with the development of a conceptual Lean model for the NZ pipfruit industry.

### 3.6.2. Industry model requirements

In order for a Lean industry model to be meaningful to the industry, the following requirements are considered:

- The model must be grounded in a set of transferable Lean principles, methods and tools in order to be valid.
- The fundamental model emerging from the literature review in chapter two can serve as the basis for a more typical industry model.

- Principal industry sectors (growing, packing/storing and exporting) each may require a variation on the fundamental model. Several other horticultural industries have similar organisational structures and the pipfruit model may be transferable for that reason.
- New theory must be added where possible to form Lean industry models.
- The model must clarify the 'visible' and 'invisible' levels to ensure that industry organisations understand the relevance of Lean as a holistic and integrated paradigm rather than a set of tools.

### 3.6.3. Using the literature review model as basis for industry models

Several Lean models have been discussed in the literature review. These are summarised in table 2-3 of chapter two. Keywords from these models and Lean literature were used to extract a list of characteristics that were grouped in themes; these themes were used to construct a model, representing Lean as it emerged from the literature review (figure 2-38). Lessons learned during the inquiry may add to or change the Lean model from chapter two (figure 2-38) to make it applicable to the pipfruit industry.

### 3.6.4. Synthesising findings of the inquiry with the literature review model

The observations that emerge during the inquiry are grouped in themes, reflecting specific industry influences that are relevant to the development of an industry-specific model. Where justified, the model can be different by industry sector, in line with the conclusion from chapter two that Lean is both fluid and adaptive.

### 3.6.5. Summarising the strategy

A separate chapter—chapter six—synthesises the Lean model from the literature review chapter with the findings from chapter four to develop a pipfruit industry model.

## 3.7. Quantitative and qualitative methods combined—a mixed method approach

The different objectives and the involved strategies lead to a mixed method approach (Creswell, 2003). In a mixed method approach, quantitative and qualitative elements can combine purposefully to increase robustness of the current inquiry (Greene et al, 1989):

1. Triangulation involves corroboration or convergence and increase s construct validity;
2. Complementing involves elaboration, enhancement or clarification and increases interpretability of constructs as well as their validity;
3. Development allows the result of one method to assist to develop or inform another method;
4. Initiation can uncover paradoxical or contradicting information to increase the depth of the enquiry; and
5. Expansion can extend the range of inquiry by using different methods for different inquiry elements.

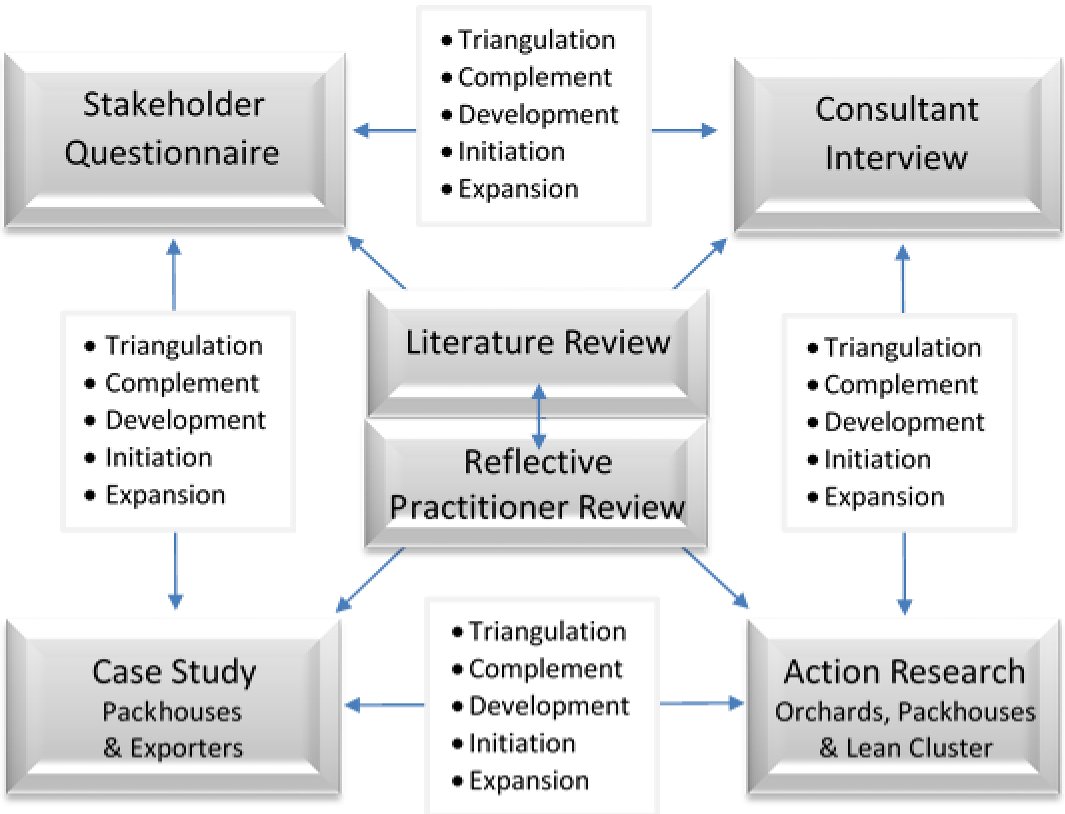



FIGURE 3-6: PURPOSES FOR MIXED METHODS EVALUATION DESIGN (MODELLED AFTER GREENE ET AL, 1989).

For this reason, the investigation uses several independent methods which are mixed where value can be added to the outcome of the investigation (Figure 3-6). Creswell and Miller (2000) and Snow and Anderson (1991, cited in Tellis, 1997) suggest that triangulation can take place across data sources, theories, methods and among investigators, each potentially adding robustness to the inquiry results. The most important point they make however lies in the fact that each of the different methods used in mixed method research can add specific forms of depth to each other method in the research method mix (Figure 3-6). Validity will be discussed in the trustworthiness section (section 3.10), which follows later in the methodology chapter.

Longitudinal or cross-sectional: The time period within which the research must take place to complete this PhD study allows the length of at least one full season and part of a second season. A longitudinal approach including a minimum of a one-year cycle is therefore selected. Simultaneously, there is a cross-sectional element in looking at various organisations and organisation types (growing, packing/storing and exporting). For the purpose of this inquiry, both longitudinal and cross-sectional elements apply.

## 3.8. Data analysis and synthesis

Data analysis took place for each individual section of the inquiry, after which cross-sectional data analysis took place. The following section explains how data were analysed within each form of inquiry and between forms of inquiry.

Saunders et al (2011) table the differences between quantitative and qualitative data as follows (table 3-2):

TABLE 3-2: DISTINCTIONS BETWEEN QUANTITATIVE AND QUALITATIVE DATA (SAUNDERS ET AL, 2011).

| Quantitative data | Qualitative data |
|---|---|
| • Based on meanings derived from numbers | • Based on meanings expressed through words |
| • Collection results in numerical and standardised data | • Collection results in non-standardised data, requiring classification into categories |
| • Analysis conducted through the use of diagrams and statistics | • Analysis conducted through the use of conceptualisation |

Although there is a strong movement to keep quantitative and qualitative data analysis segregated, Onwuegbuzie et al (2009) point out that these datasets can be jointly analysed. While data analysis is discussed separately for the quantitative and qualitative elements of the inquiry, final synthesis of results will enhance the rigour of the inquiry.

## 3.8.1. Quantitative and qualitative data analysis

### *3.8.1.1. Analysing stakeholder survey*

Data from the questionnaire was assessed to determine if data editing was required to eliminate obvious errors (Ghauri & Grønhaug, 2005). No data editing was required. Survey questions were closed questions, eliminating the need for coding of questions. Questions had been grouped in the survey in four categories (demographic data, management thinking, descriptive Lean assessment and tool knowledge and use), each category allowing quantitative analysis using measures of central tendency such as mode, median and mean and using a measure of dispersion in standard deviation. A confidence interval was determined at 0.5% significance level. The data allowed for analysis of level of Lean implementation and knowledge of Lean principles, methods and tools. Survey data allowed for presentation in tables and graphs.

## 3.8.2. Qualitative data analysis

The nature and complexity of qualitative data determines substantially how data are collected and analysed. Miles and Huberman (1984; 1994, in Ghauri & Grønhaug, 2005) differentiate between three analytical elements:

1. Data reduction (selecting, focussing, simplifying, abstracting and transforming data from field notes and other forms of data collection);

2. Data display (Compressing, reduction organising and assembling of information);
3. Analytical activities (Categorisation, abstraction, comparison, dimensionalisation, integration, iteration and refutation)

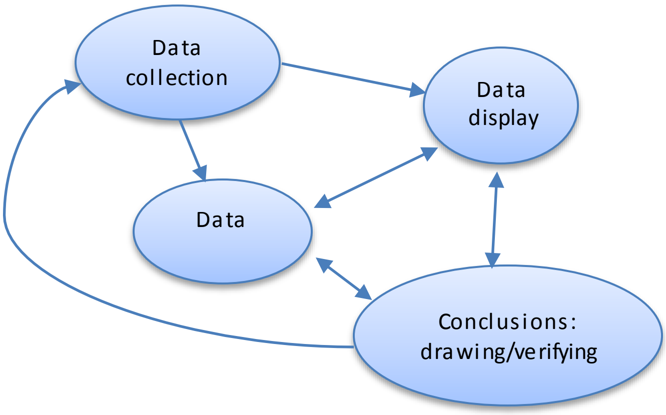



FIGURE 3-7: COMPONENTS OF DATA ANALYSIS: INTERACTIVE MODEL (RE-CREATED FROM MILES AND HUBERMAN, 1984).

The data analysis uses a number of these analytical elements to compose meaningful insights. Chapter Five (Analysis and discussion) starts the analysis and discussion for each objective with a data synthesising map, showing how data are synthesised.

#### *3.8.2.1. Consultant interviews*

Interviews focussed on elementary data in relation to consultants' knowledge and experience with Lean in the pipfruit and horticultural industries. Although interviews were semi-structured, the iterative nature of interviews meant that structured questions were followed by probing questions based on earlier answers, facilitating simultaneous data collection and analysis (DiCicco-Bloom and Crabtree, 2006). Coding of resulting data was not required to identify themes as the themes were determined by the questions. Most data could be quantified and as such represented in graphs or tables.

#### *3.8.2.2. Reflective practitioner review*

The reflective review became essential because existing literature would not complete the understanding of the industry while some of the review information would contribute to the second, third and fourth research objectives. The reflective practitioner review is analysed in combination with the literature review, consultant interviews and stakeholder data. It is not analysed as a stand-alone set of data.

#### *3.8.2.3. Action research*

Analysing action research is different but paradoxically similar to analysing case studies. The purpose of action research is not only to understand, learn and gain insight, but also to effect change. Analysis is therefore a perpetually present activity during the inquiry in order to continue achieving improvement (Cardno, 2003). At the end of the inquiry however, final reflection on the action research project can be captured in a report very similar to a case study report. With action research, the process is steered more by the participants than by the researcher, but the researcher does have bearing on what eventuates. Where action research has a focus on learning during the process (Kolb, 1984), more traditional views claim that learning takes place as a result of passing information or research findings. In the current inquiry, analysis is proposed to follow the iterative cycle but the analysis also places the action research in a case study jacket with case study analysis instruments tested.

#### *3.8.2.4. Case studies*

Gaining understanding and insight was the key purpose of qualitative data collection to assist with constructing explanations and/or theory development. The case study protocol prescribes a predetermined focus and the protocol key words can be used for analysis, however word counts are not sufficient; the researcher needs to determine if meaningful patterns are emerging (Yin, 2009). Miles and Huberman (1994) offer a set of data manipulation techniques that assist analysis, looking at data from different perspectives.

Yin (2009) relates pattern matching case information to a priori assumptions, systematic patterns that confirm suppositions. The protocol presented several suppositions that are compared with the empirical pattern, irrespective of the purpose of the study (exploratory or descriptive). The inclusion of rival explanations is used to confirm or disconfirm patterns within outcomes. Similarly, explanation building can assist with the data analysis. Yin (2009) further discusses time-series analysis, logic models and cross-case synthesis as patterns for analysis. Of these, cross-case synthesis is used to analyse the collected data.

The analysis considers two case study packhouses but includes the case of the action research packhouse as there are many overlaps between case study and action research. The exporters' mini case studies are analysed using pattern analysis and cross-case synthesis.

#### 3.8.2.5. Coding and categorising data

All records from meetings and interviews during the action research and case studies are analysed using a coding and categorisation technique that includes several steps as follows:

a) Records are coded manually, using keywords that link to Lean, are repetitive or appear significant.
b) Keywords are then assessed on meaning and grouped in a second analysis of the data.
c) The keyword/codes are then factored into three groups of categories.
   - The first group is looking for all comments and observations that link to the applicability of Lean for the pipfruit industry which is part of the third objective.
   - The second group is looking for all comments and observations that link to the implementability[8] of Lean for the pipfruit industry which is part of the third objective.
   - The third group categorises all other comments and observations according to repetitiveness or significance.

   2.1.4

1. Applicability group. This group uses the ten Tapping et al (2002) categories to help determine if Lean is applicable for pipfruit organisations (objective 3); data are clustered to- and counted within predetermined Lean themes to analyse applicability (Miles & Huberman, 1994). The ten categories were taken from Tapping et al (2002) to offer triangulation options.
2. Implementation group. This group uses ten categories to capture all those keywords that are linked to the implementability of Lean for pipfruit organisations (objective 3); here, data are clustered to, and counted within emerging implementation themes (Miles & Huberman, 1994). Categories were established by generalising all comments made in relation to implementation of Lean into ten categories.
3. Other elements group. Other patterns or themes emerge that inductively form categories (Miles & Huberman, 1994). This group captures key words/codes that

[8] The word 'implementability' is not commonly found in dictionaries but has been observed in academic literature, e.g. Green and Laffont (1987) and Kashyap et al (2005), and is considered self-explanatory.

indicate typical industry issues, researcher typical codes or repetitive but uncategorised keywords.

Frequency of codes are graphed to display the counts of each in order to assess what emerges within pre-determined categories, to assess what emerges outside of those predetermined categories, and to protect against bias (Miles & Huberman, 1994).

#### *3.8.2.6. Synthesising the data*

Collected data are synthesised where such synthesis would lead to more purposeful findings. Case study, for example, is using cross-case synthesis and pattern analysis to analyse the collected data and add validity to findings. Consultant interviews and stakeholder survey are synthesised with literature review and reflective practitioner review. Data are synthesised to summarise (integrative synthesis) and to develop concepts and theories (interpretive synthesis) (Dixon-Woods et al, 2005). The different data collected are assessed to determine where they are complementary or provide other forms of added value to findings.

After completing the literature review in phase one of the research design (figure 3-8), phase two of the research design concerns the data collection structure for qualitative data through field work. In phase three of the research design, the data collected in phase one and phase two are coded where required, analysed, synthesised and discussed to arrive at a meaningful conclusion.

#### *3.8.2.7. Wider horticultural industry*

Data collected from other horticultural industries was both quantitative and qualitative. Some numbers were obtained relating to the industries (e.g. FreshFacts, 2010) to place these in context with the subject industry of the inquiry. Several stakeholders within other horticultural industries were interviewed and summary data analysed for broad similarities. Analysed data were then used for comparative purposes between the pipfruit industry and these other horticultural industries. The comparative analysis has too few cases to permit the proper use of techniques of statistical control (Smelser, 1976; in Ragin, 2007) and comparative analysis was based on identified themes. This was then used to assess if the conceptual pipfruit model would be suitable for these other horticultural industries.

## 3.9. Summary of the research design

### 3.9.1. Deducting the theoretical approach options

The following section reasons through the spectrum of research process strata presented in figure 3-2, to arrive at the proposed research approach.

Philosophy: The expectation is that the industry will present to be quite complex. Results can be ambiguous and unlikely to be turned into laws of nature, eliminating the positivist philosophy. A holistic approach is expected to result in improved insights and the interpretivist approach (Saunders et al, 2011) appears to be a sound philosophical basis for the progression of the research approach.

Design: The next gradation focusses on the research design. Considering that relatively little is known about the research area, it is accepted that the research design will predominantly be exploratory with some descriptive elements rather probable (e.g. Patton, 1990).

Approach: Because of the uncertainty about what will be found, there is a strong likelihood that arguments will be inductive, i.e. findings are likely to lead to formation of theory, perhaps through 'creative leaps' as Mintzberg argues (1979). In fact, Mintzberg refers to induction as exploratory research "*as opposed to 'rigorous' research methodologies"* (1979).

Strategy: The next layer requires us to select between quantitative and qualitative strategies. A surveyed assessment of the baseline is typically quantitative whereas an in-depth case study is typically qualitative. Creswell (2003) argues that a researcher may claim knowledge based on 'pragmatic grounds', and that quantitative and qualitative data may be collected simultaneously or sequentially in those cases where it is judged the best strategy to understand a research problem. Mixed methods are argued to use both quantitative and qualitative approaches interactively with a clear view of synthesising through triangulation, complementarity, development, initiation, and expansion (Greene et al, 1989). The objectives stated in chapter one require both quantitative and qualitative data and a mixed method approach is used to collect data (table 3-3).

TABLE 3-3: RESEARCH STRATEGIES AND QUALITATIVE/QUANTITATIVE EMPHASIS.

| **Research strategy** | **Qualitative or quantitative** |
|---|---|
| Survey: Stakeholder questionnaire | Quantitative |
| Consultant interviews/questionnaire | Qualitative |
| Reflective practitioner review | Qualitative |
| Case studies | Qualitative |
| Action Research | Qualitative |

Time-horizon: As the primary data collection is expected to take place over time and across industry elements, the inquiry is expected to have both longitudinal and cross-sectional elements.

Data collection: Data collection involves the use of sampling and questionnaires as quantitative elements, while interviews and observations present qualitative elements. Secondary data are expected to complement specifically collected data.

The research strata 'onion' (figure 3-2) is now peeled and the research strata have been considered, resulting in an overall research pathway and guiding from the wider philosophical perspective to the specific detail.

Following Conrad and Maul's scale of certainty, it is expected that the degree of control of variables during the research is low; the inquiry is expected to be relatively fluid.

### 3.9.2. Available population, sample selection and data collection

This section examines the sample selection and data collection methods in more detail. For clarity it is noted that the first objective ('*Identify common theoretical themes for the Lean philosophy, methods and tools, that are not industry or contextually bound and that may be transferable to the pipfruit industry'*) is achieved through the literature review with some data from consultant interviews complementing the findings. Table 3.4 summarises the research strategy and data collection by organisation type. Subsequent paragraphs expound on the summary in table 3-4.

TABLE 3-4: RESEARCH ORGANISATION GROUPING BY RESEARCH STRATEGY AND ORGANISATION TYPE.

**Quantitative research component:**

| | Orchards | P/H 1 | P/H 2 | P/H 3 | Exp. 1 | Exp. 2 |
|---|---|---|---|---|---|---|
| **Survey 2012** | -------------------------- Industry-wide ------------------------- | | | | | |
| **Survey 2013/14** | Yes | Yes | Yes | Yes | No | No |

**Qualitative research component:**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Consultant Interviews 2012** | Consultants across all industries | | | | | |
| **Practitioner Reflection** | -------------------------- Industry-wide ------------------------- | | | | | |
| **Action Research** | Yes | Yes | | | | |
| **Case Study** | | | Yes | Yes | | |
| **Mini case study** | | | | | Yes | Yes |

### 3.9.3. The overall research design

Considering the elected research strata and the research objectives, it is approriate to draw an overall research design map bringing all elements of this inquiry together (Figure 3-8). The objectives described in Chapter 1 are repeated here for clarity:

1. Identify common theoretical themes for the Lean philosophy, methods and tools, that are not industry or contextually bound and that may be transferable to the pipfruit industry.
2. Identify and analyse the current Lean deployment within the NZ pipfruit industry.
3. Analyse the applicability and any implementation approaches of the Lean philosophy, methods and tools within the NZ pipfruit industry.
4. Develop a conceptual Lean model for the NZ pipfruit industry and consider if the model is applicable to the wider horticultural sector.

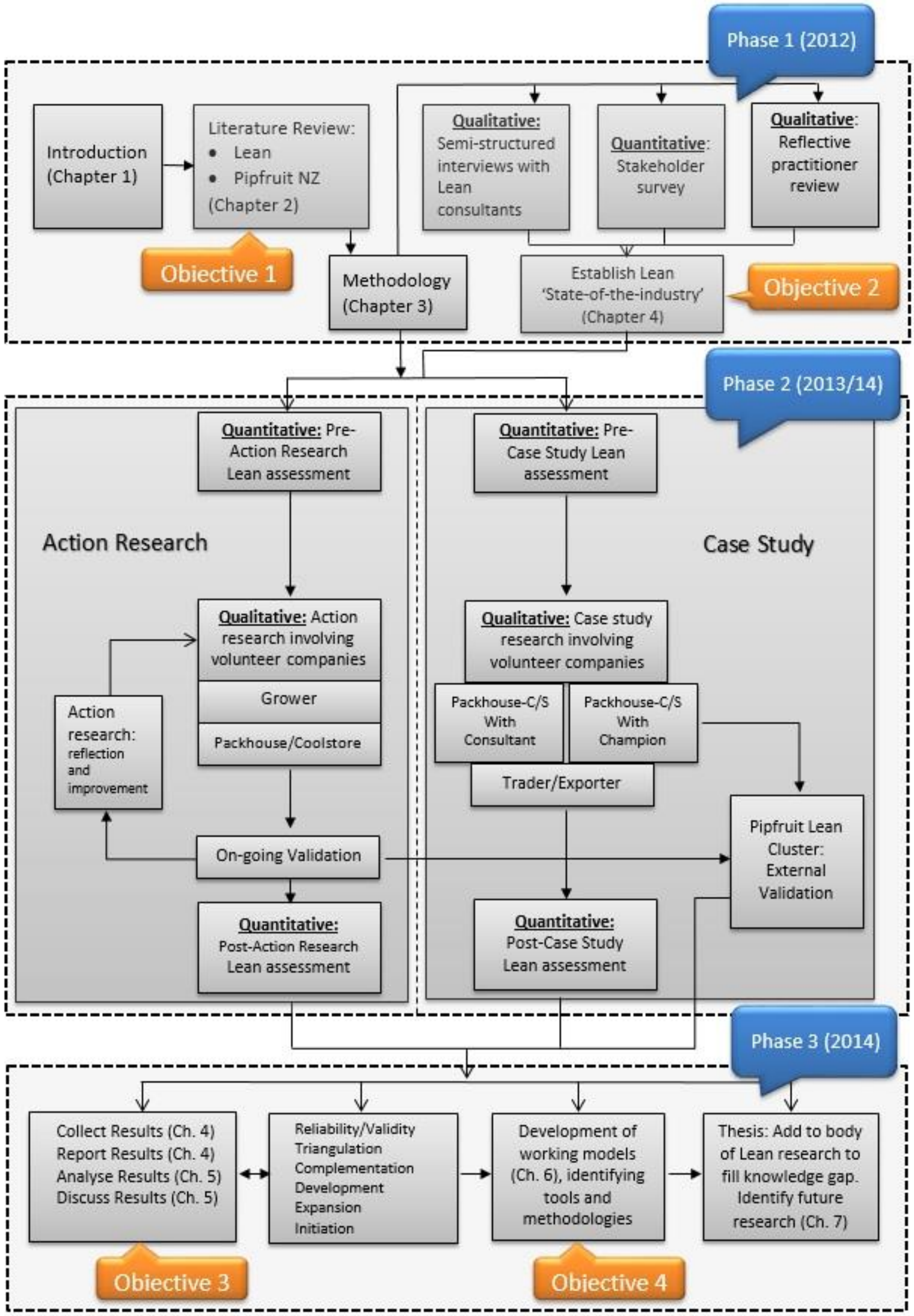



FIGURE 3-8: RESEARCH DESIGN & METHODOLOGY MAP.

The inquiry is designed in three mostly sequential phases, each contributing to completion of specific objectives:

- Phase 1 is exploratory and necessary to understand if Lean fits theoretically (objective 1) and if the industry currently is Lean (objective 2).
- Phase 2 is necessary to obtain meaningful and rich data that help analyse the applicability and implementation approaches of Lean into the industry (objective 3), and requires substantial field work.
- Phase 3 is necessary to analyse the data using triangulation and other forms of data analysis (e.g. Greene et al, 1989) and determine reliability and validity of the data, leading to completion of objective 3. Objective 4 can only follow after completion of objective 3.

The research design and methodology map in figure 3-8 also points at thesis chapters reporting on specific parts of the inquiry.

### 3.9.4. Issues of trustworthiness: Reliability and validity

*"Without rigor, research is worthless, becomes fiction, and loses its utility."*

This quote from Morse et al (2008, p14) epitomises the essence of rigour. Reliability and validity have been synonymous with rigour (Seale, 1999) and as such two of the cornerstones of science. Patton (1990) states that validity and reliability are two factors which qualitative researchers should be concerned about when designing a study, analysing the results and judging the quality of the inquiry. In a qualitative inquiry, he argues that the researcher is the instrument, and validity relies substantially on the skill and competency of the researcher. Similarly, Yin (2009) appears clear in his assessment that reliability and construct-, internal- and external validity are commonly used to establish the quality of empirical research. This section summarises the reliability and validity design constructs employed by the researcher (table 3-5). Reliability and validity are further discussed in chapter 5, 'Analysis and discussion'.

The theoretical assessment of rigour has led to confusing debate about constructs of validity (e.g. Morse, 2008; Golafshani, 2003; Guba and Lincoln, 1994; Maxwell, 1992; Altheide and Johnson, 1994), and the debate is unlikely to lead to more rigour in future research. The debate may more likely lead to more variability in terminology and inconsistency across inquiries. This is not helpful. Rigour for this inquiry is therefore primarily sought in reliability and construct-, internal- and external validity.

The rigour of the inquiry's concepts was tested by peer reviewed papers and presentations at the following international forums:

- The World Business Capability Congress (WBCC) 2012 (Doevendans et al, 2012);
- The European Operations Management Association (Euroma) conference 2014 (Doevendans et al[1], 2014);
- The Performance Management Association (PMA) conference 2014 (Doevendans et al[2], 2014); and the
- Australia New Zealand Academy for Management (ANZAM) supply chain symposium 2014 (Doevendans et al[3], 2014), where the paper was awarded shared 'best paper'.

Questions during these presentations generally focussed on parallels with other primary industries with no critique on the methodology or robustness of the presented papers. Similarly, the reliability and validity of the reflective practitioner review was tested through review by a number of industry peers and is not included in table 3.5.

### 3.9.5. Reliability

Reliability relates to the degree in which measured outcomes are free from errors of measurement; measurement errors reduce the generalizability of the outcomes of the inquiry (Moss, 1994). The use of a single researcher also provides for consistency. Despite some misgivings, Morse et al (2008) confirm that verification through participant verification adds reliability. Table 3-5 presents how reliability is intended to be achieved.

### 3.9.6. Validity

Validation strategies include theoretical sampling and sampling adequacy, methodological coherence, investigator responsiveness, an active analytic position and saturation. A good qualitative researcher oscillates between design and implementation to ensure congruence among elements of the methodology, including question formulation, literature, lot and sample selection, data collection strategies, and analysis (Morse et al, 2008). Validating means investigating, checking, questioning, and theorizing (Kvale, 1995). Table 3-5 presents a summary of design tests in relation to research methods and objectives.

TABLE 3-5: RELIABILITY AND VALIDITY DESIGN.

| **Design Test** | **Consultant Interviews** | **Stakeholder survey** | **Case study approach** | **Action research** |
|---|---|---|---|---|
| ***Objective*** | ***Identify common themes of Lean deployable to industry*** | ***Identify current Lean deployment and implementation approaches*** | ***Analyse current Lean deployment and Lean applicability; identify model*** | ***Analyse current Lean deployment and Lean applicability; identify model*** |
| **Reliability:** the extent to which the study's data (observations) are consistent and can be repeated, producing the same results. | • Use of semi-structured interviews<br>• Coding of replies<br>• Identifying themes | • Use of questionnaire with Liker scale<br>• Stratified sample selection to represent industry<br>• Increased response rate through single question approach | • Use of a protocol<br>• Use of a single researcher for consistency<br>• Coding and identification of themes<br>• Participant verification | • Use of a semi-protocol, congruent to case study<br>• Use of a single researcher for consistency<br>• Coding and identification of themes<br>• Participant verification |
| **Construct validity:** The extent to which the inquiry measures what it claims to be measuring. Convergent & Discriminative: Degree to which theoretical relation is actual relation (C) or not (D) | • Establishment of experience of consultants in pipfruit and horticultural industries<br>• Use of specific lean element questions<br>• Skilled interviewer | • Questionnaire design allowing convergence and discrimination between questions<br>• Cross-referencing of single-day questions | • Use of published alternative implementations of lean in the construction of the case study protocol<br>• Use of multiple sources of evidence within cases, allowing triangulation<br>• Skilled interviewer | • Use of multiple sources of evidence within action research, allowing internal triangulation<br>• Achieve Recoverability |
| **Internal validity:** The extent to which causal relationships are justified by minimizing systematic error. Inferences are valid if a causal relationship can be demonstrated | • Sample of all known consultants<br>• Establishment of experience of consultants in pipfruit and horticultural industries | • Stratified sample selection to represent industry<br>• Validation of respondents<br>• Validating consistency between direct and indirect questions | • Specification of unit of analysis<br>• Within case and cross-case comparisons of case data<br>• Cross-case analysis between case study and action research cases | • Cross-case analysis between case study and action research cases<br>• Achieve Recoverability |
| **External validity:** The extent to which this study's findings can be generalised beyond the immediate sample to the wider populations (of pipfruit and horticultural organisations). | • Sample of all known consultants<br>• Establishment of other known consultants from consultants | • Representative sample of the industry<br>• Differentiation between sub-samples of industry activities<br>• Establishment of similarities between pipfruit and horticulture | • Replication logic used in case study selection<br>• Having a focus group review preliminary cross-case findings.<br>• Compare with known theory and empirical evidence on Lean implementation | • Having a focus group review preliminary action research findings.<br>• Compare with known theory and empirical evidence on Lean implementation<br>• Achieve Recoverability |

## 3.10. Ethical considerations

Initial ethical considerations were prompted by Massey University's Code of ethical conduct for research, teaching and evaluations involving human participants (MUHEC) (2010). The university provides an ethics screening questionnaire which assist the researcher to preliminary assess whether a low risk notification is applicable or a full application to the ethics committee should be made. A low risk application was made and approved, based on the fact that:

- All participants were fully informed adult volunteers and organisations;
- All details that might identify participants would not be included in the thesis;
- No harm of any kind could be foreseen for participants or researcher.

The possible conflict caused by action research is well documented and a case study and action research protocol (appendix 9) mitigates ethical risks. The researcher made it general practice to inform the participants of the research, its purpose and methods of data collection, reinforcing the confidential nature of the inquiry. Participants—both organisations and individuals—were made aware of their rights in participating, including to remain unnamed and the right to withdraw. Interestingly, and despite the reluctance to participate, organisations without exception were unconcerned about identification and none withdrew. Nevertheless, the research presented in this inquiry suitably protects the participants in the survey, interviews and the participating organisations. Special consideration was given to the action research component, but no ethical dilemmas were encountered.

## 3.11. Chapter conclusion

Section 3.1 of this chapter introduced the methodology employed to achieve the objectives of this inquiry. A general approach was discussed in section 3.2, funnelling from the broad philosophical to methodological details. The methodology deployed in this inquiry follows a standard literature review with a mixed method survey and interview element to lay the basis for achieving objectives 1 and 2 during phase 1 of the inquiry (Section 3.3 and 3.4). This initial part of the inquiry is followed by an unorthodox combination of parallel action research and case study in phase 2 of the inquiry to collect rich data (Section 3.5 of this chapter). Section

3.6 discusses the methodology to achieve the fourth objective, while sections 3.7 to 3.9 present qualitative and quantitative methods, data analysis and a summary of the methodology.

This methodology is justified as a logical approach when considering the four objectives of the inquiry and the environment, being an industry with few Lean organisations to use for research purposes. Several industry segments, specifically orchards and exporters, had no organisations embarked on the implementation of Lean whereas some packhouse/coolstore organisations had decided or very recently started to implement Lean. Offering action research to research volunteers motivated one packhouse/coolstore and one orchard group to participate in the research which they would not have done otherwise. The orchard group decided to become the first in New Zealand to attempt implementing Lean, providing potentially valuable insights in the applicability of Lean in that industry segment (growing pipfruit).

This mixed methods approach places some demands on the analysis of data and the trustworthiness or rigour of the inquiry. These are discussed in some detail in section 3.10 of this chapter respectively. Section 3.11 of the chapter discusses ethical considerations to ensure that the inquiry is safe for sample companies and researcher alike.

The methodology chapter has clarified how the aim and objectives from chapter one are intended to be achieved and why the deployed methodology is relevant.

# 4. Results

## 4.1. Introduction to results

In previous chapters, we have seen an introduction to the pipfruit industry and the research problem (chapter 1). A literature review then examined Lean and the pipfruit industry (chapter 2), followed by a research design and methodology chapter (chapter 3). This chapter, 'Results', presents results from the several investigative strategies and data collection methods that were discussed in the methodology chapter. For the purpose of this inquiry, the words 'results' and 'findings' are interchangeable. Chapter 4 reports on the following:

- Findings from the literature review (section 4.2)
- Findings from the reflective practitioner review (section 4.3)
- Findings from consultant interviews (section 4.4)
- Findings from the stakeholder survey (section 4.5)
- Findings from action research (section 4.6)
- Findings from case studies (section 4.7)

The results and findings are reported without analysis; the following chapter (chapter 5) analyses and discusses the findings in the context of the research objectives. Each of the reported findings connects to one or several of the objectives identified in chapter 1.

## 4.2. Findings from literature review and the first objective

The literature review demonstrates that Lean principles, methods and tools are not unique. Gilbreth, Ford and Taylor had ideas that align substantially with what we today define as Lean, well before Lean was identified in the Japanese automotive industry by Krafcik (1988b), Womack et al (1990) and others.

The literature review shows that within Japan, automotive companies that followed Toyota adapted Toyota's TPS in order to suit their environment (Cusumano, 1994). It also presents a number of examples from the health industry, marketing and sales, the processing industry, accounting and others. Principles such as critical elements for Lean implementation and defining waste are presented from different perspectives and demonstrate that Lean can be adapted to, and implemented in, multiple 'other-than-manufacturing' environments. Diligent application of best practices, people empowerment, Just-In-Time and continuous improvement principles are transferable success enablers. Lean is not a uniquely Japanese concept.

The literature review identifies common theoretical themes for the Lean philosophy methods and tools that have proven to be transferable to numerous industries and environments. Major themes included the fluidity and environmental adaptability of Lean, the challenge of implementation and the continuum from general, less perceptible themes such as leadership, strategy behaviour and engagement to specific more perceptible themes such as methods and tools. These may be adapted to specific production or service environments but they are applicable nonetheless. The literature review therefore substantially achieves the first objective of this inquiry.

## 4.3. Findings from reflective practitioner review

### 4.3.1. The need for a reflective practitioner review

A number of developments within the NZ pipfruit industry have not been documented. As independent practitioner, the researcher has reflected on the industry from his professional perspective and this reflective review is added as appendix 1. The following section summarises findings from the reflective practitioner review.

### 4.3.2. Reflective practitioner review synopsis

The practitioner review reflects on some historical developments that have shaped the industry into its current model. The formation of a large number of exporters since deregulation has affected the value stream insofar as that was understood by the industry. It has also contributed to a sharpening of practices to assist the cost/value proposition.

The reflective practitioner review points at the following themes:

- The interpretation of customer value and the dualistic position of the exporter
- An unsettled industry, resulting in multiple supply chain and value stream changes, creating an uneven system with overburdening;
- A general unawareness of Lean as evidenced by the attendance to three regional workshops;
- Poorly timed communication of customer requirements to growers (often around December whereas the grower generally prunes from May to October;
- Consignment sales are sales of product pushed into the market and not pulled by a customer programme.
- There is waste caused by market requirements, lost market opportunities and internal competition, and this waste has gone largely unmeasured.

A number of methods and new thinking developed organically through within-industry competition that would distinctly fall within the Lean paradigm. Although these are not identified as 'Lean' by the industry, it shows that there are several Lean methods and practices that have been deployed intuitively within the industry, while other principles and methods or tools are intrinsically problematic (table 4-1).

TABLE 4-1: INTUITIVE AND PROBLEMATIC LEAN PRACTICES WITHIN THE PIPFRUIT INDUSTRY

| **Intuitively developed methods/practices** | **Problematic methods/practices** |
|---|---|
| Exporter customer value identification | Customer identification (grower or consumer) |
| Growing larger/smaller fruit with higher/normal colour | Disconnect between grower pack-out and customer value |
| Quick change-over in orchards during harvesting and packhouses during packing | Just-In-Time (JIT) production for seasonal industry with a one year production cycle |
| Load-levelling, reducing overburdening | Even flow and overburdening |
| Walking the shop floor | Adapting to the market with lead-times of 12 years for new varieties |
| Mistake/error proofing | Exporter communication of customer requirements after pruning and thinning |
| Manipulating natural resources | |

Conversely, the review evidences that the industry has both necessary and unnecessary waste through regulatory requirements. A generally accepted example is the protocol to get access to the Australian market which industry stakeholders find unrealistic, demanding a number of steps that do not contribute to phytosanitary security. If the regulator is unaware of Lean principles, it is not within his/her purview to bring these into bearing, affecting a number of industry processes by introducing regulatory waste. Regulatory waste is outside the scope of this inquiry and is only discussed where it impacts industry operations.

## 4.4. Findings from consultant interviews and the second objective

Twenty-six consultants were approached using the list of consultants established with the help of NZTE, Pipfruit NZ and a web-based search (Appendix 5). All consultants are in the public domain. Some consultants preferred to receive the questions in advance and were sent the semi-structured interview questions (Appendix 8) by email or traditional mail (one consultant). Relevant findings are presented in the following paragraphs and discussed in chapter 5.

### 4.4.1. Consultant response rate

Twenty-one consultants out of the group of twenty-six were prepared to answer questions, a response rate of 80.77%. Of the twenty-one respondents, sixteen respondents were happy to be named in the study in relation to their responses, while one respondent preferred to remain anonymous and two would prefer to read the report first. Two respondents did not answer the question and are considered to prefer anonymity for their protection. None objected against being on a list as per appendix 5.

### 4.4.2. Consultant responses

The following tables summarise the responses from consultants in key words. Where elaboration is considered useful, more complete answers are tabled. Table 4-2 shows how consultants saw their activities in relation to training, consulting, coaching, and supporting, assessing and researching.

TABLE 4-2: ACTIVITY FOCUS OF CONSULTANTS.

| **Does your business train, consult, do both or different?** | |
|---|---|
| Train | 20 |
| Consult | 14 |
| Coach | 5 |
| Support/assessment/research | 1 |

#### *4.4.2.1. Relevance of the consultants' businesses to the investigation*

Table 4-3 shows the areas in which the interviewed consultants specialised. While some had a single area, others specialised in various paradigms or approaches. Although table 4-3 shows only 15 consultants indicating Lean as their specialist area, twenty of the twenty-one (approximately 95%) respondents indicated that they assist organisations with Lean. Eighteen consultants reported assisting companies with 'Lean' in a primary industry. These included coffee, wine, aggregates, dairy, meat, forestry, animal by-products, processing, horticulture (kiwifruit, apples), honey, fisheries, and aqua-culture. Of these eighteen, ten reported that they assisted with 'Lean' in horticultural companies. These included Kiwifruit (4), Pipfruit (4), Processing (1), Nursery (1) and Fruit (1). Eleven consultants did not work in any horticultural environment.

TABLE 4-3: CONSULTANTS' AREA OF SPECIALISATION.

| **What is your business' specialist area?** | |
|---|---|
| Lean | 15 |
| Business Improvement | 3 |
| Improving profit | 2 |
| Business development | 2 |
| Leadership | 1 |
| Six sigma | 1 |
| TPS | 1 |
| TPM | 1 |
| Kaizen | 1 |
| Change/transformation | 1 |
| Removing constraints | 1 |
| Other | 3 |

#### *4.4.2.2. Consultants' views on 'push' and seasonal elements of the pipfruit industry*

Consultants were asked to comment on the 'push' element of horticultural products and on the seasonal labour element. Responses to the question how 'push' affected Lean were significantly vague and generally did not show an established pattern of thought (Table 4-4).

TABLE 4-4: 'PUSH' AFFECTING LEAN IMPLEMENTATION.

| **Horticultural product is pushed into the market. How does that affect 'Lean' implementation?** | |
|---|---|
| Vague answers or evading answers | 9 |
| Push is a fundamental difference | 1 |
| Lean does not necessarily mean pull | 1 |

| | |
|---|---|
| Upstream activities are still pulled | 1 |
| Apply only what makes sense | 1 |
| The supermarket concept helps with pull | 1 |
| There can be pull from the orchards to avoid stressing the packhouse/coolstores | 1 |
| Lean accepts push and buffers to smooth the flow | 1 |
| Lean principles apply in every industry | 1 |
| You cannot be Lean and push | 1 |
| Focus on waste, not on push | 1 |
| Push industries should consider their process as high peak pull and focus on improving that | 1 |
| Don't know | 1 |

Consultants agreed substantially on Lean elements that could be emphasised in a seasonal environment. These elements were standardisation, training and visual management (Table 4-5).

TABLE 4-5: SUMMARY VIEW OF LEAN EMPHASIS FOR SEASONAL INDUSTRIES.

| **Horticultural industries have some 80% seasonal workers. How does that affect 'Lean' implementation?** | |
|---|---|
| Call for Standardisation | 10 |
| Call for Training | 9 |
| Call for Visual management | 4 |
| Other responses (not mentioning standardisation, training or visual management) | 4 |

Similarly, consultants agreed substantially when asked to give a 'weight' to philosophy or tools. Only one consultant stated that tools were more important than philosophy. All others felt that philosophy was an absolute requirement or needed to be integrated with tools, but without philosophy Lean would fail (table 4-6).

TABLE 4-6: PHILOSOPHY OR TOOLS/METHODS?

| WHAT WORKS BETTER: PHILOSOPHY OR TOOLS/TECHNIQUES? | |
|---|---|
| Integrated | 13 |
| Philosophy | 7 |
| Tools/techniques | 1 |

### *4.4.2.3. Consultants' views on Lean and other business improvement models*

Of the twenty-one respondents, twenty agreed that Lean could add value to the NZ pipfruit industry. Almost without exception responses were definitive, mostly phrased as '*absolutely'* and '*without a doubt'*.

Asked if there were other models that they would recommend to be used by horticultural organisations rather than or in addition to 'Lean', a number of models were mentioned (table 4-7). Lean and Six Sigma appeared to be the obvious preferences by consultants, followed by Kaizen, TQM and TOC. A number of consultants (7) recommended no other approach but Lean.

Table 4-7: OTHER MODELS RECOMMENDED BY CONSULTANTS.

| **Other recommended models?** | |
|---|---|
| None | 7 |
| Six Sigma | 5 |
| Kaizen | 3 |
| TQM | 3 |
| TOC | 3 |
| TPM | 2 |
| Eclectic approach | 1 |
| Best Practice | 1 |
| Supply Chain | 1 |

### *4.4.2.4. Consultants estimates on Lean implementation in NZ and the pipfruit industry*

Consultants were asked what proportion of NZ companies would be 'seriously Lean'. This question was narrowed down asking consultants which proportion of NZ horticultural companies was 'seriously Lean'. The definition of 'seriously Lean' was deliberately left open to provoke rich answers rather than merely a percentage. Consultants agreed that a low percentage (averaging 3.3%) might be seriously Lean. The range of these estimates was between 0% and 10%. Focussing on the horticultural industry, consultants agreed that an even lower percentage of these was 'seriously Lean, averaging 1.3% with a range from 0% to 5%.

### *4.4.2.5. Consultants closing comments*

Finally, consultants were asked if they had any closing comments. A summary of closing comments is presented in table 4-8. Comments are random and flowed from the interview's line of questions and the consultant's responses.

TABLE 4-8: CONSULTANTS' CLOSING COMMENTS.

| Closing comments | |
|---|---|
| Engaging management can be a problem | 3 |
| Some companies do 5-S and call themselves Lean | 1 |
| Small & medium size companies are easier to engage; the relative cost benefit is lower | 2 |
| NZ needs all the help it can get to compete with mass producers; Lean and agile are key | 1 |
| Significant opportunity once over the 'seasonal' issue and changed attitude | 1 |
| Lean is a complete paradigm; tools alone will not work | 1 |
| Removing waste through training and maintenance is key | 1 |
| The level of training in NZ is rather thin | 1 |
| Kaizen to improve waste and flow offers significant opportunities | 1 |

### 4.4.3. Consultant synopsis

Generally, all respondents assisted customers with Lean implementation. Several assisted companies in the primary industry but further questioning established that most of these were active in the food processing section. Some consultants responded that they had worked in the kiwifruit and apple industries. Further investigation resolved that three consultants had actively worked in the kiwifruit industry, one as trainer and two as consultant. Similarly, while several consultants claimed to have done some work in the pipfruit industry, only two consultants actively worked in the pipfruit industry. Both of these consultants and their work are known to the researcher. Other consultants had done minor assessments and did not claim to have affected the companies that they visited.

The interviews with consultants show that there is little knowledge of positive implementation of Lean in the NZ pipfruit industry and the wider horticultural industry. The outcome from the consultant interviews confirm the 'state-of-the-industry' and contribute to achieve objective two: 'Identify and analyse the current Lean deployment within the NZ pipfruit industry'.

Of the 500+ stakeholders, there are very few companies that are implementing Lean, while all consultants agree that Lean will add value to each operation.

## 4.5. Findings from stakeholder survey and the second objective

A sample of 150 Stakeholders were approached via email, receiving a single multiple-choice question each day to respond to. 140 Stakeholders were counted as the sample due to double-ups and stakeholders requesting to be withdrawn. The following section summarises the responses from the stakeholders.

### 4.5.1. Stakeholder response rate

The initial response rate to the industry-wide survey averaged 23.88%. This response rate is considered satisfactory given the length of the questionnaire, the relevance of the subject and the declining response rates to surveys over the years (Sheehan, 2006). On completion of the survey, feedback was given to participants including the missed questions. Several participants then returned answers to the missed questions. This helped to increase response rates (Heberlein & Baumgartner, 1978), lifting the response rate to 24.56%.

### 4.5.2. Stakeholder responses

#### *4.5.2.1. Respondent company management intent*

Ten questions inquired about current Lean knowledge of each respondent company, intent of the company and some of the company's beliefs concerning change. One question concerning Lean knowledge was used as a pre- and post-survey question to measure if the questionnaire itself had made a difference in respondent perception. The result of the pre- and post-survey question is presented in figure 4-1. Results indicate that respondents rated their knowledge of Lean relatively higher before the survey than they did on completion of the survey.

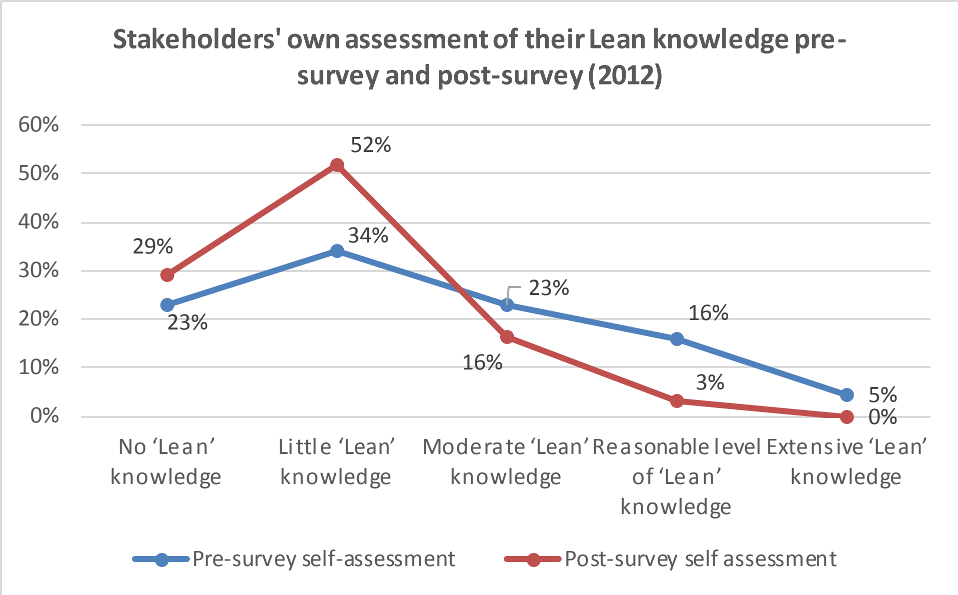



FIGURE 4-1: STAKEHOLDER PRE- AND POST-SURVEY SELF-ASSESSMENTS OF LEAN KNOWLEDGE.

#### *4.5.2.2. Kobayashi criteria*

The 2012 industry stakeholder survey showed a low level of realisation of the Kobayashi criteria within the broader industry.

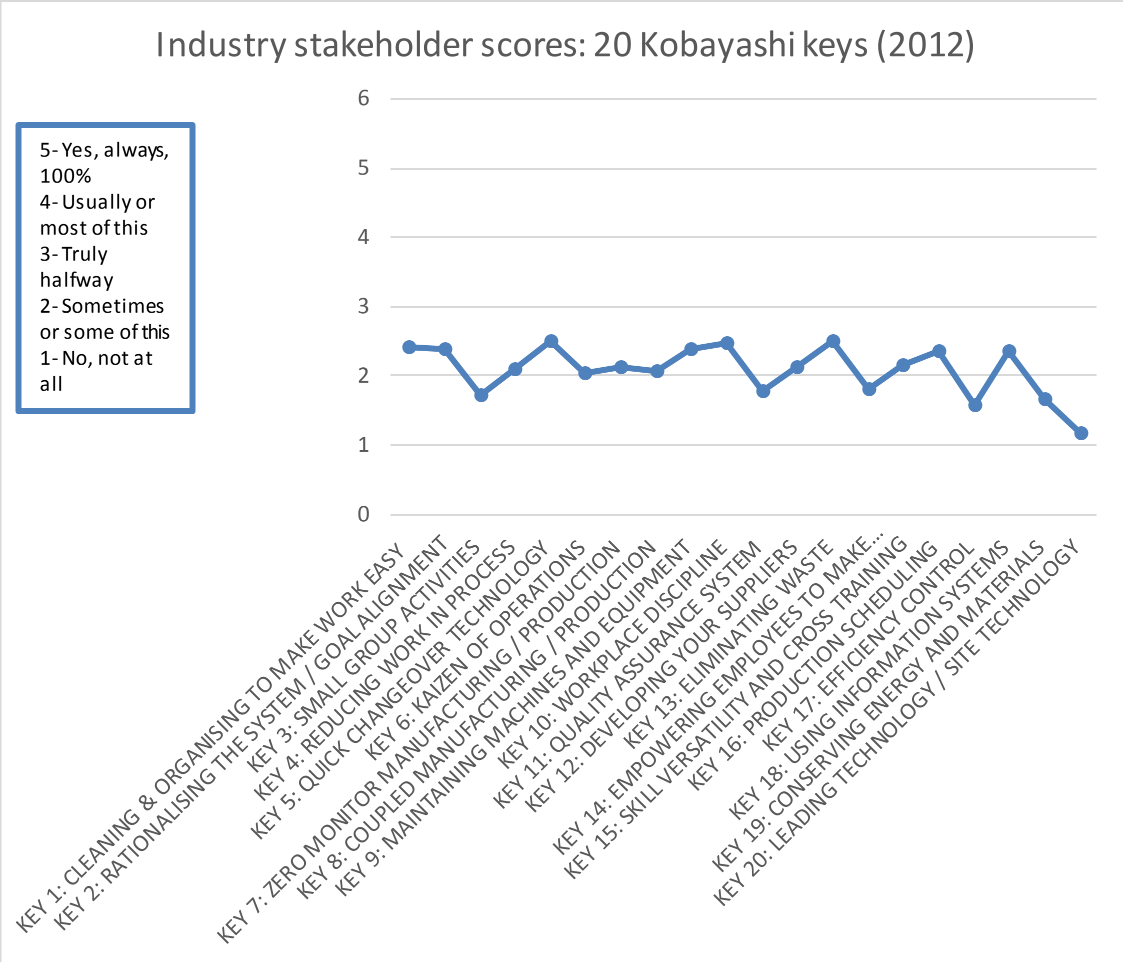



FIGURE 4-2: KOBAYASHI KEYS LEVEL OF IMPLEMENTATION – WIDER INDUSTRY STAKEHOLDER SCORES (2012).

Table 4-9 shows the relative distribution of responses to the Kobayashi statements, indicating a low level of achievement of the Kobayashi keys.

TABLE 4-9: PERCENTAGE DIVISION OF RESPONSES TO KOBAYASHI STATEMENTS.

**All Kobayashi self-assessments, all responses**

| 1. No, not at all | 2. We do this sometimes or do some of this | 3. We are truly halfway organised as in the statement above | 4. We usually do this or we do most of this | 5. Yes, always 100% |
|---|---|---|---|---|
| 29.9% | 45.1% | 12.9% | 10.2% | 2.0% |

### *4.5.2.3. Lean principles, methods and tools*

The industry survey from 2012 presented a list of 20 common Lean principles, methods and tools to assess knowledge and use of these within the wider industry. The mean industry results are presented in figure 4-3.

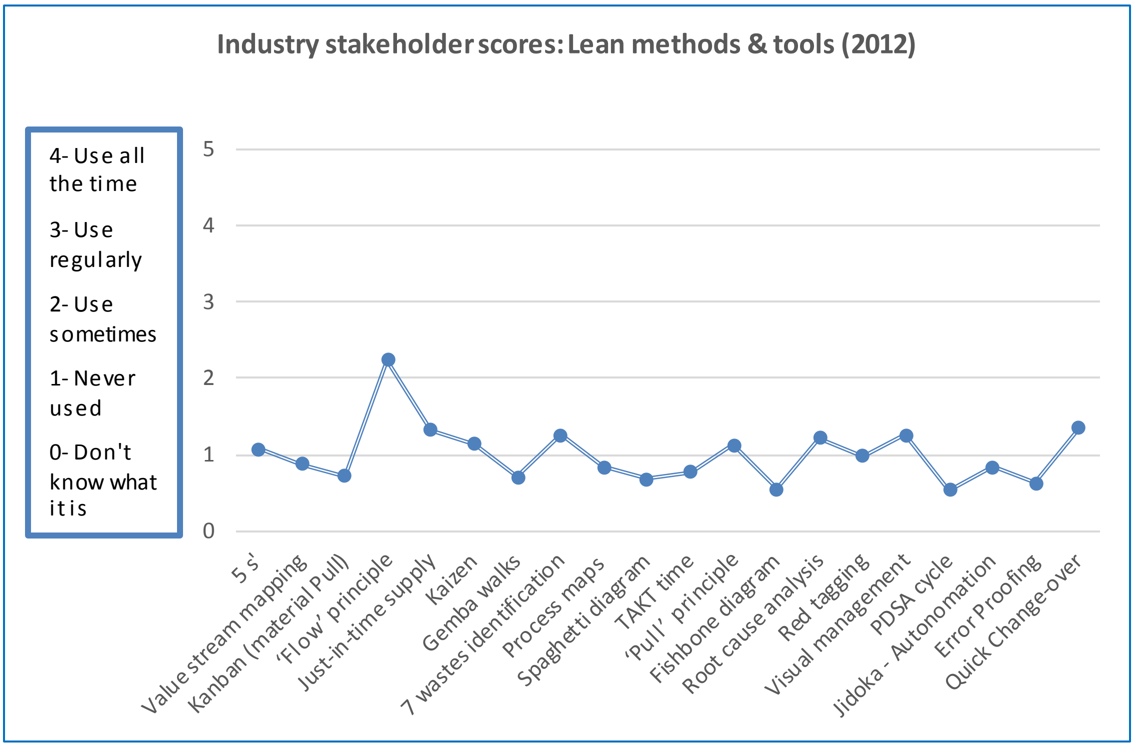



FIGURE 4-3: LEAN TOOLS KNOWLEDGE AND USE: WIDER INDUSTRY STAKEHOLDER SCORES (2012).

A more defining picture is displayed in table 4-10. Table 4-10 shows the percentage of responses to indicate the percentage of the industry that is familiar and uses principles, methods and tools. Of the 20 principles, methods and tools, only 8.6% were used regularly or all the time. 81.7% of all principles, methods or tools was either unknown or not used. This indicates that the industry is largely ignorant of Lean or does not see the benefit of implementing Lean principles, methods and tools.

TABLE 4-10: SKEWING TOWARDS 'NOT KNOWING' LEAN PRINCIPLES, METHODS AND TOOLS.

**All principles, methods and tools, self-assessment, all responses**

| Don't know what it is | Never Used | Use sometimes | Use Regularly | Use all the time |
|---|---|---|---|---|
| 62.2% | 19.5% | 9.7% | 6.7% | 1.9% |

### 4.5.3. Stakeholder survey synopsis

It is clear from the initial industry survey that the level of Lean implemented in the NZ pipfruit industry was relatively low at the time the inquiry started. This includes any organically developed methods and tools as the Kobayashi criteria simply described a state of organisation with which respondents could agree or disagree using the 5-point Likert scale. These findings confirm that the level of Lean deployment within the NZ pipfruit industry is low at the time of the survey, and it substantially achieves the second objective of the inquiry.

### 4.5.4. Findings from action research and the third objective

This section reports on the findings from the two action research (AR) organisations participating in the inquiry. The action research orchard group is abbreviated as ARO, while the action research packhouse is abbreviated as ARP. Findings relate to survey results, interviews and observations.

### 4.5.5. Guideline for reading the graphs in the results section

This section contains a number of graphs that present results. The graphs relating to the progress of the research company—in relation to the baseline—are standardised as follows:

- The baseline is a double continuous line, representing either the start of the inquiry for the research company (company colour) or the industry position in 2012 (blue)
- The 2013 result is a blocked line
- The 2014 result is a dotted line
- The Action Research Orchards (AROs) are represented by the colour green

- The Action Research Packhouse (ARP) is represented by the colour orange
- The Case Study Packhouse with a champion (CSP) is represented by the colour blue
- The Case Study Packhouse with Consultant (CSPC) is represented by the colour red.

Other graphs, not representing the progress of research companies to the baseline, may use the colours relating to the research companies.

<u>Note regarding the use of graphs</u>: Bar graphs are commonly used to compare positions between different elements while line graphs are commonly used to indicate trends and developments. However in the next section, the scores for the Lean assessments are expressed as line graphs which are considered to provide a better overview. All coded and categorised items from the action research and case study interviews are expressed in horizontal bar graphs.

### 4.5.6. Action research orchards

Data collection for the action research companies involved multiple visits. Visits were typically one to two hours during which information exchange took place and the researcher could offer Lean knowledge or suggestions and the company could respond through undertaking action.

#### *4.5.6.1. Action Research Orchards (ARO) progress measurement*

The industry stakeholder survey from the end of 2012 showed a low level of realisation of the Kobayashi criteria within the wider industry. The same criteria from the survey were used to assess the action research and case study orchards and packhouses (including their coolstores) after the first full season of engagement (2013), and again at the end of the harvest and packing season in the following year (2014). The results are presented in figure 4-4.

It is clear from figure 4-4 that the research orchards made solid progress, up from the broader industry status. The continued progress in the second year of engagement gives rise to the supposition that Lean works for orchard organisations.

Similar to the Kobayashi criteria, respondents indicated their familiarity and use of a set of common Lean principles, methods and tools. The progress of the research ARO in relation to the wider industry is presented in figure 4-5.

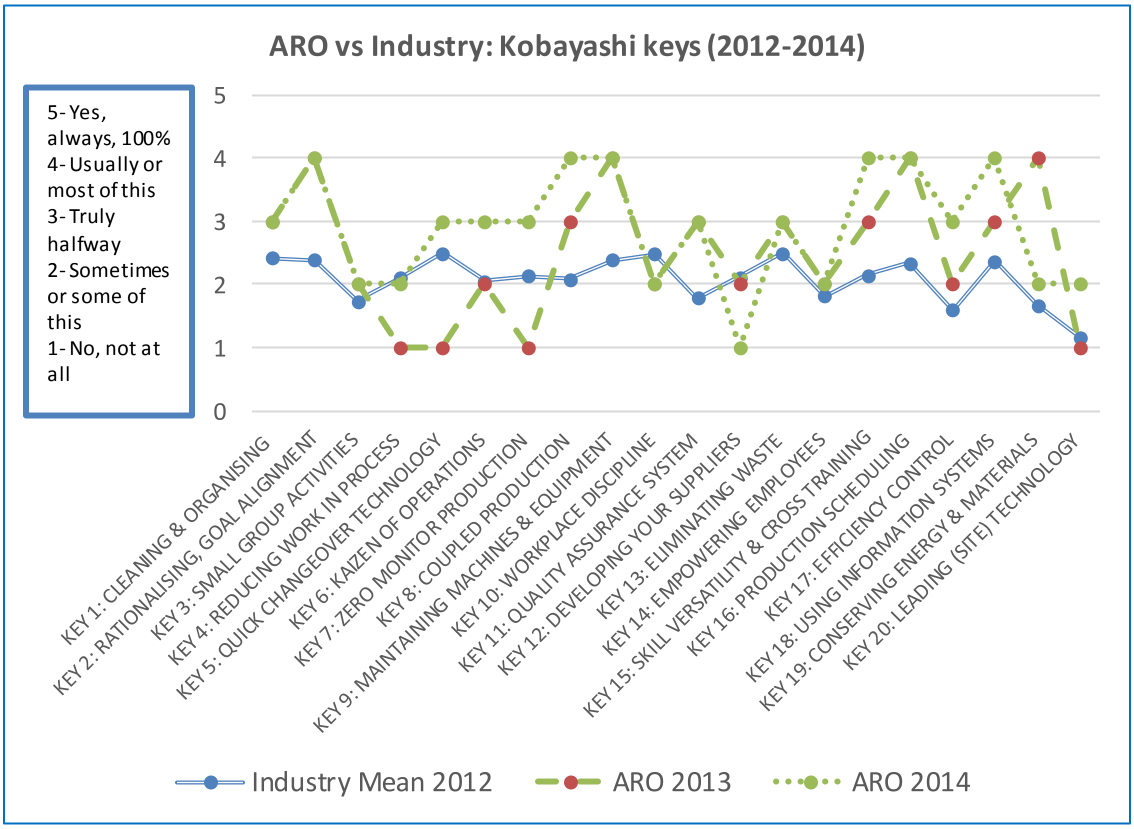



FIGURE 4-4: ARO KOBAYASHI KEYS- COMPARISON BETWEEN INDUSTRY AND ACTION RESEARCH ORCHARD PROGRESS (2012-2014).

The action research orchards demonstrated an increased knowledge and use of the common Lean principles, methods and tools in relation to the wider industry surveyed one and two years earlier (figure 4-5).

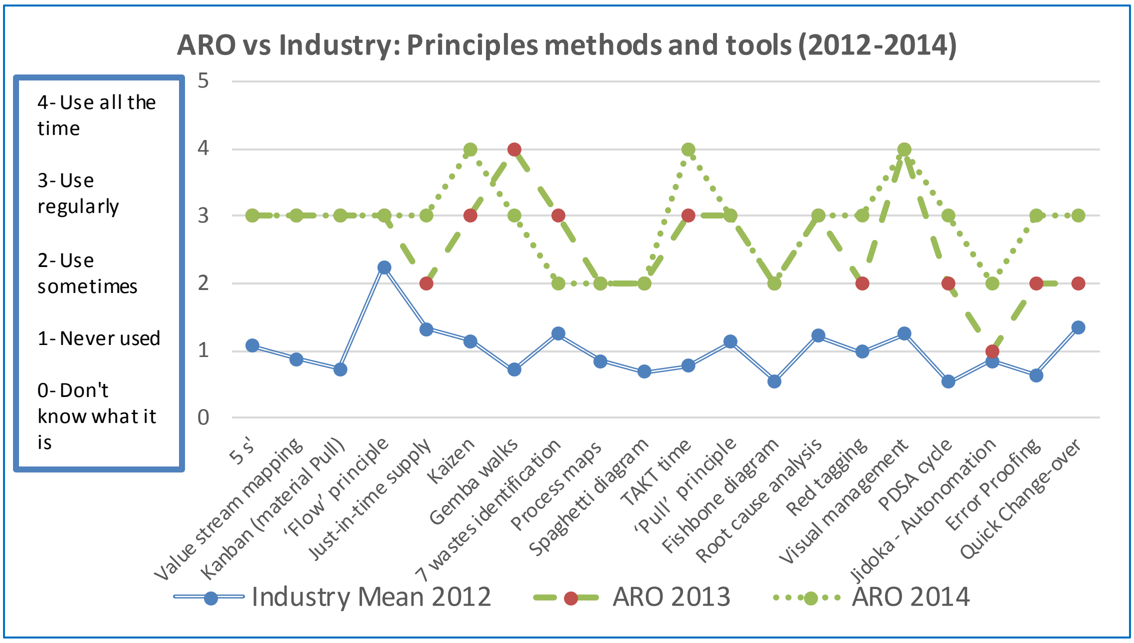



FIGURE 4-5: ARO KNOWLEDGE AND USE OF LEAN PRINCIPLES, METHODS & TOOLS- COMPARISON BETWEEN INDUSTRY AND ACTION RESEARCH ORCHARD PROGRESS (2012-2014).

The ARO was assessed using the Tapping et al (2002) Lean assessment at the start of the inquiry, at the end of the first season and again at the end of the second season. Scores for the three assessments are found in figure 4-6.

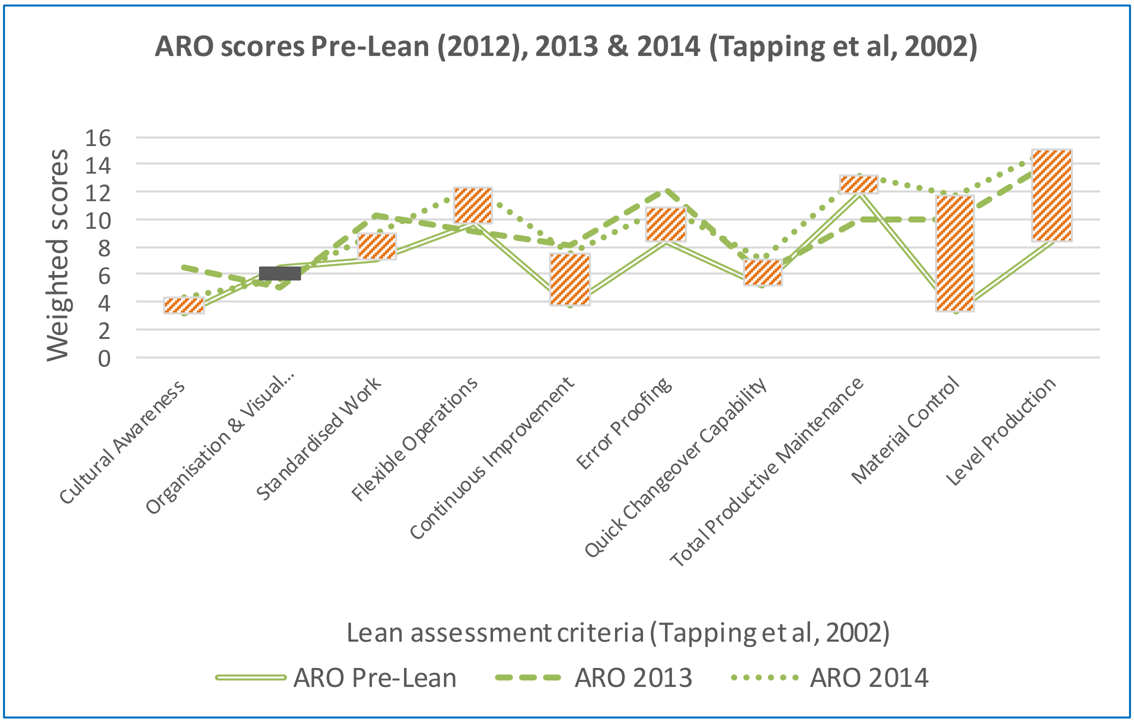



FIGURE 4-6: ARO WEIGHTED LONGITUDINAL LEAN ASSESSMENT IN 2012, 2013 AND 2014.

### *4.5.6.2. ARO Improvement meetings, interviews and knowledge data*

During the period from January 2013 to August 2014, a total of 27 visits were recorded. Visits included the technical manager and the individual orchard managers, improvement meetings (figure 4-7) and several site visits. Notes were kept by the researcher from these meetings and interviews. These notes were generally transcribed in situ as a combination of descriptive and verbatim records. The next section describes the outcomes of interventions as well as conceptualisation of some new approaches.

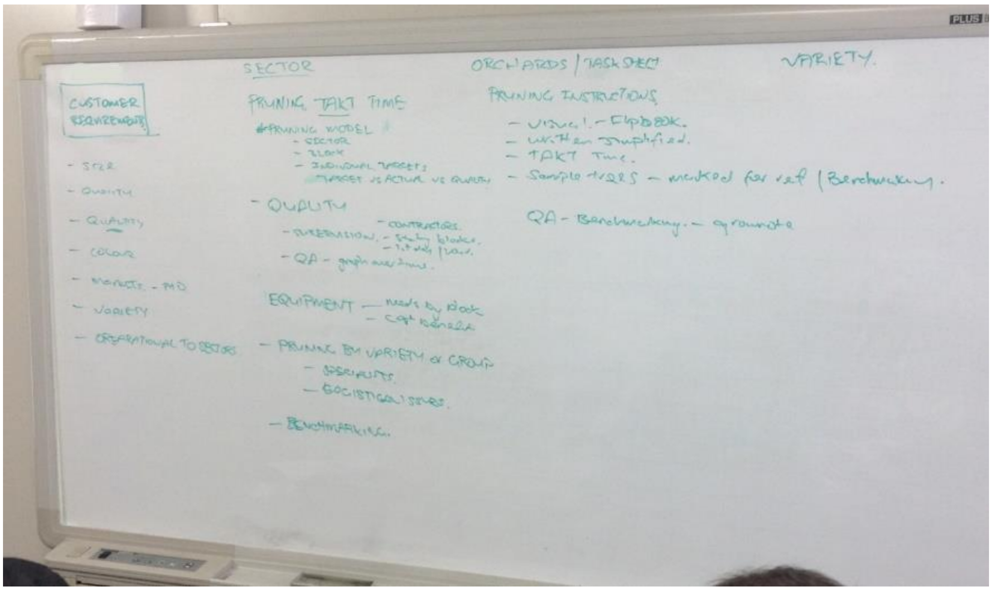



FIGURE 4-7: ARO GROUP WORK ON TRANSLATING LEAN CONCEPTS INTO GROWING PRACTICE.

Improvements included improvement and standardisation of the pruning process with a procedural and visual manual being developed, a sample of which can be found as appendix 11. Similarly, the combined orchard managers developed a thinning procedure which was tested and standardised, followed by a spraying procedure and a procedure to deal with diseased trees on-orchard. The orchards also developed a simple and easy way to size fruit on-orchard during harvest and provided this information to the packhouse during weekly harvest meetings. This allowed the packhouse to plan packing runs based on size, both more effective at filling customer orders and reducing the number of required change-overs significantly. This value stream alignment was not specifically designed as a value stream process, but the orchard managers understood the reduction of packhouse waste that was generated by the new approach.

#### *4.5.6.3. Coding and categorising ARO data*

All records from meetings and interviews were coded manually, using key words that linked to Lean, were repetitive or appeared significant. After the coding, the individual codes were tabulated and key themes emerged. A number of codes were associated with applicability of Lean, while another group of codes was associated with implementation of Lean. A third group of codes was more related to industry issues and the inquiry itself. Consequently, the researcher decided to group the codes in three groups of categories:

1. Applicability group, aiming to support the third objective and possibly complementing the second objective;
2. Implementation group, aiming to support the third objective;
3. Other key elements group that was formed inductively and sorted iteratively.

After the records of meetings and interviews had been coded and keywords identified, the keywords were then grouped to the three groups in table 4-11.

TABLE 4-11: KEYWORD GROUPS ESTABLISHED TO ASSIST ANALYSIS

| | A: Lean elements to triangulate with applicability using Tapping et al (2002) | I: Lean elements to triangulate with implementation | O: Other elements |
|---|---|---|---|
| 1 | Cultural Awareness | Change | Finance, cost, budget |
| 2 | WP Organisation & Visual Management | Difficulty & Failure | Lean theory development |
| 3 | Standardised Work | Achievement | Complexity of the industry |
| 4 | Flexible Operations | Knowledge, Experience & Training | Measurement, Indicators |
| 5 | Continuous Improvement | Method (champion, consultant, researcher) | Competition |
| 6 | Error Proofing | Management, commitment | Customer |
| 7 | Quick Changeover Capability | People (staff) | Technology, mechanical failure |
| 8 | Total Productive Maintenance | Motivation | Operational issues |
| 9 | Material Control | Communication | Researcher, intervention |
| 10 | Level Production | Season, effect of | Undefined |

An example of the coding system is given in table 4-12. Names and identifying features have been removed from the recorded notes. Notes are from observations, interviews and meetings. Each number in the three right-hand columns corresponds with the identically numbered element in the keyword groups (table 4-11), where 'A' is applicability etc.

TABLE 4-12: SAMPLE OF RECORDS, ALLOCATED KEY WORDS OR CODES AND CATEGORISATION (ALL ACTION RESEARCH AND CASE STUDY SAMPLES)

| Recorded notes (sample) | Key words / Codes | 'A' | 'I' | 'O' |
|---|---|---|---|---|
| He describes a management area where Royal Gala (an apple variety) is retained for harvest management. This is done purely to even the flow for labour. | Flow of labour | 10 | | |
| One orchard manager mentions that they need to know the customer requirements in June, possibly in May. All agree!! It is then proposed that the customer is the exporter; that the exporter is the link between the final customer and the grower. So they are going to consider the exporter to be the customer. They need to know variety, size, colour, quality and market status at the time of pruning, in June. | Customer value, integration of information, complexity, value stream | 1 | | 3, 6 |
| They come with a suggestion to use new bins for sensitive varieties because there is less chance of damaging the apples in a new bin. | | 8 | | |
| Over the next few weeks, orchards are very busy with harvest. The question is how much time there will be for any improvement trials. | Overburdening implementation difficulty | 10 | 2 | |
| They have thought of a simple idea, i.e. clipboards that can be hung from a bin in the coolstore. Right now they staple information sheets to the front bin, but every time there is a movement of bins, they have to remove the sheet and staple it to the next front bin. Clipboards that can be hung will make this process much quicker. One of the problems they are having is that (because of the extra effort required), the forklift drivers are not keeping the sheets up to day which then makes it harder to find bins in a coolstore where regular movements are required. | Visual management, improvement | 2, 5 | | |
| This year has been fantastic in terms of locating bins. Last year we lost between 300 to 400 bins. We don't hear any more that we have lost bins. We have improved our process and this year, I have only heard it once that they could not find bins. | improvement, lost bins | 5 | | |
| We have learned a lot about how to operate our plant e.g. Kanban has been very successful. It has made ordering easy and is visual. | Kanban, knowledge increase, visual | 9, 2 | 4 | |

| | | | | |
|---|---|---|---|---|
| Not much waiting at the moment. It is not as bad as it was so has improved. They improved their line changes from say 5 minutes to 1 minute. Exporter changes used to be 10 or 15 minutes and are now 5 minutes. The operator broadcasts the times of line changes. | Quick change-over, waste reduction | 7 | | |
| Now that they are doing preventative maintenance, they have found out that they are lacking a lot of information because they relied on people's memories. Now they are recording the maintenance they do. The recording is an extra effort because they have to go and wash their hands before recording and that is an extra effort. | TPM, standardising | 3, 8 | | |

Applicability Group: The ARO showed the following graph (figure 4-8) for the applicability group:

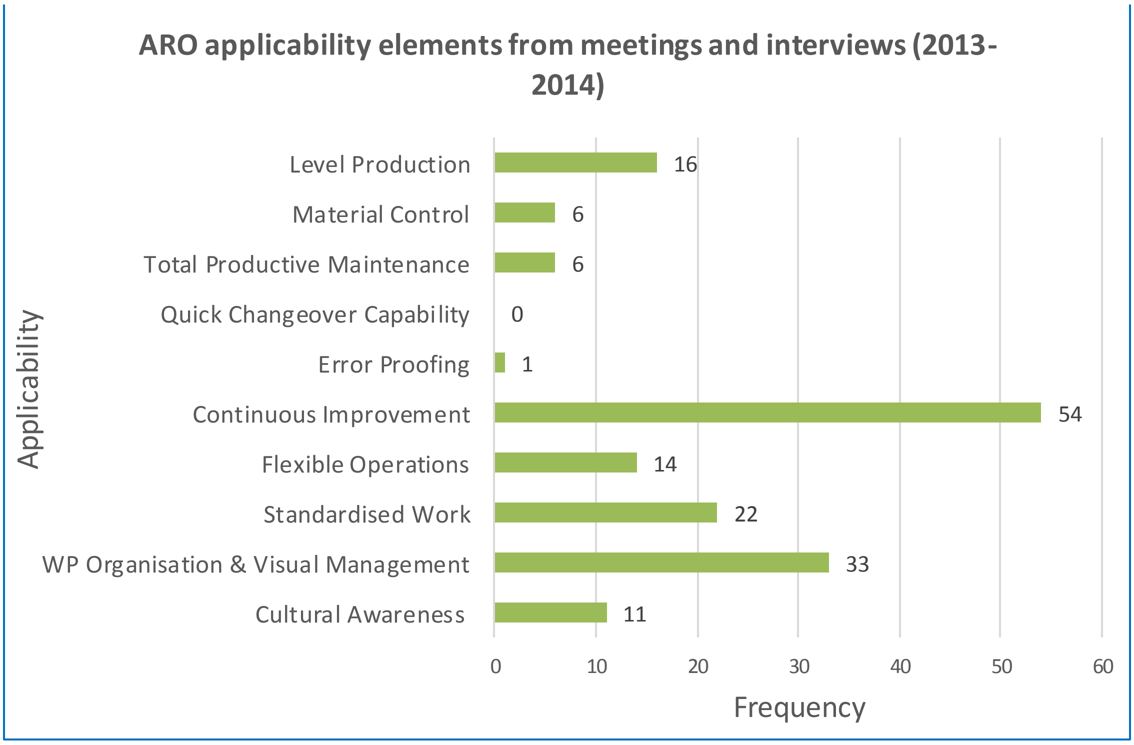



FIGURE 4-8: ARO LEAN APPLICABILITY ELEMENTS FROM MEETINGS AND INTERVIEWS (2013-2014).

The ARO showed a significant focus on improvement and workplace organisation. The majority of workplace organisation scores related to 5-S items, particularly visual management and developing procedures. The procedures were then standardised, creating a relevantly high score. The level production score was relatively high because all comments relating to load-levelling were scored under this item. The ARO was very aware of distributing and evening the load throughout its processes, particularly harvesting.

The applicability group showed that Lean can be ‘fitted’ into an orchard situation. During the inquiry period, managers tended to focus on certain aspects of Lean with relative success.

Implementation group: In terms of implementation, the ARO generated the following graph (figure 4-9):

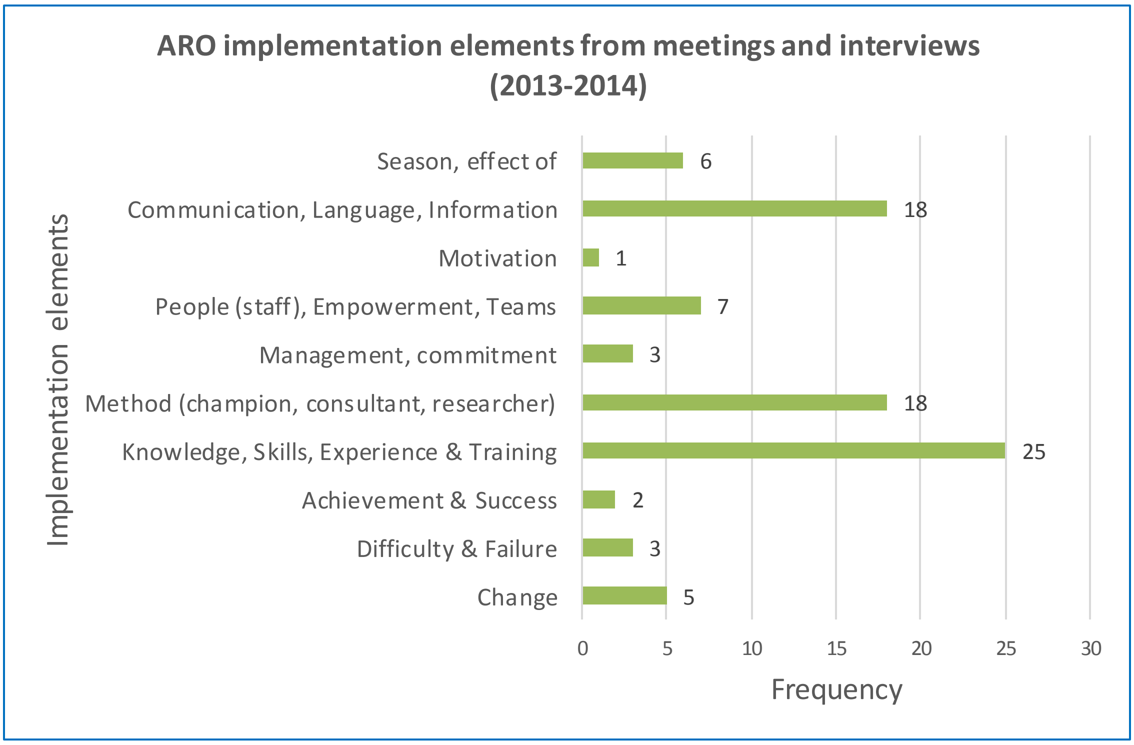



FIGURE 4-9: ARO LEAN IMPLEMENTATION ELEMENTS (2013-2014).

Data in figure 4-9 are interpreted as follows:

The knowledge, skills, experience and training element received considerable attention. Training was the single most relevant discussed and implemented subject within this category. A short excerpt of a meeting with orchard managers follows as an example:

> *‘We talk about involving permanent staff and how it is more difficult to involve the lower level and seasonal staff (requires training).’*

The method and communication elements scored relevantly high during meetings and interviews. Method related scores related to how implementation could be achieved, while communications related scores related to actual information flow between grower, packer and exporter, use of information software and geographical separation of the orchards. 'Season' was scored six times, all in relation to the difficulties caused by seasonality of the industry. 'Difficulty & Failure' was scored at times when the orchard managers did not manage to implement what was discussed, while 'Achievement and Success' was scored when there was a significant achievement. Improvements were generally scored under the 'applicability' group to indicate that methods or tools were considered or worked.

The implementation group showed that Lean can be implemented in orchards and that training, communication and method appeared to get relatively high attention.

Other elements group: The 'other elements' group scored items that appeared to have some relevance for the inquiry (figure 4-10). The researcher intervention scored relatively high as training and ideas were scored each time as researcher intervention.

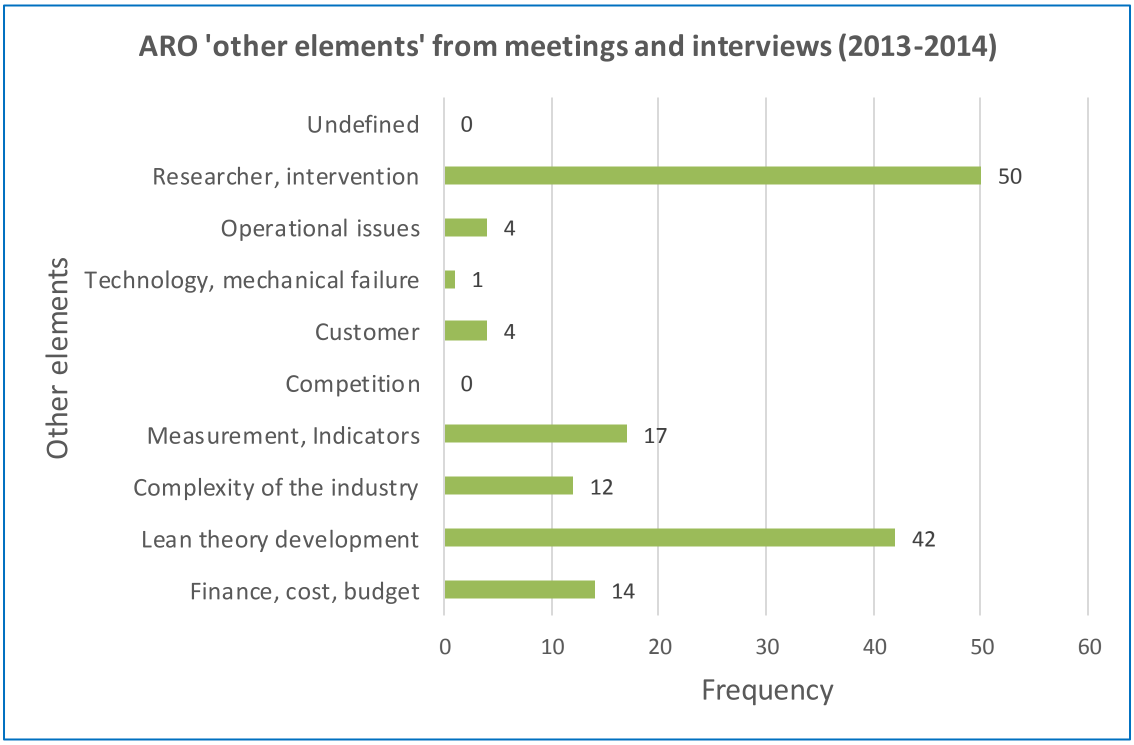



FIGURE 4-10: OTHER ELEMENTS CODING GROUP SCORES (2013-2014).

Of interest is the Lean theory development category that signifies that the ARO and researcher were attempting to develop Lean theory from the meetings and discussions around Lean in the orchard. These discussions merit a separate heading and are found in paragraph 4.6.2.5. Other categories such as finance, measurement and industry complexity returned regularly and play a role in any pipfruit business.

### 4.5.6.4. ARO observations

The general observations demonstrated that managers worked on improvement during the off-season but were absorbed almost entirely by the harvest season during which improvements were found difficult to implement. Several examples are presented:

One orchard manager observed that on half a dozen occasions each year, tractors needed to fill up diesel only to find out that all four tanks on the orchard were empty, leading to significant delays in harvesting and a lot of frustration. Having discussed this with his staff, they came up with a simple system to show the status of the tank and which tank should be used for refuelling (figure 4-11). Although nothing special, without the Lean implementation efforts, the system would have remained unchanged. It is noteworthy that one of the supervisors for this thesis asked what the colours meant. Having passed this on to the orchard manager, he replied *"I understand what you mean. To improve it further a key would be a great idea. It's all about constant improvement."*


FIGURE 4-11: THE INFLUENCE OF LEAN - A SIMPLE MONITORING SYSTEM AVOIDING WASTE.

Another orchard manager had an attachment built for his on-orchard forklift to unload bins of trucks twice as fast. In his estimation, the time saving is around 65% (figure 4-12). A third orchard manager painted all the metal hooks that hold down reflecting cloth with a highlighting colour to avoid tractors driving over them and getting flat tyres, a regular occurrence in the orchard.

FIGURE 4-12: FORKLIFT EXTENSION, LOW COST AND SAVING SUBSTANTIAL TIME.

On a larger scale, after discussing customer value and the concept of waste in natural inputs (a new concept), the ARO ordered a substantial volume of reflective cloth as reflective cloth assists with colour development of fruit and therefore improves customer value. Similarly, after discussing the waste created by dead trees (also part of the new concept), the ARO started a substantial replanting programme and managers were targeting replacement of dead and non-performing trees in order to avoid wasted movement, chemicals and orchard floor (i.e. orchard floor not used for production when it should be used for production).

#### *4.5.6.5. Conceptualisation of new approaches by ARO*

During discussions with the orchard managers, the researcher introduced elements of Lean principles, methods and tools and asked how these might be interpreted in a horticultural context, specifically pipfruit. As Lean was developed for a manufacturing environment, the orchard was compared with a factory; the tree was consequently compared with a machine that manufactured a product albeit that the inputs were not completely manipulated by design. This led to the adoption of the term 'Total Productive Tree Maintenance' (TPTM, figure 4-13). The essential natural requirements for fruit production are well known and were identified. The managers were challenged to think to what degree these natural elements could be managed and if any use of these was not optimised. Waste was therefore discussed in the traditional sense but also related to wasted sunlight, water, 'real estate' and soil (figure 4-13).

Managers were already aware of new high-density growing methods that increased production per hectare. Managers also discussed the waste element of having a dead or low production tree in a row of productive trees (figure 4-14). Every single pass while pruning, thinning, spraying and harvesting was potentially a form of waste. This related to the use of the 'real estate' and to wasted motion, chemicals, irrigation, sunlight and more.

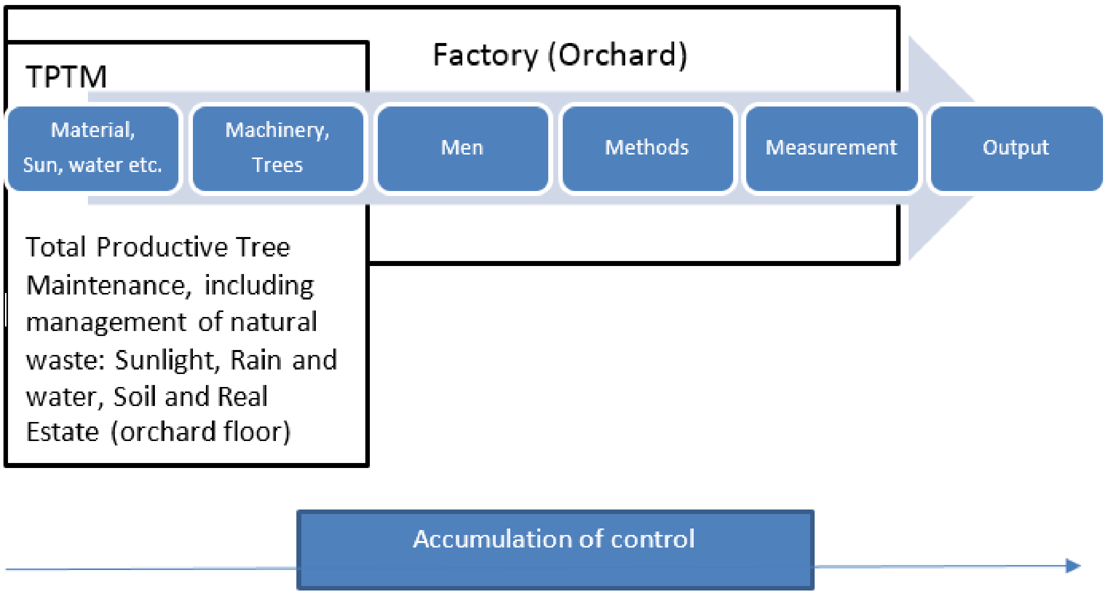



FIGURE 4-13: THE ORCHARD AS A FACTORY WITH MACHINES (TREES) REQUIRING MAINTENANCE.

Managers already used a tool to increase the sunlight reflection but only to increase colour; they started discussing the use of reflecting cloth to increase production. Irrigation, drainage and soil nutrients had long been discussion points but were now seen from a waste perspective. The concept of Total Productive Tree Maintenance (TPTM) started to take shape. This discussion showed the beginnings of original thinking but the period of the inquiry was not long enough to make measurable progress of any significance along these lines.

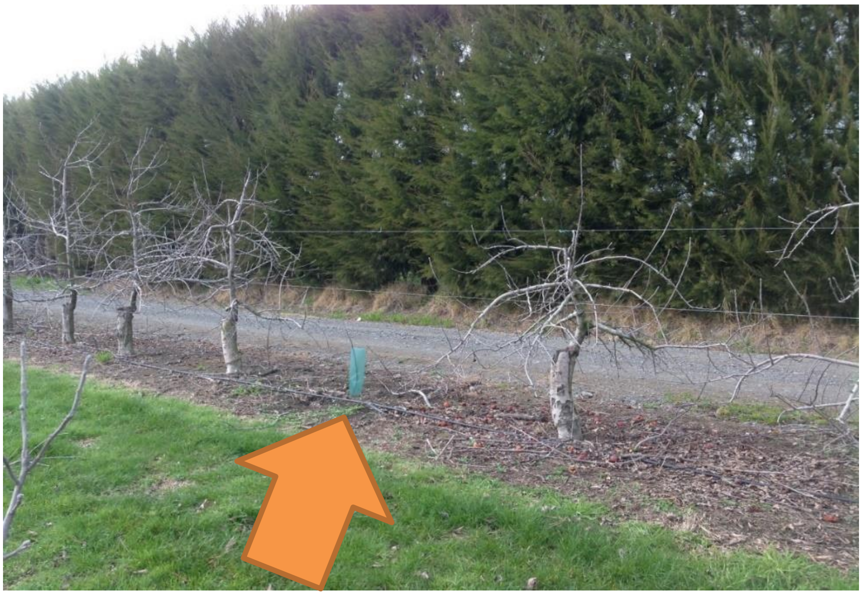


FIGURE 4-14: ARO SHOWING DEAD TREES AS LEAN WASTE THAT MUST BE CORRECTED.

#### *4.5.6.6. ARO Lean audit*

During the second year of the inquiry, the technical manager and the researcher discussed the opportunity of creating a Lean audit to help orchard managers assess their development. The researcher then developed a Lean orchard audit instrument, based on well accepted audit formats commonly known to the industry such as BRC (British Retail Consortium) and GlobalGAP, and adapting ideas from the measurement instruments from the literature review such as Tapping et al (2002).

TABLE 4-13: LEAN ORCHARD AUDIT SCORING CRITERIA.

| **2** | **Visual Performance Measurement** | **Score** | ***Scores to be used:***<br>*Not present anywhere: 0*<br>*Found in some areas or sometimes (<25%): 1*<br>*Commonly found but not embedded (<60%): 2*<br>*Typically used with some exceptions (<85%): 3*<br>*Found everywhere, always with no exceptions (100%): 4* |
|---|---|---|---|
| 1 | The orchard has a system that monitors, measures and records Lean performance criteria and makes these visible to orchard staff. | | Observation, documented, recorded, other evidence (circle) |
| | ***Reason for score:*** | | |

Important was the inclusion of some newly developed ideas such as orchard and tree maintenance which are new to Lean measurement. 20 Elements, each with between one and six criteria were formulated using standard Lean terminology from the literature review and new elements. Each criterion was scored ranging from 0 to 4 as in table 4-13. Criteria were weighted for relevance and the degree of manager influence by both the technical manager and the researcher independently, and the average weight was used for the audit criteria weights. Weights assessed between orchard manager and researcher were almost identical. Weights varied between 1.3 and 1.5. The instrument was then tested towards the end of the inquiry. A sample of the Lean orchard audit, the audit categories and the audit report is attached as appendix 12.

TABLE 4-14: RESULT OF INITIAL LEAN ORCHARD AUDIT (FIRST DRAFT).

| | Audit criteria | Orchard 1 | Orchard 2 | Orchard 3 | Orchard 4 | Orchard 5 | Orchard 6 | Mean score |
|---|---|---|---|---|---|---|---|---|
| 1 | Visual Management | 13.28 | 16.23 | 8.85 | 17.70 | 10.33 | 11.80 | 13.03 |
| 2 | Visual Performance Measurement | 1.50 | 0.00 | 0.00 | 3.00 | 3.00 | 6.00 | 2.25 |
| 3 | Workplace Organisation (Sort, Straighten, Shine) | 13.28 | 13.28 | 2.95 | 14.75 | 8.85 | 7.38 | 10.08 |
| 4 | Standardising Work | 4.43 | 5.90 | 2.95 | 5.90 | 7.38 | 11.80 | 6.39 |
| 5 | Orchard Lay-out | 2.60 | 1.30 | 1.30 | 1.30 | 0.00 | 1.30 | 1.30 |
| 6 | Improvement of the Lean Orchard Concept | 2.80 | 1.40 | 0.00 | 4.20 | 1.40 | 2.80 | 2.10 |
| 7 | Error Proofing (Preventing Human / Method Errors) | 10.50 | 6.00 | 1.50 | 12.00 | 3.00 | 1.50 | 5.75 |
| 8 | Quick Change-over (Quick Set-up) | 20.63 | 20.63 | 20.63 | 20.63 | 20.63 | 20.63 | 20.63 |
| 9 | Operational Flexibility (Process and Employee) | 16.50 | 16.50 | 16.50 | 16.50 | 16.50 | 16.50 | 16.50 |
| 10 | Orchard and orchards Team work | 8.85 | 7.38 | 4.43 | 11.80 | 8.85 | 11.80 | 8.85 |
| 11 | Total Productive Equipment Maintenance | 22.13 | 22.13 | 22.13 | 22.13 | 22.13 | 22.13 | 22.13 |
| 12 | Total Productive Tree Maintenance | 8.85 | 7.38 | 7.38 | 11.80 | 8.85 | 8.85 | 8.85 |
| 13 | Total Even Production Orchard | 8.55 | 7.13 | 7.13 | 8.55 | 7.13 | 8.55 | 7.84 |
| 14 | Production Information flow and accuracy | 13.05 | 13.05 | 13.05 | 13.05 | 13.05 | 13.05 | 13.05 |
| 15 | Pull Systems (Material and People) | 11.60 | 11.60 | 11.60 | 11.60 | 11.60 | 11.60 | 11.60 |
| 16 | Waste | 1.45 | 1.45 | 0.00 | 2.90 | 1.45 | 4.35 | 1.93 |
| 17 | Lean Disciplne | 4.50 | 1.50 | 0.00 | 6.00 | 3.00 | 3.00 | 3.00 |
| 18 | Continuous Improvement (Small, Regular, by all) | 9.00 | 4.50 | 0.00 | 16.50 | 7.50 | 12.00 | 8.25 |
| 19 | Work-Culture Awareness (Customer Focus-Awareness) | 4.28 | 2.85 | 4.28 | 4.28 | 4.28 | 14.25 | 5.70 |
| 20 | Management Support | 4.35 | 1.45 | 1.45 | 4.35 | 4.35 | 4.35 | 3.38 |
| | | **182.10** | **161.63** | **126.10** | **208.93** | **163.25** | **193.63** | 172.60 |

Table 4-14 summarises the first draft audit results. With a maximum raw score of 276 and a maximum weighted score of 395.7, the achieved scores showed a distinct level of Lean deployment. Interestingly, the scores can also be used as benchmarks for future development. The total score for the combination of all highest measured (weighted) scores (combining the highest score by any orchard in any of the audit criteria) was 230.55.

The Lean orchard audit instrument was analysed after the conclusion of the field work period and it is the intention of the orchard group to simplify the instrument and make it easier to understand and implement to guarantee its future value to the orchard group, however this could not be accomplished during the course of this inquiry.

#### *4.5.6.7. ARO, a final orchard manager questionnaire*

At the end of the inquiry, a final questionnaire was answered by orchard managers to relay their experience and thoughts about the implementation of Lean in their field. Orchard managers answered free-text questions about their experiences and indicated on a 5 point Likert scale (table 4-15) to what degree they found a number of Lean elements suitable and implementable in an orchard environment.

Key findings of the final survey of orchard managers were:

1. Orchard managers believed that there was a definite place for Lean on orchards.
2. The greatest benefits were found in tidiness, error proofing and waste reduction, as well as team culture through a focus that everyone can help to improve.
3. The greatest downfalls were believed to be the seasonal staff and general buy-in but also trying to fit Lean principles that do not fit.
4. Orchard managers generally experienced the action research period as 'pretty good', with some struggles as well as benefits.
5. Orchard managers believed that it might take between a few years and a number of years to achieve the 85% audit mark. A comment was made that Lean had to be embedded before getting some traction.
6. The seasonality of the industry plays a significant role; some indicated that this can be mitigated or is sometimes used as an excuse.
7. The orchard managers agreed with the new interpretations of Lean for the orchards. They believed that Lean had offered a different perspective to help improve their operations.
8. The audit was found to be too long and in need of simplification but orchard managers also decided that the instrument could be developed further.

TABLE 4-15: ARO - APPLICABILITY AND IMPLEMENTABILITY SCORES.

| Applicability score: | Implementability score: |
|---|---|
| 0 – Not suitable | 0 – Cannot be implemented |
| 1 – Marginally suitable | 1 – Difficult to implement |
| 2 – Reasonably suitable | 2 – Reasonably implementable |
| 3 – Very suitable | 3 – Relatively easy to implement |
| 4 – 100% Suitable | 4 – Extremely easy to implement |

The results of the final questionnaire are listed in figure 4-15.

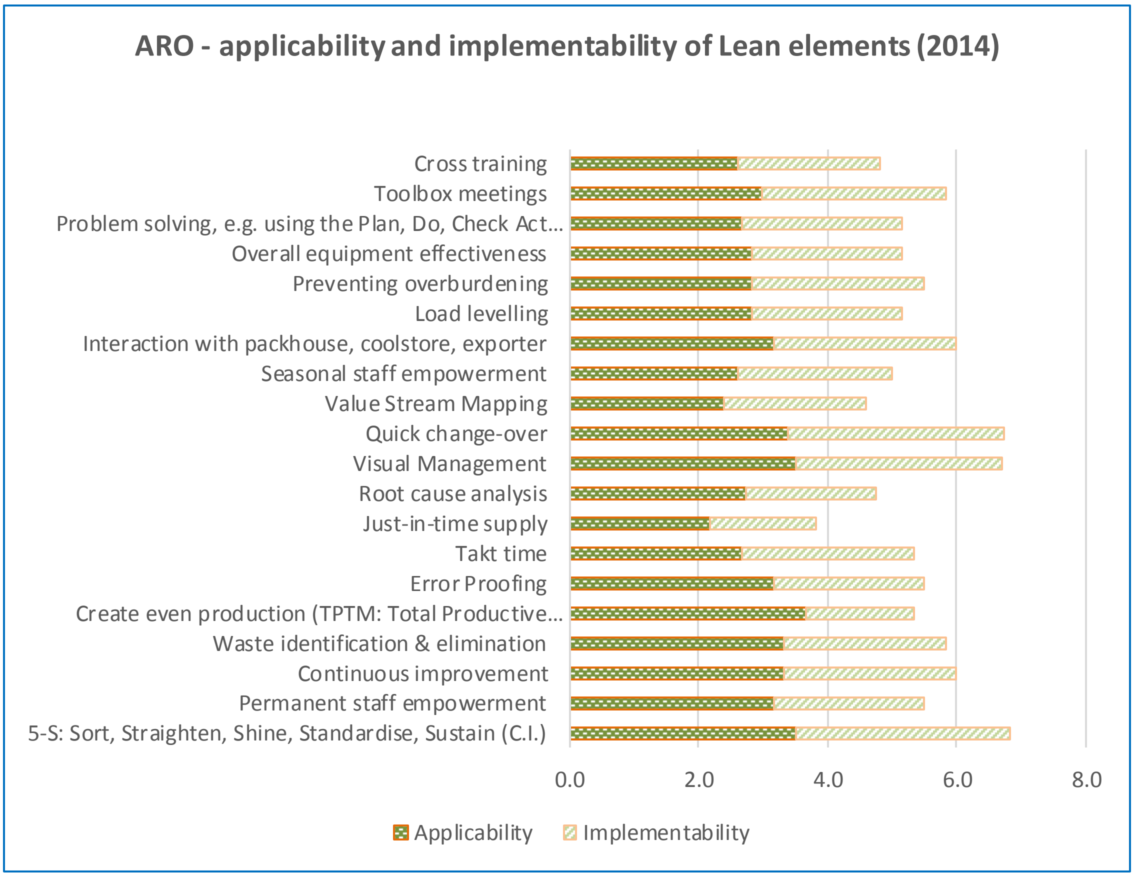



FIGURE 4-15: ARO – ORCHARD MANAGERS' SCORES FOR ON-ORCHARD APPLICABILITY AND IMPLEMENTABILITY OF LEAN ELEMENTS (2014).

### *4.5.6.8. ARO conclusion*

All indicators point towards a positive Lean deployment during these early stages of implementation. Sustainability of results was not assessed. Results are further discussed in chapter 5, 'Analysis and discussion'. These findings support the third objective, 'Analyse the applicability and any implementation approaches of the Lean philosophy, methods and tools within the NZ pipfruit industry'. The conceptualisation of TPTM may assist with the development of a Lean model for the industry, the fourth objective. Similarly, the development of a Lean orchard audit instrument may be helpful to assist orchard managers with Lean implementation in the future.

## 4.5.7. Action research packhouse

### *4.5.7.1. Action Research Packhouse (ARP) progress measurement*

Similar to the action research orchards, the action research packhouse was assessed using the 20 Kobayashi keys, 20 common Lean principles, methods and tools and Tapping et al (2002) Lean assessment. Results are presented in figures 4-16, 4-17 and 4-18 respectively.

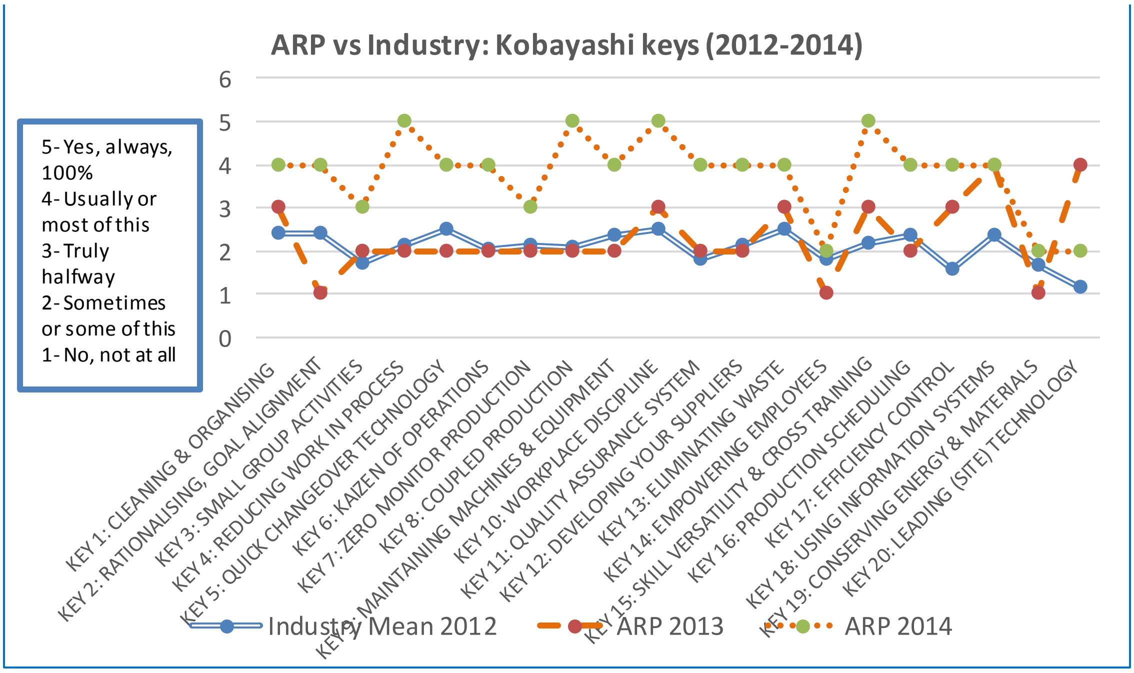



FIGURE 4-16: KOBAYASHI KEYS: COMPARISON BETWEEN INDUSTRY AND ACTION RESEARCH PACKHOUSE PROGRESS (2012-2014).

The action research packhouse (ARP) demonstrated an improved level of Kobayashi best practices, particularly after the second packing season (figure 4-16). The ARP also demonstrated an increased knowledge and use of the common Lean principles, methods and tools in relation to the wider industry surveyed one and two years earlier (figure 4-17). Progressing through the inquiry, the ARP demonstrated similar progress on the Tapping et al (2002) instrument (figure 4-18).

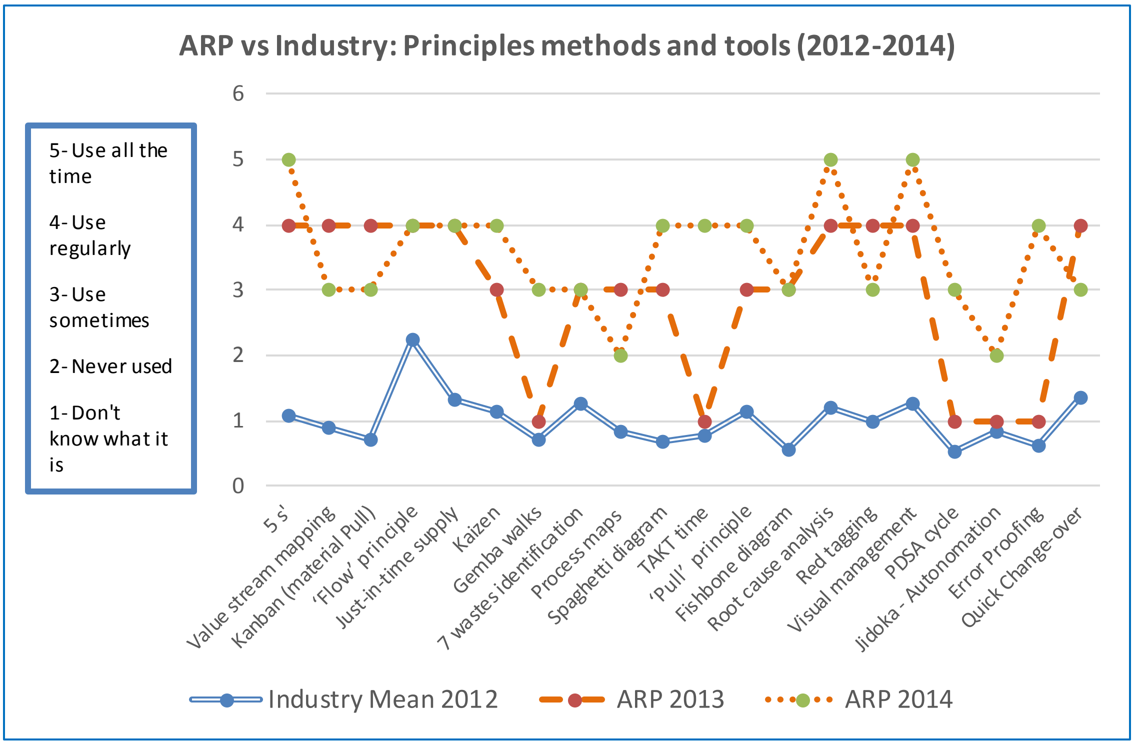



FIGURE 4-17: ARP KNOWLEDGE AND USE OF LEAN PRINCIPLES, METHODS & TOOLS (2012-2014).

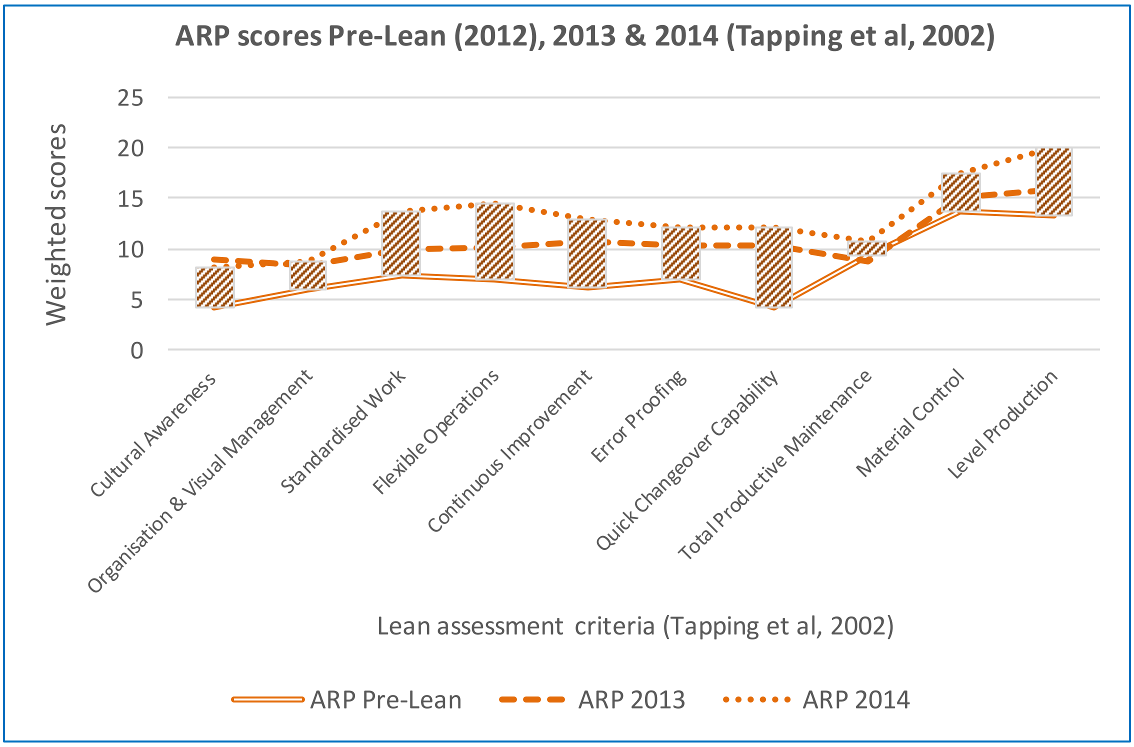



FIGURE 4-18: ARP WEIGHTED LONGITUDINAL LEAN ASSESSMENT IN 2012, 2013 AND 2014.

#### *4.5.7.2. ARP Improvement meetings, interviews and knowledge data*

Thirty-two action research visits to the packhouse took place between February 2013 and August 2014. Visits included meetings with management, supervisors and workers as well as regular observations. Visit notes were transcribed in situ as a combination of descriptive and where relevant, verbatim records. On several occasions, planned visits did not proceed due to seasonal pressures on the organisation. The ARP had little knowledge and understanding of Lean and consequently sessions would regularly include explanations of Lean principles and methods, often followed by a discussion on how this might apply to a packhouse/coolstore organisation.

The researcher tried to maintain a cycle of discussing an issue, challenging for and contributing to solutions, implementing these and then reflecting on the result. Several iterative cycles were completed, relating to the implementation selection by the ARP staff. Iterative cycles related to identifying waste in the process (e.g. appendix 16), identifying value adding activities, implementing improvements and reflecting on their effectiveness.

Interview and meeting notes were coded, categorised and grouped as before, resulting in the following three graphs (figures 4-19, 4-20 and 4-21 respectively). An example of coding of action research and case study research organisations was presented in table 4-12.

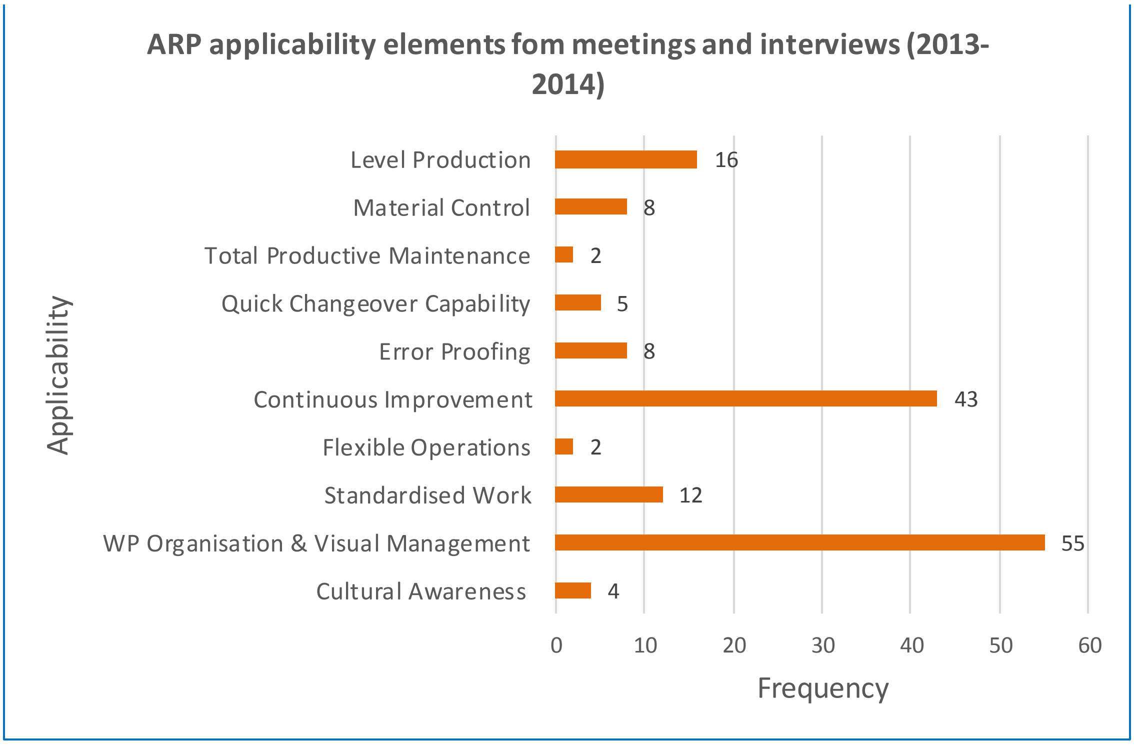



FIGURE 4-19: ARP APPLICABILITY CODES AND RESULTS (2013-2014).

The ARP generally found workplace organisation easy to implement and it was the Lean element most discussed, followed by discussions of continuous improvement (figure 4-19). Level production is emphasised because all load-levelling is scored under level production. Other elements appear to have low focus. TPM and flexible operations appear of low relevance to the organisation.

Implementation elements (Figure 4-20) showed that knowledge, skills, experience & training was an item of relative interest, followed by communication and information. The effect of the season is also worth mentioning. Interest in failure appeared more frequent than interest in achievement.

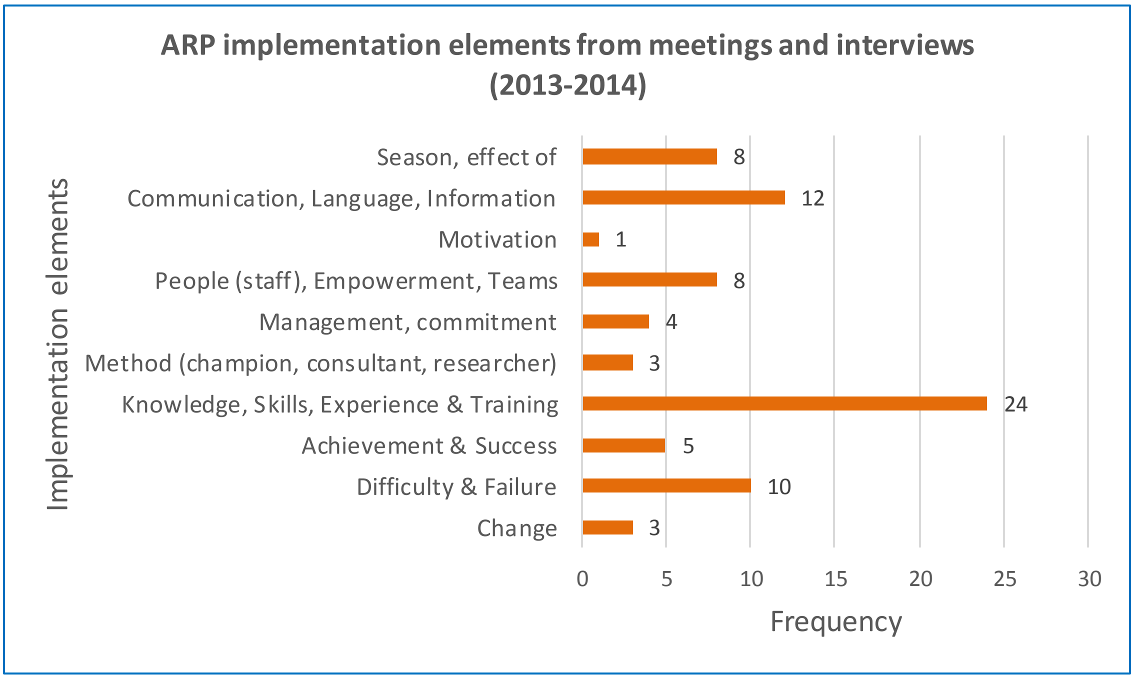



FIGURE 4-20: ARP IMPLEMENTATION CODES AND RESULTS (2013-2014).

Of the other elements (figure 4-21), it appears that operational issues were discussed or attributed regularly while researcher and intervention featured regularly as one can expect during action research. Industry complexity also featured while no Lean theory development took place.

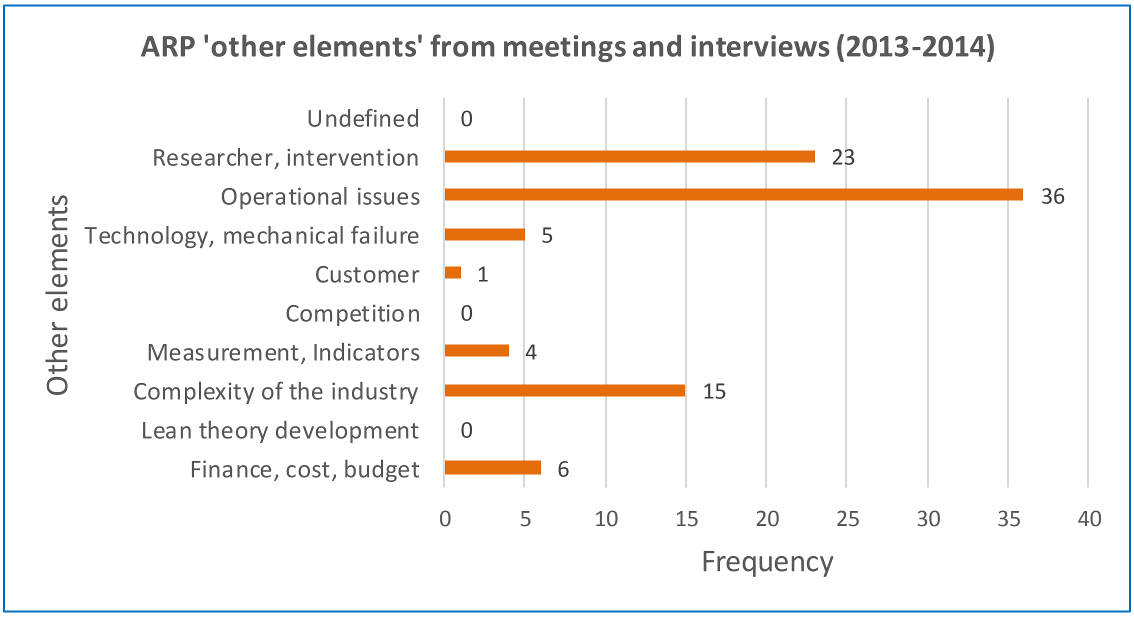



FIGURE 4-21: ARP 'OTHER ELEMENTS' AS THEY FEATURED IN INTERVIEWS AND MEETINGS (2013-2014).

### 4.5.7.3. ARP observations

The next section describes the outcomes of some of the interventions.

A number of improvements were made during the research period. These were mostly related to the tools and techniques available. Although management started to understand intellectually what Lean entailed, the organisation was very much dependent on external suppliers and decision makers and found it difficult to adopt a complete Lean philosophy. This was reinforced by the fact that during the off-season, less than a handful of people would be involved with maintenance.

FIGURE 4-22: ARP INSTALLATION OF TRAFFIC LIGHT SYSTEM TO CORRECT GRADING.

Improvements included the direct feedback to the organisation's graders about the quality of the graded fruit by means of a traffic light system (figure 4-22). This was reinforced by a visual display of the results of a day's work (Figure 4-23).

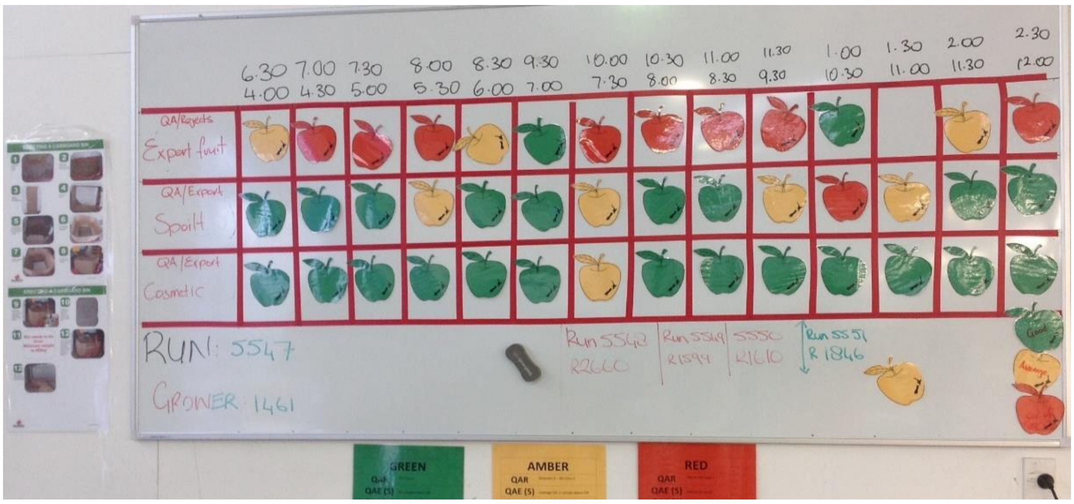



FIGURE 4-23: ARP VISUAL FOR GRADING FEEDBACK.

At one of the very first meetings, the researcher witnessed a production delay because the operator could not get the equipment started due to the fact that there was no standard operating procedure. Having discussed the incident, the team decided to work on simple visual start-up instructions that were attached to the wall in the right locations (figure 4-24).


FIGURE 4-24: DRAFT AND COMPLETED STANDARD PROCEDURE FOR FLUME FILLING.

A number of improvements, particularly in the 5-S area tidied the organisation up substantially while making work easier. Other improvements involved daily stand-up meetings. Although discussed several times, the organisation did not manage to introduce these successfully. The researcher then arranged a visit to a different Lean organisation to witness three 5 minute stand-up meetings at different levels after which the ARP successfully introduced their own version of this coordination and information tool.

The ARP produced an annual 'end-of-season report and reports from 2013 and 2014 consisted of reports from individual supervisors. A sample of comments concerning Lean are shown in table 4-16. The comments from supervisory staff and management show some positive experiences as well as the observation that the implementation could improve. Comments focussed mostly on the visual aids. Little was stated about improvements by the reporters themselves.

TABLE 4-16: SELECTED COMMENTS FROM ARP END-OF-SEASON REPORTS (SIC.).

| | |
|---|---|
| 1 | Lean: A great tool, we need to follow up and continue with this. Feedback has been positive. |
| 2 | We have put a number of new ideas into place over the season and have a lot to put in place over the off-season. |
| 3 | The lean initiative introduced during the season has already paid dividends with many small changes making things a lot easier. |
| 4 | Lean/Simple: Daily floor meetings were a great success, helped create a tighter supervisors team as well as disseminating information amongst themselves and then out to the wider team. |
| 5 | It could be an extension of the tool box meetings we have daily. It could also act as an extension of our Lean production board. |
| 6 | Lean management - Started with a hiss and a roar however it lost enthusiasm as the season progressed. I think more drive needs to come from management especially in regards to the boards and OFI's. Simple meetings were really effective and found them useful. |
| 7 | Lean: Toolbox meetings were good for all concerned, took approximately 5 minutes and everyone knew what was happening for the day |

#### *4.5.7.4. ARP conclusion*

For the action research packhouse, indicators point towards a positive Lean deployment during these early stages of implementation but the organisation appeared to be hamstrung by others in the value stream. Most Lean principles, methods and tools appear to find their place comfortably within a packhouse situation despite the season-forced build-up of stock that is partly pushed into market. Sustainability of results was not assessed. Results are further discussed in chapter 5, 'Analysis and discussion'. These findings support objective 3, 'Analyse the applicability and any implementation approaches of the Lean philosophy, methods and tools within the NZ pipfruit industry'.

### 4.5.8. Action Research Lean Pipfruit Cluster

#### *4.5.8.1. Formation of the Pipfruit Lean Cluster*

As a result of the researcher's investigation, the NZ pipfruit industry's governance body asked the researcher to co-ordinate a Lean pipfruit cluster in 2013. The cluster would consist of volunteer companies that would like to practice 'Lean'.

The industry approached a number of likely candidates and six companies joined the cluster of which some of the researcher's action research and case study companies. Potential members formed a steering group which created a programme based on the researcher's Lean Pipfruit Cluster summary (appendix 13). A meeting calendar was created aiming for 'on-the-job' sessions at each of the members' locations, focussing on different areas and sharing ideas (table 4-17).

TABLE 4-17: INITIAL LEAN PIPFRUIT CLUSTER CALENDAR.

| Date | Times | Weekday | Location | Who | Activity |
|---|---|---|---|---|---|
| 17-10-2013 | 8.30-10.00 AM | Thursday | Pipfruit NZ | Steering group | Setting up cluster |
| 25-10-2013 | 8.30-12.00 PM | Friday | Pipfruit NZ | Steering group | Finalizing cluster & 3 Lean indicators per operational area |
| 22-11-2013 | 8.30-12.00 PM | Friday | Company 1 | Orchard | What is Lean pruning |
| December | | | | | |
| 24-1-2014 | 8.30-12.00 PM | Friday | Company 2 | Orchard | What is Lean thinning |
| 21-2-2014 | 8.30-12.00 PM | Friday | Company 3 | Orchard | What is Lean harvesting |
| 21-3-2014 | 8.30-12.00 PM | Friday | Company 4 | Packhouse | Lean packing |
| 25-4-2014 | 8.30-12.00 PM | Friday | Company 5 | Coolstore | Lean coolstore |
| 23-5-2014 | 8.30-12.00 PM | Friday | Company 1 | Exporting | Lean exporting |
| 27-6-2014 | 8.30-12.00 PM | Friday | Company 2 | Packhouse | Lean visual management |
| 25-7-2014 | All day | Friday | To be seen | SG and interested | Field visit outside industry |
| 29-8-2014 | 8.30-12.00 PM | Friday | Company 3 | Orchard | Lean spraying |
| 26-9-2014 | 8.30-12.00 PM | Friday | Company 1 | Packhouse | Lean people |
| 31-10-2014 | 8.30-12.00 PM | Friday | Company 4 | Coolstore | Lean shipping |
| 28-11-2014 | 8.30-12.00 PM | Friday | Company 2 | Orchards | Lean pruning |
| December | | | | | |

The cluster would send operational people to each of the on-location meetings in order to learn how Lean could be implemented in practice. No single member proclaimed to be truly Lean. All understood that each on-site visit would show the area of interest 'warts-and-all'; where companies were underprepared, an opportunity existed to help by making suggestions.

#### *4.5.8.2. The Lean pipfruit cluster in operation*

At the time of the recording of this section of the thesis, the cluster has had five steering group meetings with the frequency of these meetings decreasing as the format became more established. The cluster had eight operational on-site meetings which were well attended by selected managers and operational staff. Feedback from attendants at the end of each visit is collated by the cluster co-ordinator (the researcher) and sent to all member companies to assist the iterative process. An example of feedback is attached as appendix 14. Some meetings were short (e.g. one hour) and to-the-point; others took several hours. Members are invited to make photographs and pick up ideas and use these in their own operations (refer figure 4-25). The researcher states here that this attitude is in stark contrast to the paranoia that had developed since the industry's deregulation in 2001; it is more in line with Toyota's philosophy and a promising attitude change for the industry's future.


FIGURE 4-25: LEAN PIPFRUIT CLUSTER COOLSTORE VISIT - STAND-UP MEETING BOARD.

### *4.5.8.3. Lean Pipfruit Cluster synopsis*

The Lean pipfruit cluster has been founded and meetings are organised and attended by appropriate staff from cluster members. Feedback from participants to cluster sessions indicates that they learn to interpret Lean from visits to other organisations (appendix 14). A summary of Lean pipfruit cluster observations by participants assists validating the third objective of this inquiry through complementary data (table 4-18).

TABLE 4-18: SUBJECTS OBSERVED DURING CLUSTER MEETING FEEDBACK

| Lean indicator | Visit 1 | Visit 2 | Visit 3 | Visit 4 | Visit 5 | Visit 6 | Visit 7 | Visit 8 |
|---|---|---|---|---|---|---|---|---|
| Long journey | | | | Yes | | | | |
| Reduced rework | | | | Yes | | | | |
| Visuals make things easy | | | Yes | Yes | Yes | Yes | | |
| Simple Kanban works | | | | Yes | | | Yes | |
| Stand-up meetings and visuals | | | Yes | | | Yes | | |
| No complacency for improvement | | | | Yes | | Yes | Yes | |
| Information to all workers | | Yes | | Yes | | | Yes | |
| Small things cause big downtimes | | | | Yes | | | | |
| Waste interpretation | | | Yes | | | Yes | | |
| Small things make a difference | | | | Yes | | | | |
| Staff participation; great culture | | | Yes | Yes | | | | |
| Buy-in from bottom | | | | Yes | | | | |
| Buy-in from top | | | | Yes | | | | |
| Crop load management | Yes | | | | | | | Yes |
| Exporter/customer | Yes | | | | | | | Yes |
| Thinning counts to achieve right size apples | Yes | | | | | | | Yes |
| Tagging non-productive trees | Yes | | | | | | | Yes |
| Importance of live data | | Yes | | | | Yes | | |
| 5S | | | Yes | Yes | | | Yes | |
| Quick change-over | | Yes | | Yes | | | Yes | |
| Maintenance | | | Yes | Yes | | | Yes | |

### 4.5.9. Action research summary results supporting objectives

Although the action research period covered only two seasons, most indicators point towards a positive Lean deployment during these early stages of implementation. Orchards developed new interpretations of Lean that are being tested; these are discussed in chapter 5, 'Analysis and discussion'. The action research packhouse had a similar result. Sustainability of both results was not assessed due to the relatively short inquiry period. The Lean pipfruit cluster has been founded and meetings are organised and attended by operational staff from cluster members. Feedback indicates that the cluster is considered valuable by its members.

These findings support objective 3, 'Analyse the applicability and any implementation approaches of the Lean philosophy, methods and tools within NZ pipfruit industry'. The results are considered useful in assisting with objective 4, 'Develop a conceptual Lean model for the NZ pipfruit industry and consider if the model is applicable to the wider horticultural sector'.

## 4.6. Findings from case studies and the third objective

This section reports on the findings from the two case studies (CS) packhouse organisations participating in the inquiry and the mini case studies of two exporters. The case study packhouse using a Lean champion is referred to as CSP, while the case study packhouse using a consultant is referred to as CSPC. The mini exporter case studies are limited by the restrictions imposed by the two exporters and are referred to as CSE1 and CSE2. Findings of the exporter mini case studies are derived from interviews and some observations.

### 4.6.1. Packhouse with Lean champion (CSP)

The CSP senior management had shown continued interest in developing staff and had hired a packhouse manager who had Lean experience from a different industry. Considerable empowerment was given to the packhouse manager and staff to improve packhouse setup, systems and processes. The case study covers a period of 2 packing seasons, essentially 1½ years. During this period, the packhouse was visited on a number of occasions and interviews were conducted in addition to evidence collected. Lean progress was measured pre-Lean, after one season and after the second season, using Kobayashi criteria, common Lean principles, methods and tools and a Tapping et al (2002) assessment.

#### *4.6.1.1. Case Study packhouse with Lean champion (CSP) progress measurement*

The case study packhouses were assessed using instruments identical to those used for the action research organisations—excluding the Lean cluster. Results are shown in figures 4-26, 4.27 and 4.28 respectively.

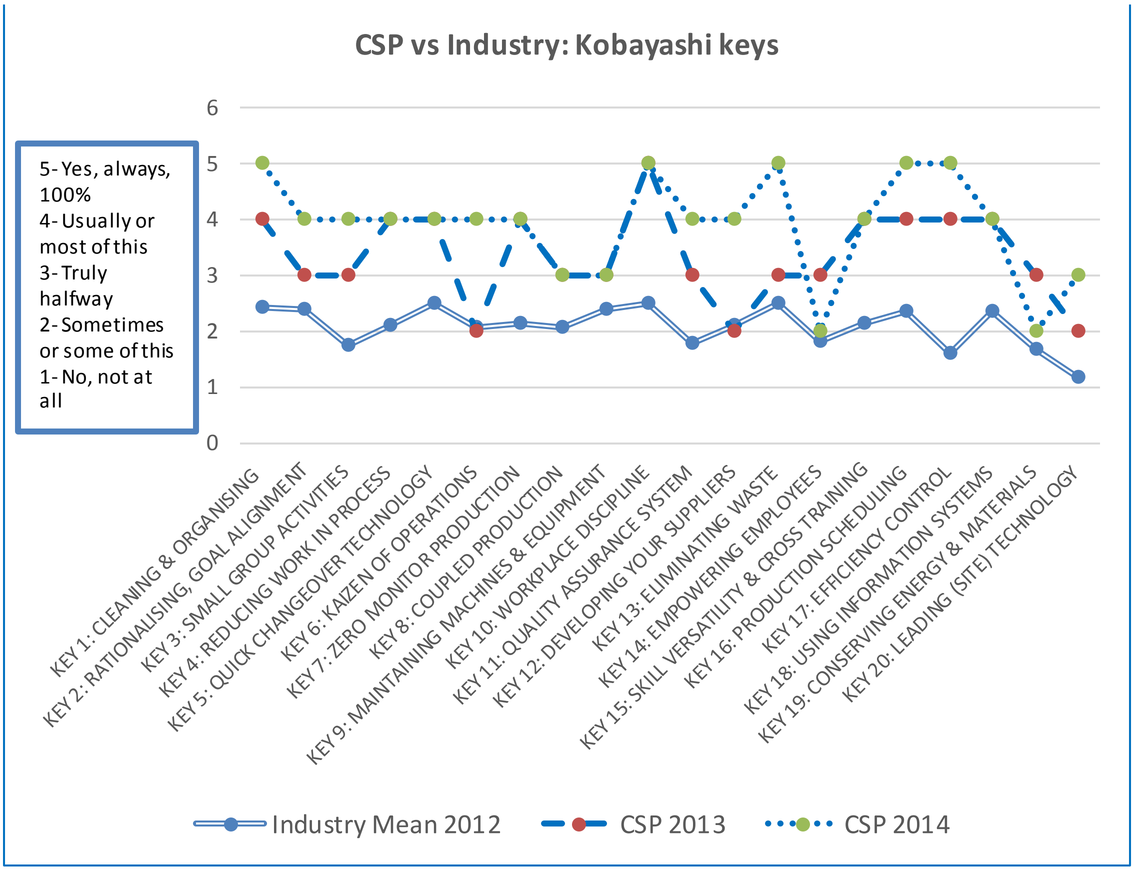



FIGURE 4-26: KOBAYASHI KEYS: COMPARISON BETWEEN INDUSTRY AND CSP PROGRESS.

The CSP made considerable progress over the research period measured by the Kobayashi keys as seen in figure 4-26.

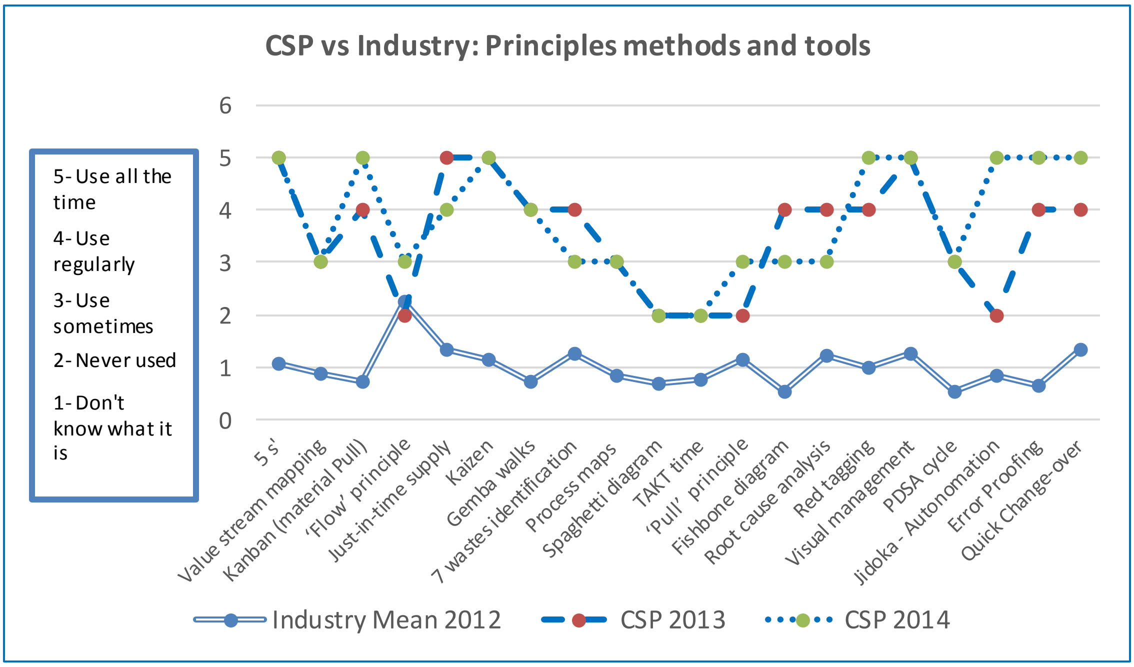



Figure 4-27: CSP KNOWLEDGE AND USE OF LEAN PRINCIPLES, METHODS & TOOLS.

Similarly, the CSP made considerable progress over the research period in the knowledge and use of Lean principles, methods and tools (figure 4-27). Similar to the ARO and ARP, progress was not consistent throughout the measured criteria. In several areas, the CSP scored lower at the end of the second season than it did at the end of the first season. Results showed significant progress at the end of the first season and generally showed continued —but to a lesser degree—progress at the end of the second season.

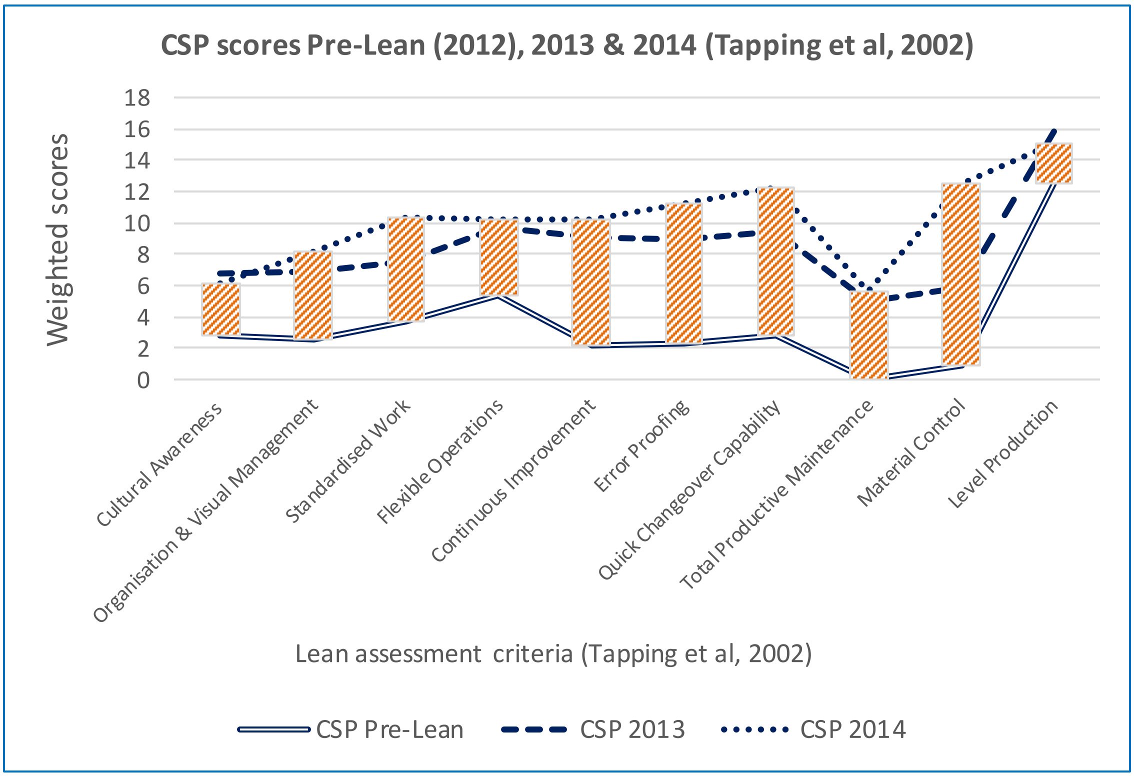



FIGURE 4-28: CSP WEIGHTED LONGITUDINAL LEAN ASSESSMENT IN 2012, 2013 AND 2014.

Progress was also measured with a pre-Lean assessment and an assessment after the 2013 and 2014 season using the Tapping et al (2002) instrument and results are presented in figure 4-28. Here too, results show significant improvement at the end of the first season and continued progress—but to a lesser degree— at the end of the second season.

#### *4.6.1.2. CSP Interviews, meetings and knowledge data*

The case study packhouse was visited 25 times, during which interviews meetings and observations were recorded. Interviews and records of meetings were transcribed in situ, both summarising information and recording verbatim where useful. Records were grouped in three groups of categories to sort transcriptions that assisted in determining the applicability and implementation of Lean in the pipfruit industry (objective three). Figures 4-29, 4-30, and 4-31 respectively show the coded and grouped results. The coverage of all ten applicability categories gives an indication of the applicability of those ten categories. The stand-out categories are continuous improvement and Workplace Organisation & Visual Management, indicating that these elements were foremost in the minds of the participants of all items in the applicability group.

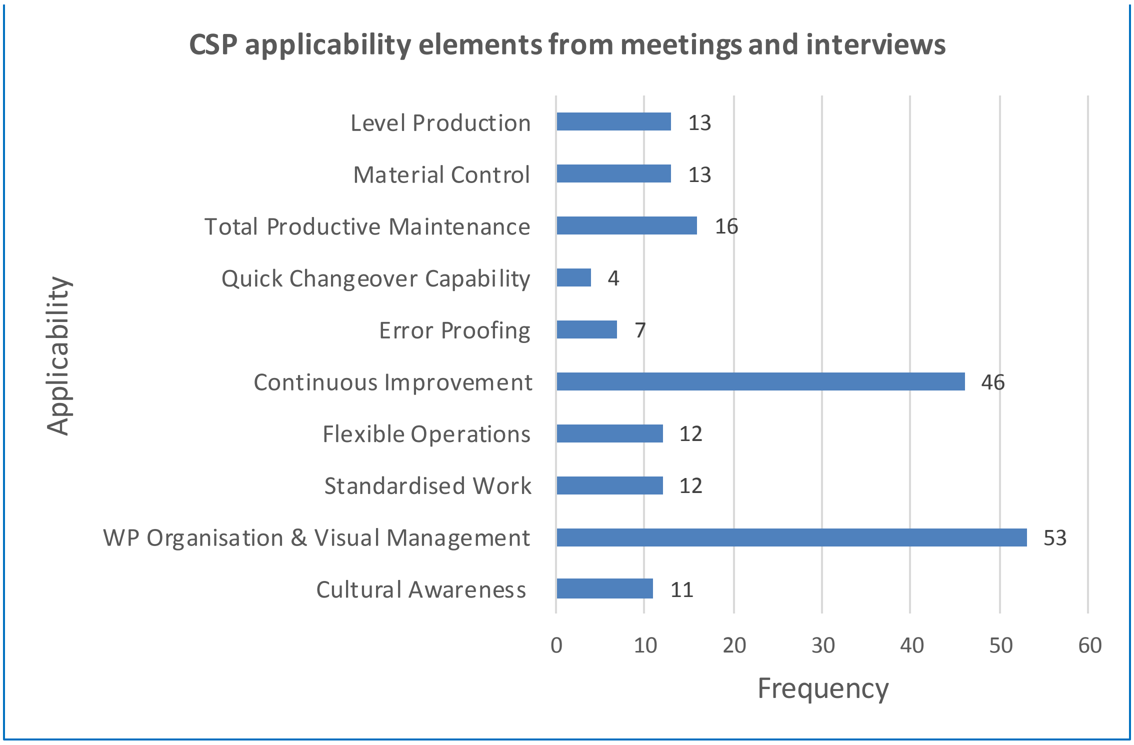



FIGURE 4-29: CSP APPLICABILITY CODE CATEGORIES AND RESULTS.

Results relating to the implementation of Lean are shown in figure 4-30. Results here indicate that people, empowerment and teamwork as well as knowledge, skills, experience and training were the most discussed subjects. Of the 'other elements', only the complexity of the industry stood out as a point of discussion.

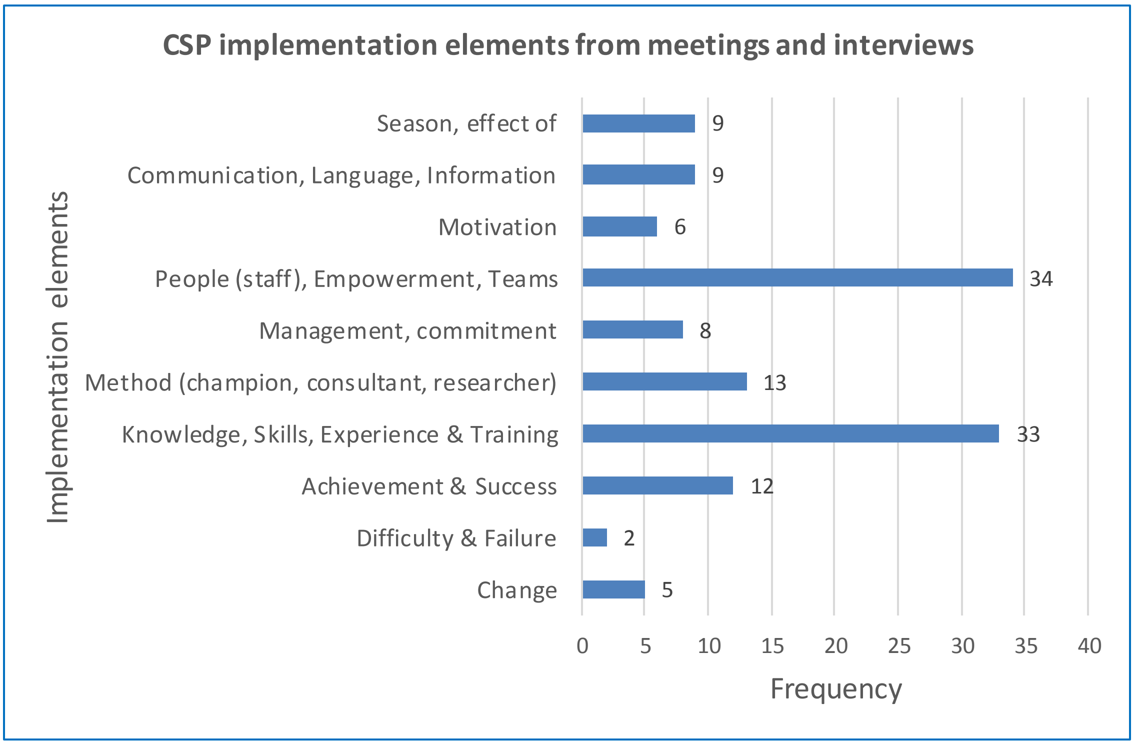



FIGURE 4-30: CSP IMPLEMENTATION CODE CATEGORIES AND RESULTS.

Results relating to other elements affecting Lean implementation are shown in figure 4-31.

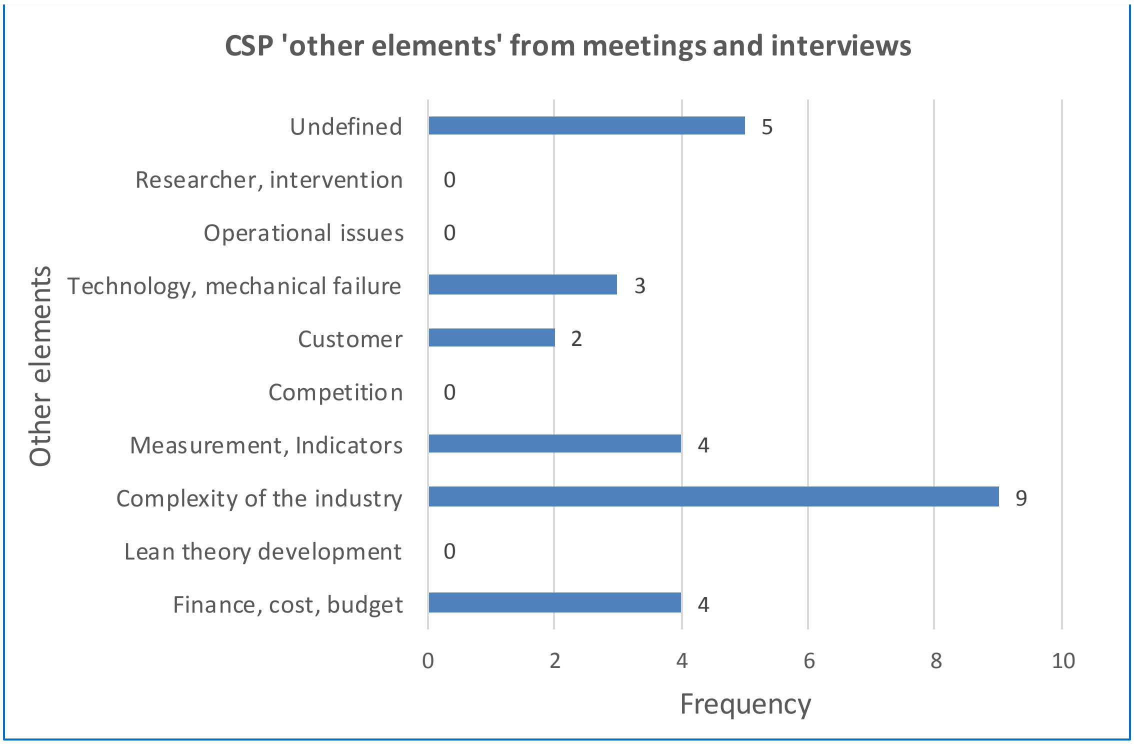



FIGURE 4-31: CSP OTHER ELEMENTS CODE CATEGORIES AND RESULTS.

### 4.6.1.3. CSP observations

The next section describes the outcomes of some of the interventions.

The CSP manager had a very good and practical understanding of Lean. The CSP business owners were very aware of the importance of ongoing training and progressing in terms of production and management models and invested time and money accordingly.

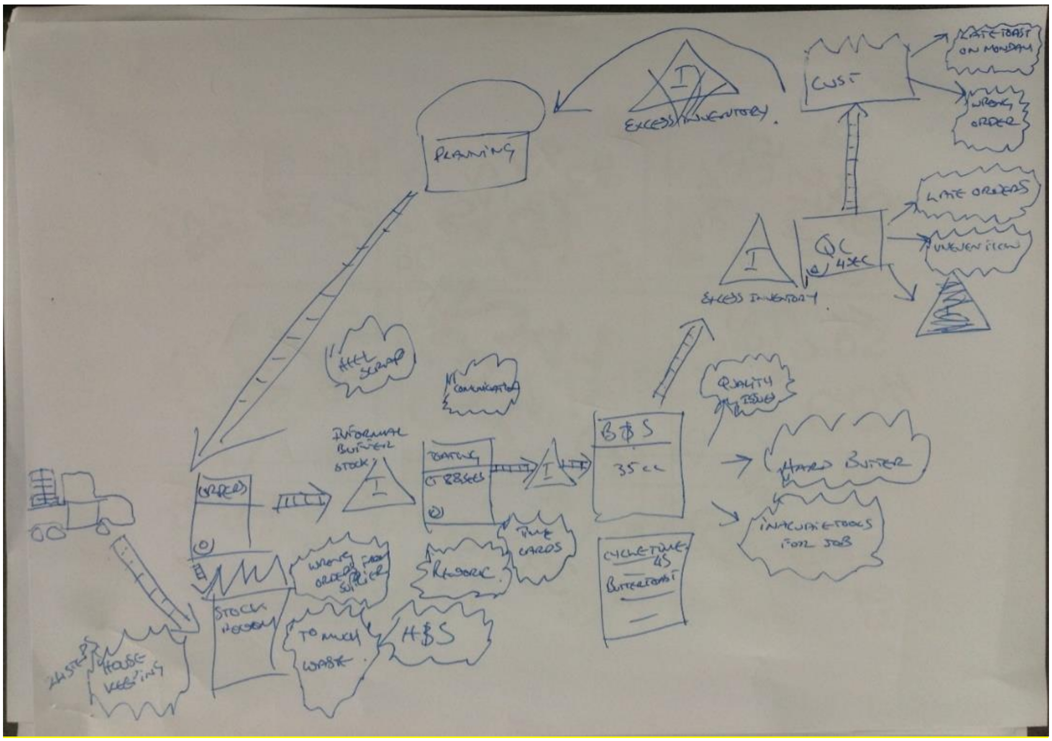


FIGURE 4-32: CSP EXAMPLE OF VALUE STREAM MAPPING EXERCISE.

Consequently, the packhouse made considerable progress in changing the culture and functioning of the packhouse. A number of improvements were made during the research period. These were related to principles, methods and tools and included value stream mapping (figure 4-32).

The packhouse introduced numerous visual aids to make the operation simple, both in value-added departments as in the necessary waste departments. Staff were involved in the process and initiated a number of improvements without much further thought.


FIGURE 4-33: SIMPLE REVERSIBLE VISUAL.

Their thinking had developed around waste removal, 'making things simple' (Figure 4-33).

The CSP included maintenance in their programme and one of the supervisors developed a visual maintenance board where preventative and improvement maintenance were colour coded on post-it notes which were folded when the maintenance was completed. This provided flexibility in design and management of maintenance Figure 4.34).


FIGURE 4-34: MAINTENANCE PLANNING—VISUAL, FLEXIBLE, PRIORITISED, SEGREGATED, EASY TO UNDERSTAND.

The CSP displayed an ongoing drive to implement Lean and the drive of management was easily picked up by supervisory staff who displayed an equal e nthusiasm and pride in their achievements.

### *4.6.1.4. CSP synopsis*

The CSP made considerable progress over the measured period. Most of the Lean principles, methods and tools appeared applicable and fitted without much adaptation. Some common principles, methods and tools were less or not applicable. The pull principle was not entirely applicable in the value stream but it was understood. Tray and packaging manufacturers were not set up for production to demand and built up considerable stocks of the most common items during the 'off-season'. Some arrangements were made to pull these into inventory but packaging production clearly did not have the capacity to produce to demand. Similarly, bins with fruit were harvested when the fruit was at the right maturity level and then stored until required to be packed. Once decided, bins were pulled from inventory and packed to exporter order. TAKT time was not used. The CSP achieved improved flow by coordinating in-field measured fruit specifications with packing requirements. Flow was also improved by significant packhouse layout changes between the first and second season, reducing overburdening—which is typical for the industry. Interviewed staff demonstrated a number of continuous improvement results and were engaged in the process.

### 4.6.2. Packhouse with Lean consultant (CSPC)

The second case study packhouse (CSPC) had engaged a consultant at the start of the inquiry, offering an opportunity for triangulation and complementation. CSPC staff initially struggled somewhat with the concepts and coaching presented by the consultant. During the first year, the consultant returned on an almost monthly basis and presented a mixture of training sessions, gemba walks with individual staff, visual aids, documentation aids and assessments. Although not a horticultural specialist, the consultant worked diligently with numerous staff and encouraged, suggested and assisted where required. After a number of months, packhouse staff reported a shift in mind-sets and started to take some initiative.

The case study covers a period of 2 packing seasons, essentially 1½ years. Here too, the packhouse was visited on a number of occasions and a number of interviews were conducted in addition to evidence collected. Lean progress was measured pre-Lean, after one season and after the second season, using Kobayashi criteria, common Lean principles, methods and tools and a Tapping et al (2002) assessment. These results are discussed in the following paragraphs.

### *4.6.2.1. Case Study packhouse with Lean consultant (CSPC) progress measurement*

The case study packhouse was assessed using identical instruments to the action research organisations (survey of 20 Kobayashi criteria and 20 common principles, methods and tools, as well as pre- and post-inquiry assessment using Tapping et al (2002)). Results are shown in figures 4-35, 4-36 and 4-37 respectively.

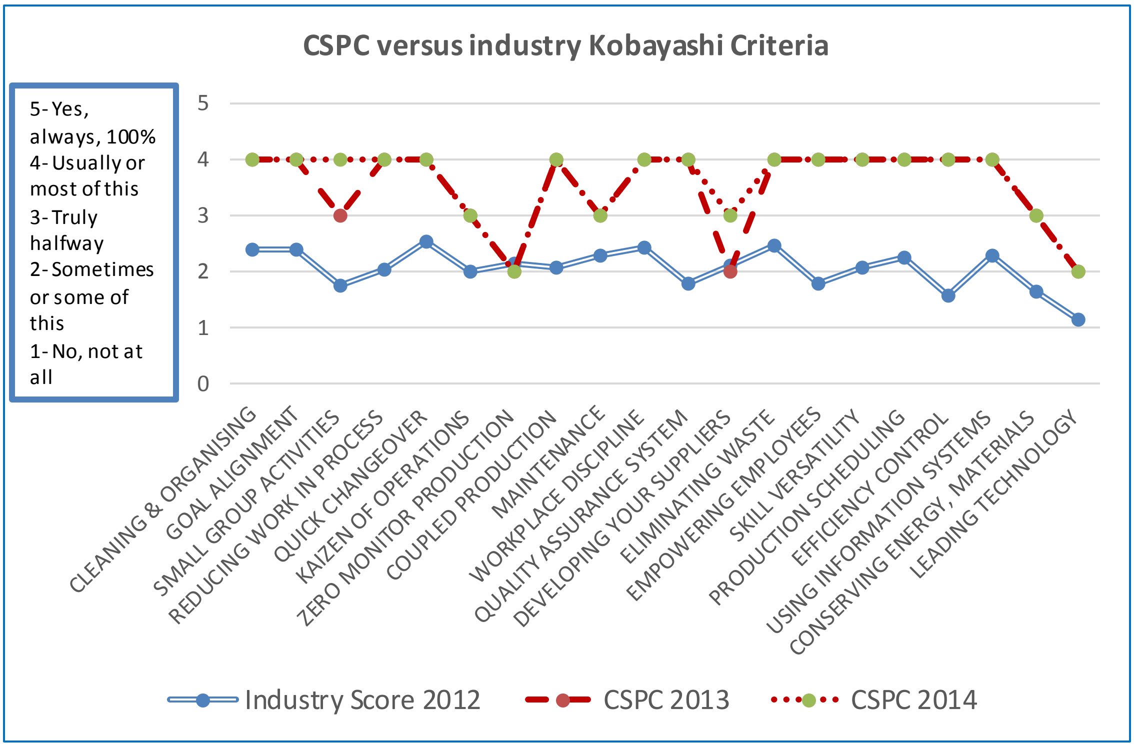



FIGURE 4-35: KOBAYASHI KEYS: COMPARISON BETWEEN INDUSTRY AND CSPC PROGRESS.

The packhouse made significant progress in the area of the Kobayashi criteria during the first year of the inquiry and progressed only a little during the second year (figure 4-35). A similar result resulted in the area of knowledge and tools (figure 4-36). The Tapping et al (2002) assessment showed a very similar result, indicating consistency across measurements (figure 4-37).

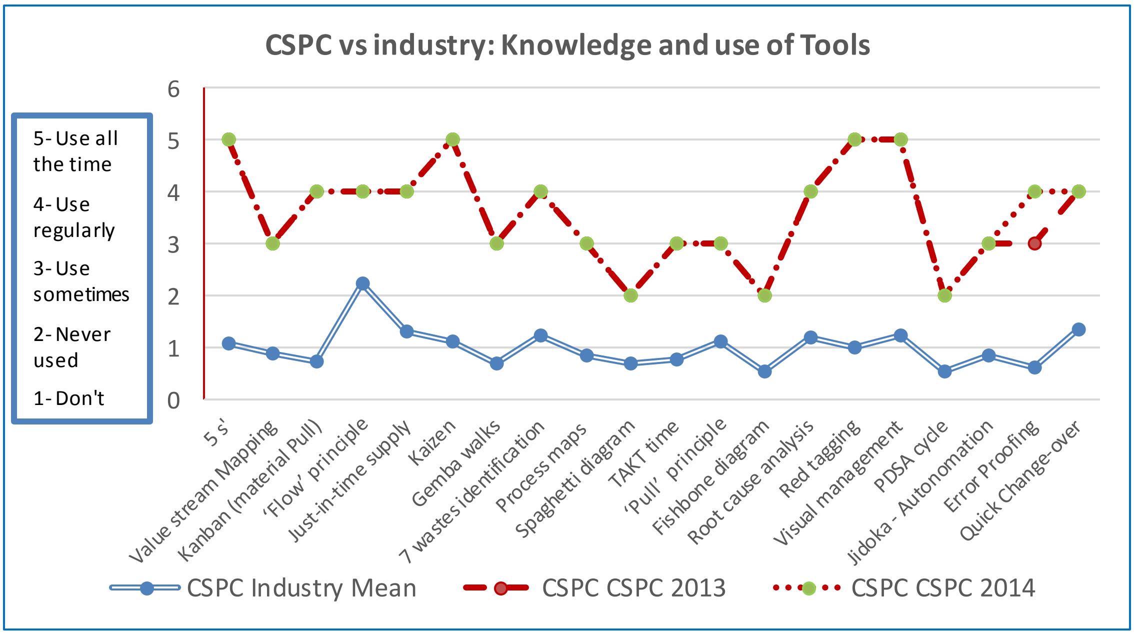



FIGURE 4-36: CSPC KNOWLEDGE AND USE OF LEAN PRINCIPLES, METHODS & TOOLS.

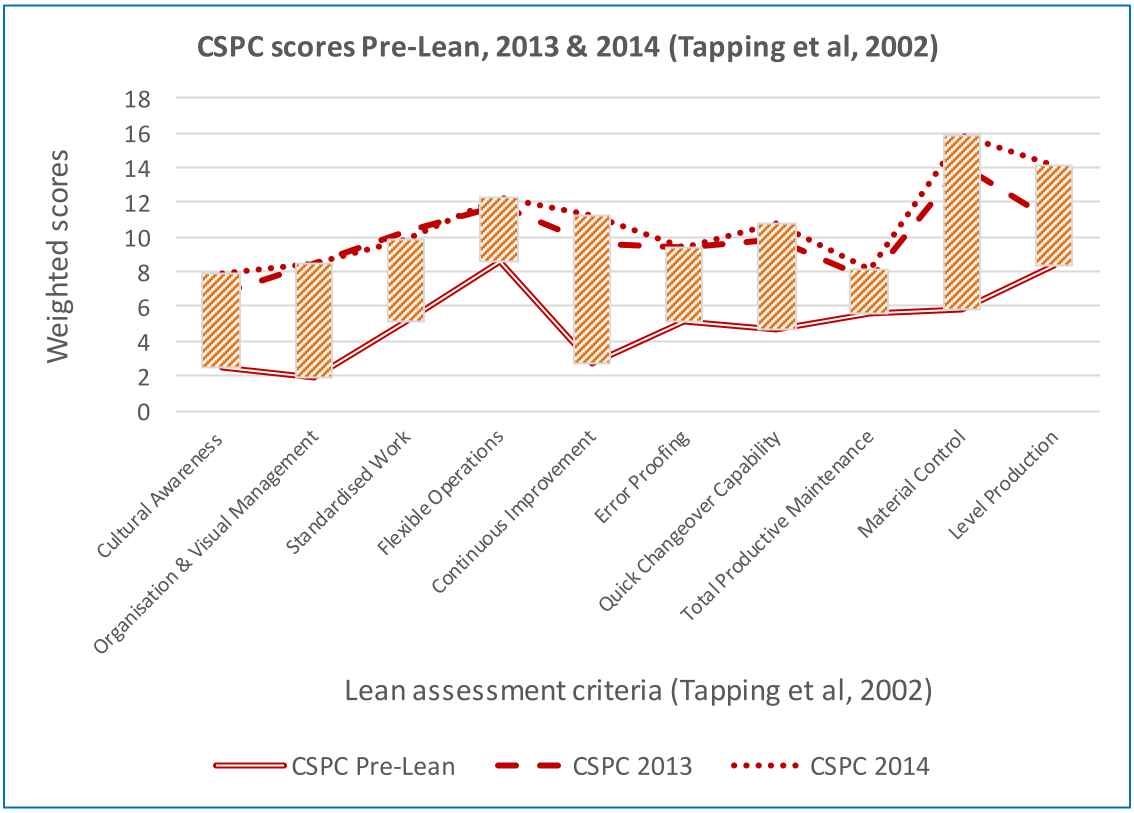



FIGURE 4-37: CSPC WEIGHTED LONGITUDINAL LEAN ASSESSMENT IN 2012, 2013 AND 2014.

### *4.6.2.2. CSPC Interviews and knowledge data*

During meetings and interviews, the CSPC organisation also demonstrated a focus on workplace organisation and continuous improvement (Figure 4-38). In addition, the organisation developed material control systems they had not before enjoyed. The introduced Kanban system was used as an example by several other organisations in the Lean pipfruit cluster. Most elements were addressed by the CSPC with some elements having a lower focus.

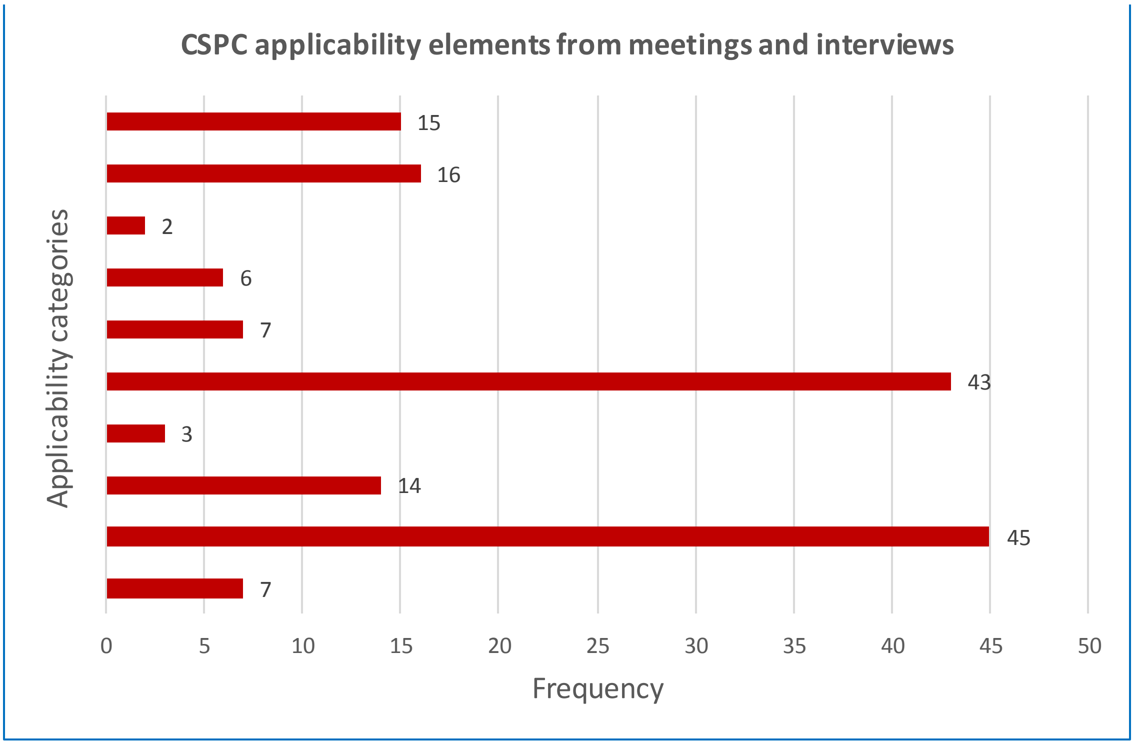



FIGURE 4-38: CSPC APPLICABILITY CATEGORY SCORES.

Similarly, the implementation elements showed a broad focus on implementation. Of particular interest is the high score in staff empowerment and the obvious recording of the consultant's activities. The high number of recorded 'Difficulty and Failure' events is attributed to the fact that staff had learned to recognise their difficulties and discuss these openly (Figure 4-39). An example of empowerment was the visit of a Lean cluster group where the General Manager stated that the supervisors would 'do' the Lean tour, expressing confidence in staff engagement and knowledge. To emphasise the relevance of this statement, the researcher states here that it is common in the industry for a reasonably senior manager to lead visitors so that visitors would get the right information presented to them.

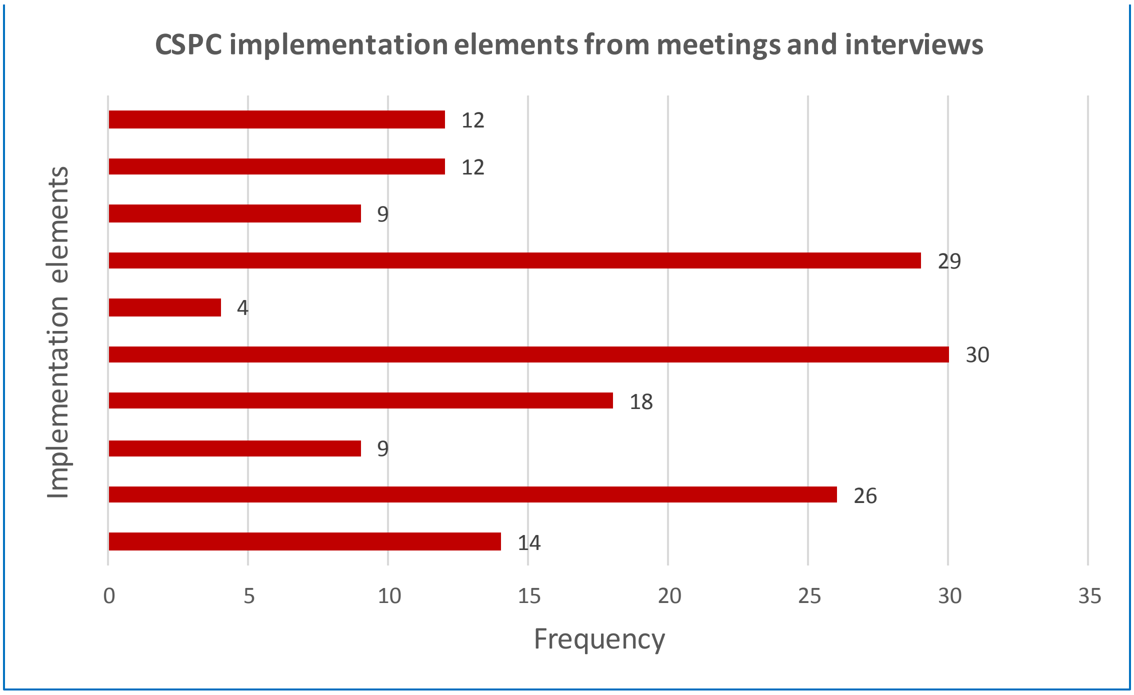



FIGURE 4-39: CSPC IMPLEMENTATION CATEGORY SCORES.

The 'Other Elements' categories showed focus on measurement and costs and as with most, recognised the complexity of the industry (figure 4.40).

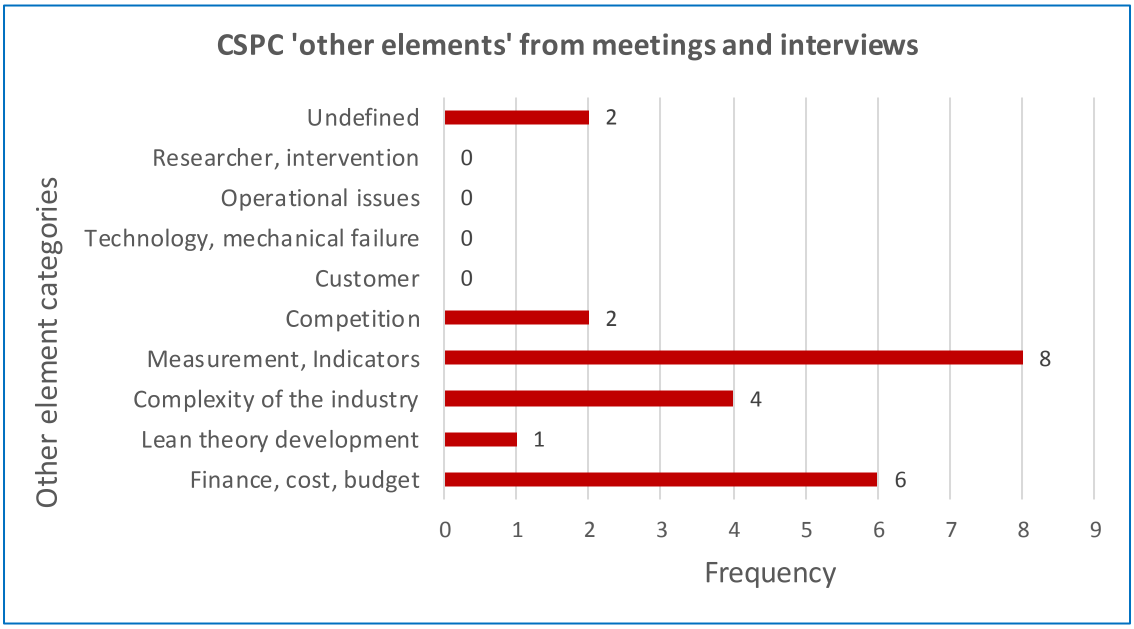



FIGURE 4-40: OTHER ELEMENTS CATEGORY SCORES.

### *4.6.2.3. CSPC observations*

The CSPC made solid progress during the period of the inquiry, aided by the consultant. A number of improvements were introduced over time and the staff took considerable pride in their achievements during the latter part of the inquiry. This culture change was noticeable both within and from outside the organisation. Several visitors observed that the organisation had undergone a transformation which was reflected typically in the visual perception of the organisation. A few examples are shown in figures 4-41 and 4-42.


FIGURE 4-41: A SIMPLE VISUAL SYSTEM FOR PUTTING PACKAGING IN ITS PLACE AND RE-ORDERING.

The start of mastering a Kanban system was observed by several other organisations during a Lean cluster visit. One other company modelled their system on the CSPC model.

FIGURE 4-42: CSPC KANBAN BOARD FOR RE-ORDERING.

Despite having difficulties adapting to the Lean paradigm early into the Lean programme, the CSPC got to the point where people started 'getting it' and made good progress from that point onwards.

During an open day in 2013, organised by Pipfruit NZ Inc. (the pipfruit industry's governing body), the CSPC manager presented a graph (figure 4-43) of the labour cost to pack a carton which showed that the company had been reducing its cost during the first Lean implementation year to levels not experienced since 2007. The general manager explained that he could not empirically attribute the lower cost to Lean but that Lean was the only change they had made; the transformation through Lean appeared to create financial results.

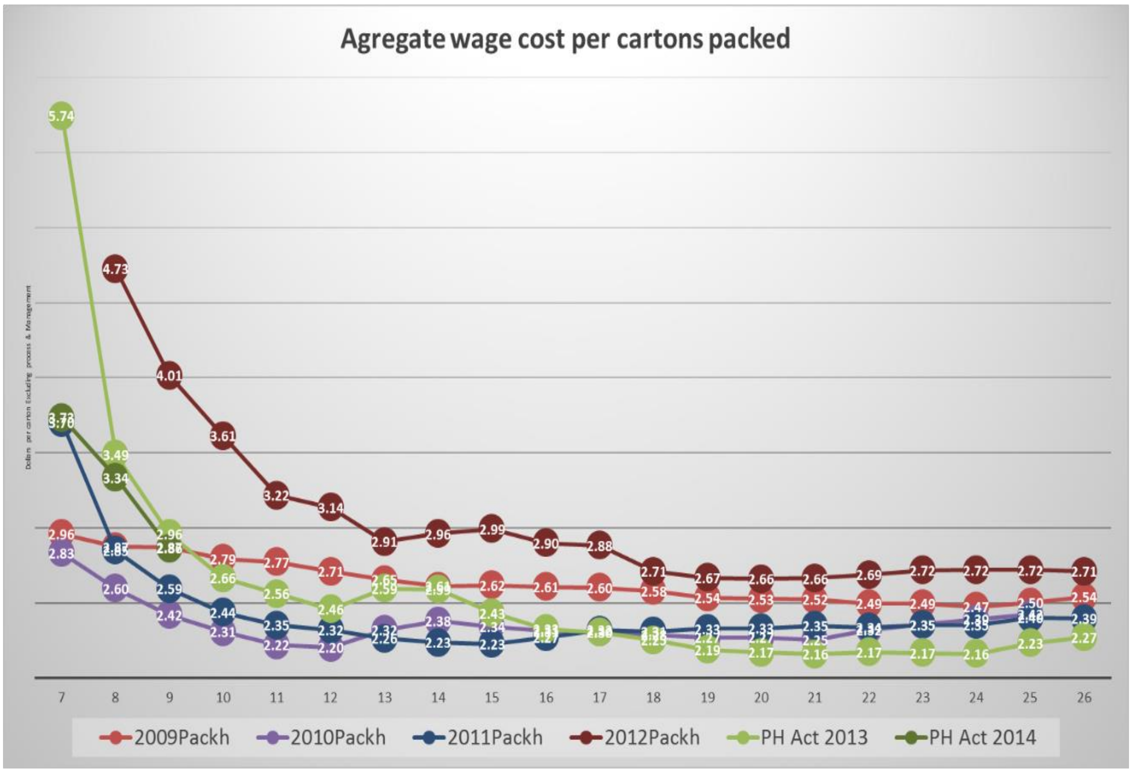



FIGURE 4-43: LABOUR COSTS PER PACKED CARTON (GRAPH REPRODUCED SIC - AS PROVIDED)

#### *4.6.2.4. CSPC synopsis*

The CSPC achieved considerable improvement during the period of the inquiry. The consultant had intensive two-day visits where a mixture of training, education, assistance and challenging led to permanent staff being able to start thinking Lean. Although culture did not score high in interviews, the company culture had changed considerably over the period of the inquiry as was observed by the researcher. Some of the elementary tools were used well and when asked, proved to be of high value. The CSPC case study points towards the suitability and implementation validity of Lean in a pipfruit packhouse environment.

### 4.6.3. Exporter 1

Exporter 1 was highly concerned about the time involved in the inquiry and the sensitivity of the information that might be released during the inquiry. A single interview was allowed, specifying that the interview would be with a specific manager. The interview lasted 1½ hours. Although the exporter granted a second interview late in the inquiry, the timing of this was too late to contribute to the findings.

#### *4.6.3.1. Exporter 1 interview*

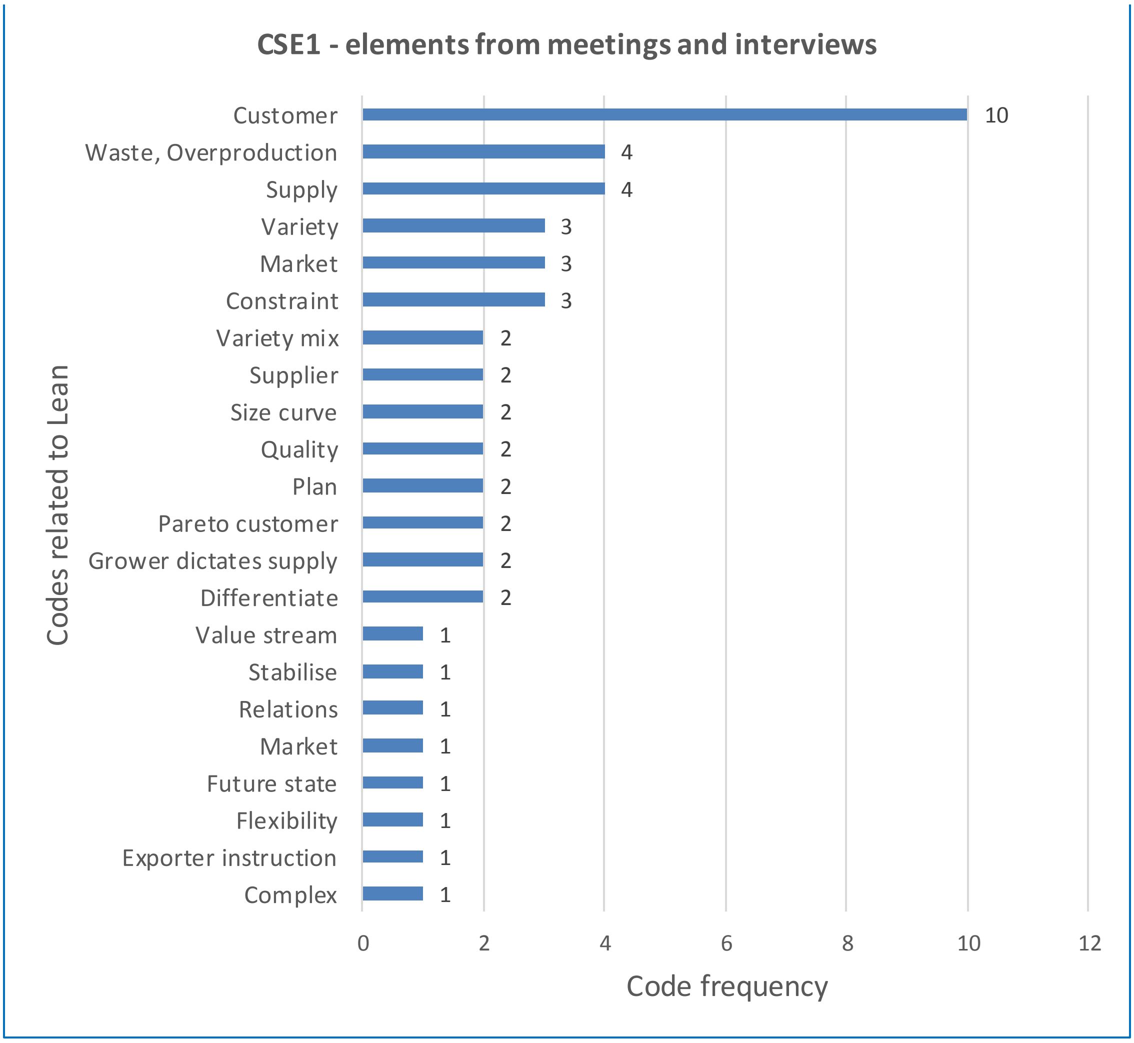



FIGURE 4-44: CODES AND FREQUENCIES IDENTIFIED IN MINI CASE STUDY EXPORTER 1.

The interview was transcribed in situ and analysed from the generated document. This was later coded, where possible matching verbatim terms, used by the participant, with existing theory. The researcher used Lean terminology for coding where Lean was evident but Lean terms were not used by the interviewee, e.g. the interviewee did not use the word 'waste' but identified overproduction of undesirable sizes as an issue. Thirty codes were identified, twenty-two of which could be interpreted as directly or indirectly related to Lean while the balance was largely interpreted as related to trading. Results are presented in figure 4-44.

#### *4.6.3.2. Exporter 1 synopsis*

Although a single interview cannot be considered a case study, the contents gives some indication of exporter thinking. During the interview, the customer featured significantly, while waste and supply were the next highest frequency. It appears therefore that the exporter had an intuitive understanding of some Lean principles but was not aware of this. Important other Lean principles and methods did not arise during the interview.

### 4.6.4. Exporter 2

Exporter 2 agreed to interviews after presenting very similar concerns as exporter 1, these being the time required and the commercial sensitivity of data. A total of four intervi ews took place both at the head office and with one of the regional representatives.

#### *4.6.4.1. Exporter 2 interview(s)*

Interviews were transcribed in situ and analysed from the generated document. This was coded later. Where possible, verbatim terms used by the participant were matched with existing Lean theory. In order to categorise meaningfully, the researcher used Lean terminology for coding and categorising where Lean was evident—but identifiable terminology was not used by the interviewee. Fourteen categories were selected, one of which was a collection of individually Lean terms. The balance was largely interpreted as related to trading or technical issues. Results are presented in figure 4-45.

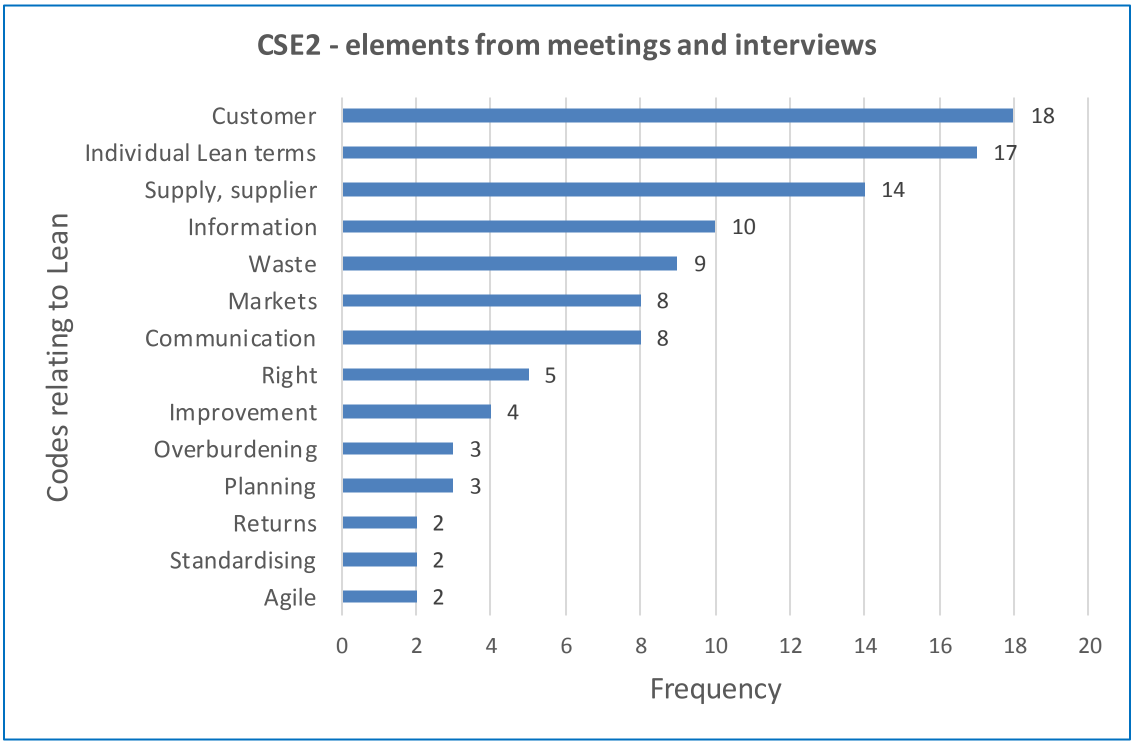



FIGURE 4-45: CODES AND FREQUENCIES IDENTIFIED IN MINI CASE STUDY EXPORTER 2.

It is evident that CSE2 pays significant attention to customers, customer demand and customer value. Therefore, CSE2 appears to be conscious of the primary of the five Lean principles without identifying it as the first Lean principle (Womack et al, 1990). Although the individual Lean terms scored high, each term was used only once, thereby indicating that CSE2 was not very conscious of Lean thinking. Similarly, the 'Supply, supplier' category related more to the logistics of supply than to the value stream. Information and communication were considered important by CSE2, although most of the comments related to logistics, matching supply with demand; the customer requirements were related to the grower supply in December, allowing only late action by the grower to attempt to correct the supply size and volume. CSE2 was conscious of waste, particularly where a grower produced fruit that had no market, but also noting reworking as a possibly necessary waste. CSE2 also referred to overburdening and improvement several times and mentioned standardising after improvement once, although not aware of this as a Lean approach.

The researcher then considered his observations and knowledge of the exporter in relation to the categorised outcomes of the interviews. The exporter is customer focussed but, considering that the exporter has upstream and downstream customers, also has a grower focus. The customer focus is therefore related to maximising the return to the grower.

Throughout the interviews there was limited focus on process improvement of the value stream as a deliberate and conscious approach.

#### *4.6.4.2. Exporter 2 synopsis*

This mini case study comprised four interviews and several observations and may only be seen as potentially indicative of exporter approaches. CSE2 was clearly customer focussed, predominantly to maximise returns to the grower. The supplier, communication and information and waste reduction also featured in the interviews. The exporter appeared to have some intuitive understanding of some Lean principles but was not aware of these as Lean. Other Lean principles and methods did not emerge during the interview.

### 4.6.5. Interviews with stakeholders in kiwifruit and wine

Several interviews with stakeholders in kiwifruit and the grape and wine industry provided elementary data about these industries, both larger than the pipfruit industry. Kiwifruit is most synonymous with the pipfruit industry as it exports fresh fruit, however a difference is that kiwifruit is exported under a single export desk. Grapes and wine are different in that most grapes are exported as wine. In both cases, seasonal pressures are similar just as the push element with wine not being subject to a restricted shelf life.

The kiwifruit organisation had started Lean five years before with the assistance of the government, the single desk exporter and a consultant. While the growing side was difficult, the post-harvest side of the organisation thrived on Lean and made substantial progress, particularly in operations but also including the administrative side. The interviewed organisation included seasonal staff in improvement ideas which resulted in some great ideas. The organisation invests significantly in training, differentiating between permanent and seasonal staff. Value stream mapping was introduced quite late in its programme. Observations show an organisation that looks and feels Lean, meaning that it looks highly organised and there is an atmosphere of calm professionalism.

The wine organisation had several locations across the country. The main office displayed a large Lean storyboard in the canteen, a board which was also available on other locations. The board served both as educational tool and positive reinforcement, celebrating successes. The organisation had appointed a continuous improvement specialist; somebody whose sole focus was on visiting all locations and departments with a focus on improvement. The organisation collated the information from its subsidiaries into a company newsletter, again telling the story and celebrating successes. Improvements affected departments across the company, including vineyards, winemakers, financial department, kitchen, laboratory and more. The company invested significantly in training and value stream mapping was practiced by most.

Summarising, both kiwifruit and wine appeared similar to the pipfruit industry. The two organisations had several years' experience implementing lean and showed good progress over that time.

### 4.6.6. Case study summary results supporting objectives

The case studies included two packhouse/coolstore combinations and two exporters, albeit with a mini case study for the exporters. The packhouse case studies supported the suitability of Lean in a pipfruit packhouse/coolstore environment. Similarly, it appeared that Lean can be implemented in that environment with the exception of some specific Lean methods and tools. The difficulties of implementing Lean in this environment are specifically linked to the seasonal component of the industry, however case study packhouses have demonstrated that most of the Lean principles, methods and tools can be implemented as they were designed with minor adaptation. This supports the third objective of this inquiry.

The exporter case studies showed some intuitive understanding of principles, methods and tools. The exporter volunteers however were not educated or trained in Lean and did not feel that Lean would contribute to their performance. The other two horticultural organisations were ahead in Lean progress but confirmed significant similarities between themselves and the pipfruit industry; something that will prove helpful when considering the fourth objective.

## 4.7. Chapter conclusion

This chapter presented results from a consultant survey, an industry stakeholder questionnaire and action research and case study inquiries.

The literature review demonstrates that Lean principles, methods and tools are not unique to the automotive industry and have been adapted to fit a number of different industries, not all of which are involved in manufacturing. The common theoretical themes have proven to be transferable to a number of industries and production or service environments. The literature review therefore substantially achieves the first objective of this inquiry, '*Identify common theoretical themes for the Lean philosophy, methods and tools, that are not industry or contextually bound and that may be transferable to the pipfruit industry*'.

The reflective practitioner review confirms that the industry has organically or intuitively introduced some Lean or 'approaching-Lean' methods and tools, without conscious awareness of the underlying principles. The survey of Lean consultants shows that there is very little experience within the NZ pipfruit industry. Furthermore, the industry stakeholder survey confirms that there is a low level of Lean understanding and deployment within the industry. These results combined '*identify and analyse the current Lean deployment with the NZ pipfruit industry*', the second objective of this inquiry.

The action research of orchards demonstrates that a number of Lean elements are suitable and can be implemented but, other Lean elements need new interpretation or simply do not fit the orchard environment. A result of the action research orchards was the interpretation of orchard maintenance which may lead to new theory.

The action research and case studies of packhouse/coolstore organisations and the Lean pipfruit cluster demonstrate that Lean is both suitable and implementable using various different implementation approaches in the packhouse/coolstore environment. These findings assist with the third objective of this inquiry, '*Analyse the applicability and any implementation approaches of the Lean philosophy, methods and tools within the NZ pipfruit industry*'.

The results of the inquiry therefore appear to support the first three objectives of the inquiry. The fourth objective is discussed later in this document.

# 5. Analysis and Discussion

**"Well, it may be all right in practice, but it will never work in theory."** Warren Buffett in a variation of a French proverb.

## 5.1. Introduction to analysis and discussion

In the introduction to this work (chapter one), the problem and objectives for this inquiry were identified. This was followed by a chapter on the literature review, a chapter on methodology and a chapter on results.

This chapter, 'Analysis and Discussion', intends to critically analyse and discuss the findings presented in chapter four. Findings are discussed in line with the objectives from chapter one, first examining the theoretical themes that may be transferable to the pipfruit industry. In the next section, the current level of Lean deployment within the industry is examined, followed by the discussion of the applicability and implementation approaches of Lean in the NZ pipfruit industry. The development of a model for the NZ pipfruit industry (and 'considering its applicability to the wider horticultural industry') requires the critical analysis and discussion to be completed before it is given shape in chapter six.

A critical analysis of findings adds balanced value to the outcome of this inquiry.

> "*Whoever is careless with the truth in small matters cannot be trusted with important matters*". *"Truth never damages a cause that is just*." — Combined wisdom of Albert Einstein and Mahatma Gandhi.

## 5.2. Objective 1: Transferable common theoretical themes

The first objective proposed in chapter one is to:

*'Identify common theoretical themes for the Lean philosophy, methods and tools, that are not industry or contextually bound and that may be transferable to the pipfruit industry'.*

This section discusses the elements presented in previous chapters that contribute to confirm or disconfirm the first objective. During this section, the synthesis between mixed methods will be based on Greene et al (1989) as presented in the methodology, where different research elements combine through selected synthesising methods to confirm or disconfirm the stated objective (figure 5-1). As the range of the inquiry is expanded by using different methods for each of the four objectives, this aspect is not specifically highlighted in figure 5-1.

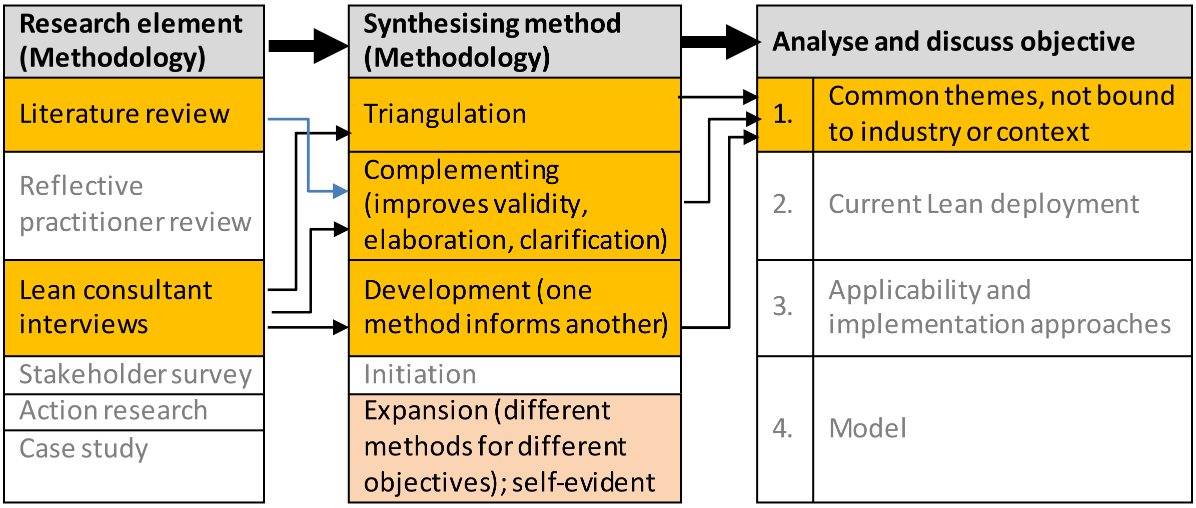



FIGURE 5-1: RESEARCH ELEMENTS SYNTHESISED TO OBJECTIVE 1.

### 5.2.1. Common themes: Historical development in literature review

Popular Lean theory has identified Toyota and its production system as the birthplace of 'Fragile', or 'Lean' (e.g. Krafcik, 1988; Womack et al; 1990, Womack, 2013), however the literature review points out that a number of different industries started implementing Lean and claim successes as well as failures before and since Toyota. These different implementations have required researchers and operators to adapt the Lean concept to those specific environments. As a consequence of that process, it is argued that successfully implemented Lean has become both fluid (developing as time changes) and environmentally adaptive (Chapter 2, paragraph 2.3, 4.1 and section 2.4).

Ohno would have been interested to see these different implementations because Lean was developed solely by Toyota for Toyota as he expressed in Monden (1983). But over time it has become clear that Lean is not owned by any person or company; it developed over a long period of time and took Ford and Taylor as inspiration as Womack (2013), Ohno (Monden, 1983) and Shingo (1992) agree. In fact, Ohno warned against codifying his system because that would remove all flexibility (Seddon, 2010). Over time, common themes of successful Lean have been the fluidity and adaptation to the environment within which it was implemented.

Womack (2013) discusses how literature appears to be building a 'lean tower of Babel' and falls back on the fundamental focus of Lean; to create a perfect process, i.e. perfectly satisfying the customer's requirement of value with zero waste. He quotes an example of his own bicycle manufacturing plant and immediately acknowledges that none of us has seen such a process, but that true Lean thinkers travel on a never-ending pathway toward that truly Lean process. He emphasises that the original book was a catalyst for new ideas and in saying that, acknowledged the fluidity of Lean.

> *"So, 25 years on, we know that the "The Triumph of the Lean Production System" wasn't perfect. But we believe that it was a watershed event in the history of the lean movement and that it helped open a floodgate of new ideas for the world's managers. We continue to see its benefits today and we hope you will enjoy reading the original article in light of what you have learned on your own lean journey."* (Womack, 2013, Sic. location 3585, Kindle)

### 5.2.2. Common themes across industries in literature review

The diverse environments in which Lean has been implemented mean an almost equally diverse interpretation and use of methods and tools across those environments. This effectively means that specific methods and tools may apply to a certain industrial environment and not to another. Common themes are broader than specific methods and tools and contend that:

- Lean is fluid and adaptive to its environment;
- Lean is challenging to implement;

- There is an apparent thematic continuum from general to specific, general being less perceptible and tangible—but fundamental—while specific is more perceptible and tangible—and necessary for operationalising Lean.

Two examples follow to illustrate that Lean implementation is idiosyncratic to industry types and therefore common themes are of a general nature.

<u>Example one</u>: In the health care discussion, Radnor et al (2012) point out that healthcare is capacity led instead of demand led, deviating from Lean theory. Similarly, the customer (the government) decides for the consumer (the patient). Radnor et al (2012) also translate the classic seven wastes into waste in healthcare, deviating from standard Lean theory and in fact state that if Lean is not translated for a specific environment, it could impact negatively on its implementation effectiveness. This is confirmed by Radnor's translation of the five Lean principles (Womack et al, 1990) into six healthcare principles (Williams & Radnor, 2014). Buesa (2009) and Dickson et al (2009) rationalise that they use certain Lean elements because not all Lean elements can be applied per se. Dickson et al (2009) believe that medical institutions or departments seeking to adopt Lean must concentrate on the core principles of Lean rather than on copying specific process changes made at other institutions or departments. Joosten et al (2009) also confirm that Lean depends on its environment; however they select those elements that they see as applicable to their specific research.

<u>Example two</u>: Accounting is a service that spans most industries and, despite computerisation, has not changed in essence and needs revising (Johnson, 1991). Over the years, management accounting has become a driver for operations and this does not reconcile with Lean because it accounts on fragmented information (Maskell, 2004). Operational decision-making must be assisted by analysing the effect of any proposed changes on the profitability of the value stream as a whole, not the individual products (Kennedy & Brewer, 2006). Visual management with real-time data allows operators to make 'running' improvements which after-the-fact financial reports do not facilitate. So depending on the type of organisation the product of Lean accounting differs and does not specifically conform to generalised methods or tools.

An argument could be made that a common theoretical theme is that all types of industries benefit from 5-S, which has become both a simple best practice tool, and a culture for the advanced exponents of Lean (Gapp et al, 2008). Additionally, a valid question can be asked whether tools such as 5-S belong to the Lean paradigm or are merely an introduction of a best practice which leads to better performance (e.g. Pil and MacDuffie. 1996 and Ichniowski et al (1996). In New Zealand (and other English speaking countries) e.g. there is a saying 'There is a place for everything and everything is in its place', depicting the intuitive use of 5-S elements as best practice.

### 5.2.3. Common themes: The view by consultants

The consultants were strongly positive (95.2%) that Lean would benefit the NZ pipfruit industry and all but one (also 95.2%) believed that philosophy was the common prerequisite theme when looking at philosophy and tools as a crude distinction of Lean elements. A common theme then appears to be that the Lean philosophy is more relevant for Lean success than the Lean tools are. As one consultant indicated "…*tools without philosophical support will become isolated, while the right philosophy will lead to the introduction of the right tools; philosophy is transferable to any industry*". The question was intended to get an idea of consultants' approaches and was not specific enough to extract more meaning than was presented in the findings.

The consultants' responses are presumed to be based on their wider industrial experience, because only ten consultants reported experiences with horticultural companies, four of which were pipfruit-related experiences. These four are further qualified: One consultant worked with the same companies as another but with a different focus and at a different time, while a second consultant had only engaged in a preliminary service delivery assessment.

In terms of tools, consultants (when asked about the seasonal nature of the industry) regarded standardisation, training and visual management as methods and tools that would deal with the seasonal aspect of staff. Challenged to consider the impact of the 'push' concept of the industry, the answers varied widely and there was little commonality amongst replies. It appeared that consultants struggled somewhat with this aspect of the industry.

### 5.2.4. Synopsis of analysis and discussion of the first objective

If well respected and quoted authors do not agree on a definition of Lean we have to ask ourselves if there can be a single definition or if, perhaps like the Lean paradigm itself, the definition must be adaptive to its environment and the chronological time in industrial development. It is clear from the literature review on Lean manufacturing (e.g. Pettersen, 2009) that different authors consider largely similar but also different Lean characteristics. The wider group of authors focussing on other Lean implementation elements, essentially 'pick and choose' Lean elements that fit their specific environment, while in that process agreeing on elements that appear to fit in most environments. These elements include the enabling 'below the surface' elements of the sustainable 'Lean iceberg model' (Hines et al, 2011a) such as philosophy, strategy, alignment, leadership, senior management support, behaviour and engagement, and also a number of methods, techniques and tools that are idiosyncratic to each different environment. The list of common theoretical themes that are not industry or contextually bound but are applicable to the NZ pipfruit industry can therefore not be perfect but its existence is undeniable.

The consultants corroborate the view that philosophy is universally applicable and complement that with several ideas of approaching the seasonal staff issue.

## 5.3. Objective 2: Identification and analysis of current Lean deployment

The second objective proposed in chapter one is to:

*'Identify and analyse the current Lean deployment within the NZ pipfruit industry'*.

This section analyses and discusses the results of the stakeholder survey. The stakeholder survey and reflective practitioner review triangulate to identify and analyse Lean deployment within the NZ pipfruit industry (figure 5-2). The Lean consultant interviews assist with development of the stakeholder survey and complements constructs, while the reflective practitioner review also complements interpretability of constructs.

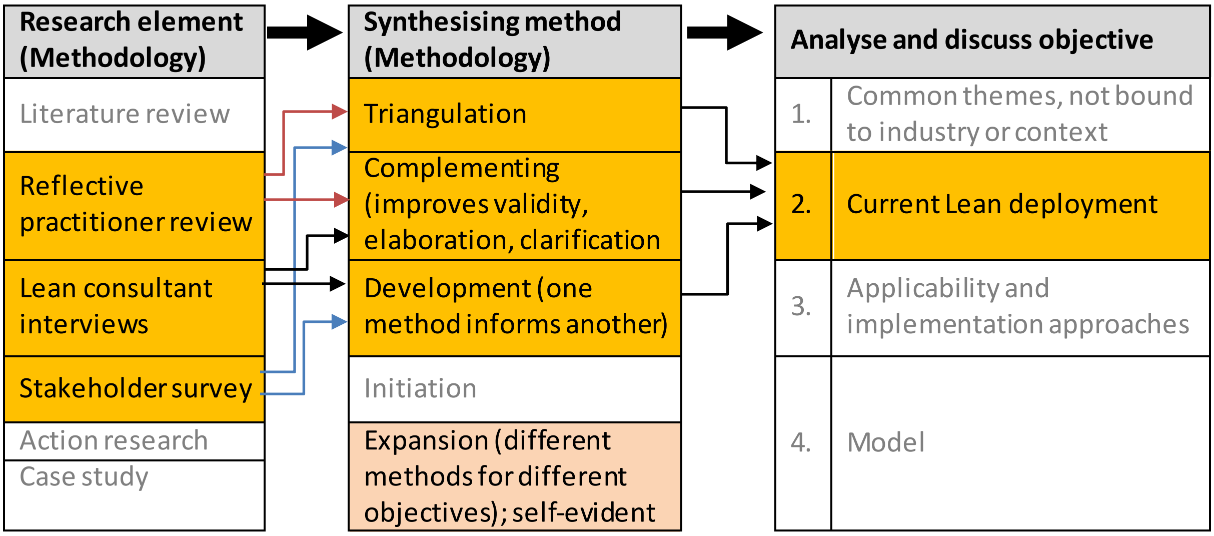



FIGURE 5-2: SYNTHESISIGNG METHODS USED FOR OBJECTIVE 2.

As the range of the inquiry is expanded by using different methods for each of the four objectives, it is not specifically highlighted in figure 5-2.

### 5.3.1. Current Lean deployment: A consultant estimate

This section analyses and discusses the consultants' estimate about Lean deployment in New Zealand and in particular the NZ pipfruit industry.

Of the twenty-one consultants responding to questions, eighteen confirmed experiences with the primary industry and ten confirmed experiences with the horticultural industry, four of which were with the pipfruit industry.

When asked, consultants estimated that an average of approximately 3% of NZ organisations might be 'seriously' Lean (described as 'Dedicated to become Lean and having made substantial inroads') with a range from 0% to 10%. Focussing on the horticultural industry, consultants estimated that an even lower percentage of these were 'seriously' Lean, averaging approximately 1% with a range from 0% to 5%. There was no significant difference between the mean score of all consultants and the mean score of consultants with horticultural experience. Considering that only ten of the twenty-one respondents had experiences with any form of horticultural industry, the estimate is relatively low in validity and does not carry too much weight. The ranges of 0-10% and 0-5% respectively, also indicate a level of uncertainty about the number of organisations that would fall into the 'seriously Lean' category.

The 2013 statistical Annual of the NZ pipfruit industry refers to 370 growers for 2013, 61 packhouses/coolstores and 84 exporters, a total of 515 stakeholders (appendix 10). The consultants' estimate of approximately 1% might theoretically imply that approximately 7 pipfruit organisations would be seriously Lean, which is optimistic in the researcher's view and not validated because only half of the consultants had any experience in the area. However the researcher never intended for the question to contribute high value to the analysis; the consultants were approached very early in the research project to confirm or disconfirm some basic facts about Lean in the NZ horticultural industry that might change the course of the inquiry, and that purpose was served by the interviews. The results however converge with the stakeholder results which are discussed in 5.3.2.

### 5.3.2. Current Lean deployment: A stakeholder survey

This section analyses the stakeholder survey and discusses the various responses to establish the current level of Lean deployment within the industry.

#### *5.3.2.1. Transition from unconscious incompetence to conscious incompetence*

Stakeholders responded differently to an identical question asked at the beginning and at the end of the 'single-question-per-day' questionnaire as shown in figure 4-1 in chapter 4 'Results'.

Stakeholder respondents believed they had a fundamental knowledge of Lean before the survey with an average score of 2.47 which places them between moderate and reasonable Lean knowledge. Conversely, towards the end of the survey the number of respondents that estimated their knowledge of Lean as being low increased with stakeholder respondents scoring an average of 1.94 which places the group just below moderate Lean knowledge. The inference here is that stakeholders confirmed a degree of unconscious ignorance at the start of the survey, transforming that to a degree of conscious ignorance as the first step of a learning cycle (Flower, 1998).

| | **Ignorant** | **Knowing** |
|---|---|---|
| ***Unconscious*** | 1. "I don't know that I don't know how to do this."<br><br>*(Typical pre-survey response)* | 4. "I did it right automatically, without realising that I knew how to do this" |
| ***Conscious*** | 2. "I know that I don't know how to do this."<br><br>*(Typical post-survey response)* | 3. "I do know that I know how to do this." |

FIGURE 5-3: COMPETENCY/KNOWLEDGE MATRIX, MODELLED AFTER FLOWER (1998).

This result indicates that stakeholders are likely to have been truthful in their responses (not distorting results in order to mask incompetency) and were very much in the 'ignorant' zone (conscious or unconscious) , corroborating that Lean is not significantly deployed in the NZ pipfruit industry.

### *5.3.2.2. Analysis of stakeholder responses to Kobayashi*

The Kobayashi criteria used in the survey described a 'state' of the respondents' organisations and asked for an indication in how far that state had been achieved. With an average response of 2.07 the stakeholders indicate that their organisations do some of the things in each statement or do them sometimes.

The Kobayashi statements in the questionnaire represented a mixture of level 2 to level 5 of the original statements (appendix 4 and 7), meaning that the identified level of Lean implementation was lower than if the complete statements were used; in other words the 2.07 mean score is expected to have been lower if the complete statements had been used.

These were not used because they were considered too long by the researcher and might have reduced the number of responses and the intent of quick responses.

Because the survey statements described a state, there is no reason to suspect that responses are inaccurate and here too, there is no reason to suspect largely inaccurate responses; the results corroborating that Lean is not significantly deployed in the NZ pipfruit industry.

#### *5.3.2.3. Analysis of stakeholder responses to Lean principles, methods and tools*

Table 4-10 in chapter 4 shows a significant number of responses (62.2%) indicating ignorance of the presented principles, methods and tools. Several of the presented principles methods and tools were similar, e.g. Pull as a lean principle was mentioned, but so was 'just-in-time' and Kanban. All of the key words were taken from popular literature and where necessary were presented with translation, e.g. 'Poka Yoke (Error Proofing)'.

Most of the 'use all the time' responses came from the single company that had embarked on the lean pathway, indicating that, once committed, all 20 principles methods and tools should at least have been known, even if not used. A case could be made that if a respondent does not know what a construct means, he or she cannot indicate if they are using it or not. The argument is considered weak because the results of the principle method and tool question is in line with the responses to the Kobayashi criteria statements, corroborating the state of the industry within the context of the survey. The results, particularly when taking into account the 62.2% 'Don't know what it is' score, converge towards the position that the level of current Lean deployment within the industry is poor.

### 5.3.3. Current Lean deployment: The reflective practitioner review

In the researcher's experience, there may be no more than four organisations that are dedicated to become Lean and have made moderate to significant progress. Several others are currently showing interest, some individually and some through the Lean pipfruit cluster.

The industry does however use a number of practices that align themselves more or less with Lean. These include understanding customer value, walking the shop-floor, load-levelling to prevent some overburdening, quick change-over, some error proofing and some use of just-in-time. These practices appear to display a form of accidental unconscious competency, which is closely aligned with unconscious incompetence or ignorance.

The practitioner review was sent to several industry stakeholders, each representing an industry sector, for verification and validity. Stakeholders confirmed the practitioner's review as correct.

### 5.3.4. Synthesising the results towards the second objective

Results from the consultant survey and the stakeholder questionnaire converge with the reflective practitioner review to deduce that the level of conscious or unconscious Lean deployment within the NZ pipfruit industry is low. This is not surprising considering the low level of Lean knowledge within the industry. Practitioner elaboration on some industry practices that align themselves with Lean complements the view that, regardless of the lack of Lean knowledge, certain practices organically emerge and prove their value in order to be sustained by industry. The incontrovertible conclusion however, is that the NZ pipfruit industry is not consciously Lean. The question now remains whether the industry should and could be Lean. If Lean simply does not fit, then the results of interviews and survey match the theoretical 'fit' of Lean into the industry. The following paragraph looks at the fit of Lean, both in applicability and implementation.

## 5.4. Objective 3: Applicability and implementation approaches

The third objective proposed in chapter one is to:

*'Analyse the applicability and any implementation approaches of the Lean philosophy, methods and tools within the NZ pipfruit industry'*.

In this section, the literature review and reflective practitioner review complement and enhance interpretability of constructs, while action research and case study triangulate to corroborate and increase construct validity. The literature review assists with development of the action research and case study strategies. As the range of the inquiry is expanded by using different methods for each of the four objectives, it is not specifically highlighted in figure 5-4.

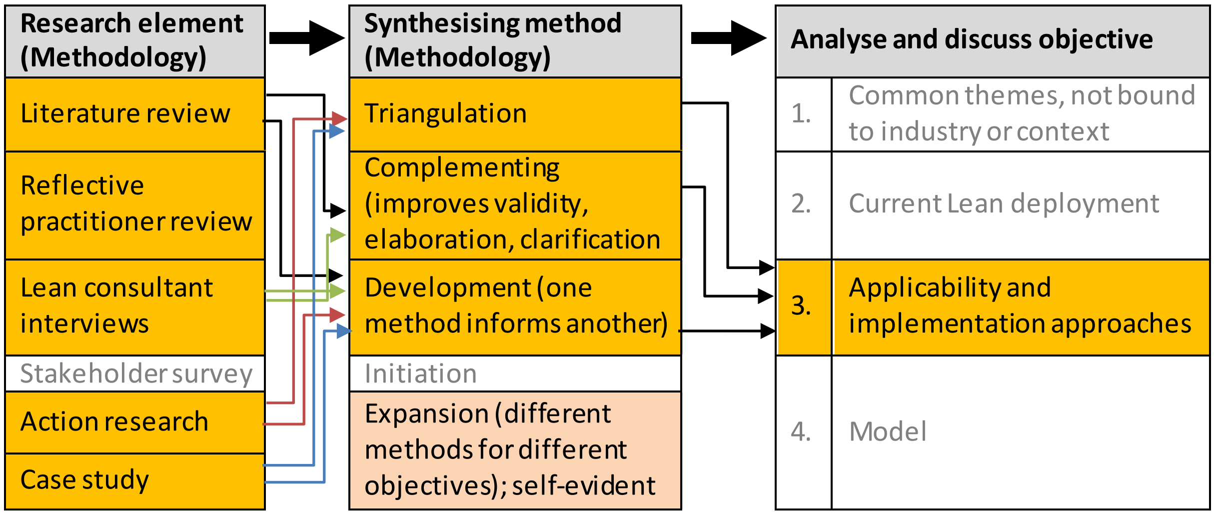



FIGURE 5-4: SYNTHESISING METHODS USED FOR OBJECTIVE 3.

### 5.4.1. Applicability and implementation: From the literature

This section summarises the analysis of the Lean literature towards establishing the applicability and implementation approaches of Lean in relation to the NZ pipfruit industry and presents a critical comment.

The literature review has revealed that there is no single definition for Lean and that the definition in fact has been adapted to different environments. Similarly, the literature review revealed different views on critical elements, forms of waste and implementations for various industries. As Womack et al (1990) stated that they were 'convinced that the principles of Lean could be applied to every industry', Womack and Krafcik believe (Womack, 2013) that Krafcik's landmark paper on 'The Triumph of the Lean Production System' (Krafcik, 1988b) helped open up the floodgate of new ideas for the world's managers.

Lean is not perfect and there is no single detailed model that determines its applicability or implementation approaches across industries. Each organisation can benefit from implementing selected elements of Lean theory that suit that organisation's activities.

Literature provides a number of examples of implementation approaches, each particular to individual organisations' internal and external environment, culture, activities, timing and other factors. Popular literature provides some articles on implementation approaches of

Lean in a pipfruit environment (e.g. A Case Study of Adrian Cripps Ltd., 2007) but no academic papers could be found.

The literature review therefore informs and complements other research methods to determine the applicability and implementation approaches for the NZ pipfruit industry.

### 5.4.2. Applicability and implementation: Reflective practitioner review

This section uses the reflective practitioner review as a basis for a brief analysis and discussion of the applicability and implementation approaches of Lean for the NZ pipfruit industry.

The practitioner has seen a number of pipfruit organisations over the years but none of these were intending to become Lean before this research project started. A number of these organisations displayed particularly 'un-Lean' behaviours, often based on old-fashioned beliefs. These included for example the embedded belief that higher pack-outs lead to higher returns and that the quality of the product merely had to be to the lowest specification.

As a result of the fact that there were no Lean organisations in the pipfruit industry at the time this inquiry started, the practitioner could not report on applicability and implementation in the NZ pipfruit industry from an empirical perspective. He can however report on what he has observed and learned in other industries and what he observed in the NZ pipfruit industry that offered opportunities for Lean implementation. Similarly, from the practitioner's perspective, not all Lean principles methods and tools are equally applicable to the industry. Some simply do not fit this industry that conceptually differs vastly from manufacturing cars.

The reflective review clarifies and elaborates on the intuitive applicability of Lean to the pipfruit industry; in the practitioner's view, there are Lean elements used with some adaptation required (e.g. table 4-1).

### 5.4.3. Applicability and implementation: Consultants complementary views

Two questions to consultants resulted in their view of the applicability of Lean for the NZ pipfruit industry. Consultants were strongly positive (95.2%) that Lean would benefit the NZ pipfruit industry. Consultants also pointed at philosophy or a combination of philosophy with tools as preferred implementation approach (95.2%). Although this result has been qualified earlier in section 5.2.3, it complements and converges with the results from other methods which are described in the following sections to confirm the applicability and implementation approaches for the NZ pipfruit industry.

### 5.4.4. Applicability and implementation: Action research component

This section analyses and discusses the action research results to assess the applicability and implementation approaches of Lean for the NZ pipfruit industry. The action research method was expected to provide some original data, particularly where it concerned an element of the industry for which no academic literature had been found: The orchards or growing fruit.

#### *5.4.4.1. Action research orchards (ARO) contribution to applicability and implementation*

Assessments: The pre-, middle- and post-inquiry period Lean assessments provide evidence that orchards can implement Lean with a degree of success. The assessments also show a movement upwards and downwards; there was no consistent upward trend across all assessment criteria, and this was not expected considering the volume of extra information that the orchard managers had to cope with. Some elements were scored higher at the end of the first season than they were scored at the end of the second season. This may have been caused by elements being neglected after the initial result or a form of 'improvement fatigue'; it may also have been caused by inaccuracies in the assessment or by 'assessment fatigue'. There is however relative consistency across cross-sectional assessments, indicating that the general result of an improved Lean status is acceptably reliable.

Score consistency: Consistency of scores across the different measurement instruments also indicates that the general results are reliable and valid. This indicates that the Lean principles, methods and tools that had been implemented by the ARO are applicable to the orchard situation. A broader list of principles methods and tools was discussed as not all were implemented, and the views and experiences of orchard managers can be found in a table as appendix 15 (refer to table 5-1 for an example).

TABLE 5-1: SAMPLE OF APPENDIX 15 WITH 32 PRINCIPLES/METHODS/TOOLS DISCUSSED

| ***Principle/method/tool*** | **Use** | **Grower/Orchard** |
|---|---|---|
| *Customer Value* | Current | Not specifically communicated to orchards or communicated late, most commonly around December of January. |
| | Future state | Growers can affect what is grown (production) if they know what the customer requires and in which country the customer is based (in order to get access to that market). The ideal state communicates customer value just before pruning. |

Appendix 15 discusses the current state and the potential future state of thirty-three Lean principles, methods and tools considering the findings from the inquiry and provides general and specific examples that can be considered. The table is a volume of pages long and is appended for that reason.

Managers' experiences: Orchard managers expressed their views on the applicability and implementation of Lean at the end of the inquiry. While during the inquiry the focus was on the technical aspects of lean in an orchard situation, orchard managers expressed their beliefs on the applicability and implementation as they had experienced Lean during the course of the inquiry.

Applicability and implementation: The results shown in figure 4-15 show that some elements are assessed by orchard managers as very suitable but relatively difficult to implement. These included staff empowerment, continuous improvement, waste identification, even production and load levelling. Orchard managers appeared to see the justification for using these elements, but found the implementation harder. Responses to a question about the role that the seasonality of the industry played, varied from '*everything revolves around the season*' and '*throws some curve balls*' to '*each year is different from the last which is why there will be some difficultly in implementing all parts of lean*'. Responses also indicated that '*we are able* *to act or re-act with careful planning and open discussion*' and that '*many orchardists have blamed external factors for poor performances in the past*', indicating that the managers were aware that the season cannot be blamed for everything and that the managers exerted a certain amount of influence.

<u>Low scoring elements</u>: Several elements scored low in terms of applicability and implementation. These included Just-in-time supply and value stream mapping. Just-in-time supply is not practical for fruit that must be harvested at the optimum maturity level. Delaying harvest until the fruit is required is a physiological impossibility if fruit quality must be optimal. It is applicable, for example for the supply of chemicals, where JIT is used by the managers. Value stream mapping scored low as well. The researcher considered the low score to be the result of inadequate education and training of the orchard managers by the researcher. Orchard managers were simply not in a position to judge the applicability and implementation of value stream mapping as they did not have enough background to do so. Some managers did not answer the specific question in the final questionnaire.

The orchard action research converges with other action research and case study results to validate the third objective and is discussed in the synopsis to this chapter.

##### *5.4.4.2. Action research packhouse (ARP) contribution to applicability and implementation*

<u>Assessments</u>: The action research packhouse/coolstore (ARP) also participated in different assessments at the start of the inquiry, after one season and after the second season. The results on the used Kobayashi criteria (figure 4-16) show significant progress across criteria over the two-season inquiry period, with one criterion regressing, being technology. This is not considered significant as the ARP continued improvement in general and technology is not directly relevant to Lean. The slow progress after the first season is reflected by the scores that are relatively similar as the wider industry scores. The first season presented little progress in the state of the ARP, while the ARP reported improvement across the board after the second season.

<u>Applicability</u>: Relevant are the areas where little progress has been made during the inquiry period. These areas may not have a high level of applicability in a packhouse situation or may

be difficult to implement and include people empowerment, conservation of energy and materials and technology.

Effect of season: People empowerment is presenting to be an issue in seasonal activities where the permanent employees—particularly supervisors—appear to have little time for training and coaching while being the people that have the most knowledge of the operation and its processes.

Methods and tools: On the more technical side, the ARP appeared to pick up methods and tools with relative ease and make progress in their use of these (figure 4-17). Consultants often refer to these as 'the low hanging fruit', a comparison that reflects a poor analogy in fruit-technical terms; in orchards, it is not the low hanging fruit that must be harvested first — it is the fruit approaching maturity that is ready for harvesting. The analogy will play a role in the development of a model for the industry in chapter six.

A difficult start to implementation: The start of the inquiry appeared difficult for the ARP. The manager had some knowledge of Lean but generally, staff had no knowledge of Lean. This led to a number of sessions with explanations, followed by challenges by the researcher, e.g. to identify waste (e.g. appendix 16). On a number of occasions, the ARP supervisors had not been able or only partly been able to follow up, given the challenges of the packing season. Working 'in' the business was considered more pertinent than working 'on' the business. This made for slow progress and highlights the difficulty of getting an organisation to focus on organisational change during periods of intense seasonal activity. During the off-season, it appeared easier to introduce Lean elements than during the season itself when short term daily pressures distracted from longer term gain efforts. This experience is consistent with the experience of the ARO. Packhouse staff readily confirmed this to be the case and seasonal pressures may be a distractor throughout Lean implementation during the season.

A number of the critical factors involved in implementing Lean (e.g. table 2-6) were readily identifiable within the ARP, ranging from fundamental ignorance to lack of implementation skills to company culture and the relationship between management, permanent staff and seasonal staff.

The packhouse action research converges with other action research and case study results to validate the third objective and is discussed in the synopsis to this chapter.

##### *5.4.4.3. The Lean pipfruit cluster; additional confirmation*

The Lean pipfruit cluster offered an additional opportunity to exercise limited action research and help achieve the third objective.

The cluster's activities include orchard activities and packhouse/coolstore activities. Exporters have not yet joined and here too, the absence of exporters is conspicuous. Each visit forms a basic iterative cycle where the researcher can elaborate and complement the host organisation's information. The feedback loops through the steering group confirmed the value of the operational sessions.

Before each visit, the coordinator clarified that feedback from participants is expected in relation to what participants have learned and plan to implement in their own organisations, as well as any recommendations they have for the host organisation. Host organisations have reported that feedback has been valuable. Feedback has been informative and has focussed on visual management and 5-S elements including stand-up meetings, flow and Kanban for packhouses and coolstores. Orchards focussed on processes. Several orchard visits included visits to orchards that had little knowledge of Lean. Some of these presented their process and received feedback that could help them improve the presented process. On other occasions, distinct Lean elements were recognisable despite the unconscious Lean ignorance. No list of applicable Lean elements has been developed by the cluster as it progresses through further meetings. Practical implementation is both shown and discussed at each session, leading to validation of applicability and implementation through practice.

The ongoing results from the Lean pipfruit cluster converge with other action research and case study results to validate the third objective and establish applicability and implementation approaches.

##### *5.4.4.4. Reflective cycles; reflection at long and short term intervals*

Both the action research orchards and packhouse were subject to reflective iterative cycles within cycles; the Lean cluster was not. The iterative cycles included data gathering, feedback of data, analysis and discussing new action (Coughlan and Coghlan, 2002). Meetings with staff resulted in actions by staff which were reviewed at the next meeting and in an operational context: Why did some things work? Why did some things not work? The researcher then reflected on the previous period before the next mini-cycle was started. Short term reflective cycles provided some opportunity for learning and developing a problem solving mind-set (Calhoun, 1993). Typical outcomes were that intended measures were not completed due to time constraints. Seasonal pressures did not facilitate sometimes simple improvement tasks.

At the end of each of the two action research years, the researcher reflected on the year gone-by and extracted broader lessons learned as a result of the longer iterative cycle. These too were discussed with participants in order to continue the exploration of Lean in the industry. Broader lessons learned included the realisation that the seasonality of the industry demanded a different approach towards learning, training and improvement. Other lessons are discussed as original theory in paragraph 5.4.4.5.

#### *5.4.4.5. Original theory; Lean re-defined for pipfruit and horticulture*

During the course of the action research component with the orchards, several original interpretations of Lean emerged. These included a construct regarding the orchard as a factory and trees as machines, producing product for a customer. Considering what made the machines produce (and thus could be wasted), waste was not restricted to human activities and processes but was also considered to include the in-process use of inputs such as (wasted) sunlight, (wasted) water, (wasted) real estate, i.e. orchard floor space and (wasted) soil qualities. These interpretations have not been encountered before in literature and it is here that new theory is resulting from action research.

#### *5.4.4.6. Action research synopsis*

The action research component of the inquiry synthesises with elements of the literature review and the reflective practitioner review to conclude that Lean is applicable to the sample organisations, albeit that not all Lean principles methods and tools were equally applicable. This synchronises with Lean theory which has clarified in the literature review that different industries adapt in different ways to Lean theory. Similarly, the implementation appears challenging for certain principles methods and tools, particularly caused by the seasonal nature of the industry which leads to a high volume of casual workers in a push environment. Triangulation across data sources and methods adds robustness to the results (e.g. Creswell and Miller, 2000), and the action research component also complements through elaboration and develops robustness of results by collaborating with other methods.

### 5.4.5. Applicability and implementation: Case study component

This section analyses and discusses the case study results to assess the applicability and implementation approaches of Lean for the NZ pipfruit industry.

#### *5.4.5.1. Case study packhouse (CSP) contribution to applicability and implementation*

Assessments: As with the action research companies, the CSP showed considerable progress on all three measurements, the 20 Kobayashi keys, 20 Lean principles methods and tools and the Tapping et al (2002) assessment. A number of tools were well understood and used. The Lean packhouse manager had made sure that there was improved employee involvement and empowerment and most of the interviewees showed an enthusiasm during interviews that appeared to be a reflection of their involvement in Lean.

Applicability: The improvements measured during the assessments showed that most of the assessment elements were applicable in a packhouse environment. Of all industry elements (growing, packing, storing and exporting) a packhouse shows the most parallels with a manufacturing environment and it is expected that the packhouse would demonstrate the best ‘fit’ with traditional Lean principles methods an tools. A summary of the applicability of lean principles methods and tools is attached as appendix 15. An example of appendix 15 is given in table 5-2.

TABLE 5-2: SAMPLE OF APPENDIX 15 WITH 32 PRINCIPLES/METHODS/TOOLS DISCUSSED

| ***Principle/method/tool*** | **Use** | **Packhouse/coolstore** |
|---|---|---|
| *One Piece Flow* | Current | A form of one piece flow applies; apples from 400 kg bins are continuously packed into different cartons of 18 kg, which are packed sequentially. |
| | Future or ideal state | Questionable if improvement can be made when assembly follows disassembly. One piece flow can be applied after pre-sizing, allowing packing to demand. |

Pull was used for bins from the coolstore in order to be packed but less so to comply with customer orders. On a number of occasions however fruit was packed particularly for a non-specific customer in a country with special access requirements. This is a well-known fact in the industry because several countries ask for specific phytosanitary quality assurance programmes which require registrations of orchards, packhouses and coolstores. Packing for customers in these countries requires selection of bins of orchards that comply with strict MPI requirements.

Implementation approach: The packhouse manager drew up a dedicated Lean transformation programme with himself being the champion, and he was supported by senior management. A number of fundamental Lean elements were listed by the champion with target dates for achievement. These included 5-S split up in sequential target dates, daily stand-up meetings, visual management improvement, Lean thinking and training. The manager reported after the first season that staff had started to demonstrate behaviours along the lines of continuous improvement to the point where they would no longer ask to change something but rather effect the improvement and report afterwards. Emiliani (1998) refers to this behaviour as 'Lean behaviour' where people perform actions because of their intrinsic rewards; the improvement results in pleasure that is worth repeating. A distinct culture change took place in the packhouse.

During the second season, the CSP hired a consultant to attend for several days and practice value stream mapping with a number of supervisory staff. These sessions were attended with enthusiasm and the CSP staff was encouraged by management to continue to look at their processes via the value stream mapping tool. During one of the Lean cluster visits, the staff made a point of showing how they had improved a load-out process using value stream mapping. This session was considered valuable by the packhouse manager as it presented a new face to present new information, and staff responded well to the initiative.

The CSP case study corroborates with the CSPC case study and action research data to confirm that the tested Lean principles methods and tools as in appendix 15 are largely transferable to the packhouse/coolstore situation and thereby helps to validate the third objective of the inquiry.

##### *5.4.5.2. Case study packhouse using a consultant (CSPC) contribution*

<u>Assessments</u>: The CSPC showed a significantly improved Lean position on the assessment using the 20 Kobayashi keys (Kobayashi, 1995). A similar result was evident with the scores on the 20 Lean principles, methods and tools. Interesting was that the difference between the post 2013 season and post 2014 season scores was relatively minimal. Scores on the Tapping et al (2002) instrument followed a similar pattern with the 2014 score showing an improvement on 2013 in seven criteria and a deterioration in one criteria. The total weighted score for 2014 was slightly higher than for 2013 at 108.0 versus 98.7. The total weighted score of the assessment before the inquiry started was 50.4, confirming that the organisation had made significant progress but progress decelerated during the last half year.

Possible causes for the result were that the company had 'dropped the ball' perhaps because the consultant stopped visiting monthly and started visiting quarterly in October 2013. Having interviewed several people and seen the packhouse operating at the same time of the last assessment, it appeared erroneous to believe that the operation had 'dropped the ball'. The researcher discussed the results with the packhouse manager and quality manager who both agreed that there appears to be a significant drop in Lean activity, immediately following the pressure of the export season. They personally experienced this and reported on 'Lean fatigue' which lasted for between one and two months. This phenomenon is of some significance as the sudden finish to the seasonal activities happens to most organisations within the industry.

The organisation has improved its position from the start of the inquiry on all three scales.

<u>Applicability</u>: The organisation had made significant progress during the period of the inquiry and indicated that the workplace organisation and continuous improvement had been applicable and helpful. Material control, standardised work and level production all featured during the interviews and the researcher's observations confirmed the applicability of these methods and tools. The fact that the Kanban system was taken as an example and copied by other Lean cluster companies indicates that the tool can be applied effectively. Other tools were also used successfully, confirming the applicability of these. These included some problem solving skills, PDCA, coaching, Lean accounting and a number of other standard Lean methods and tools.

Implementation approach: The consultant's monthly visits, combined with elements of the Toyota coaching method such as agreeing on a timescale for reviewing the introduced elements was very helpful. The consultant is an external champion, knowledgeable and dedicated to the single task of Lean implementation. The company paying for the consultant created an environment of getting the best value for money, leading to motivation to learn. The consistent introduction of new Lean elements provided education, training but also potential mental 'overload' of staff trying to implement what was understood while doing their normal jobs the normal way. Reinforcement and encouragement by the consultant meant that the organisation continued to make progress. In addition, the consultant would provide an implementation activities plan, stating activities, people responsible for each and when each was planned to be completed. This too appeared to be a helpful guide to continue working 'on' the business aside from working 'in' the business.

During interviews, key staff explained that they worked more 'on' the business in the off-season and this appears consistent with the experience at the action research orchard and packhouse. Although the opportunity to work on continuous improvement may be easier to take during the off-season, it appears imperative to continue with observations and improvement during the season, when it matters.

#### *5.4.5.3. Mini case studies Exporter 1 (CSE1) and Exporter 2 (CSE2) contribution*

As reported in paragraph 3.5.5.1 of the chapter on methodology, exporters did not respond to the call for research volunteers, and direct approaches to a number of export companies eventually resulted in two exporters granting restricted cooperation. The researcher had to use his personal influence and discuss the inquiry objectives in some detail before both exporters agreed to participate as they did. The fact that out of more than eighty exporters, there were no offers to volunteer and that only two exporters participated albeit with caveats, may be taken as evidence of the exporters' position in relation to the inquiry.

If nothing else, the inquiry was not considered relevant enough to volunteer participation. Considering the earlier reported value stream breakthroughs from the ARO, it appears that the opposite is evident. Contributing to the reluctance to contribute is the within-industry competition between exporters for supply (growers) and the in-market competition for customer sales as is evident from the practitioner review.

Both exporters rated the customer very high in the interviews. The customer must be qualified at this point in order to clarify exporters' positions. The practitioner review clarified that exporters deliver a sales and logistics administration service to the grower for which they claim a commission or set fee per sold unit. The exporters sell the fruit to the customer. To the exporter therefore, both the grower and the purchasing customer are customers for their services. This is an important point as the exporter's value stream is confused with one customer at the end of the value stream and the other at the beginning of the value stream. This dichotic relationship is unlikely to serve the end-customer as well as it potentially could, and by inference, the same applies to the grower.

Notwithstanding the up- and downstream customer concept, the exporters both made clear that they spend a lot of time in the market to discuss product and delivery options to the purchasing customer. Exporters are therefore knowledgeable about the purchasing customer's requirements and intuitively maintain the first Lean principles of Womack et al (1990). Although CSE2 was adamant that communication and information were very important, relevant customer information was not relayed to the grower/supplier until such time that less influence could be exerted by the grower on the product. CSE2 did communicate to growers what varieties were in demand but growers would sometimes plant a different variety because they needed to level the load during harvest.

The responses of exporters to requests for volunteers and the subsequent lack of exporter volunteers may illustrate that there may be unconscious ignorance (Flower, 1998) amongst exporters that prevents a more positive approach towards Lean in the industry. The exporter's position in the value stream is very much applicable as was shown by the ARO. Although not exposed to any measurements, the researcher believes that exporters would benefit from Lean supply chain and service delivery principles methods and tools. The exporter case studies do not triangulate very well with the action research and case studies of orchards and packhouses/coolstores. The mini case studies do complement our understanding of the third objective by clarifying the difficulties in obtaining data about applicability and implementation approaches from exporters. Exporters would do well to remember that it is the supply chains that compete, not individual companies (Christopher & Towill, 2001).

#### 5.4.5.4. Case study synopsis

Both packhouse case studies demonstrated that Lean is applicable in a packhouse environment and that Lean can be implemented in various ways. It is evident that seasonal pressures distract from Lean implementation and packhouses would benefit from a dedicated and regular reinforcement of Lean. It was also apparent that Lean cannot be implemented inside a period of a few years and that continued attention is required to keep the positive development going.

Exporters appeared to be aware of the relevance of their paying downstream customers but were compromised by their dependence on upstream customers (growers) for supply. This placed exporters in a position of balancing grower demand for high pack-outs with customer demand for high quality fruit. In addition, case study exporters did not see that customer requirements are best communicated before pruning, at the end of each harvesting season, and not in December or January when the grower cannot change the quality of his fruit.

### 5.4.6. Synopsis of analysis and discussion of the third objective

The case study component of the inquiry synthesises with elements of the literature review, the reflective practitioner review, the consultant interviews and the action research element through triangulation, complementing and development to support the third objective of chapter one and helps to provide a basis for achievement of the fourth objective; the model.

## 5.5. Chapter conclusion

### 5.5.1. Achieving objectives

This chapter analysed and discussed the results of the inquiry and supports the following:

- Common Lean themes partly fit the orchard activity, substantially fit the packhouse/coolstore activity and fit the exporter activity as service provider but remains mostly untested. This confirms the first objective.

- The current level of Lean deployment in the industry is low; there are elements of intuitive but intuitive unconscious knowledge in terms of Lean implementation. This confirms the second objective.
- A number of, but not all, Lean principles methods and tools are applicable to the several industry sector activities of growing, packing, storing and exporting. Certain principles methods and tools are affected by the seasonal nature of the industry; this means that some are affected by the push component of the industry, some require more emphasis (e.g. visual management, standardised procedures and training for seasonal staff) while others such as the waste of natural resources, are new concepts to Lean theory. The implementation appears more challenging during the season than during the off-season and a dedicated champion may prove valuable when implementing Lean.

This synchronises with Lean theory which has clarified that different industries adapt in different ways to Lean theory.

This achieves the third objective.

### 5.5.2. Reliability and validity

Triangulation across data sources and the applied mixed methods adds robustness to the results and supports the results accordingly (Creswell and Miller, 2000; Snow and Anderson (1991, cited in Tellis, 1997)). The elements of table 3-5 of the methodology chapter have been executed diligently to ensure reliability and validity of the inquiry results.

Although the results are the consequence of an inquiry into the pipfruit industry, numerous references have been made to the wider horticultural industry. Applicability of results is expected to cross reference with other horticultural annual tree crops and to a lesser degree with annual horticultural crops such as vegetables. Horticultural crops, but specifically annual tree crops, have similar dilemmas to the pipfruit industry. These include long lead times before production, use of natural resources, seasonality of the industry and push of product into the market.

### 5.5.3. General comment

The number of research companies and the complexity of mixed research methodologies resulted in a substantial volume of data. Outcomes were nonetheless both generalised and detailed in terms of specific Lean principles, methods and tools because of the large number of these involved. For specific information on applicability of principles methods and tools, appendix 15 summarises thirty-three, indexing each to the three main industry sectors.

# 6. Developing a Model, the fourth objective

**“There is nothing quite as practical as a good model”** (variation on Kurt Lewin, 1951)

## 6.1. Introduction to development of a model

Objective four of this thesis is to:

*‘Develop a conceptual Lean model for the NZ pipfruit industry and consider if the model is applicable to the wider horticultural sector’.*

The next section analyses and discusses the development of an industry model as proposed for the fourth objective.

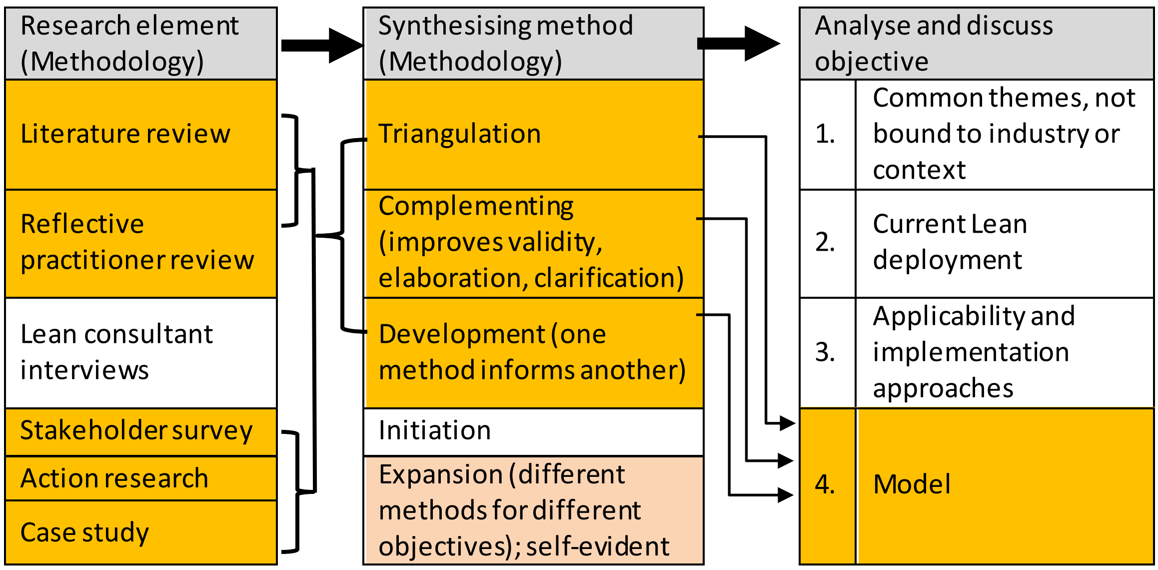



FIGURE 6-1: SYNTHESISING FINDINGS INTO INDUSTY MODELS

The deductive component synthesises between mixed methods following the format of Greene et al (1989) where different research elements combine through selected synthesising methods to support the stated objective (figure 6-1). The fifth synthesising method (expansion) is not specifically highlighted as the range of the inquiry is expanded throughout the inquiry by using different methods to achieve objectives.

The section will first reiterate the model extracted through the literature review at the end of chapter two. A discussion follows on how results from the inquiry can be used to adapt the model to industry-specific characteristics. The model is followed by the development of a framework. The framework includes the lessons learned, including a future state Lean activity planner with principles, methods and tools that supports the application of the conceptual model. The relevance of the framework is discussed during the development of the industry-specific model. A brief discussion on its applicability to other horticultural sectors follows, after which a synopsis of the chapter captures the essence of the model and framework.

### 6.1.1. The Lean model

Several Lean models have been discussed and analysed in the literature review. These are summarised in table 2-3 of chapter two. The fundamental model from chapter two is shown in figure 6-2 with two text boxes added, summarising the critical elements of the model.

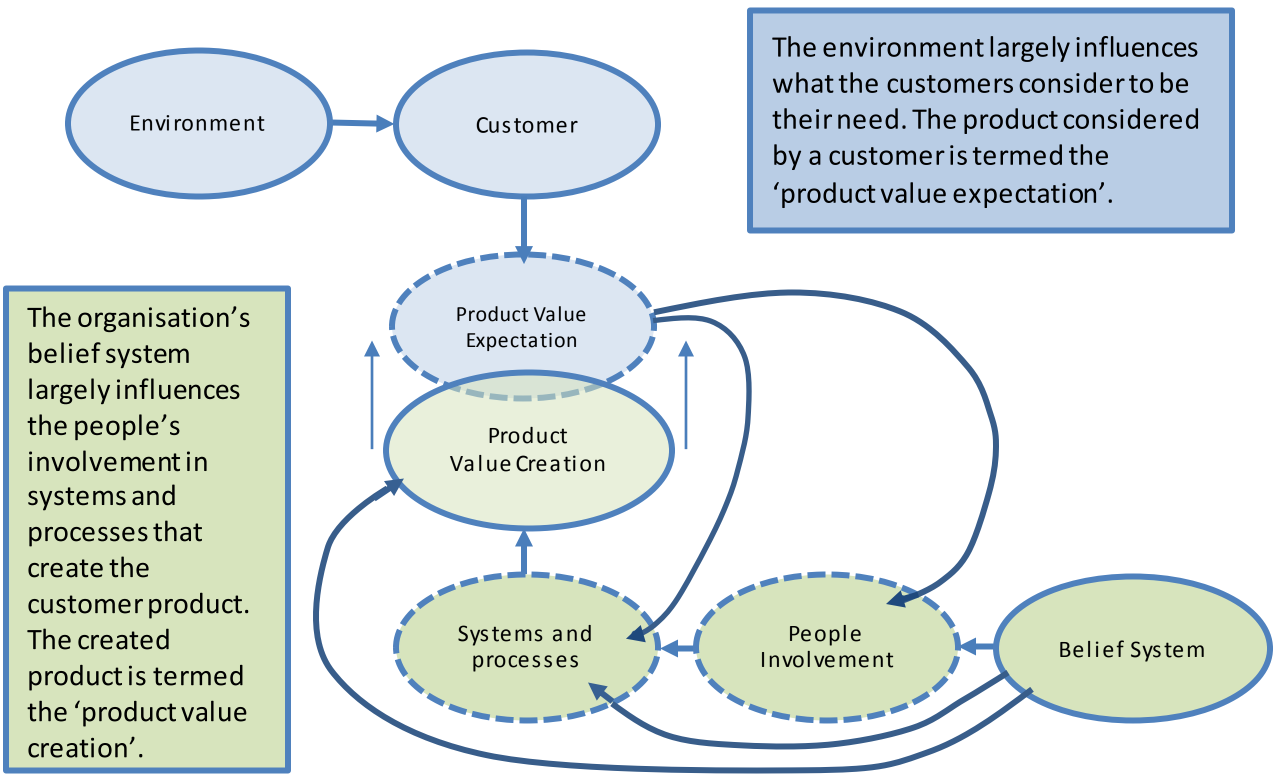



FIGURE 6-2: FUNDAMENTAL LEAN MODEL WITH SUMMARY EXPLANATIONS

### 6.1.2. A framework to complement the industry model

Models are created from concepts and ideas and intend to help people understand the real life subject of the model; in essence, they are a representation of a real life situation. A stand-alone model may well be an accurate conceptual representation of reality but may not necessarily explain how to implement the model in specific environments or circumstances. For this, it is helpful to provide a framework to support the model. A framework provides an orderly scheme that can bring together observations and facts resulting from an inquiry—the 'what and why'. The framework then links findings to a useful structure that is accessible and provides a coherent guide to understanding of the model—the 'when and how'. Frameworks can help explain what occurs and why something occurs or how it works, which implies that a framework can provide a basis for prediction (Polit & Beck, 2004).

## 6.2. Applying lessons from the inquiry to the model

### 6.2.1. Themes that emerged from the inquiry

Major themes that emerged from the multiple methods inquiry are reiterated in table 6-1, with some detail added:

TABLE 6-1: RESEARCH FINDINGS, GROUPED AND DETAIL ADDED

| Theme | Detail |
|---|---|
| **1. Lean theory:** | |
| | • Lean is fluid and adaptive to its environment. |
| | • Lean is challenging to implement; factors critical for success are identified. |
| | • There is an apparent thematic continuum from general to specific, general being less perceptible and tangible such as philosophy—but fundamental, while specific is more perceptible and tangible, such as tools—and necessary for operationalising Lean. |
| | • Organisations can never truly 'be' Lean; they only achieve levels of Lean maturity. |
| **2. Current deployment theme:** | |
| | • A very low percentage of pipfruit organisations engage in Lean. |
| | • There is some organically developed Lean (unconscious competence). |
| | • Organisations acknowledged being unconsciously ignorant of Lean. |
| **3. Applicability themes:** | |
| | • Some Lean principles are less applicable than others, e.g. 'pull'. |
| | • Multiple Lean tools are usable but, |
| | • The usable tools differ from sector to sector. |

| | |
|---|---|
| **4. Implementation themes:** | |
| | • Lean is difficult to implement. |
| | • Having the Lean philosophy is a prerequisite of becoming Lean. |
| | • The use of a champion or consultant drives progress. |
| | • The relative level of progress decelerates over time. |
| **5. Industry-wide themes** | |
| | • There is a lack of communication in the supply chain; exporters communicate fruit quality demands too late (after all pruning and thinning has been completed, affecting colour and size of fruit). |
| | • Lean fruit type development is achieved by time-paced development. |
| | • The Lean pipfruit cluster encourages benchmarking. |
| **6. Sector specific themes:** | |
| | • Lean applications differ by industry sector. |
| | • Orchards compared manufacturing process with machines to growing process with trees. |
| | • Orchards identified different forms of waste in the orchard such as (wasted) sunlight, (wasted) water, (wasted) real estate, i.e. orchard floor space and (wasted) soil qualities |
| | • Packhouses packed fruit while customers (and export countries) were unknown ('on consignment'). |
| | • Country rules concerning pests and market access create instability/variable packing outcomes for orchards, packhouses/coolstores and exporters. |
| | • Exporters had a focus on the customer but did not timely communicate customer demand to the orchards. |
| **7. Seasonal themes:** | |
| | • The seasonal pressures caused by high volume and little time creates overburdening during the season. |
| | • This leads to a sudden 10-fold staff increase which requires:<br>• Training<br>• Is difficult to empower<br>• Is difficult to cross-train |
| | • Organisations had different approaches for permanent staff and seasonal staff. |
| | • Seasonal pressures do not facilitate working on the organisation; pressures allow only working in the organisation. |
| | • There is possibly a form of 'improvement fatigue' developing. |
| | • Weather variability determines production activities which vary to achieve customer demand. |

These grouped observations present challenges to the basic model from chapter two, and will assist adapting the model to industry sectors and the associated framework.

### 6.2.2. Synthesising sector-specific applicability data to the model

The results of the literature review led to the fundamental Lean model that emerged in chapter two. The model from chapter two is transparent for stakeholders as a meta-model.

The question arises if this model is affected by the applicability of principles, methods and tools for each industry sector as these emerged from the inquiry. This will be discussed in the following paragraphs.

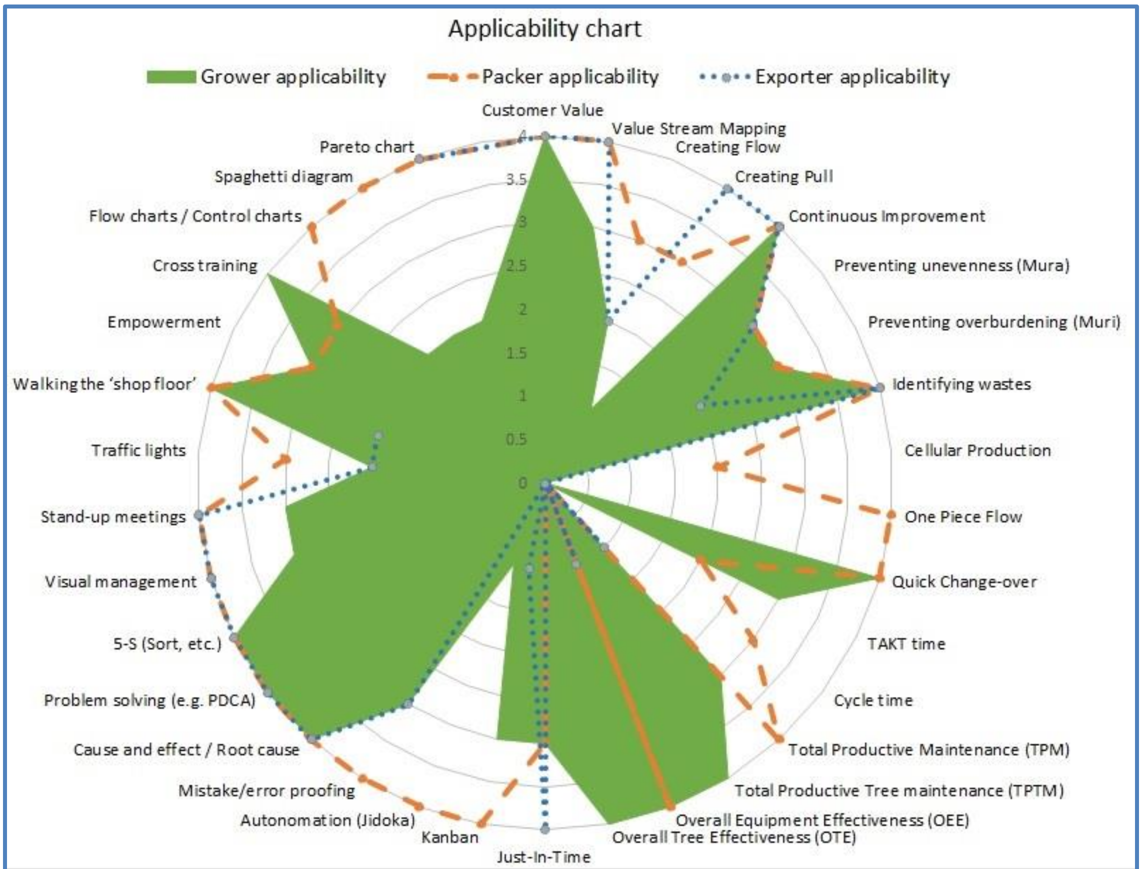
The supporting framework for the model includes the lessons concerning the implementation of Lean in different types of industry sectors such as growing, packing/cool-storing and exporting. The inquiry showed that not all Lean principles, methods and tools are equally applicable to these different types of sector activities within the industry. Appendix 15 ('Future state Lean activity planner') elaborates on the level of current implementation and future applicability. It is considered helpful to visually summarise the differences between applicability of principles methods and tools to each of the different industry sector activities (figure 6-3).

The results of the action research and case study demonstrate that most common Lean methods and tools that were tested are applicable to a packhouse/coolstore situation. The action research orchard evidenced that not all standard Lean methods and tools can be readily implemented in an orchard environment. In addition, the action research orchard started developing the theory that natural resources can be wasted when they should be used, and this created the beginning of a new form of waste, followed by processes to reduce that waste.

Figure 6-3 presents a comparison of the applicability of thirty-three Lean principles, methods and tools for each of the industry's sectors (growing, packing/storing and exporting). The comparison resulted from the inquiry. Each of the principles, methods and tools was scored using the following criteria:

- 0 = Not applicable,
- 2 = Partly or potentially fully applicable-if contextualised to industry,
- 4 = Highly applicable

Not all thirty-three principles, methods and tools were included in the inquiry for all industry sectors and figure 6-3 shows several 'blank' areas where the inquiry did not provide data. Where an item did not quite fit the descriptions above, the scores of 1 and 3 were used to indicate the expected level of applicability.




Key:
**0** = **Not applicable,**
**2** = **Partly or potentially fully applicable-if contextualised to industry,**
**4** = Highly applicable

FIGURE 6-3: APLICABILITY OF LEAN PRINCIPLES, METHODS AND TOOLS BY SECTOR

Although the thirty-three principles, methods and tools were not aligned with the characteristics established in chapter two (table 2-12), they can be allocated to the themes of people involvement or systems and processes and can be projected on the model from chapter two—for each industry sector. The effect of this conceptual approach would be a different radar graph for each industry sector inside the People Involvement and Systems and Processes themes, resulting in different applicability models for each industry sector. Such projection is expected to clutter the clarity of the model and it is proposed to reflect the applicability of elements within the supporting framework.

### 6.2.3. Effect of the inquiry findings on the model

This paragraph intends to discuss the effects that the inquiry findings have on the basic model from chapter two and help shape the basic model into several industry models.

Paragraphs 6.2.1 and 6.2.2 discussed the findings which are summarised as follows:

1. Lean theory, where Lean was found to be challenging, fluid and adaptive.
2. Current deployment, where Lean was found to have a low level of deployment.
3. Applicability (6.2.2), where different tools were found to have different levels of applicability for each industry sector.
4. Implementation, where Lean was found difficult to implement and instilling the philosophy and the use of a transformational driver assisted implementation.
5. Industry-wide themes, such as lack of communication in the supply chain.
6. Sector-specific themes, such as new orchard waste identification, production without knowing the customer, the customer's value expectation and the customer's country.
7. Seasonal themes, such as variability of production due to effect of the natural environment (e.g. weather) in the orchard, high seasonal pressures leading to overburdening and a 10-fold increase of staff with all its consequences.

The effect of the seven themes on the basic Lean model from chapter two is discussed here:

1. The fact that Lean theory was found to be challenging, fluid and adaptive is partly evidenced by the fact that the Lean pipfruit industry model that follows is an adaptation from the basic model. Lean continues to develop, posing challenges for those who implement Lean, specifically in new environments.
2. The relatively low level of current deployment in the industry is an empirical fact and has no effect on the creation of a new pipfruit industry model, other than confirming the need for such a model to assist the industry with understanding Lean.
3. The different levels of applicability of selected tools for each industry sector may affect the model, however as stated in paragraph 6.2.2, projecting the level of

applicability of tools on the basic model would clutter the model and also finds a better fit in the framework.

4. The difficulty implementing Lean showed the importance of the embedded philosophy as already presented in the model from chapter two. The use of a transformational driver such as a champion or consultant to assist deployment of Lean is important. As implementation is difficult, it is apparent that a framework is needed to assist implementation.

5. Industry-wide themes, such as lack of communication in the supply chain affect each individual industry sector but specifically the value stream between sectors. The belief system and systems and processes of the mature Lean organisation manage effective communications between value stream partners and communications do not present a new theme that would need to be introduced to an industry or sector-specific model.

6. Sector-specific themes such as new orchard waste identification and production without knowing the customer do lead to the potential to develop sector-specific models.

7. Some seasonal themes are buffered by a Lean organisation, e.g. the natural environment (e.g. weather) in the orchard cannot be changed but processes and people involvement can mitigate such effects and therefore lead to improved production. Other seasonal themes such as a 10-fold increase of transient staff will affect the model, e.g. the Lean organisation may use the permanent workers during the off-season to plan, prepare, simplify, enable and smooth the seasonal activities.

Summarising the effect of the inquiry findings, there are themes that affect the industry model because they affect the people involvement, the systems and processes and the product themes of the model. These are:

- The fact that only a portion of the product is created to match the customer's value expectation while the balance is pushed into the market

- The 10-fold increase of staff to the growers and the packhouse/coolstores; and

- The approach by orchards to identify new forms of waste in not maximising the use of natural resources such as sun light.

This leads to the proposal that the models representing the exporter, packhouses/coolstores and growers are adaptations from the fundamental mode from chapter two. The sector-specific models will be discussed next.

### 6.2.4. A Lean pipfruit model for industry sectors

The model in figure 6-4 emphasises that the Lean vision, philosophy, principles and strategy—captured by the concept of 'Belief Systems'—are a vital prerequisite to reach the people within the organisation and affect the systems and process design. Lean must be pervading the organisation at all levels before it can call itself truly Lean. Similarly, the different applicability of Lean principles, methods and tools (figure 6.3) shows that not all Lean applies equally to the different industry sectors while other elements are new to the theory of Lean (e.g. Total Tree Maintenance).

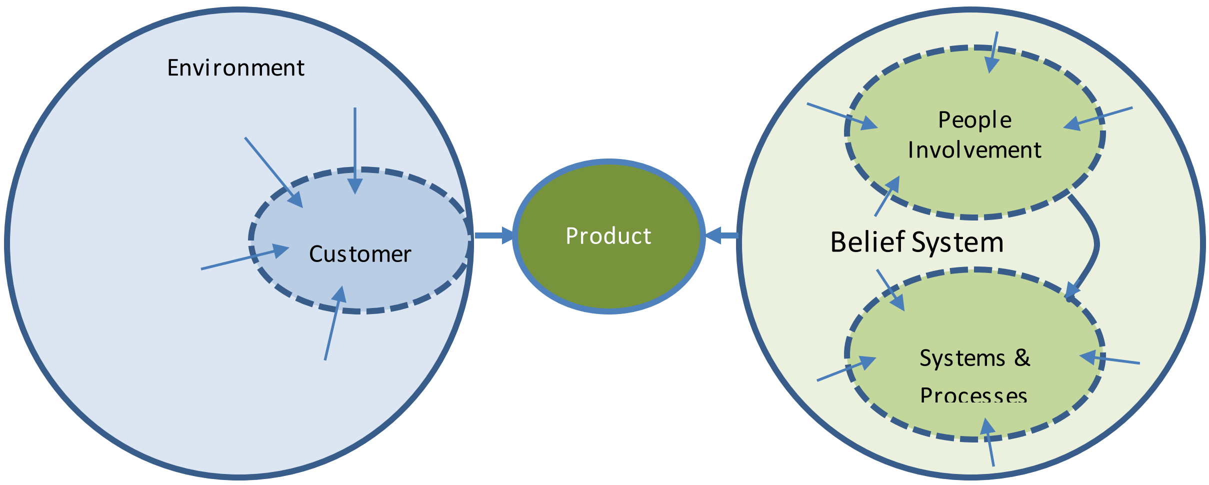



FIGURE 6-4: FUNDAMENTAL LEAN MODEL

The model depicted in figure 6-4 shows an integrated and interacting connection between people and processes to create products (services are considered to be a product) of value to customers, independent of available machinery or material, and similar to Krafcik's 4-M model that differentiates between hardware and human factors (figure 2-14).

A mature lean organisation is expected to make better use of machinery and material through its people and systems and processes than immature Lean organisations. As the organisation matures, it develops more Lean characteristics within the people and process themes. Throughout, the belief system expands across all departments or layers of the organisation, irrespective of how many layers the organisation has, similar to the recursive layers of the viable systems model. Within the organisation belief system, people involvement and systems and processes may be nested in different departments or layers. Recursive sub-systems—similar to Beer's model—are not shown in the model to avoid cluttering of the model.

#### *6.2.4.1. Illustrating the different exporter products in the model*

The exporter has a number of dedicated programmes where the customers and the customers' value expectations are known. However during the packing process, all size, colour and grade combinations are packed/stored—a lot of these without any known customer. This product is pushed into the market; it is not produced to meet a specific customer expectation, it is produced because it was convenient to pack it at the time and was the indirect result of the normal size and colour distribution of fresh horticultural product (figure 6-5).

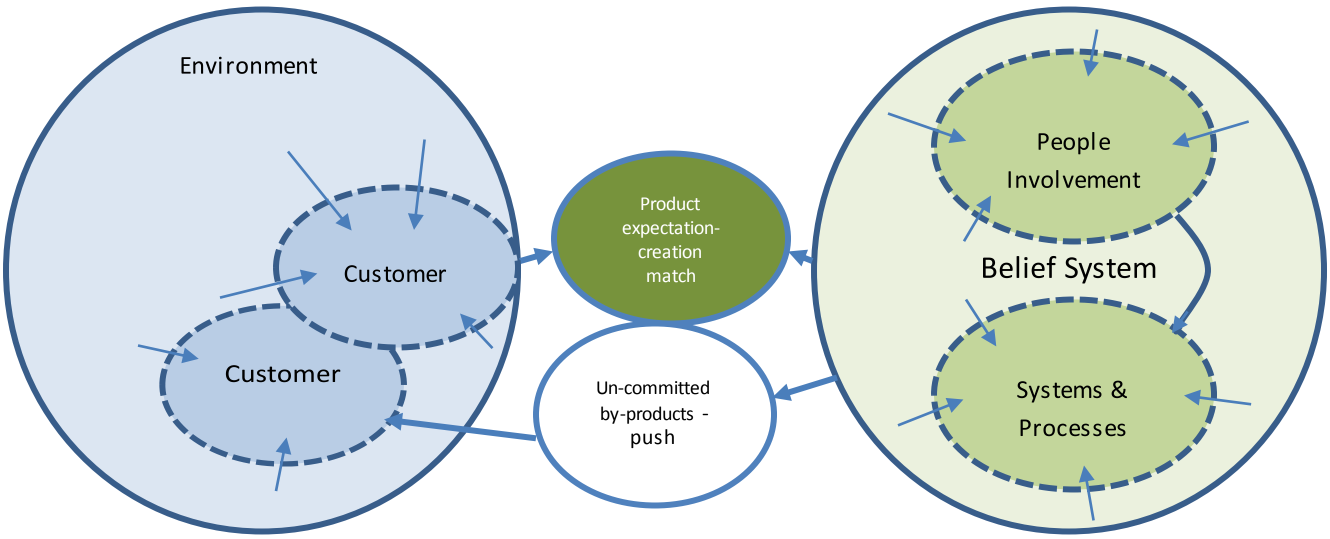



FIGURE 6-5: LEAN MODEL, ADAPTED TO EXPORTER SECTOR

In the exporter sector-specific model, there is no significant increase of staff during the season. The exporter however is faced with the production to customer demand, combined with production to 'push-to-customer'. This is caused by the packhouse packing all the apples in the bin, including all sizes and all colours and defect grades; there is no other option for the packhouse unless a significant pre-sizing process is undertaken after which product can be packed to demand. This process is not used in the NZ pipfruit industry except small scale exceptions.

The exporter has a customer for the specific sizes, colours and defect grades that he/she has pre-sold, but has no specific customer for the balance of the product. This product is pushed into the market. Where the exporter can theoretically be Lean for the customers and products known when growing and packing the product, the exporter can only be pushing the balance of the product, finding customers that will accept the product as opportunistic value. Although the model is poor in that it can only ever partly be Lean, it is also real in that it reflects the current pipfruit export process.

#### *6.2.4.2. Illustrating the effect of the seasonal staff increase on the model*

The 10-fold increase of staff for the period of three to four months each year has an impact on the basic model (figure 6-6). It is unreasonable to expect seasonal staff to adopt the Lean belief system within the short period of employment and while being driven to focus on productivity (productivity being output-volume focussed). Although seasonal staff will be exposed to most of the visual Lean clues and some of the Lean influences on systems and processes, seasonal staff are aware of their short-term involvement. Doevendans (2010) identified a different focus between permanent and transient staff and the effect on the organisation is different.

Seasonal staff is more short-term orientated and has a stronger focus on immediate financial rewards. This is represented in a sector model, applicable to packhouses/coolstores—those organisations that have a 10-fold staff increase for a short period of time, including the grower section whose model is discussed next (Figure 6-6).

In figure 6-6, the seasonal people involvement and seasonal systems & processes have been drawn separate to the -what is now termed- 'stable' people involvement and seasonal systems & processes. The term 'stable' signifies the permanency of the influence of the belief system on the people involvement and seasonal systems & processes.

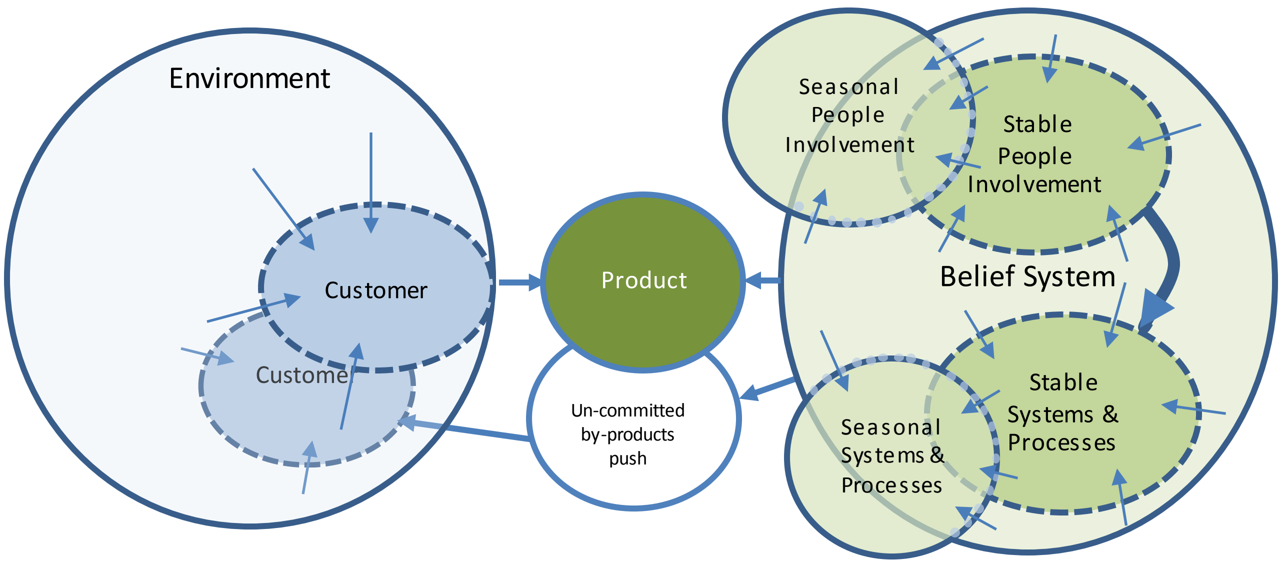



FIGURE 6-6: LEAN MODEL, ADAPTED TO PACKHOUSE/COOLSTORE SECTOR

Within the organisation, few arrows show that there is some influence by the belief system on the seasonal workers, both in their involvement and in the systems and processes, while more arrows point at a greater influence of the belief system on the stable people involvement and systems and processes. The two seasonal boxes (seasonal people involvement and seasonal systems and processes) are drawn partly outside the influence sphere of the organisation's belief system as solid lines. The solid lines symbolise that there is no effect of the belief system on part of the seasonal people involvement and seasonal systems & processes. They overlap the stable people and process boxes as well as the belief system, as well as the non-Lean outside world to show the influences to which they are exposed.

The second major theme is the production of product without known customer by growers and packhouse/coolstores. This is shown in figure 6-6 as it impacts the grower and packhouse/coolstore, however the explanation is found in paragraph 6.2.4.1 to avoid repetition of the justification.

### *6.2.4.3. Illustrating the effect of new forms of waste on the model*

Both the growers and packhouse/coolstores are significantly affected by the seasonal staff increase, however only the grower results defined a new approach towards waste, identifying the waste of free natural resources such as sun and rain. This new perception of waste becomes an important part of the systems and processes theme for the orchard sector and is highlighted within the systems and processes theme. The permeable border symbolises the effect of the belief system on systems and processes, specifically the stable systems and processes and particularly the new approach towards free resource waste such as sun and water (figure 6-7).

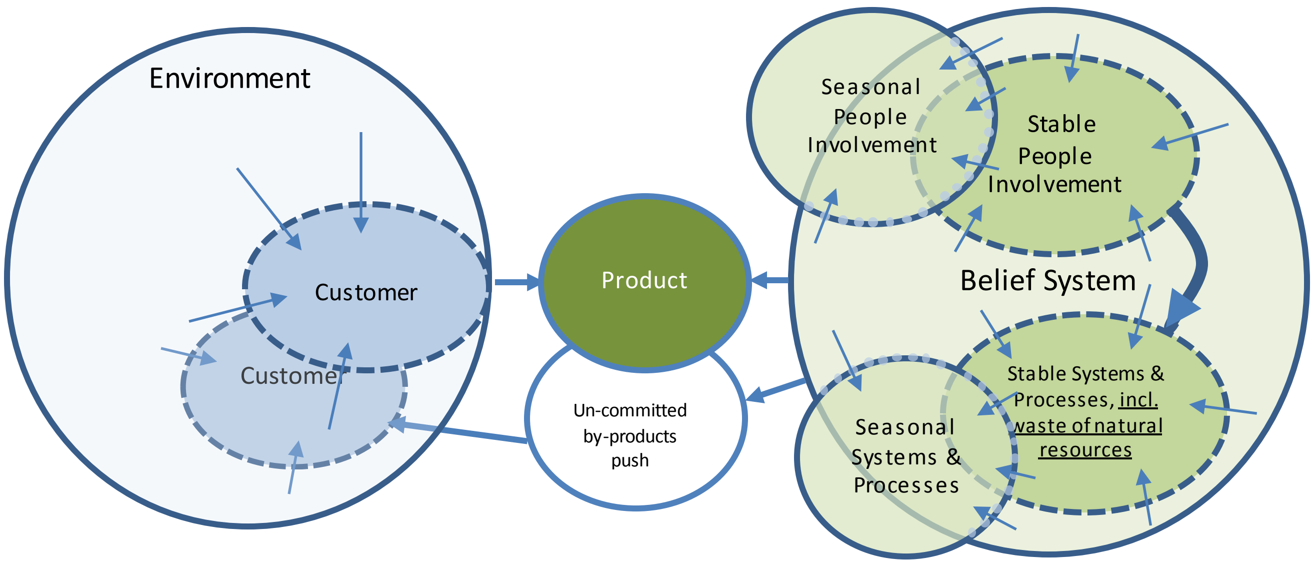



FIGURE 6-7: LEAN MODEL, ADAPTED TO THE GROWER SECTOR

## 6.2.5. Summarising the industry's sector-specific models

The Lean model extracted from the literature research in chapter two is in essence a valid model for all Lean organisations. The essence of Lean is not in the technology—all organisations can purchase technology—and it is not in the materials. The essence of Lean lies in what is done to the material inputs during the pre-production and production process by the involvement of the people within the Lean organisation and the systems and processes that they created and continue to improve to create customer value.

The generic Lean model from chapter two is taken and adapted into three specific industry sector models; one being faced with the production of customer-value products combined with non-customer products of which the value is unknown (exporters); one having a 10-fold staff increase for a short period of time (packhouses/coolstores) and one having a 10-fold staff increase for a short period of time and new forms of waste to consider (growers). In all three sector models, the essence of the organisational model remains intact; it is the belief system that creates Lean through people involvement and systems and processes (table 6-2).

TABLE 6-2: EFFECT OF THEMES ON INDUSTRY SECTOR MODELS

| | **Exporters** | **Packer/coolstores** | **Growers** |
|---|---|---|---|
| **Product** | Affected | Affected | Affected |
| **Staff increase** | Not affected | Affected | Affected |
| **New forms of waste** | Not affected | Not affected | Affected |

The models match the model requirements posed earlier in the methodology section, namely:

- The models are grounded in a set of transferable Lean principles, methods and tools.
- The fundamental model emerging from the literature review in chapter has served as the basis for sector-specific models.
- New theory in the form of orchard natural resource waste have been added to the grower sector-specific model.
- The model shows the effect of the 'invisible' Lean themes on the 'visible' ones and displays Lean as a holistic and integrated paradigm.

However no claim can be made that the production of customer value and non-committed product is similar for other horticultural industries, and this element of the industry models must be individually assessed for those industries.

The models give rise to consider the suitability and implementation of Lean in the horticultural industry sectors generally and in the pipfruit industry specifically.

## 6.3. Building the framework

### 6.3.1. A living model and its place within a framework

The last of five principles identified by Womack et al (1990) is to continuously improve. The same principle is referred to by Liker in the Toyota 4P model and it also returns in the Toyota house of Lean (Liker, 2004). It is evident that continuous improvement is the last step in the Toyota process; the process and tools can always be improved. This implies that no matter how 'good' a company is, it can always get better. This potentially creates a problem for any Lean model as follows. Models are reasonably static in how they mirror the real life situation. Mitroff's model, for example, creates more than 3000 options within the same model, but the options are finite (Mitroff et al, 1974). Although the situations and solutions may change, the model remains unchanged.

Earlier analysis proposed that Lean is both fluid in time and adaptive to its environment. The continuous learning discussed by Liker (2004) parallels with action research models where iterative cycles spiral until the inquiry is completed (e.g. Cardno, 2003) (figure 7-3). Lean however is not a finite state. Lean is an endless process of improvement.

#### *6.3.1.1. Forever learning and exploring*

Axiomatically, a company can never be fully Lean because that would imply that no further improvements could be made. Both from literature and from the inquiry it is clear that Lean cannot be achieved in a short period of time, e.g. a few years. This implies that a Lean model will have no finite end. In principle therefore, the Lean model is an infinite system with no end once started. Another axiom is that initial steps lead to some improvement which will facilitate improved production and further Lean steps to explore. In essence, a Lean model is an infinite stair case (figure 6-8), forever ascending towards the ideal state but never quite achieving that ideal state. Weick and Quinn (1999) confirm this with their belief that the trajectory of change is often in the form of a spiral.

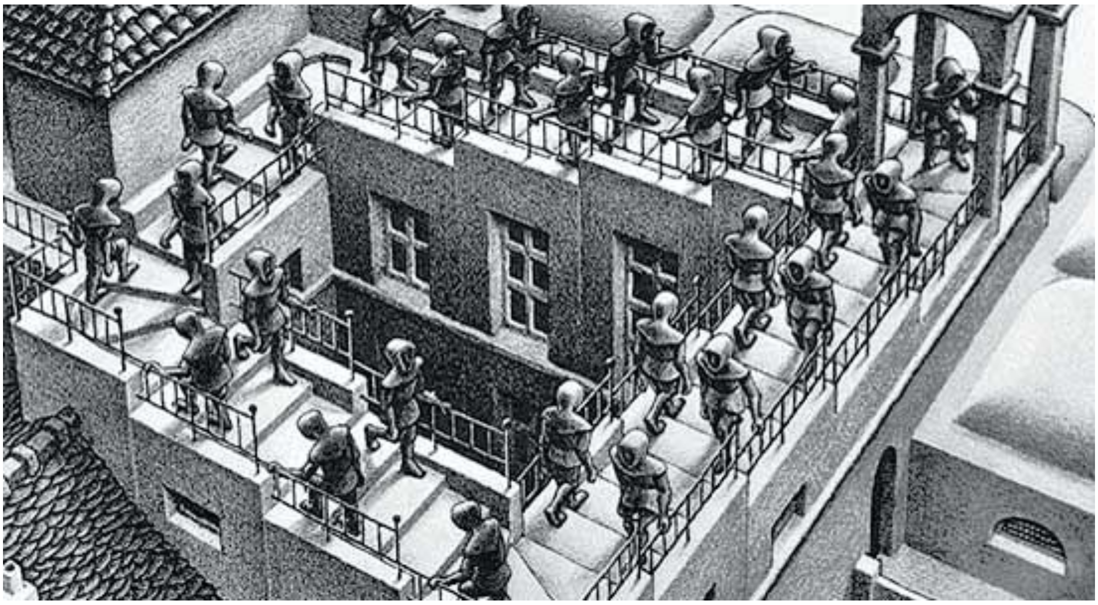


FIGURE 6-8: FOREVER LEARNING AND IMPROVING, AN INFINITE STAIRCASE



It is therefore proposed that the model becomes part of a framework which considers both what we have learned and how the model should be implemented. The model then, although a static representation, becomes part of a holistic approach, where lessons learned mix with requirements to lead to implementation and sustainability. The following paragraphs elaborate on the second part of the framework, the 'when and how'.

### 6.3.2. The implementation approach of the framework

Steps can be individual or combinations, as the organisation deems appropriate. The sequence of steps is proposed to be very similar if not identical to Shewhart's PDSA cycle, also referred to as the Deming's PDCA cycle (Deming, 1986), however corresponding to the inquiry results, the first step needs to be education, transforming the sequence into EPDCA. Individual steps must include education in Lean, training, discussing, trialling and anchoring. It is important to maintain a step-wise approach to prevent overburdening and achieve positive reinforcement through success (Catania, 1984) until the culture is established.

Lean implementation continues while critical success factors are favourable. If critical success factors are unfavourable, the literature review has shown that it is detrimental to continue because the effort is likely to fail. In such a case, it is better to focus on consolidation and 'live to fight another day'.

It is appropriate at this point to discuss the effect of the overburdening season on Lean implementation. One of the case study packhouses clearly indicated a deflated period immediately following the end of the export packing season. Staff were tired and hesitant to continuously improve for a period of approximately six weeks. At this point of the inquiry, it is accepted that there may be some Lean implementation fatigue and that there may be merit for a pre-determined period of lower drive to continue with continuous improvement. If Lean were forced in such an environment, the negative reinforcement following failure to implement would have a detrimental effect on the overall implementation strategy.

Once the culture is embedded, it is axiomatic that there is no urgent need to check that the critical factors are still in place. This is the higher stage of lean implementation, effectively Lean sustainability. An embedded Lean culture continues to learn and improve at all levels, without the need for plateaus.

### 6.3.3. Framework adjustments for growing, packing/storing and exporting

Now that the fundamental model and the implementation phases have been established, the only difference between industry sector activities lies within the applicability of different principles, methods and tools. Not all principles, methods and tools will be equally applicable or can be implemented similarly (refer figure 6-3). A single 'detailed' model for all sectors and all sizes of organisation is not practically achievable. The following sections discuss several specifics for the different industry sectors (refer also to appendix 15).

#### *6.3.3.1. Orchard future state Lean activity planner*

The orchard model differs from manufacturing because it involves manipulating nature in order to produce. Growing natural products is philosophically new to Lean implementation. The orchard model proposes to consider natural inputs as 'standard' inputs that can be used to add value or can be wasted. Natural elements include soil, orchard floor, sun, water, soil and possibly other unexplored elements.

For growing, there is waste in activities (e.g. wasting spraying chemicals) and waste in passivity (e.g. not using all available sunlight, rain or orchard floor available). This new philosophy needs adjusting to, but has already been interpreted by the ARO (refer chapter 5) and has led to the planning of more reflecting cloth to use sunlight more effectively and a deliberate re-planting program for dead and diseased trees. Generally, orchards already unconsciously understand load levelling of labour.

TABLE 6-3: CURRENT AND FUTURE STATE FOR ORCHARD QUICK CHANGE-OVER PLUS EXAMPLE

| ***Principle/method/tool*** | **Use** | **Grower/Orchard** |
|---|---|---|
| *Quick Change-over* | Current | Change-overs in orchards include trees, sprayers and people. Orchards can plan for quick change-over of trees. Filling up sprayers requires quick change-over. More time consuming is the changing of pruners, thinners and pickers from block to block. |
| | Future state | Trees are pulled, soil fumigated and trees re-planted in high density fast maturing plantings, reducing non-productive period to a minimum. Spray filling combined with refuelling or other. Setting up blocks before staff arrive, getting staff to take own ladders and buckets to new blocks. |
| | Example | A grower trains staff that they must take their picking ladders to the end of the row to make pick-up for removal less time consuming. The next phase is that the harvesters move in a grower provided van and tow the ladders themselves, saving time and making change-over much quicker. |

Details for orchard specific applicability of Lean principles, methods and tools are found in appendix 15. Looking at figure 6-3 (applicability by sector/activity), the following examples are given, one from appendix 15 (Quick Change-over, table 6-3) and a second descriptive example below.

An orchard may for example decide to start working on getting timely customer requirement information from the exporter. In that case, it needs to discuss the Lean paradigm with the exporter and explain how it intends to go about achieving the right product for the customer.

The exporter forms part of the value stream and the exporter's assistance is a prerequisite for the grower's successful production of the right size, the right colour and the right specifications for country access.

### 6.3.3.2. Packhouses and coolstores future state Lean activity planner

The packhouse and coolstore both provide a value-adding service. The literature review clarified that the packhouse 'dismantles' a bin of apples and packs each size and colour variant according to specifications obtained from the exporter. The coolstore receives bins with raw product from the orchard and receives pallets with packed fruit (finished product) from the packhouse and stores these at the appropriate temperature to maintain the quality before packing and shipping the product. A packhouse is quite similar to a manufacturing environment where product is called up just-in-time, packed to specification and stored in inventory. A coolstore is similar to a distribution centre, although stock turnover differs and is dependent on orders while the packhouse continues to pack regardless of whether the customer is known. The packhouse continues to pack to level the load (e.g. figure 6-9).

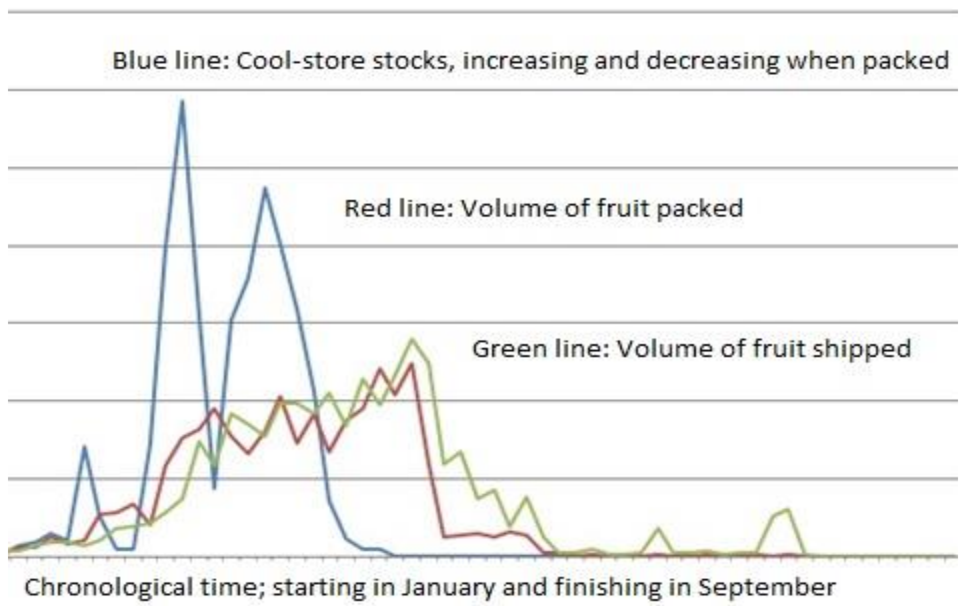



FIGURE 6-9: RELATIVE LOAD-LEVELING IN THE PACKHOUSE COMPARED WITH HARVESTING

Most Lean principles, methods and tools can be implemented in a packhouse. Most Lean principles, methods and tools commonly used for distribution centres (e.g. Jones and Hines, 1997) can be implemented in a coolstore distribution centre. Details for packhouse and coolstore specific applicability of Lean principles, methods and tools are found in appendix 15.

An example of a future state activity could be the following: A packhouse knows that it cannot invest in computerised blemish grading to achieve consistency and uses human graders who perform with variable outcomes. In order to achieve real time information to feed back to the graders, the packhouse installs a traffic light system and introduces a process that checks the quality of graded fruit immediately following grading, steering the traffic light and thus giving immediate feedback to graders on their performance.

#### *6.3.3.3. An early future state Lean activity planner for exporters*

The limited lessons learned from the inquiry about exporters within the pipfruit NZ value stream do not allow the Lean principles, methods and tools to be as specific as they have been for the orchard and packhouse/coolstore environments. Nonetheless, the general model is argued to apply to all pipfruit organisations that intend to implement Lean. Reichhart and Holweg (2007) define lean distribution as minimising waste in the downstream supply chain, and this forms part of the exporter activities. The reflective practitioner review discusses how exporters are cost and supply focussed but in essence the exporter arranges all downstream logistics from the coolstore door. It is essential that the area is explored further as will be reiterated in the conclusion. Details for exporter specific applicability of Lean principles, methods and tools are found in appendix 15.

An example of the use of the future state Lean activity planner for the exporter is to work in close communication with the customer to determine the customer requirements in May of each year, and then communicate those to the grower before the grower starts pruning.

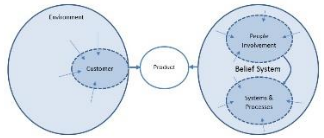
### 6.3.4. Summarising the framework

The proposed framework includes lessons learned, requirements, the model, implementation and sustainability segments. The last two of these can be used by organisations that intend to implement Lean.

The 'what and why' has been sufficiently explained. The 'when and how' includes implementation and sustainability phases, methods and tools. The three phases are similar to the NZTE phases as described in Wilson et al (2008). Phase one emphasises the importance of the initial decision and commitment to implement Lean, while phase two focusses on the first years of implementation, highlighting the step-wise implementation approach. The third phase is the stage where Lean happens automatically as a result of a Lean culture that sustains Lean.

Lean maturity appraisals assist organisations, reflecting where the organisations are in their Lean development programme much like e.g. the Crosby quality management maturity grid (Crosby, 1979). The Lean cluster provides an excellent platform for sharing knowledge and experiences between similar organisations. Growers can see how other growers implement Lean and learn from these experiences. This benchmarking opportunity—where the emphasis is not on the numbers but on how the numbers are achieved (Camp, 1998) —forms an additional mechanism within the framework to advance the model and implement it successfully within the industry.

What and Why? | When and How?

| Learned from inquiry | Requirements | | Implementation phase | Sustainability phase |
|---|---|---|---|---|
| Literature review:<br>Lean is fluid<br>Challenging to implement<br>Critical factors<br>Continuum from general to specific<br>Summary of Lean models | Applicable to:<br>Growers<br>Packers/coolstores<br>Exporter | <br>Model | Prerequisite (e.g. figure 7-4):<br>Decision to 'go Lean'<br>Preparation<br>Education<br>Champion or consultant | Perseverance:<br>Develop continuous improvement culture at all levels that adapts to required change |
| Consultants:<br>Philosophy prerequisite<br>Counter season with training, visual management and standardisation | Organisation size:<br>Micro<br>Small<br>Medium<br>Large | Systems and processes (visible):<br>Process management<br>Processes, methods, techniques, tools | Method:<br>Select one or more items from Lean activity planner<br>Implement using fixed time frame for measurement | Lean maturity appraisal:<br>Use developed orchard appraisal<br>Develop Lean maturity appraisal for packers, coolstores and exporters and use |
| Survey:<br>Low level of Lean<br>Unconsciously ignorant<br>Unconscious knowledge through organic development | Framework must include:<br>Critical success elements<br>Principles methods tools<br>Implementation<br>Sustainability | People involvement (partly visible):<br>People<br>Behaviour & engagement<br>Empowerment<br>Communication<br>Culture | Lean maturity appraisal:<br>Use developed orchard appraisal<br>Develop Lean maturity appraisal for packers/stores and exporters and use | Lean cluster:<br>Join Lean pipfruit cluster<br>Actively attend meetings to learn |
| Fieldwork:<br>Seasonal pressures<br>Sector differences<br>Applicable characteristics<br>Supply chain communication | Other:<br>General model<br>Add new theory<br>Wider horticultural sector | Belief System (largely invisible):<br>Vision<br>Philosophy<br>Principles<br>Strategy & alignment | Lean cluster:<br>Join Lean pipfruit cluster<br>Actively attend meetings to learn | |

Supporting Framework

FIGURE 6-10: FRAMEWORK SUPPORTING THE MODEL

### 6.3.5. Applicability to the wider horticultural sector

The model developed in this chapter is expected to be applicable to elements of the wider horticultural industry. A conceptual diagram about the different degrees of applicability and the need to adapt for industry sector activities is presented as figure 6-11.

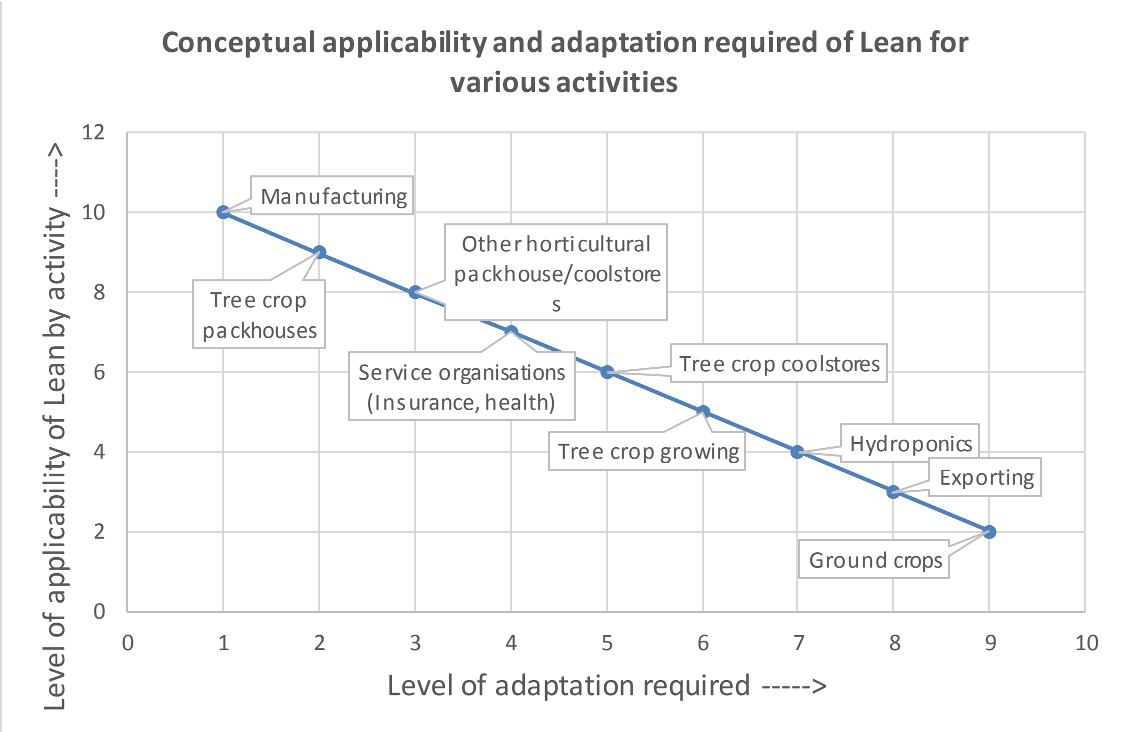



FIGURE 6-11: SYMBOLIC CONTINUUM, DEPICTING LEAN APPLICABILITY VERSUS REQUIRED ADAPTATION. NOT BASED ON EMPIRICAL DATA.

Pipfruit is a tree crop and the model can in principle be used for organisations operating commercial tree crops, i.e. growers, packhouses, coolstores and exporters. Tree crops have an annual and seasonal cycle and harvesting and packing is still largely completed with manual labour. Crops such as grapes for wine are commonly harvested mechanically and while a substantial proportion of the manual labour has been removed, there is still a significant manual labour component. Kiwifruit is quite similar to pipfruit in terms of the growing, storing and packing processes, while exporting is achieved through a single desk exporting company.

Both of these crops can benefit from a Lean implementation and it is expected that other annual tree crops will gain similar benefits.

Ground crops such as vegetables usually require a much lower manual labour component with the exception of a few such as e.g. berry crops. Here, the principle of waste takes on a different dimension again. A missing plant will mean waste of water, sun light, chemical s and nutrients, but any missing plant will be made up for in the next year. Ground crops rotate in a year and waste of resources this year will be gone next year. So the model may apply to the operations component of horticultural ground crops but the cal culation of wasted resources is experienced differently. This inquiry has not researched ground crops and no further conclusions can be drawn relating to ground crops.

Hydroponic and glasshouse crops are different again. With a higher level of automation, a controlled capture of natural resources and a slightly lower manual labour content, it may benefit less from Lean implementation than those crops that are returning every year with a higher labour component. Hydroponics or glasshouse crops have not been studied specifically for this inquiry and the statements hereinbefore are speculative in nature and serve only to illustrate the concept of an applicability/adaptation continuum.

## 6.4. Model and framework conclusion

This chapter attempted to develop a conceptual Lean model for the NZ pipfruit industry and place that model within a supporting framework. The model and framework are based on what we know from literature, i.e. Lean literature and pipfruit literature and the reflective practitioner review, as well as the action research and case study results of the inquiry. It also briefly discussed the potential applicability of the model to the wider horticultural industry.

The model that was conceptualised includes a meta-view of Lean as it would fit within the NZ pipfruit industry. The meta-model makes visual the invisible but critical belief system that is prerequisite to implementing Lean in the industry; it related the belief system to the resulting visible people involvement, systems and processes and points towards improved production results.

A framework is provided in addition to the model that relates to the implementation and sustainability of Lean into the industry. Three broad phases systematise the implementation process:

- Phase one is the lead-in, a one-way set of small steps to ensure that the organisation is committed, educated and prepared for the changes ahead.

- Phase two is represented by an endless staircase that symbolises that there is always opportunity to improve, using a repetitive EPDCA-like cycle. The addition of a Lean maturity appraisal and participation in the industry Lean cluster assist with the successful implementation of Lean, regardless of size or industry activity.

- Phase three starts somewhere on that endless staircase when the organisational culture has changed to the point where continuous improvement is achieved without specific consideration. This phase is also where sustainability starts.

The combination of the understanding of what Lean would look like in a pipfruit environment, combined with the concept of endless trying and learning is expected to lead to continuously improving production management and production.

The model has been projected onto several other horticultural industries, resulting in a realisation that the lean model applies to all industries and that applicability of Lean methods and tools to other horticultural industries varies; different levels of adaptation of Lean elements and the organisations involved are required as was the case within the pipfruit industry.

***"In theory, theory and practice are the same. In practice, they are not"***

(Albert Einstein)

# 7. Conclusion

## 7.1. Introduction

This section reconciles the aim and objectives stated in the first chapter with the findings and the analysis of the findings. It summarises how and to what degree the aim and objectives have been achieved and what else was learned during the course of the inquiry.

The aim of this inquiry is to research the concept of Lean and its theoretical 'fit' and practical applicability in a horticultural setting, specifically the New Zealand (NZ) pipfruit industry. The four objectives detailing the aim of the inquiry and tabulated in chapter one are repeated here and discussed in separate sections of this chapter:

1. Identify common theoretical themes for the Lean philosophy, methods and tools, that are not industry or contextually bound and that may be transferable to the pipfruit industry.

2. Identify and analyse the current Lean deployment within the NZ pipfruit industry.

3. Analyse the applicability and any implementation approaches of the Lean philosophy, methods and tools within the NZ pipfruit industry.

4. Develop a conceptual Lean model for the NZ pipfruit industry and consider if the model is applicable to the wider horticultural sector.

The chapter intends to summarise the originality of the inquiry and the contribution of this thesis to the body of existing knowledge. It further intends to provide signposts for the direction of future research: 'What comes next?'

## 7.2. Conclusion

In broad lines, the inquiry edified that Lean substantially fits the different elements of the NZ pipfruit industry. The theoretical 'fit' is partly different and partly the same for the orchard and packhouse/coolstore sectors of the industry. Not much was learned about the exporter sector of the industry. Similarly, Lean proved to be substantially practically applicable, also partly similar and partly different for the orchard and packhouse/coolstore sectors of the industry. Here too, not much was learned about the exporter sector of the industry.

### 7.2.1. Common themes transferable to the NZ pipfruit industry

A number of common Lean themes for the Lean philosophy, methods and tools have been identified that are not industry or contextually bound and that are readily transferable to the NZ pipfruit industry and the wider horticultural industry (the first objective).

The commonly accepted proposition that Lean was created by Toyota is partly disproven by demonstrating that earlier pioneers were using substantially similar 'best practice' approaches. These best practices form a substantial component of the Lean theory. Womack (2013) pointed out that "The Triumph of the Lean Production System" (Krafcik, 1988b) created a watershed event in the history of the lean movement and that it helped open a floodgate of new ideas for the world's managers. The same could be argued about 'the Machine that changed the world' (Womack et al, 1990). These may have been a turning point in the history of Lean; timing of the identified theory combined with Toyota's—and more broadly Japan's—success started a tidal wave and created a fixation on this specific system without realising that a number of common elements of the philosophy, methods and tools were already in existence long before the Lean tidal wave. It should therefore not be surprising that there are a number of common themes that are not industry or contextually bound and are transferable to the pipfruit industry.

### 7.2.2. Current Lean deployment within the NZ pipfruit industry

The level of current Lean deployment within the NZ pipfruit industry is low. Consultants estimate that an average of 1.3% of the horticultural industry is dedicated to become Lean (section 4.4.2.4) and has made substantial progress in doing so. This number is considered of relatively low validity because less than half of the interviewed consultants had any experience with a horticultural industry, the remaining part having no experience with this type of industry. Despite this, consultants were unanimous in their belief that the industry would benefit from Lean implementation.

Of more relevance is the result of the industry stakeholder survey. The industry stakeholder survey demonstrated that Lean is marginally consciously known or implemented, but that there is some unconscious implementation of Lean within the NZ pipfruit industry. This result is supported by the researcher who has broad experience within the industry and summarises this in a reflective practitioner review. The industry has learned to get cleverer over the years but this cleverness was born from practical survival, not from implementing theoretical models that are known to work.

### 7.2.3. Applicability and implementation of Lean within the NZ pipfruit industry

Lean is largely applicable and implementable to the different industry sector activities of growing, packing and storing product. The orchards practiced Lean and found that specific Lean principles and methods or tools had low applicability in the orchard environment while the balance of what was tried worked effectively. An example is 'Pull' which could hardly be applicable in the orchard production environment. A restricted number of principles, methods and tools were implemented during the inquiry and the conclusion only relates to what was tested in the orchard environment. Implementation using a champion or consultant approach to stabilise implementation appears to be successful. The orchards delivered some original interpretations of waste in the orchard which deserves further research. These specific findings may not be readily transferable to other industries except other horticultural industries. The literature review demonstrated that orchards are the least researched in terms of Lean and therefore demand more attention in the future.

The packhouse/coolstore environment was most comparable with a manufacturing and distribution environment and a number of Lean principles, methods and tools from existing Lean literature were readily applicable in this environment. The champion or consultant implementation approach worked successfully over the period of the inquiry.

Although the expectation is that exporting could benefit from Lean implementation, no firm conclusion can be reached due to lack of data. One fact that emerged clearly was the focus on customers, however the exporter appeared to have two customers on opposite sides —both upstream and downstream—and this may well confuse the exporter's position in the value chain. It was the lack of data that was available that perhaps complemented our understanding of the third objective in relation to exporters.

The inquiry showed substantial applicability of the Lean philosophy, methods and tools within the NZ pipfruit industry. It further analysed several implementation approaches which appear to have the beginnings of success. It remains obvious that implementation requires commitment for a period of years and the period of the inquiry was not long enough to deploy Lean fully and build a sustained Lean culture, which is one of the limitations of the inquiry.

### 7.2.4. A conceptual Lean model for the NZ pipfruit industry

A Lean model for the industry has been presented and clarifies the relevance of people and processes as making the difference in a socio-technical approach to production.

The concept of implementing Lean and continuous improvement is then captured in a framework by an endless 'EPDCA' spiral, where the letter 'E' stands for education. The inquiry showed that there was very limited education and both the action research and case study companies showed that people had to be educated before they could 'Plan, Do, Check and Act'.

The specific methods and tools differed somewhat per industry sector/activity (growing, packing/storing, exporting), because sector-specific themes led to different effects on the fundamental model. Specifically in the orchard environment, new forms of waste were identified in relation to the elements of nature that created a new form of thinking, concerning waste of natural resources. Additional themes affecting the fundamental model were the 10-fold increase of staff during the season and the production of non-committed product simultaneously with the production of value created product.

The fundamental model is applicable to all industry sectors however sector-specific models clarified the specific themes that made each sector different.

### 7.2.5. Considerations for implementing the model to the wider horticultural industry

The brief engagements with two other horticultural industries during the inquiry indicated firstly that Lean had already been instigated by the two interviewed organisations, and secondly that the Lean Pipfruit model could easily be applied to these other annual tree-crop industries. In both cases, the decision to implement Lean had been made years ago and the pipfruit industry may well learn from these organisations. But for any 'newcomer' in these industries, the lean pipfruit model can easily and quickly be transformed into a Lean horticultural model.

## 7.3. Limitations

One of the limitations to the full inquiry is that exporters found it difficult to commit to full participation; this affects how valid results are in relation to exporters and supply chain/value stream. Just as Lean involves workers at all levels, the inquiry attempted to include all parts of the value stream. Industry-related factors presenting methodological limitations include:

- Only one orchard-company in the research group which affects validity.
- Only three packhouse/coolstore combinations which affects the validity.
- Only two exporters in the research group who provided limited data, which affects validity; no real conclusions can be drawn although it is clear that exporters have a strong focus on the customer.
- Limited supply chain / value stream data as a consequence of, amongst others, the lack of timely and full exporter participation.
- The inquiry is restricted to the NZ pipfruit industry with possible extensions to the wider horticultural industry.

Other factors presenting limitations include:

- Researcher involvement: The researcher was an industry insider and was part of the methodology, specifically the action research component. As such, the researcher both influenced the results and is subject to researcher bias.
- Quantitative data from the surveys were not able to be triangulated with other quantitative data as none were available.

The period of the inquiry was not long enough to deploy Lean fully and build a sustained Lean culture. The inquiry is therefore regarded as providing valid data concerning early applicability and implementation but is restricted to that period of which theory indicates it is not possible to achieve a true Lean culture.

## 7.4. Originality and contribution

The aspiration and aim of any PhD student must be to deliver something truly new and original and it was no different for this PhD student. Experience appears to dictate that PhD students go through a turmoil of emotions during the course of their work (Murray, 2011), one moment on an emotional high when something truly original appears to emerge, the next moment emotionally deflated because further research demonstrated that another inquiry had already found the same result, and perhaps even built a better inquiry.

The contribution by this inquiry is its focus on Lean in the NZ pipfruit industry, which is part of the broader horticultural environment. This environment has been largely dominated by technological innovations; larger tractors, smarter planters, reversible ploughs, combine harvesters, better spray equipment and more. All of these innovations have substantially reduced the manual labour component of horticulture but not so in some segments of the pipfruit industry. Growing and packing fruit is still a largely manual component of the industry. This research is necessary to make a start with the implementation of different production management systems that will improve the industry as a whole, particularly because of that large manual labour component. The inquiry showed that implementing Lean can start to lead to a more effective operation. Sustainability is the next item on the research agenda.

During the course of the inquiry, a different method of surveying through questionnaires was developed which delivered a relatively high response rate to the survey. The approach emailed a single question to the sample, every day, with a five point Likert scale response request. Questions or statements took less than a minute to respond to and the approach led to an excellent response rate at 24.56% for this type of survey. This approach is argued to be original and contribute to the wider issue of improving response rates to long or difficult questionnaires.

The inquiry further found interpretations of waste that had not been encountered in literature before. These indicate original thinking in terms of wasting natural resources that are required for production in a horticultural environment such as sunlight, rainwater, and soil. If the orchard is considered to be a factory, this is analogue to wasting power, additives and other inputs. Another interpretation involves ‘real estate’, the orchard floor. Within the industry there appeared to be no urgency to replace dead and diseased trees. The inquiry revealed that this leads to multiple forms of waste during successive seasons. These interpretations of Lean have not been encountered anywhere during the literature review.

An element that was always there but not truly interpreted was the poor link between grower, packer and exporter. It was not clear to the exporter that the grower needs customer requirements at the time of pruning. At least one company now adopts the approach that they prune trees to grow fruit to customer requirements. This approach should be elementary to the industry but appears not to be.

A deliverable result is the Lean maturity assessment combined with the Lean activity planner. The Lean maturity assessment has the potential to develop into a useful instrument which can be used by horticultural organisations, particularly annual tree crop organisations. Similarly, the Lean activity planner offers organisations a view of potential improvements.

Lastly, the inquiry presents a model, supported by a framework that represents both Lean in the horticultural environment and an implementation expectation. The model clarifies that Lean has an invisible 'belief system' that affects the involvement of people who create systems and processes that continuously improve production; it further expounds that there is no finite Lean state; that Lean continues infinitely and is a state-of-mind, a culture, more than a state of the organisation.

The result of this inquiry is a contribution of some original knowledge to the body of knowledge that exists in relation to 'Lean' and to the wider horticultural industry in New Zealand, but specifically the NZ pipfruit industry.

## 7.5. Recommendations for the industry

If the industry intends to become Lean as a whole, there must be a vision and guidance from the governing body. There is support from the governing body for this inquiry and there is an initiative supported by this inquiry in the establishment of the Lean pipfruit cluster. This cluster has successfully organised open meetings for members, where information is shared without restriction in an attempt to spread the Lean message. However, the governing body is not a business owner and can therefore not make business decisions that others must follow. It can only point in a direction and express the view that that may be a right direction.

Implementing Lean is not easy; it requires dedication and the best possible implementation method with the highest chance of success. It requires education before any attempt can be made to implement Lean. It requires continued guidance until the point has been reached where Lean is so embedded into the culture of an organisation that the organisation starts to educate the guide.

Having observed the industry as it is, there is only one recommendation and that is to seriously consider Lean—under any name—as a production management system that will help transform the industry.

## 7.6. Contribution to practice: The Lean apple tree

The results of this inquiry are of little value unless they can be communicated effectively to the industry. A model for industry stakeholders is proposed to use the metaphor of an apple tree, rather than the model presented in chapters two and six. An apple tree is fundamental to the industry stakeholders and understood by most industry stakeholders; they understand that it has roots; that it grows; that it produces food and that it needs nurture to do so. The metaphor of a living tree also easily translates to other horticultural industries such as kiwifruit, grapes or avocados. For convenience of the visual metaphor, the leaves of the tree have not been emphasised in the model, however leaves fulfil a distinct function for the tree and thereby symbolise a distinct interacting function in the Lean tree model metaphor (figure 7-1). Please note that the term 'Lean apple tree model' refers to the pictorial image that follows as a metaphor for the 'Lean pipfruit model' which is proposed in section 6.4 for the wider industry.

The metaphor of the apple tree model is useful to facilitate the transfer of knowledge to the industry. Tools and processes with the emphasis on Lean appear to be highly visible and appear to be strongly correlated with production results. The tree's root structure is essential for the tree to grow and produce; the tree cannot grow and produce without roots and vice versa. Nutrition flows from the roots through the trunk through the branches to leaves and to feed fruit, a metaphor for the energy provided by the belief system to the people involved. The idea is contextualised in the following section, linking lessons learned to the model.

The principal model proposed in this section is emphasising that vision, philosophy, principles and strategy—all encompassed by the word 'belief system'—is invisible although essential along the lines of the models of Hines et al (2011a) and Liker (2004). These enablers are generally not obvious; they may give direction and facilitate growth but are not the sensory

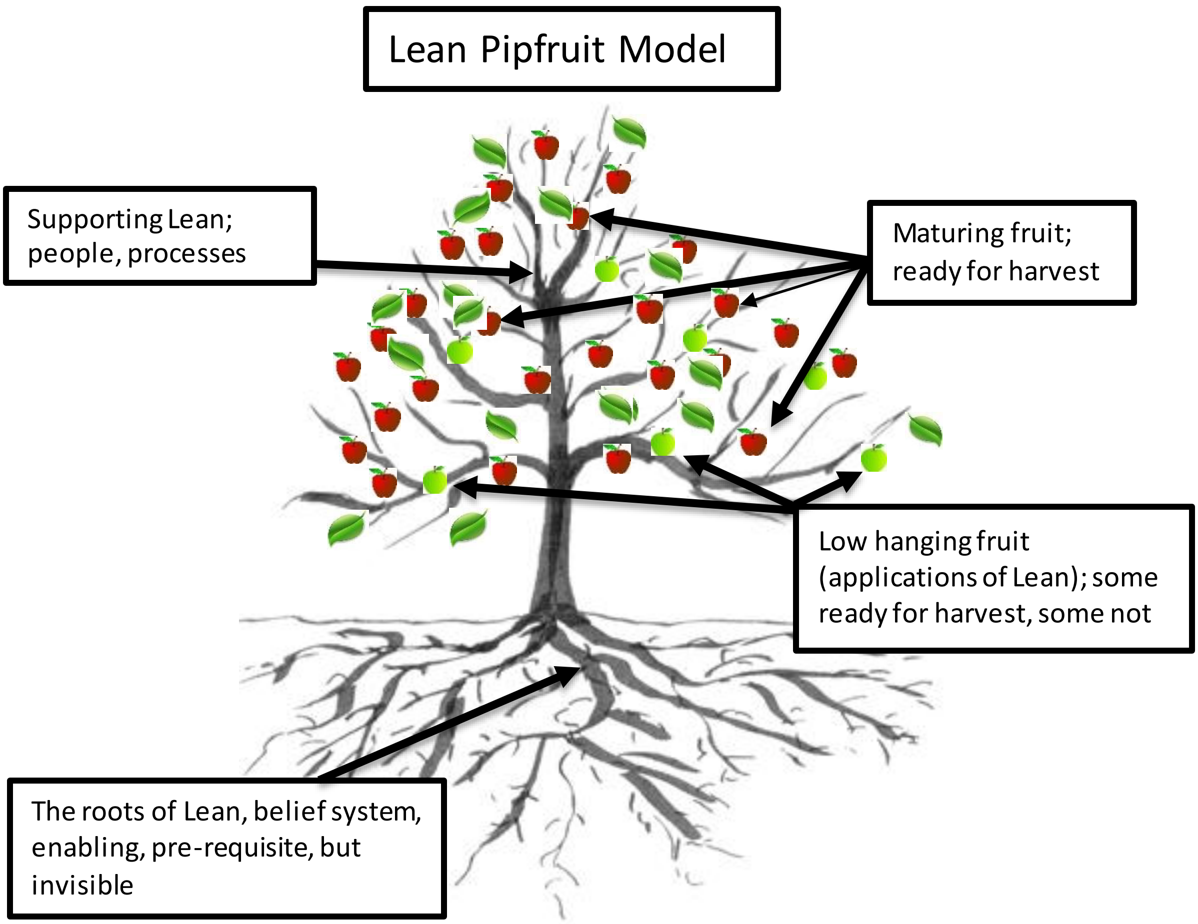



FIGURE 7-1: LEAN APPLE TREE MODEL

providers of production results. The root system of the tree represents the belief system that is a prerequisite for successful implementation of Lean. Roots form the basis of the living tree. The implementation of Lean without the fundamental requirements is futile and as literature has shown, likely to fail. The literature review recognises philosophy, people and process as the main Lean themes and refers to critical factors (table 7-1) which include:

The supporting trunk is the visual exponent of the belief system and supports the branches (Lean characteristics), shoots and leaves and represents the communication from the prerequisite factors to the applications of principles, methods and tools and vice versa. Employees know where the organisation intends to head and what their role is in this process. It is not only essential for employees to know that they have the leadership that backs them up as they endeavour to implement Lean; it is also essential that the leadership knows that the endeavours are successful.

TABLE 7-1: SUMMARY OF CRITICAL FACTORS FOR SUCCESSFUL LEAN IMPLEMENTATION

| | *Critical factors* |
|---|---|
| *1.* | Understanding Lean, education and training |
| *2.* | Commitment to long term engagement |
| *3.* | Senior management leadership |
| *4.* | Open communication of strategy |
| *5.* | Employee preparation for change |
| *6.* | Staff involvement/empowerment |
| *7.* | Visual monitoring of progress |
| *8.* | Willingness of employees to learn |
| *9.* | Resources availability |
| *10.* | Proper deployment method |

The fruit represents the applications of the Lean principles methods and tools. A method or tool can be implemented in one area of the organisation and not (yet) in another. These specific applications are the fruits, some of which are ready for harvest—i.e. can be implemented successfully—and others are not. The essence of this argument is that the organisation must implement Lean elements that it is ready for.

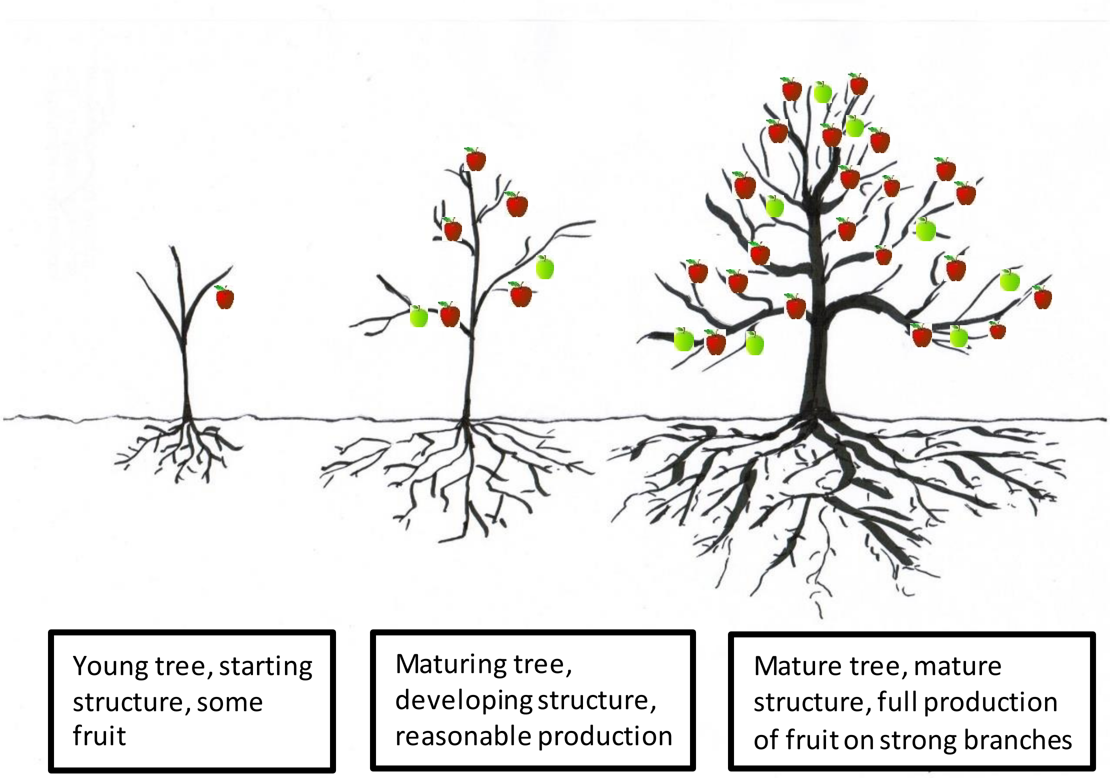



FIGURE 7-2: THE LEAN ORGANISATION TREE, MATURING OVER A PERIOD OF YEARS.

The fruit that is not ready for harvest may be obvious and appear easy to harvest (to implement) at face value, but careful consideration must be given to when, where and how new Lean elements are introduced. Every chance must be given to succeed. The alternative — failure to successfully implement the tool in a specific situation — creates negative reinforcement (Catania, 1984) which may negatively affect each next endeavour.

As an example, a company may attempt to introduce a fundamental Lean method that requires substantial resources and re-organisation in the middle of the season when people and the system are already overburdened. This is likely to fail. It is not ready to be implemented.

Taking the metaphorical model one step further, the growth of a tree takes years and over the years, the tree produces more fruit as it develops stronger roots, a robust trunk and branches with better structure as a result of annual tree maintenance, equivalent to working on Lean and improvements. As Lean matures within a company, the roots will become more embedded and the tree structure will grow and end up producing more fruit or in Lean terms produce more effectively (figure 7-2). This metaphor is representative in terms of time involved to develop a mature Lean state as a tree matures over a period of seven to eight years just short of Monden's estimate for an organisation to become Lean (Monden, 1998).

This metaphorical model logic applies to all organisations within the pipfruit industry—and indeed the wider horticultural industries—regardless if they are growing, packing, coolstoring or exporting.

### 7.6.1. Growing Lean from a seed or graft

Symbolically, Lean implementation should grow from a seed, perhaps more accurately from a graft. Grafting is a horticultural technique whereby tissues from one plant are inserted into those of another so that they join together. In most cases, one plant is selected for its root system and the other plant is selected for its stems, leaves, flowers, or fruits. The graft contains the desired genes to be duplicated in future production by the plant. Grafting Lean means taking something 'we want' (Lean) and grafting it onto an existing system that does not produce what it is intended to produce.

The analogy is evident. The decision to plant a seed or to graft an existing tree is the start of lean implementation. Usually, organisations already have an operational structure at the time that Lean implementation begins. In grafting, the existing structure is used to grow a new production system that has to mature over the years to follow.

### 7.6.2. Originality of the model

The Lean apple tree model was designed mid-2014, specifically to serve as a metaphor that industry stakeholders would understand and could associate with. The model is believed to have real communicative value in that stakeholders can contextualise the model, especially one that is characteristic and appropriate for the industry. Late September 2014, it emerged that a similar model had been used as a metaphor by an industrial company earlier that month. The originality of the Lean apple tree model is discussed further in appendix 17.

### 7.6.3. The implementation approach of the framework

| Step | Activity |
|---|---|
| 1. | Learn about Lean |
| 2. | Commit to implementation |
| 3. | Prepare for change: Discuss the plan |
| | |
| 4. | Educate and train |
| 5. | Plan and implement one or a few Lean elements (that are ready for harvest) |
| 6. | Plan implementation time (e.g. week) |
| 7. | Reflect and analyse progress: Correct where necessary |
| | |
| 8. | Confirm Critical Factors are OK to continue |
| 9. | Educate, plan and implement the next Lean elements (that are ready for harvest) |
| 10. | Plan implementation time (e.g. week) |
| 11. | Reflect and analyse progress: Correct where necessary |
| | |
| 12. | Point of established culture |

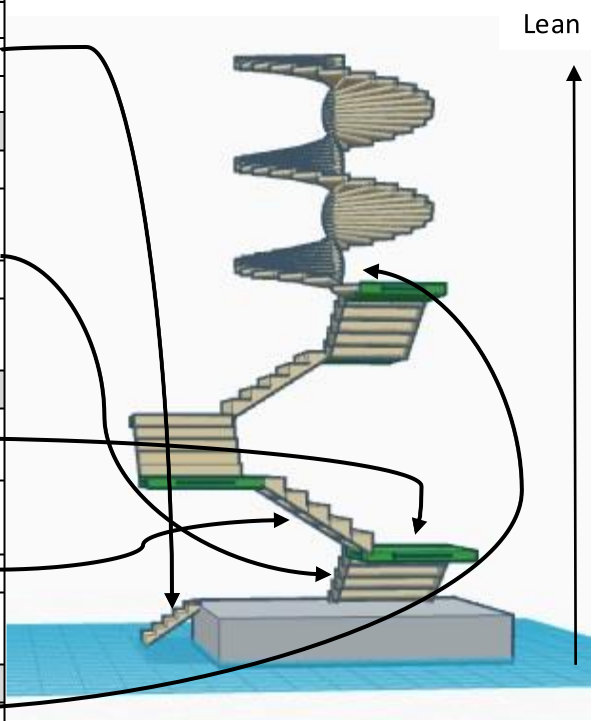



FIGURE 7-3: ENTRY ONTO AN INFINTE STAIRCASE IMPLEMENTATION MODEL.

The Lean pipfruit model forms part of a framework which includes an infinite implementation staircase—similar for each industry activity (orchards, packhouses, coolstores and exporters)—where each step represents implementation of one or more Lean principles, methods or tools that may vary by industry activity. Each step symbolises a distinct effort; the step needs to be climbed (figure 7-3).

The initial few steps relate to learning about Lean and the decision to become Lean. After the organisation has decided to introduce Lean as a paradigm, several steps are necessary to prepare the organisation for the implementation of Lean. Failure to prepare properly is likely to lead to maladjustment to the change, leaving employees in an uncertain state and likely to reject the change. This is similar to the first stage in NZTE's approach (Wilson et al, 2008) or Murti's first step in a 5-P model (Murti, 2009).

Once the decision to implement Lean has been made, the organisation is committed and prepared, the second phase includes the implementation of Lean principles, methods and tools.

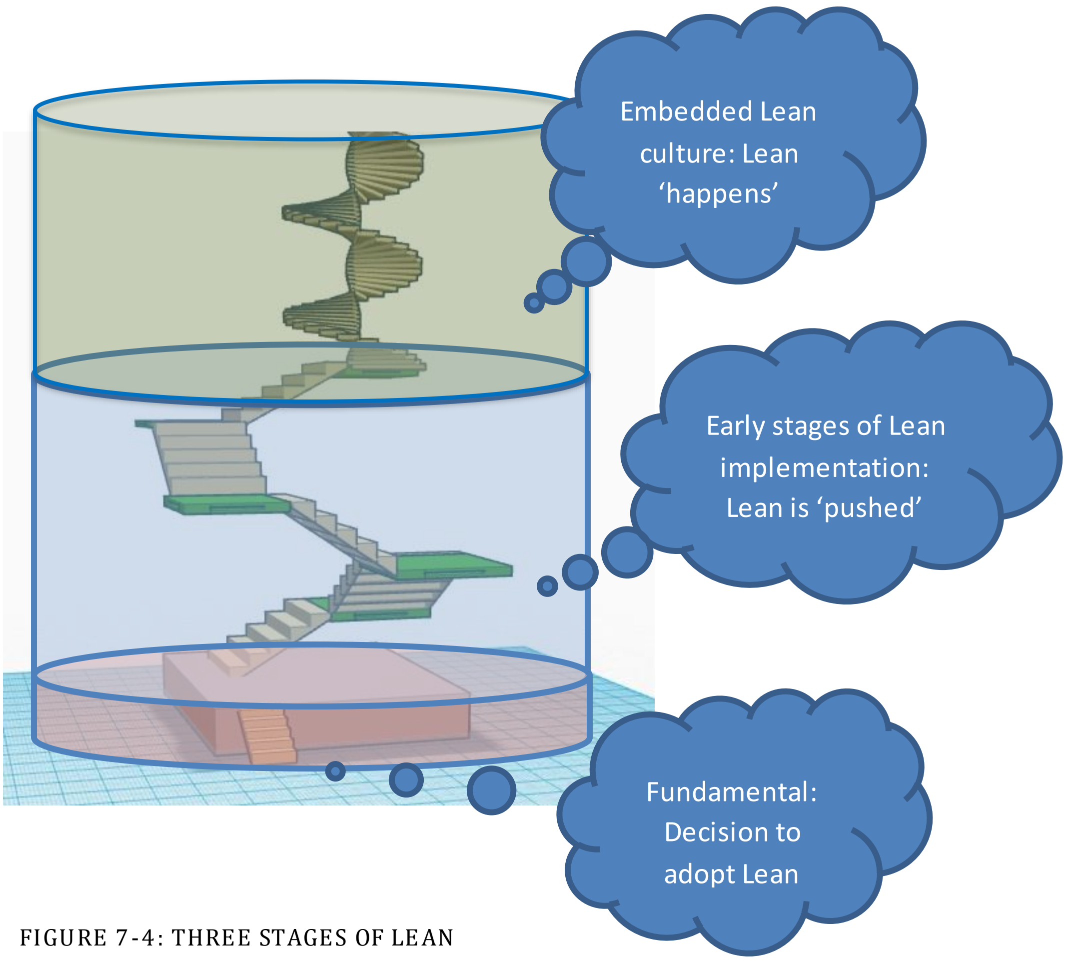



FIGURE 7-4: THREE STAGES OF LEAN IMPLEMENTATION.

In practical terms, it is suggested that a flight of steps take one or several weeks to implement. Each flight of steps may focus on implementing only a single Lean principle, method or tool (e.g. from appendix 15) or may introduce a combination.

Consequently, the eternal staircase spirals upward, while the organisation continues to become more effective through Lean. The upward spiral reflects three stages (figure 7-4):

- The initiative to adopt Lean as an approach to production;
- The early and difficult stages of Lean implementation;
- The mature Lean state where the culture is embedded in the organisation and Lean just happens.

## 7.7. Future research

The inquiry has not provided all the answers; it really conjures the question 'now what?' It has perhaps succeeded in establishing that the industry is not currently Lean; that common theoretical themes are transferable to the industry and that Lean is both applicable and can be implemented within the industry. It may have built a model and framework that demonstrate a way to implement Lean. However the inquiry produced a number of questions which were not researched to sufficient depth. These include:

1. Exploring further the concept of waste of natural elements in the horticultural 'factory'.
2. Explore the concept and analogy of trees as machines further.
3. Refining the Lean maturity appraisal tool for growing (and build it for packing/storing and exporting), test the instrument further and produce a sustainable assessment concept for orchards.
4. Test the implementation model for the industry elements and develop further.
5. Research the exporter element of the industry specifically.
6. Assessing sustainability of Lean in the pipfruit industry. We know where we can get in the period of two seasons. But can Lean be sustained in this environment?
7. Explore how generalizable findings are to the wider horticultural industries such as kiwifruit, avocados, wine and others, and to agribusiness in general as a further widening of the field of applicability.

Not directly related to the objectives of this inquiry:

1. Research the effectiveness of the 'question per day survey' option for long or complicated surveys, compared with whole questionnaires.

The answers to questions 1 to 5 and 7 will help pave the way for a more successful implementation of Lean into the NZ pipfruit industry and other horticultural crops. The inquiry into question 6 is essential for the longevity of this inquiry. Question 8 may lead to a more effective way of obtaining reliable data for long or complicated surveys. Researching the effectiveness of the 'question per day survey option' compared with other survey methods has relevance for research methodologies world-wide.

## 7.8. A final word

After completion of the field work and just before submitting the thesis, the researcher learned that three of the sample companies had been purchased by or merged with other companies. Two of the managers involved in the inquiry had left their organisations for different reasons. It will be interesting to see how the initial implementation of Lean under the original structures and management will sustain the transfer of companies and the departure of champions after less than two years of Lean implementation.

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# 9. Appendices:

## *Appendix 1: Reflective practitioner industry review*

### *1. The need for a reflective practitioner review*

Over the years, much has happened within the NZ pipfruit industry that has not been documented. As an independent practitioner, the researcher has reflected on a number of past developments and reviewed the industry from his professional perspective. The reflective review became essential when it became clear that existing literature would not complete the understanding of the industry. The following section reflects on and reviews the industry from the practitioner's perspective. The reflective review has been presented to industry representatives to corroborate the accuracy of the practitioner's presentation and was found both interesting and correct by these representatives.

### *2. After-effects of deregulation and their relevance*

The documented history of the NZ pipfruit industry is summarised for the purpose of this inquiry in chapter 2 of this thesis, the literature review. The undocumented consequences of deregulation have had both positive and negative effects on the industry. A description of post-deregulation processes elaborates on this statement.

Just before deregulation in 2001, the industry consisted of 1488 growers, 130 packhouses and a single exporter (FreshFacts 2002). Growers would just grow their fruit, submit it to their packhouse and wait for packhouse information (export pack-out percentages) and their monetary returns from the single desk exporter. Generally, they would have no specific idea where their fruit was going. Similarly, packhouses would receive the fruit, pack it to the single-desk exporter specification and submit the fruit to the exporter. Growers and packers had no idea of end-customers and value streams.

After deregulation of the single desk exporting platform, a number of organisations saw opportunities in exporting pipfruit. The resources required to become an exporter were minimal. Exporters did not have to grow the fruit, they did not have to store the fruit nor did they have to pack the fruit. Exporters did not need substantial financial resources because they did not purchase the fruit under the NZ model. The grower retained ownership of the fruit until sold. An exporter required customers for fruit and suppliers for their services, combined with means of communication and both a logistics and documentation capability. The capital outlay to become an exporter was low.

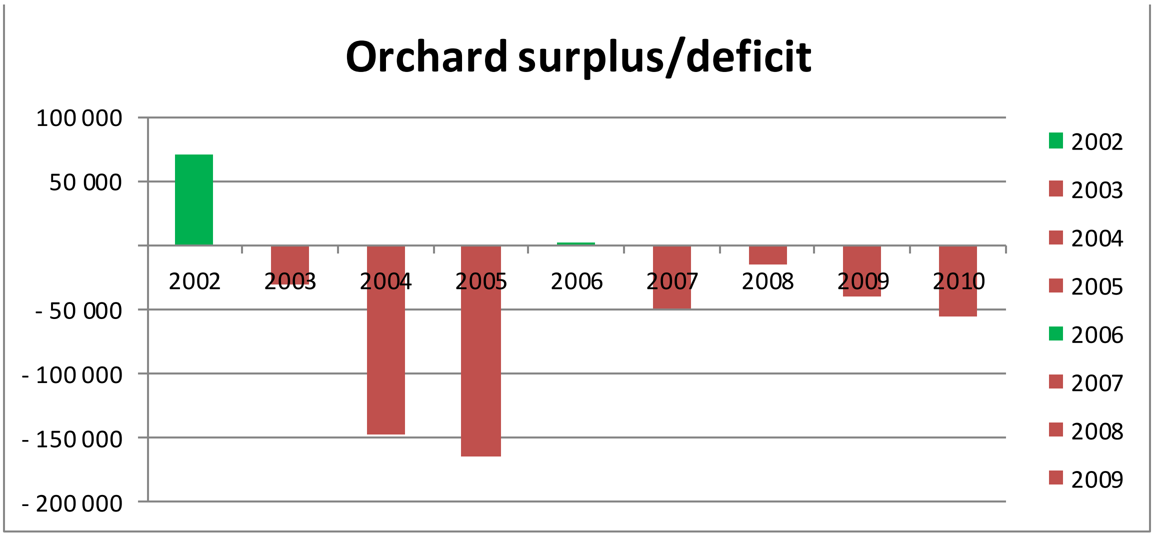
This circumstance, combined with the existing and lingering dissatisfaction with the single existing exporter, led to the formation of multiple exporters in a brief time — just under 100 exporters in the third year after deregulation (figure 2-2). Some of these may be called opportunists but regardless, each exporter needed supply. Exporters would visit growers and describe their past and expected returns to growers in order to get growers to commit to supply. Exporters created outcomes and expectations that were shared with growers but were considered confidential so that other exporters would not gain knowledge of their performance and expectations created for the coming season. The outcomes were often produced on an A4, expressed in dollars by size by variety, but often the underlying calculations were different. Presented outcomes often looked good to growers initially.

This resulted in a guarded approach between growers who in the past would share information as there was no disadvantage to sharing. Exporter stakeholders were using terms such as 'poaching' growers when other exporters approached 'their' growers to attain supply. Market claims were exaggerated in order to secure supply, often leading to disappointing returns. The expectation-perception gap widened (Zeithaml et al, 1990). Growers would have planned their next season based on projected outcomes and then find out that there was not enough money to complete their plans. This researcher has personally witnessed, on a number of occasions, the level of hate and paranoia between organisations and his several qualifications in organisational and abnormal psychology and as practicing therapist allow him to record such observations with a degree of reliability.

In addition to the claims made to growers, NZ exporters were competing in-market with each other, rather than focussing on competing with supplies from other countries. During the first years of deregulation, NZ was still considered the most competitive apple producing country in the world by the World Apple Review 2002 (Belrose). From 2003 onwards, NZ was driven from first place and never regained that place again (Doevendans, 2010), although always finding itself in the top five. After a disastrous 2005 season, the industry attempted to unify exporters which led to the formation of a market panel in 2006. The panel would meet weekly during the season and discuss pricing by variety, size and market. Although the initiative to coordinate was a positive one, the market panel was referred to by some as 'the liar's club' as communicated claims and commitments were subject to exporters' personal interests and inconsistent with real outcomes. Exporters confirmed the fragmented industry approach and may have believed that, rather than focusing on becoming the most effective exporter, it would be beneficial to misdirect the on-shore competition.

The New Zealand Ministry of Agriculture and Forestry (MAF) produced an annual monitoring report on the NZ pipfruit industry, analysing data from a number of model orchards in Nelson and Hawke's Bay (MAF has been renamed 'Ministry for Primary Production' (MPI) since March 2013). The last report was produced in 2012 and the report has not resumed since.

Data released for Hawke's Bay—the largest pipfruit growing area in NZ—by MPI NZ at the writer's request show an average orchard deficit after re-investment between 2002 and 2011 of approximately $44,900 per year. Prolonged periods of re-investment deficit are not sustainable for the organisations involved. This raises the question how an industry can be ranked as highly competitive internationally and still be unsustainable economically. It implies that the industry needs to become even more competitive in order to be sustainable. This research project intends to find out if Lean can play a role in improving the industry's competitiveness.




Orchard surplus (deficit) after re-investment (HB area) for the period from 2002 to 2010 (data provided by MPI).

On the other hand, deregulation caused some positive developments. The internal competition did drive towards an intense exporter effort to increase markets and improve prices, leading the way to an improved market distribution. Although the days were gone where the growers would lean over the fence and voluntarily share technical information, within interest groups there was a level of development that assisted these interest groups with technical improvements. Technically, the industry continued to be one of the frontrunners in the world as a result of the industry's Integrated Fruit Production (IFP) programme, which was improved in later years by the 'Apple Futures' programme, as well as a number of other growing and post-harvest developments.

This chapter of the NZ pipfruit industry about the after-effects of deregulation is not well documented and forms a possibly unavertable blemish in the history of an otherwise promising primary industry. It combines the good with the bad. As an industry, the pipfruit industry did not settle after deregulation, resulting in multiple supply and value chain changes and therefore an uneven system with variable overburdening.

### *3. Stakeholders using Lean principles and methods intuitively*

Over the past four years the interest in Lean has increased a little. Within the industry, the practitioner is aware of four companies that are relatively dedicated to 'make Lean work'. During 2013 and at the request from the governing body, the researcher presented three Lean workshops in the three main pipfruit regions and found that a limited number of companies were attending and that Lean was generally an unknown paradigm. Independent of that, a number of methods and tools have developed intuitively over the years. These include load-levelling, quick change-over and various other methods. These methods are discussed in this section.

### *4. Customer value*

The exporter is the closest to the customer and generally is very aware of the customer's product preference. This is relevant since exporters estimate that, as a rough estimate, half of the NZ export product is sold on consignment, i.e. without a dedicated purchaser. The other half is sold on 'programmes', i.e. the customer and exporter agree on a sale and purchase programme and schedule product deliveries up to six months in advance. Unfortunately not many exporters communicate these customer requirements timely to growers (i.e. before pruning starts); consequently, although the customer value and demand may be known approximately, growers are not generally placed in a position where they can grow fruit for customers.

Growers do however plan target countries as early as September of each year (which essentially is after pruning but before thinning) for regulatory reasons. Regulatory country requirements demand management programmes that generally start in October; the country planning affects the specifications of the fruit grown. So to a degree, customer value is affected by regulatory requirements that force the grower to plan his/her crop details.

### Who is the customer?

Within the industry there is some confusion who the customer is. The grower is usually not talking to the end-customer. The packer has growers as customers (who pay for the packing and cool-storing service) but pack to exporter requirements (who may represent the end-customer if known). The exporter delivers a sales and logistics documentation service to the grower but claims commission on the sale price received from the customer. Identification of customer and therefore customer value is problematic.

#### *Just-in-time*

Coolstores store raw product as inventory when it arrives. Packhouses order stock-to-pack 'just-in-time' for packing from coolstores, bearing in mind that huge stocks are built up through the harvesting period where packing does not keep up with harvest (Figure 6-9). In figure 6-9, the blue line depicts harvested fruit entering cool-storage, the red line depicts fruit volume packed and the green line depicts product shipped. Exporters monitor packed stock that is ready for shipping and focus on getting product from coolstore into market as and when required by customers (programmes) or by market buoyancy (consignment product).

#### *Growing to size and colour*

Growers have learned to manipulate the size curve of fruit grown to average certain sizes by reducing the crop load more or less. A lower crop load produces larger fruit. Similarly, growers have learned to increase the colour profile of their fruit by using reflective cloth. Provided exporters communicate the customer requirements at the right time, growers can adjust the size and colour profile of their product. Growers start the growing process in June or July when they start pruning.

### *Mistake/error proofing*

In orchards there are a number of application options; numbering of rows, storing herbicides away from insecticides so they cannot be accidently interchanged; some organisations have the spray operator mark the last row and tree sprayed before re-filling the spray tank. Generally the industry adopts the 'common sense' approach which is not necessarily best practice (Ohno, 2013).

In packhouses/coolstores there are a number of application options; visual management, numbering of lanes, scanning bin-cards before packing to ensure the correct fruit is packed; confirming spray certificate before packing for a market. There are a number of examples where software warnings or blockers prevent errors. Error proofing is used spasmodically with some very clever applications while on other occasions simple forms of error proofing are not implemented, leading to obvious mistakes. An example is spray operators who do not mark where their tank ran out of spray; after filling their tank they spray the same row again or omit a row.

### *Walking the shop floor and continuous improvement*

Orchard managers spend considerable time on the shop floor, as do packhouse and coolstore managers. This is generally the case because the organisations are small to medium and managers spend considerable time working in the business versus on the business. Although the walking of the shop-floor does take place, the missing element is the focus on value stream, flow and waste which is essentially not well understood. Managers focus on isolated efficiencies rather than overall effectiveness.

### *Load-levelling and preventing overburdening*

Orchards are historically planted in different varieties. These different varieties generally have different maturity periods, leading to different harvest periods from early export varieties (harvested from early February) to late export varieties (harvested until early May). This mixture of varieties not only creates variation for the customer, it also leads to a natural form of load-levelling which is a Lean form of waste avoidance. The industry uses chemicals to bring tree bloom forward or delay it. Effectively this brings the maturity of fruit and therefore the harvest window forward or delays it. The motivation to bring the harvest forward is mostly driven by marketing demands; exporters prefer to enter markets early in relation to their competitors, demanding a premium in the market place. These financial motivators also lead to a degree of load-levelling. Instead of harvesting a particular variety over a four week period, it is now harvested over a five to six week period. Similarly, delaying the fruit maturity spreads the load backwards. The load levelling factor means that the seasonal labour requirement is spread differently and is presumably leading to less overburdening of the system.

### *Quick change-over*

Quick change-over is applicable to different activities. When harvesting, an important criterion is the harvesting at the correct maturity level of the fruit. If fruit is harvested too early, it is immature and will not taste right as not enough starches have converted to sugars. If fruit is harvested too late, the fruit will be 'mature' or 'over mature', meaning that the fruit will not have the life span it would otherwise have. A grower has to therefore harvest the same tree several times, each time when there is sufficient mature fruit on the tree. This leads to labour and equipment movements and therefore to potential waste. Most growers will check their orchard blocks for maturity and then prepare to harvest that particular block a first time, or a second time or even a third time. Most growers will send trucks with empty bins to the block to be harvested. Forklifts unload the trucks and tractor drivers set up the empty bins in rows to reduce wasted motion by pickers having to walk distances from harvested trees to their bins (pickers generally fill up their own bin). This is commonly done before the pickers arrive and the approach likens a quick change-over process. Pickers can arrive on-site and start harvesting without delay.

### *Managing natural resources versus assembling man-made components*

Although most of the pruning, thinning and harvesting are manual activities, the actual production of the fruit is a natural but managed process. Trees need soil with water and nutrients to grow in; they need sunlight and oxygen, day and night, the right temperatures and rain to help the fruit grow. Most of these factors can be managed complementary to what nature provides. These processes can be, but are generally not, seen from a Lean perspective.

Examples include the management of soil nutrients by examining soil samples and adding necessary nutrients. This prevents wasting of growth and tree health opportunities. Water can be managed by draining water if the water level in the soil is too high, or adding water if the water level in the soil is too low. A water level that is too high reduces growth which is leads to a loss of production which is an orchard waste. A water level that is too low has a similar effect. Drainage and irrigation is generally well understood by the industry. Fruit needs sunlight to get colour, often a customer requirement. As the sun does not reach the underside of fruit, orchardists have started using reflective cloth to reflect sunlight onto the underside of the apple. Customers require fruit of certain sizes. The orchardist can substantially achieve a specific average size (note that the size distribution will always follow a standard distribution or bell curve) by determining the number of fruit on a tree. More fruit on a tree leads to smaller fruit; less fruit leads to larger fruit. If the grower knows what the exporter intends to sell, he can grow more accurately to size demand.

### *Observations of levels of applicability of Lean*

Having observed the industry over the years, it is this practitioner's view that most Lean principles, methods and tools are applicable to most areas within the industry. Some however are not. It is obvious that the 'just-in-time' (JIT) principle cannot be maintained for fruit production because the production is driven by nature. The principle of pulling just-in-time can however be applied to a number of facets of the businesses involved. The seasonality of the industry also affects even flow as harvest is driven by nature and shipping is driven by northern and southern hemisphere market opportunities (the southern hemisphere exports to the northern hemisphere during a period in which fruit cannot be produced). These aspects of Lean are not equally applicable but still find some applications.

### *Observations of waste*

Over the years there have been numerous instances of 'un-Lean' activities that are worth mentioning. A worker in one organisation started tracking repacking or reworking for a single season. The spreadsheet was huge, and demonstrated an enormous direct cost of repacking. These were caused by the packhouse having to meet volume targets and consequently packing to a lower standard than they should do. The packhouse manager was adamant that the grower paid the packhouse bill and therefore was the packhouse customer; in order to provide good service to the grower customer, the packhouse tried to get as much fruit as possible in the export carton. The packhouse saw the customer as the end of the value chain.

There was little consideration within the industry that the product had to be sold to a customer who would also pay the grower, who could only then pay the packhouse. The industry packhouses compared average 'pack-outs' (the percentage of submitted fruit that was packed for export) and growers tended for some considerable time to select packhouses with the highest average pack-out as a selection criterion. The fact that their fruit would be harder to sell or sell at a lower value was often not reflected on. Most packhouses calculate the direct costs involved in packing and base their pricing on that cost. The system is self-defeating in that the grower would receive a lower return from market for a higher packed percentage of his fruit, while the packhouse/coolstore incurred more indirect costs as a consequence of not doing it right first time. Recognition of the product customer was confused with recognition of the packing service customer. The two customers' requirements were not aligned.

For years, the orchardist would grow his fruit and try to grow blemish free fruit, only knowing that blemishes would see the fruit removed from the export pool. Growers were relatively unaware what the customer wanted, and did not grow fruit specifically for a customer. In fact, the industry for a number of years adopted the approach that all fruit was grown for all markets, i.e. all customers. The fruit grown was not very well coordinated with the exporter and the number of growers that changed exporters since deregulation, often more than once, meant that it was a challenge for exporters to coordinate stable supply.

Another typical orchard waste feature is the use of land. Existing orchards were set up following the times and it is not uncommon to have an orchard where multiple varieties are planted, sometimes only two rows of trees. These 'fruit salad' orchards lead to wasteful activities such as having to spray only two rows, having to thin only two rows or having to harvest only two rows. The grower does not easily decide to replace trees because under the current growing strategies, it may take seven years for a tree to reach full production. There are always trees that do not grow well or die, and these are not always replaced with healthy trees because it takes so long to get to the point of full production. These delays of course mean that the 'shop floor' is not always used effectively which does not fit the Lean paradigm. In addition, the poka yoke philosophy leads to resolving the root cause of a problem affecting production; leaving the tree with low production without solving the problem (replacing the tree) is not in line with the Lean philosophy.

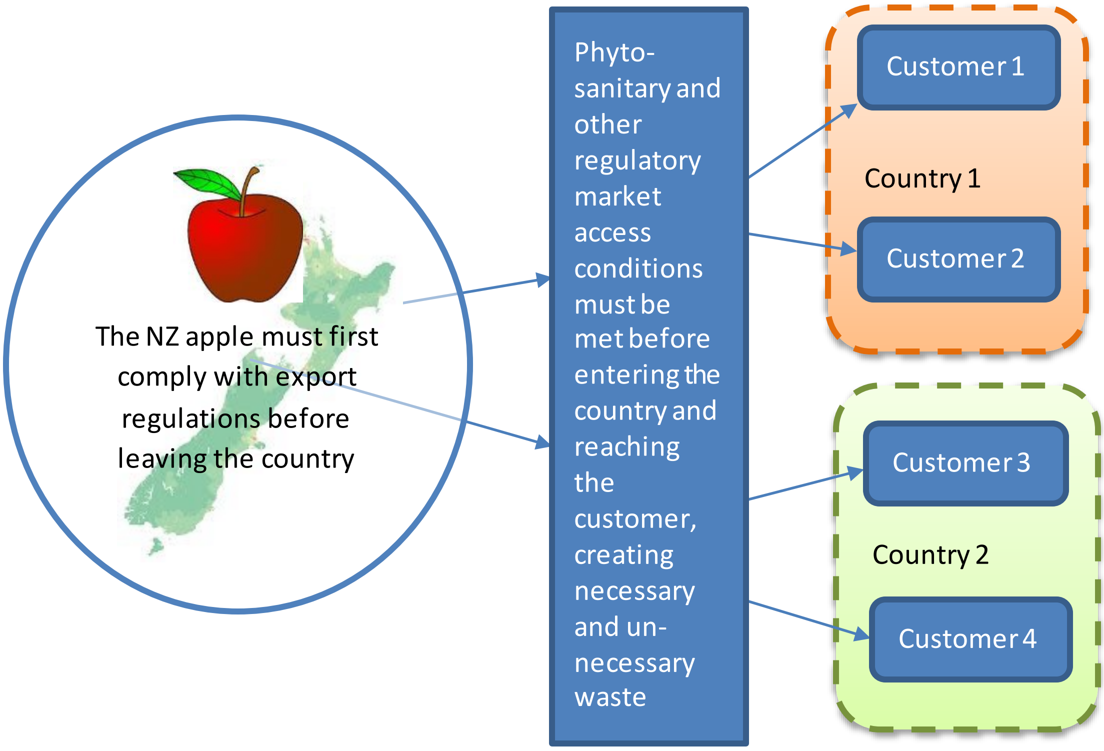
### *5. Regulatory access to countries: A waste, necessary or not?*

In order to export pipfruit, the product must gain regulatory access to countries. This means that the grower needs to control pests and diseases and adhere to a number of regulatory requirements. International phytosanitary rules are determined by the International Plant Protection Convention (IPPC) of which New Zealand is an assignee. Under the IPPC, each country has to appoint a National Plant Protection Organisation (NPPO) which is responsible for ensuring that exports comply with importing countries' phytosanitary rules. MPI is the NZ NPPO and has created a system of regulatory standards and programmes that organisations have to comply with in order to grow, pack, store and export product.

The grower, packhouse, coolstore and exporter also must comply with other regulatory market access rules and regulations. In broad terms, regulatory market access is divided in several areas:

1. Phytosanitary requirements mean that perfect fruit may not get to the customer because certain pests are found in the fruit. Not being able to enter a country for whose customers the fruit was grown is essentially a waste. The fruit must be diverted to a country for whose customers the fruit was not grown and therefore there is waste in the process.
2. Environmental requirements by countries mean that some countries (e.g. Europe) are highly sensitive to the chemicals used to keep fruit blemish and insect free. The paradox is that more chemicals are required to suppress pest populations which then reduces market access through the residues found on fruit as a result of the use of those chemicals. This is a form of waste.

3. Other regulatory requirements concern for instance the labelling of fruit cartons. Several countries have introduced measures that require packhouses to label cartons specifically for those countries. Once labelled, the fruit cannot be sent to other countries unless the carton is reworked. The processes involved are precise and laborious because this type of labelling is completed manually. Special labelling creates waste in the process.
4. Tariff barriers are considered to affect monetary decision making only (i.e. not fruit growing or packing) and are not further addressed in relation to market access.




Market access before product reaches the customer: A necessary waste?

Until several years ago, MPI would dictate standards and systems, allowing little input from industry. This led to a number of imposed on-shore requirements that were impractical, at times ineffective and costly, in addition to market restrictions that negatively affected returns.

An example that is generally accepted as such is the protocol to get access to the Australian market. Industry stakeholders have expressed the view that the protocol is unrealistic, and that it demands a number of steps that do not contribute to Phytosanitary security. In recent years, the dialogue between MPI and the industry has improved, allowing better industry input in the design of MPI standards and programmes and thus reducing the waste caused by these.

Generally, customers have some concern about food safety although the quality of food is seen to have improved. Röhr et al (2005) differentiate between price-sensitive customers (for who these requirements represent waste) and safety-sensitive customers (for who these requirements are part of the value), indicating that there is some willingness to pay for food safety through other regulatory requirements.

In general, the regulatory market access requirements are considered a necessary waste where they have minimum impact and an unnecessary waste where they require wasteful activity when the importing countries' objectives can be achieved in a less-wasteful manner.

### 6. *The industry supply chain or value stream*

The industry as a whole appears to have limited understanding of the supply chain, less understanding of the value chain and marginal understanding of Lean and value streams. The supply chain is still often referred to as the logistical chain — not as the upstream and downstream suppliers and customers to which the business should be tuned. This is stated despite the fact that a number of individuals understand the supply chain and the importance of the customer very well and are experts in the logistical side of operations. The understanding of supply and value chain and value stream appears to have been both hindered and helped by deregulation. In the market and on-shore, there is still distinct competitiveness between NZ based companies for market share. Since deregulation there has been slow growth of institutionalised trust and exporters still largely drive a distinct concern for market share in favour of industry good approaches. The waste caused by market requirements and lost market opportunities, the waste caused by internal competition and all the grower and packhouse actions involved in these has gone largely unmeasured.

### 7. *Validity of this summary and position*

This review has been presented to selected industry representatives for each industry activity to ensure that the researcher's views as practitioner are trustworthy and valid. Industry representative stakeholders' responses confirmed the practitioner reflective review as an accurate reflection on the industry.

## *Appendix* 2: Pipfruit Varieties (apples, pears, nashi)

Pipfruit varieties (data provided by Pipfruit NZ Inc.)

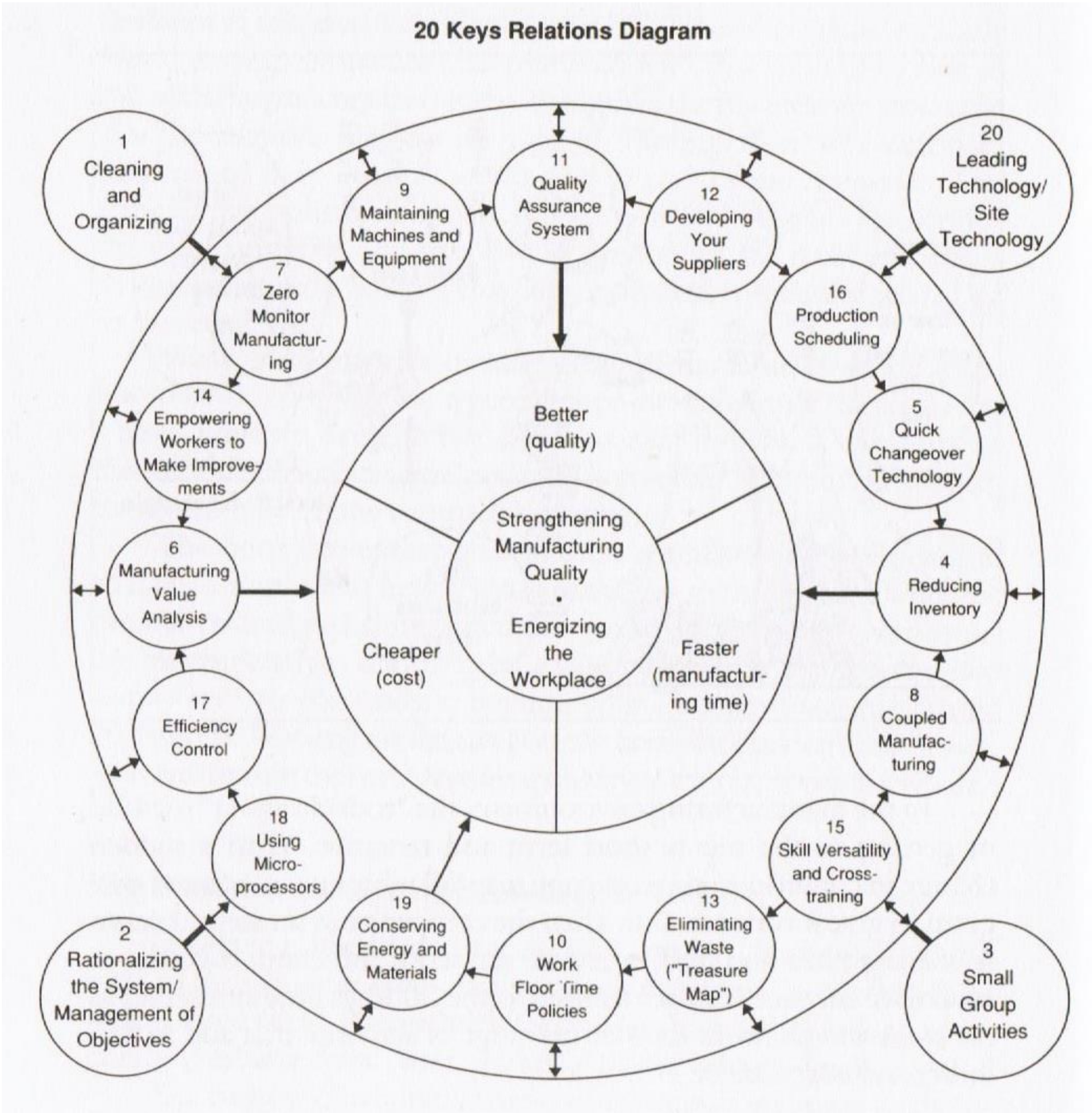
| Code | Name | Apple/pear/nashi |
|---|---|---|
| 1 | Cox Orange Pippin | apple |
| 2 | Granny Smith | apple |
| 3 | Freyberg | apple |
| 4 | Golden Delicious | apple |
| 5 | Rubinette | apple |
| 6 | Tydeman's Late Orange | apple |
| 7 | Egremont Russet | apple |
| 8 | Sturmer Pippin | apple |
| 9 | Merton Russet | apple |
| 10 | Monty's Surprise | apple |
| 11 | Gravenstein | apple |
| 12 | Co-op 43 (Juliet™) | apple |
| 14 | Priscilla | apple |
| 15 | Tydeman's Early Worcester | apple |
| 16 | Bramley's Seedling | apple |
| 17 | PremA17 | apple |
| 18 | Peasgood's Nonsuch | apple |
| 19 | Reinette du Canada | apple |
| 20 | Karmijn de Sonnaville | apple |
| 29 | Ballarat | apple |
| 32 | Oratia | apple |
| 33 | Divine™ | apple |
| 34 | Delfloga | apple |
| 35 | Braeburn | apple |
| 36 | Gala | apple |
| 37 | Gala Supreme | apple |
| 38 | Huaguan | apple |
| 39 | Royal Gala (Tenroy) | apple |
| 40 | Sweet Lady (Royal Gala) | apple |
| 41 | Coromandel Red | apple |
| 42 | Kanzi® or Nicoter (Nicoter) | apple |
| 43 | Aurora™ (Joburn ) | apple |
| 45 | Meta | apple |
| 48 | Galmac | apple |
| 49 | Regal | apple |
| 52 | Pacific Rose™ (Sciros) | apple |
| 53 | Starlite | apple |
| 55 | Regala | apple |
| 56 | Rosy Glow | apple |
| 57 | Lady in Red | apple |
| 58 | Cripps Pink | apple |
| 59 | Pink Lady® (Cripps Pink) | apple |
| 62 | Jive™ (GS48 / Sciray) | apple |
| 63 | Fuji | apple |
| 66 | Red Delicious | apple |
| 67 | Sunglo Red | apple |
| 68 | Galaxy | apple |
| 69 | Otago Red Delicious | apple |
| 72 | Southern Snap™ (Sciglo) | apple |
| 77 | Lochbuie (Braeburn) | apple |
| 78 | Jonagold | apple |
| 79 | Jonathan | apple |
| 85 | Biesterfelder-Renette | apple |
| 86 | Grimes Golden | apples |
| 87 | Rhode Island Greening | apple |
| 88 | Pacific Beauty™ (Scifresh... | apple |
| 89 | Stark® Golden Delicious | apple |
| 90 | Sundowner™ (Cripps Red) | apple |
| 93 | Fiesta | apple |
| 96 | Edilwood | apple |
| 97 | Mahana Red™ (Redfield ) | apple |
| 99 | Kitaika | apple |
| 100 | Cherry Gala | apple |
| 101 | Kempston | apple |
| 109 | Rayada (Fuji) | apple |
| 110 | Lisa (Fuji) | apple |
| 111 | Aztec (Fuji) | apple |
| 112 | Mawfu™ (Fuji) | apple |
| 113 | Kiku® (Fidex) | apple |
| 114 | Fuji Supreme™ (Fuji) | apple |
| 115 | KORU® (Plumac) | apple |
| 116 | Candy (Fuji) | apple |
| 117 | Fugachee (Fuji) | apple |
| 118 | Fiero (Fuji) | apple |
| 153 | Lemonade™ or Lola™ (PremA153) | apple |
| 168 | Pacific Queen™ (Scired) | apple |
| 193 | PremA193 | apple |
| 201 | Queen Cox (Cox Orange Pippin) | apple |
| 232 | Cameo | apple |
| 288 | Joy™ (Scijoy) | apple |
| 298 | Pink Rose | apple |
| 299 | Valrose | apple |
| 303 | Sundancer | apple |
| 311 | Mariri Red | apple |
| 321 | Sonya™ | apple |
| 322 | Sanza | apple |
| 326 | Orin | apple |
| 327 | CIVG198 (Modi®) | apple |
| 350 | DelBlush™ (Tentation) | apple |
| 351 | DelBard Jubilee™ | apple |
| 352 | DelBlush™ (Golden Sun) | apple |
| 353 | Harmonie | apple |
| 360 | Sunrise | apple |
| 600 | Alborz Seedling | apple |
| 601 | Splendour | apple |
| 628 | Scigold | apple |
| 629 | Jazz™ (Scifresh) | apple |
| 630 | SkyFresh (Scifresh) | apple |
| 631 | Envy™ (SciLate) | apple |
| 688 | Breeze™ | apple |
| 730 | Red King Oregon | apple |
| 731 | Harrold Red Delicious | apple |
| 735 | Starking | apple |
| 808 | Harley Red | apple |
| 816 | Gilmac™ | apple |
| 818 | Y129 | apple |
| 832 | HoneyCrisp | apple |
| 833 | Moonglo | apple |
| 834 | SweeTango™ (Minneiska) | apple |
| 835 | GR81 | apple |
| 836 | Topaz | apple |
| 847 | Brookfield | apple |
| 855 | Ariane | apple |
| 856 | Astra (Cox Orange Pippin) | apple |
| 857 | Rex Cox (Cox Orange Pippin) | apple |
| 858 | Pinova | apple |
| 859 | Opal | apple |
| 860 | Red Jonagold | apple |
| 861 | Ruby Bay Pippin (Cox Orange Pippin) | apple |
| 862 | Ambrosia | apple |
| 867 | Annaglo | apple |
| 868 | Imperial Gala | apple |
| 869 | Premier Star | apple |
| 880 | Emergo | apple |
| 885 | Red Braeburn | apple |
| 886 | Hillwell (Braeburn) | apple |
| 900 | Albany Beauty | apple |
| 901 | Sweetie™ Var One cv | apple |
| 902 | Star Lady | apple |
| 996 | Rockit® | apple |
| 999 | Trial Variety | apple |
| 21 | Velvetine® (PremP33) | European pear |
| 22 | Packhams Triumph | European pear |
| 23 | Beurre Bosc | European pear |
| 24 | Winter Cole | European pear |
| 25 | Winter Nelis | European pear |
| 26 | P Barry | European pear |
| 27 | Clapps Favourite | European pear |
| 28 | Doyenne du Comice | European pear |
| 30 | Beurre Hardy | European pear |
| 31 | Beurre Easter | European pear |
| 60 | Taylors Gold | European pear |
| 73 | Red Bartlett | European pear |
| 257 | Conference | European pear |
| 258 | Glou Marceau | European pear |
| 269 | Red D'Anjou | European pear |
| 270 | Worden Seckel | European pear |
| 581 | Hosui | Nashi/Asian pear |
| 582 | Kosui | Nashi/Asian pear |
| 583 | Nijiseiki | Nashi/Asian pear |
| 584 | Shinseiki | Nashi/Asian pear |
| 585 | Shinsui | Nashi/Asian pear |
| 586 | Hayatama | Nashi/Asian pear |
| 587 | PremP109 | Nashi/Asian pear |
| 622 | Dan Bae | Nashi/Asian pear |
| 887 | Magners | European pear |
| 888 | Twyford Monarch | European pear |
| 889 | Louise bon De Jersey | European pear |
| 890 | Saturn | European pear |
| 891 | Crispie™ (Crispie™ Prem2P cv) | European pear |
| 892 | Maxie™ (Maxie™ Prem1P cv) | European pear |
| 893 | Concorde | European pear |
| 894 | Buttira Precoce Moretini | European pear |
| 895 | Williams Bon Chretien | European pear |
| 896 | Starkrimson | European pear |
| 897 | Crimson Gem | European pear |
| 898 | Cascade | European pear |
| 899 | Belle de Jumet | European pear |

## *Appendix* 3: Export variety -by size -by country example

Example of export variety by size and by export country

| Example of a variety, exported to specific countries in percentages of total export volume of that variety (anecdotal data) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variety and Size | | Country | | | | | | | | | | | | | |
| Variety | SizeDesc | Europe | India | USA | Hong Kong | Thailand | UAE | Taiwan | UK | Singapore | China | Bangladesh | Malaysia | Indonesia | Total |
| Royal Gala | Size 060 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| | Size 070 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| | Size 080 | 0% | 0% | 2% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 3% |
| | Size 090 | 0% | 0% | 6% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 7% |
| | Size 100 | 11% | 3% | 1% | 0% | 0% | 1% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 16% |
| | Size 110 | 11% | 4% | 0% | 0% | 0% | 1% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 16% |
| | Size 120 | 6% | 7% | 0% | 0% | 3% | 1% | 2% | 0% | 0% | 0% | 0% | 0% | 1% | 21% |
| | Size 135 | 0% | 8% | 1% | 6% | 1% | 1% | 0% | 0% | 1% | 0% | 0% | 0% | 0% | 19% |
| | Size 150 | 0% | 2% | 0% | 5% | 0% | 3% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 10% |
| | Size 165 | 0% | 0% | 0% | 0% | 3% | 1% | 0% | 0% | 0% | 0% | 1% | 0% | 0% | 4% |
| | Size 180 | 0% | 0% | 0% | 0% | 1% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 2% |
| | Size 198 | 0% | 0% | 0% | 0% | 1% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 1% |
| | Size 216 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Royal Gala Total | | 28% | 23% | 11% | 11% | 9% | 8% | 3% | 1% | 1% | 1% | 1% | 1% | 1% | 99% |

*Appendix* 4: 20 Kobayashi keys in relationship diagram (from Kobayashi, 1995)




20 Kobayashi keys in a relationship diagram (from Kobayashi, 1995)

## *Appendix* 5: Lean Consultants

List of lean known consultants in New Zealand

| | *Lean Consultants* |
|---|---|
| *1.* | 5 Wise – Wanganui |
| *2.* | Business Flow - Auckland |
| *3.* | Continuous Business Improvement Ltd - Auckland |
| *4.* | CTPM - Auckland |
| *5.* | DA Business Solutions - Christchurch |
| *6.* | Free Flow Partners – Tauranga |
| *7.* | Go Solutions - Hastings |
| *8.* | Improve Group – Auckland/Christchurch |
| *9.* | Improvement Direct - Hamilton |
| *10.* | INTENT Group Limited – Auckland, Wellington & Christchurch. |
| *11.* | Kaizen Institute - Auckland |
| *12.* | KM&T - Auckland |
| *13.* | Lean Production Consulting – Palmerston North |
| *14.* | LMAC – Christchurch/Wellington/Auckland |
| *15.* | Peter Ramsden – Wanganui |
| *16.* | Productivity Solutions Limited – Auckland |
| *17.* | QCD Systems Inc - Auckland |
| *18.* | Ross Newman Enterprise Training Consultant - Nelson |
| *19.* | Simply Lean Business Solutions – Auckland/Blenheim/Christchurch |
| *20.* | Skills4Work - Auckland |
| *21.* | SNRG Solutions – Auckland |
| *22.* | Spirals Resultants - Auckland |
| *23.* | Step Change Associates – Palmerston North |
| *24.* | Strategia - Wellington |
| *25.* | Thornley Group - Auckland |
| *26.* | Viago – Auckland/Hamilton/Christchurch |

## *Appendix* 6: Announcement of Lean industry study and request for volunteers

# Hans Doevendans QMAC Systems

## Urgently required: Volunteers for 'Lean' case studies!

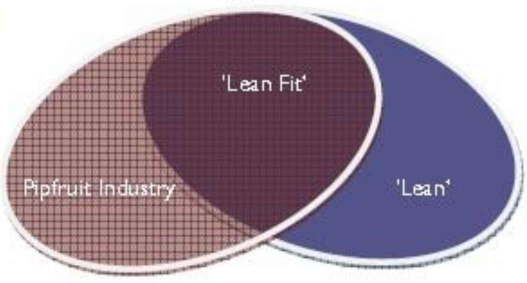
### Lean

'Lean' or 'Lean Manufacturing' has been (almost solely) credited with the success of the Toyota car company. The 'Toyota Production System' is quoted around the world to be the single one driver for Toyota's successes. And Toyota has certainly grown. From its inception in 1937 it has grown to become the largest car manufacturer in the world in 2010.

As a result, many companies in the world have tried to copy Toyota's success by copying their production systems. Numerous studies have uncovered the secrets of Toyota's success and the 'Lean' principles and methods are now applied in a substantial number of organisations and service industries around the world.

### Can 'Lean' apply?

The question for us is: Can the 'Lean' approach also be made to work for an industry like the pipfruit industry in New Zealand. Can it be made to work for the wider horticultural industries at all? And how does an application in a horticultural industry like Pipfruit differ from the original fundamental 'Lean' approach? Does it all fit nicely? And if it doesn't fit nicely, which elements should we then discard or change and which new elements should we look at introducing?




Fact is that 'Lean' evolved around a car manufacturing process where production can be adapted to the customer's requirements and wishes. That is not quite as simple to achieve in the pipfruit industry. The important principle however 'creating customer value through identifying and eliminating waste', is very applicable in any industry.

### Research Project:

A three year research project proposes to follow and guide nine pipfruit companies using 'action research'. This year, a baseline assessment will be completed. After that, the companies will be involved in continuous improvement processes with regular measurements. The outcome should be a substantial shift towards 'Lean' production with measurably improved performance. Fundamental processes should be in place that should sustain further development within those companies and a cycle of continuous improvement.

### Participation:

I am looking for nine companies to participate in this study: Three large organisations, three medium organisation and three smaller organisations. The organisations can be growers, packers, coolstores and exporters or integrated organisations.

What do you commit to:

- Participating for a three year period
- Regular (recorded) interviews of staff and management
- Regular measurements of various aspects of the organisation
- Introducing new principles that have been proven over time
- Photos and videos of processes
- Regular feedback sessions
- An in-depth analysis of your business
- Confidentiality is assured

What can you expect as outcomes:

- Different management insights
- Regular feedback
- Sustainable improved performance
- A report

In New Zealand, NZTE is substantially supporting the implementation of 'Lean'. Consequently, there are opportunities to participate in NZTE funded training for interested organisations.

### Contact

If you believe that you would like to improve your organisation through the implementation of 'Lean', please contact me as soon as possible and definitely before the end of the season. I can sit down with you and discuss the opportunity in more detail before any decisions are made.

This is an opportunity to improve your business with minimal investment!


**Hans Doevendans (MQS)**
**QMAC Systems Ltd**

| | |
|---|---|
| Email | qmacs@xtra.co.nz |
| Mobile | 029 200 9079 |
| Home: | 06 877 5033 |
| Fax: | 06 877 5063 |


*Appendix* 7: Pipfruit industry stakeholder questionnaire

## Pipfruit 'Lean' questionnaire

Thank you for participating in this study. The study aims to better understand how 'lean production' or 'lean thinking' can be made useful for the pipfruit industry. Outcomes of this study are for the benefit of the pipfruit industry. Once sufficient questionnaires have been returned, all participants will receive the mean answers to the questions by email. This may help you understand the 'lean thinking' within the pipfruit industry as it stands. Your name and the name of your organisation will be kept confidential.

This questionnaire consists of two sections:

1. Organisation contact details and information
2. General 'lean' statements

There are no correct or incorrect answers.

The information provided by you will be kept confidential and your organisation will not be recognisable in this study.

**Part 1: Organisation contact details and information**

## Survey Questionnaire:

| | | | |
|---|---|---|---|
| Organisation name: | | | |
| Contact Person: | | | |
| Person completing this questionnaire: | | | |
| Please tick appropriate boxes: This organisation is: | Growing | | Other: |
| | Packing | | |
| | Cool-storing | | |
| | Exporting/Trading | | |
| Pipfruit Turnover per year (Bins, TCEs, or Tonnes) | | | |
| Phone: | | | |
| Email: | | | |

**(*) This information will be treated as confidential.**

**Part 2: 'Lean thinking'**

This table contains a number of random statements or questions with which you may agree or disagree moderately or strongly, or may indicate how you score your organisation. Please tick the box that best suits your view. You can use any letter or number in the MS-Word version. There are no incorrect answers. There is room for comments at the end of each section.

| | Statement | Strongly disagree | Moderately Disagree | Agree nor disagree | Moderately Agree | Strongly agree |
|---|---|---|---|---|---|---|
| | *'Lean thinking'* | | | | | |
| 1. | Our company would like to learn how useful 'lean production' or 'lean thinking' can be for the future. | Absolutely not | Probably not | Not sure if we do or don't | Probably | Definitely |
| 2. | On a scale of 1 to 5 where 1 means no knowledge and 5 means extensive knowledge of lean, where do you believe your company is positioned? | 1 | 2 | 3 | 4 | 5 |
| 3. | If an organisation wants to introduce a new and fundamental management philosophy (where it does not matter what the philosophy is), it is said that the organisation needs a champion or a team of champions to achieve that change. In your organisation, who would be the champion? | I don't know | I would be the champion | I would be part of the champion team | My boss or the business owner would be the champion | A consultant would be the champion |
| 4. | In order to achieve a fundamental management philosophy change in our company, the most effective persuasion would be: | I don't know | A solid theory or model that is widely used in other industries | A recommendation by Pipfruit NZ | Hearing facts about organisations that have tried the management philosophy change and have documented proven benefits | Co-funding of consultants by NZTE |
| 5. | The last time that our organisation deliberately considered a fundamental change in management philosophy (paradigm) was: | I don't know | Never happened | More than 3 years ago | In the last few years | This year |
| 6. | My personal influence on managerial paradigm shifts (changing fundamental management direction) is best described as follows: | No influence at all | Some influence but less than 50% | More than 50% but less than 80% | More than 80% but not 100% | I am the decision maker |
| 7. | The questions I have answered and am answering next, I did (and will) answer from the perspective of: | A Grower | A Packer/Coolstore | A Trader/Exporter | A vertically integrated operation (please indicate activities) | Other (Please specify, e.g. 'Transport Operator', or 'Chemical |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | Supplier') |
| 8. | On a scale of 1 to 5 where 1 means no knowledge and 5 means extensive knowledge of lean, where do you believe your company is positioned after reading all the statements and questions of this survey? | 1 | 2 | 3 | 4 | 5 |
| 9. | As a result of this survey, my interest in following the developments in terms of 'Lean' and its usefulness for the pipfruit industry is best described as follows: | Not interested at all to follow developments | Marginally interested to follow developments | Moderately interested to follow developments | Quite interested to follow developments | 100% interested to follow developments |
| 10. | As a result of the questions of this survey: | We have not changed our thinking at all about the way we run the organisation. | We are not sure where to head next; should we learn more about 'lean' or not in order to run the organisation | We believe that we will make some minor changes or have made a few minor changes to the way we run the organisation | We will make changes or have made changes to the way we run the organisation | We have changed our thinking substantially about the way we run the organisation and have made or will make changes accordingly. |
| | ***'20 Kobayashi Keys'*** | | | | | |
| | On a scale of 1 to 5, where 1. means 'No, not at all' and 5. means 'Yes, always 100%', indicate where your company is positioned at up to today. | | | | | |
| 11. | In our company, everything has its place; there are no unneeded items lying around. Everything is labelled. Signs indicate where tools go. Notice boards are always up-to-date. Stock levels are marked as in supermarkets. | 1. No, not at all | 2. We do this sometimes or do some of this | 3. We are truly halfway organised as in the statement above | 4. We usually do this or we do most of this | 5. Yes, always 100% |
| 12. | In our company, everybody knows their exact responsibility. Meetings between management, supervisors and workers clarify policy, goals and targets. 100% of goals are achieved each year. People assist each other across the company to achieve goals. Motivation is high. Every employee understands the company vision, medium (5 year) and long term (10 year) plan thoroughly. | 1. No, not at all | 2. Sometimes we do some of this | 3. We are truly halfway organised as in the statement above | 4. Usually we do most of this | 5. Yes, always 100% |
| 13. | In our company, all work involves small teams that meet daily to discuss performance, problems, solutions and set targets and align goals. Staff not only do their work but make extra value-adding contributions. We use visual | 1. No, not at all | 2. Sometimes we do some of this | 3. We are truly halfway | 4. Usually we do most of this | 5. Yes, always 100% |

| | | | | | | |
|---|---|---|---|---|---|---|
| | displays showing up-to-date action plans, production/quality figures/graphs, suggestions etc. Staff know how to use the PDCA cycle to solve problems. Everyone feels free to express honest opinions on all issues. Each staff member suggests more than 5 improvements each month. | | | organised as in the statement above | | |
| 14. | In our company, everybody understands waste as result of Work-in-progress (WIP). Production processes are analysed with visually displayed flow charts and target inventory levels. Unnecessary processes are eliminated. Production is flexible in response to demand. The organisation can respond instantly to varying customer demands. WIP inventory is kept low. | 1. No, not at all | 2. Sometimes we do some of this | 3. We are truly halfway organised as in the statement above | 4. Usually we do most of this | 5. Yes, always 100% |
| 15. | In our company, everybody understands that quick change-over times mean more flexibility and reduced 'over-production' waste. All employees are trained on quick change-over. Change-overs are analysed by everybody and improvements suggested. Everybody can get required information. Information retrieval is instant. Standard change-over procedures are in place. | 1. No, not at all | 2. Sometimes we do some of this | 3. We are truly halfway organised as in the statement above | 4. Usually we do most of this | 5. Yes, always 100% |
| 16. | In our company, everybody is in the habit of looking where improvements can be made—all the time. Employees have identified priority areas for improvements. All employees have had 'value analysis' training. Systematic improvement has yielded measurable results. Productivity improvement is coordinated between all departments. All forms of waste have been eliminated. | 1. No, not at all | 2. We do this sometimes or do some of this | 3. We are truly halfway organised as in the statement above | 4. We usually do this or we do most of this | 5. Yes, always 100% |
| 17. | In our company, everybody understands that having to be checked is a form of waste. We use one-page standards, also in the office. Machinery can be operated without fear of breakdowns and production of rejects. Operators are given high standards of technical training. Operators help each other without their own work being interrupted. We achieve zero monitoring or QC checking and do the job right. | 1. No, not at all | 2. We do this sometimes or do some of this | 3. We are truly halfway organised as in the statement above | 4. We usually do this or we do most of this | 5. Yes, always 100% |
| 18. | In our company, we understand how production and in-process inventory are coupled. Information flows are analysed to improve communication and reduce Work In Progress (WIP). There is good understanding between up- and downstream processes. People understand that the next process is the customer. All barriers between functions/departments have been removed. A pull system supplies only what is needed. | 1. No, not at all | 2. We do this sometimes or do some of this | 3. We are truly halfway organised as in the statement above | 4. We usually do this or we do most of this | 5. Yes, always 100% |

| | | | | | | |
|---|---|---|---|---|---|---|
| 19. | In our company, floor staff understand the need for preventative maintenance. A sign on each machine tells who is responsible for it. Each machine has an up-to-date maintenance log. Consumables, lubricants, spare parts and tools are kept close in a clearly marked location. Equipment deterioration is recorded. Inspections and maintenance are routine and operators use spare time to clean and touch up machines. Most operators are proficient at improvement maintenance. | 1. No, not at all | 2. We do this sometimes or do some of this | 3. We are truly halfway organised as in the statement above | 4. We usually do this or we do most of this | 5. Yes, always 100% |
| 20. | All our staff are clear about punctuality; shifts start on time with a safety and production briefing. Nobody smokes. Uniforms are always tidy; people are friendly and energetic. Everyone returns tools. Desktops are always tidy. There is no litter and if there is, anybody will pick it up and discard properly. Morning briefings are brief and effective. The next day is organised before people leave. Meetings are focussed. Employees perform value-adding work whenever they can. Work has a steady rhythm and is not hectic. | 1. No, not at all | 2. We do this sometimes or do some of this | 3. We are truly halfway organised as in the statement above | 4. We usually do this or we do most of this | 5. Yes, always 100% |
| 21. | In our company, everybody treats the next process as the next customer. Quality is built into all processes. Staff use the 7 QC tools. Operational standards are visually displayed, are clear and include key points. A defect feedback system informs the defect source for corrective measures. The Poka Yoke concept is well understood and implemented throughout the organisation. Complaints, errors and the amount of rework between processes is reduced significantly and close to zero. | 1. No, not at all | 2. We do this sometimes or do some of this | 3. We are truly halfway organised as in the statement above | 4. We usually do this or we do most of this | 5. Yes, always 100% |
| 22. | Our company and our suppliers understand that they are extensions of each other. Both parties accept responsibility for poor quality. Value Analysis (VA) and Value Engineering (VE) study groups have been formed with suppliers. Defects and delays from all key suppliers are continuously reduced as a result. We have initiated a best practice development program with suppliers. We audit suppliers annually. | 1. No, not at all | 2. We do this sometimes or do some of this | 3. We are truly halfway organised as in the statement above | 4. We usually do this or we do most of this | 5. Yes, always 100% |
| 23. | In our company, everybody understands that reducing waste makes work easier. Everybody is motivated to reduce all forms of waste and do only value-adding work. Every aspect of the job is regularly re-examined to do so. Employees accept challenges rather than negatively criticise innovation. There is good-natured competition between staff to find waste elements and eliminate these. Waste eliminating ideas are shared. Employees' jobs are easier and more meaningful, resulting in high morale. | 1. No, not at all | 2. We do this sometimes or do some of this | 3. We are truly halfway organised as in the statement above | 4. We usually do this or we do most of this | 5. Yes, always 100% |
| 24. | In our company, employees who have improvement proposals are allowed to implement these themselves as that is most effective. There is mutual agreement that everyone can improve by finding time to improve during work-time. We have created | 1. No, not at all | 2. We do this sometimes or do some of | 3. We are truly halfway organis | 4. We usually do this or we do most | 5. Yes, always 100% |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 'Improvement stations' where employees can build shelves, platforms and other simple items to improve processes. Employees feel strongly empowered to make improvements. Employees are provided with the latest technological education so they can make equipment improvements when they deem it appropriate. | | this | ed as in the statem ent above | of this | |
| 25. | In our company, both management and staff want to develop skill versatility. Employees do not prevent others from learning the skills they have; they encourage others to learn what they know. Employees understand that cross-training makes them more valuable - not less valuable. A skill versatility matrix is displayed in every workplace and supervisors create time for cross-training during shifts. Standard operating procedures are on display and make cross-training easy. Our company can freely re-distribute people and adapt to all changes in the market place without holding skill inventory. | 1. No, not at all | 2. We do this sometim es or do some of this | 3. We are truly halfwa y organis ed as in the statem ent above | 4. We usually do this or we do most of this | 5. Yes, always 100% |
| 26. | Production priorities are never re-arranged; operators always know what to do. Today's and tomorrow's work is clearly displayed. Raw materials and inventory required for production are always delivered to coupling points on time. Process lead times are accurate. Bottlenecks are taken into account when scheduling. Each product has a documented process flow-chart. Work is tracked effectively through the system. Schedulers are fully aware of production capability. Machine breakdowns have been eliminated. Fluctuations in work load have been eliminated by smoothing of work-load and cross-training of employees. | 1. No, not at all | 2. We do this sometim es or do some of this | 3. We are truly halfwa y organis ed as in the statem ent above | 4. We usually do this or we do most of this | 5. Yes, always 100% |
| 27. | In our company, we maintain daily work reports for operators, daily and periodical (e.g. weekly) efficiency charts, and display these visually so that efficiency drops can be identified and addressed by all. Employees feel that managers and supervisors understand and appreciate the effort they put into work. Difficulty indices and standard times are reviewed periodically. Everyone is interested in efficiency trends and is motivated and confident about reaching efficiency goals. | 1. No, not at all | 2. We do this sometim es or do some of this | 3. We are truly halfwa y organis ed as in the statem ent above | 4. We usually do this or we do most of this | 5. Yes, always 100% |
| 28. | Office and work automation has been introduced with backup systems allowing quick retrieval of data and information. Employees are interested in automation because they understand the benefits. There is full scale implementation of seamlessly integrated business and production systems. Data and information are readily and easily available to all users without duplication. There is an information systems strategy and it is an integral part of the business strategy. Real time data is captured at the point of origin and information is available to all users at all stations in real-time. | 1. No, not at all | 2. We do this sometim es or do some of this | 3. We are truly halfwa y organis ed as in the statem ent above | 4. We usually do this or we do most of this | 5. Yes, always 100% |
| 29. | In our company, the importance of conservation is quantified by showing energy and material costs as percentage of total costs to all employees. Awareness and training programs | 1. No, not at all | 2. We do this sometim | 3. We are truly halfwa | 4. We usually do this | 5. Yes, always 100% |

| | | | | | | |
|---|---|---|---|---|---|---|
| | take place and all workers are aware of the need to conserve materials and energy. We have a company-wide conservation strategy. Well planned and substantiated equipment modification plans are implemented organisation-wide. Improvements in conservation using technology have been exhausted and new technologies are being developed. | | es or do some of this | y organised as in the statement above | or we do most of this | |
| 30. | In our company, a radar chart for required site technologies has been completed. Our company's level of site technology is world class. A significant percentage of employees are rated as world-class. Benchmarking to compare technology and performance has been completed. There is a skill certification system by vocation in place. We are one step ahead of the normal world industry. We are more advanced than other companies in our industry in the development of fundamental technologies. | 1. No, not at all | 2. We do this sometimes or do some of this | 3. We are truly halfway organised as in the statement above | 4. We usually do this or we do most of this | 5. Yes, always 100% |

**Part 3: Current use of Lean Tools and Methods**

| | Do you use: | Don't know what it is | Never used | Use sometimes | Use regularly | Use all the time |
|---|---|---|---|---|---|---|
| 1. | 5-S' | | | | | |
| 2. | Value stream mapping | | | | | |
| 3. | Flow as one of five basic 'lean' elements | | | | | |
| 4. | Kanban (material pull) | | | | | |
| 5. | Just-in-time | | | | | |
| 6. | Continuous improvement (Kaizen) | | | | | |
| 7. | Gemba (floor) walks | | | | | |
| 8. | 7 wastes identification | | | | | |
| 9. | Process maps (swimming lane maps) | | | | | |
| 10. | Spaghetti diagram | | | | | |
| 11. | TAKT time | | | | | |
| 12. | 'Pull' as one of five basic 'lean' elements | | | | | |
| 13. | Fishbone or Ishikawa diagram | | | | | |
| 14. | Root cause analysis (5 why's) | | | | | |
| 15. | Red tagging | | | | | |
| 16. | Visual management | | | | | |
| 17. | PDSA cycle | | | | | |
| 18. | Jidoka (autonomation) | | | | | |
| 19. | Poka Yoke (error proofing) | | | | | |
| 20. | SMED or Quick Change-over | | | | | |
| | | | | | | |

Additional Comments:

## *Appendix* 8: Consultant semi-structured interview guideline

| **Consultant semi-structured interview guideline** | | **Participant** |
|---|---|---|
| | This research project intends to find out how useful 'Lean' is (*or is perceived to be*) as a model for the NZ Pipfruit (apples, pears, nashi) industry and consequently the wider horticultural industry. The industries are 'push', seasonal (seasonal staff), and deal with perishable products. | |
| | General and ethics | |
| a. | Is the consultant prepared to provide info for a PhD study in Lean in the Pipfruit industry? | |
| b. | Would you prefer to give the information anonymously, or | |
| c. | Would you be happy to be mentioned in the research report? | |
| | The business | |
| 1 | What is your business' specialist area? | |
| 2 | Does your business train, consult, coach, do all these or different? | |
| 3 | Does your business assist companies with Lean? | |
| 4 | Does your business assist companies with Lean in any **primary industry** company? | |
| 5 | Can you give examples? (either names or industry sectors) | |
| 6 | Does your business assist companies with Lean in any **horticultural** company? | |
| 7 | Can you give examples? (either names or types of horticulture) | |
| | Horticulture | |
| 8 | Horticultural product is **pushed** into the market. How does that affect Lean implementation? | |
| 9 | Horticultural industries have some **80% seasonal workers**. How does that affect Lean implementation? | |
| 10 | Horticultural products are live, **perishable goods**, i.e. limited lifespan. How does that affect Lean implementation? | |
| 11 | Horticultural products are commodities sold on consignment (***NO known customer***). How does that affect Lean implementation? Who is the customer? | |
| | Theory | |
| 12 | Are you familiar with any **academic work** done in the horticultural area with Lean implementation? If so, can you provide some examples? | |
| 13 | Are you familiar with any **practical work** done in the horticultural area with Lean implementation? If so, can you provide some examples? | |
| | Lean in NZ | |
| 14 | In your estimate, what percentage of NZ companies is **seriously Lean**? *(Dedicated to become Lean and having made substantial inroads)* | |
| 15 | In your estimate, what percentage of NZ **horticultural** companies is seriously Lean? *(Dedicated to become Lean and having made substantial inroads)* | |
| 16 | What works better: **philosophy** or **Tools/Techniques**? | |
| 17 | Could Lean add value to the NZ horticultural industries? | |
| | Other models or consultants | |
| 18 | Are there any other models that you would recommend to be used by horticultural organisations rather than or in addition to Lean? | |
| 19 | Do you know any other consultants that specialise in Lean that should be part of this research? | |
| 20 | Closing comments? | |
| | Thank you | |

## *Appendix* 9: Protocol for case study with partial applicability to action research

### *Introduction*

Case study requires strict protocols in order to provide robust research results (Yin, 2009). This appendix discusses the protocol design used in the current inquiry.

The case study protocol follows a number of considerations. Yin (2009) emphasises the importance of a preparation and protocol design before the actual data collection phase starts. In case of multiple researchers, the protocol gives guidance to each researcher and will result in reliable findings across researchers based on consistent research questions and aims. In addition, and particularly in case of a single researcher as is the case in this inquiry, a protocol ensures that the researcher stays 'on track' and firmly focuses on the research objectives and the way in which his research will be analysed and reported (Yin, 2009). The protocol for the case study phase of the research project provides guidance for the following:

5. Basic information
6. Data collection procedures
7. Proposed analysis and method
8. Proposed report structure

In helping to structure the case study, the case study protocol also provides helpful structure for the action research component of this inquiry. Where parallels are observed between case study and action research, the protocol will provide similar structure and stability to the action research component of this inquiry.

### *Protocol Basic Information*

The inquiry's objectives are not bound to research methodology and the protocol relates to:

a. Case study and action research objectives
b. Theoretical framework

### *Research questions and objectives*

The research objectives intend to give direction; to avoid a study of everything related to the subject organisations and Lean. The following research questions arise:

Phase 1 (Exploratory stakeholder survey and consultant survey and interviews):

1. Are organisations within the NZ pipfruit industry generally aware of Lean; are they using Lean, and to what extend? (Purpose is to explore);
2. Do practical experts such as Lean consultants believe that Lean can be expected to contribute to a more competitive position for the NZ pipfruit industry? (Purpose is to explore).

Phase 2 (Case Study and Action Research):

3. **Status Quo**: Did organisations use the Lean paradigms at the time of the inquiry start, or did they use any other paradigm (and which)? (Purpose is to explore)
4. **Applicability (induction)**: How are Lean principles, methodologies or tools fitting a seasonal horticultural industry such as the NZ pipfruit industry? (Purpose is theory building)
   a. Which principles, methodologies or tools work better or not-so-well within each of the industry segments (i.e. growing, packing, cool-storing and exporting) of the NZ pipfruit industry?
   b. For each of these, why do or don't they apply? (Practical aspects and theory development (e.g. Voss et al, 2002))
5. **Implementation (case studies and action research)**: How can Lean be implemented in a seasonal horticultural industry such as the NZ pipfruit industry? (Purpose is exploration and theory building).
   a. How is implementation of Lean potentially affected by this 'push' industry which produces perishable products?
   b. How is implementation of Lean potentially affected by the strong seasonal influences?
6. **Pipfruit Lean Model (induction)**: Can a Lean model be created for each of the three different segments within the industry? Conceptualise a model (Purpose is theory building)

A further question, logically derived from the above is:

1. **Transferability**: Are Lean pipfruit models likely to be transferable to the wider seasonal horticultural industries? (Purpose is theory building)

### *Propositions*

The research questions in combination with Lean theory and the industry history leads to the following propositions:

1. Lean is not well-known, nor is it commonly used by the NZ pipfruit industry as a paradigm (based on industry historical development including strong traditional management views).
    a. Heuristic, traditional or intuitive management philosophies are commonly used within the industry.
2. Lean can be useful to improve the competitive position of organisations within the NZ pipfruit industry (based on Lean theory that Lean is universally applicable).
3. A number of Lean philosophies, principles, methodologies or tools do not automatically 'fit' a horticultural industry such as the NZ pipfruit industry (e.g. TAKT time, or Pull).
4. The seasonality and product of the industry automatically affect Lean philosophies, principles, methodologies or tools (based on the fact that uncontrollable elements - such as weather- influence the product while seasonality causes uneven people requirements).
5. The industry organisations have developed some Lean tools and methods organically over the years (Based on the continuous traditional cost-reduction focus).
6. There is waste in the commodity process, caused by e.g. the fact that the buyer is unknown (based on the fact that fruit volumes, packaging, timing, labelling-PLUs are completed partly on experience or perceived trends, not on known customer requirements).

Propositions can be split for orchard, packhouse/coolstore and exporter sections but also combined where applicable to all.

*Theoretical framework:*

| Tests | Approach | Case Study Phase |
|---|---|---|
| Construct Validity | Use multiple sources of evidence | Data Collection |
| | Establish chain of evidence | Data Collection |
| | Key informants have reviewed draft statements and report sections | Composition |
| Internal Validity | Pattern matching | Data analysis |
| | Explanation building | Data analysis |
| | Address rival explanations | Data analysis |
| | Use logic models | Data analysis |
| External Validity | Use theory for single-case studies | Research design |
| | Use replication logic in multiple-case studies | Research design |
| Reliability | Use case study protocol | Data Collection |
| | Develop case study database | Data Collection |

*Data collection procedures:*

*Identification of research subjects*

Use the following (case study) locations including managers/contact persons and informants. Actual locations and manager names are not mentioned in order to safeguard the identification of the organisations involved (Massey University Code of Ethical Conduct for research, teaching and evaluations involving human participants, retrieved 2012, p10).

Sample by research method:

| Phase 1: Survey/Interview | Case Study | Action Research |
|---|---|---|
| **150 Industry stakeholders** | C/S Packhouse/Coolstore (with champion) | A/R Orchard (or orchard group) |
| **26 Lean Consultants** | C/S Packhouse/Coolstore (with consultant) | A/R Packhouse/Coolstore |
| | C/S Exporter 1 | Lean pipfruit cluster |
| | C/S Exporter 2 | |
| **Other horticultural organisation(s) interview** | Mini case-study | |

### *Who to interview plus guideline:*

| Research organisations | Manager | Floor supervisors | Seasonal staff |
|---|---|---|---|
| **A/R Orchard (or orchard group)** | Yes | Yes | Some, if possible |
| **A/R Packhouse/Coolstore** | Yes | Yes | Some, if possible |
| **C/S Packhouse/Coolstore (with champion)** | Yes | Yes | Some, if possible |
| **C/S Packhouse/Coolstore (with consultant)** | Yes | Yes | Some, if possible |
| **C/S Exporter (1)** | Yes | No | None |
| **C/S Exporter (2)** | Yes | No | None |
| **Other horticultural** | Yes (or specialist) | No | None |

**Note: In principle, interview as per table in order to achieve consistency.**

### *What to observe:*

**Guideline for processes for which data are collected**

| Orchards | Packhouse/Coolstore | Exporter |
|---|---|---|
| Harvest | Intake | Input/output |
| Pruning | Cold storage raw material | Inventory management |
| Thinning | Packing Planning | Customer focus |
| Spraying | Coolstore/treatment planning | Shipping |
| Planning | Grading/Packing | Documentation |
| Maintenance | Packaging | |
| Staff training | Coolstore inventory management | |
| Transport/Logistics | Maintenance | |

Review organisation in terms of Kobayashi (1995) or Tapping et al (2002) criteria through management assessment with researcher assistance.

***Observe use of common Lean tools (refer questionnaire) such as:***

| | |
|---|---|
| *1* | 5-S' |
| *2* | Value stream mapping |
| *3* | 'Flow' as one of five basic 'Lean' management elements |
| *4* | Kanban (material Pull) |

| | |
|---|---|
| *5* | Just-in-time supply |
| *6* | Continuous improvement (Kaizen) |
| *7* | Gemba walks |
| *8* | 7 wastes identification |
| *9* | Process maps (swimming lane maps) |
| *10* | Spaghetti diagram |
| *11* | TAKT time |
| *12* | 'Pull' as one of five basic 'Lean' elements |
| *13* | Fishbone or Ishikawa diagram |
| *14* | Root cause analysis (5 why's) |
| *15* | Red tagging |
| *16* | Visual management |
| *17* | PDSA cycle |
| *18* | Jidoka |
| *19* | Poka Yoke (Error Proofing) |
| *20* | SMED or Quick Change-over |

#### *Evidence, documents and artefacts to collect*

Collect evidence as follows:

- Correspondence in relation to Lean implementation
- Forms, templates, posters, notices
- Photos, videos, recordings
- Collect the following type of data:
    - Documentation (reports, forms, letters/emails, etc.)
    - Possibly archival data (uncertain if relevant data exist considering the contemporary nature of the programme)
    - Interviews (senior managers, orchard/packhouse/exporter managers, orchard/packhouse/exporter supervisors and permanent staff)
    - Direct observations (participant observation in AR) (Yin, 2009, p102)

### *Proposed analysis and method*

#### *Criteria for interpreting the study's findings*

The study intends to:

- Develop theory;
- Generalise from case study and action research to theory.

### *Units of analysis*

One unit of analysis is the organisations' ability to adopt and implement new management paradigms such as Lean. How do organisations (growers, packhouses and exporters) adopt new management paradigms such as Lean into their seasonal activities? For each of these organisations, the unit of analysis differs slightly as the type of organisation is different. Data collection may be slightly different. So the unit of analysis is the organisation with the people who need to implement the change (Hopkins, 1982).

The following are different (non-equivalent) variables:

- People will struggle with Lean because they are unfamiliar with it;
- People will find very little time for Lean because they are too busy (fixing things);
- Lean organisations will be isolated and poorly understood;
- Production will be more effective.

The pipfruit environment makes implementation of Lean desirable, required or difficult and pressurised, etc.

The key people are the key people in the organisation involved in Lean implementation. The start is at the start of Lean implementation process. The completion is after a minimum of a full season.

A second unit of analysis is the ability to improve/adapt and standardise the new Lean management paradigms. Interesting data may allow triangulation of the champion vs the consultant vs the researcher, or the matching of Lean principles and tools with industry dynamics.

### *Coding and categorising data*

Interviews are coded and categorised as follows:

1. Interviews are generally transcribed in situ as a combination of descriptive and verbatim records.
2. Paragraphs are analysed looking for:
    a. Identifiable Lean elements (words or sentences);
    b. Repetitive elements (words or sentences);
    c. Elements that may affect the suitability and implementation of Lean positively or negatively.
3. The key elements are captured with key words and/or abbreviations.
4. Categories are designed to capture related keywords. Possibly link categories to measurement instruments, e.g. the Tapping et al (2002) instrument.
5. Key elements and categories are re-assessed throughout the process to ensure continued homogeneity of the categories.

### *Analytical techniques: Link data to propositions and criteria for interpreting findings*

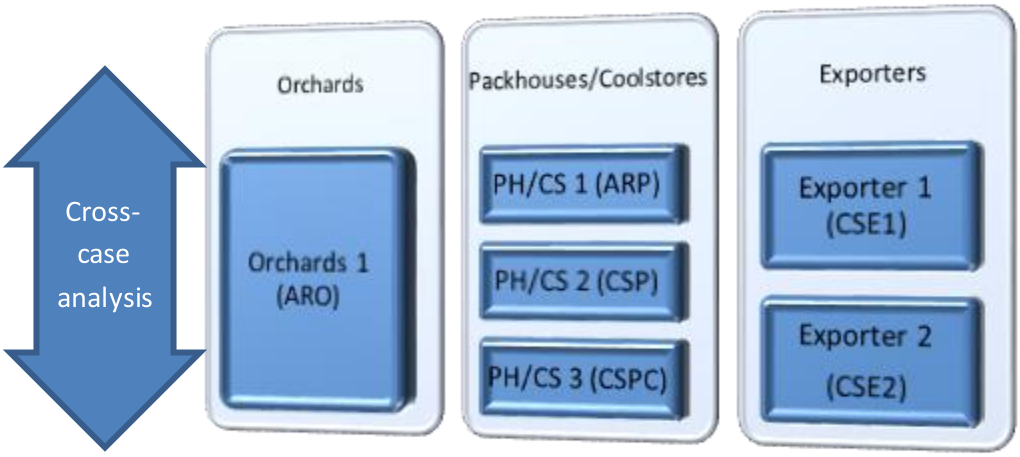
Data are linked where possible using pattern matching, explanation building, time-series analysis, logic models or cross-case synthesis.

<u>Logic models</u>: Comparing (pattern matching) empirically observed events to theoretically predicted events (propositions). Examples:

a. Organisations struggle to implement orthodox Lean and

B. become more effective as they implement Lean (e.g. stock control is easier, planning is better). (Yin, 2009, p153-154)

<u>Cross-case synthesis</u>: Complete cross-case analysis




*Proposed report structure:*

Description of organisation modus operandi and position within the pipfruit industry (growing, packing, exporting etc.). How did the organisation improve while implementing Lean (Improvement process)? How did they go about introducing Lean? Chronological presentation of the implementation programme in the organisation and the resulting effects.

1. How has the organisation improved? What worked and what didn't and why? What have they not tried yet and why? Presentation of evidential data. Possible development of grounded theory from case studies.
2. References; documents, interviews, observations and evidence thereof, tabled where possible.
3. How was Lean put in place; how was it operationalised?
    a. Introduction of Lean if introduced (motivation, timing, process)
        i. Identification of Lean and 'un-Lean' operational aspects before Lean
        ii. If not introduced: identification of Lean and 'un-Lean' operational aspects
    b. Effects of Lean introduction (if introduced)
    c. Identification of Lean principles and methods that are less or not suitable in the environment

Related documents:

- Industry survey
- Tapping et al (2002) assessment

## *Appendix 10: Pipfruit NZ statistical annual data for orchards and packhouses 2012*

**Table 5.3 Number of Orchards (R-pins) Registered for Export Production by Area (hectares) 2008-2013**

| | No. of R-pins | | | | | | Total Area | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
| **0- 5ha** | 418 | 399 | 386 | 370 | 349 | 354 | 1214 | 1114 | 1121 | 1070.9 | 998 | 1,008 |
| Proportion of total | 40% | 40% | 39% | 38% | 37% | 37% | 13% | 13% | 13% | 12% | 11% | 12% |
| **5- 15ha** | 482 | 472 | 462 | 471 | 468 | 464 | 4130 | 4081 | 4036 | 4101.6 | 3,996 | 4,008 |
| Proportion of total | 47% | 47% | 47% | 48% | 49% | 49% | 46% | 46% | 46% | 46% | 46% | 46% |
| **15- 30ha** | 101 | 101 | 105 | 103 | 99 | 100 | 2048 | 2035 | 2191 | 2144.81 | 1,999 | 2,079 |
| Proportion of total | 10% | 10% | 11% | 10% | 10% | 10% | 23% | 23% | 25% | 24% | 23% | 24% |
| **> 30ha** | 35 | 34 | 32 | 32 | 37 | 35 | 1616 | 1601 | 1502 | 1565.7 | 1,712 | 1,665 |
| Proportion of total | 3% | 3% | 3% | 3% | 4% | 4% | 18% | 18% | 17% | 18% | 20% | 19% |
| **Total** | 1,036 | 1,006 | 985 | 976 | 953 | 953 | 9,008 | 8,831 | 8,850 | 8,883 | 8,705 | 8,760 |
| **Number of Export Growers** | 509 | 454 | 431 | 406 | 391 | 370 | | | | | | |

*(NB As a result of area assumptions made, detailed in Notes, 2.1 Area Statistics, and the interpretation of the table legend 2008 & 2009 R-pin numbers and area figures are not comparable. 2007 figures illustrate a percentage of the total area (from Table 1.1) relating to export production. 2008 - 2012 figures illustrate actual R-pins and corresponding areas registered for export production, regardless of whether fruit is exported, sold locally or juiced.)*

**Figure 5.3.1 Number of Orchards (R-pins) Registered for Export Production by Area (hectares) 2012**

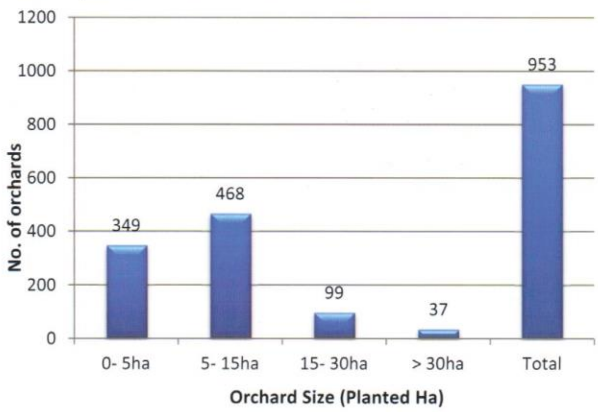
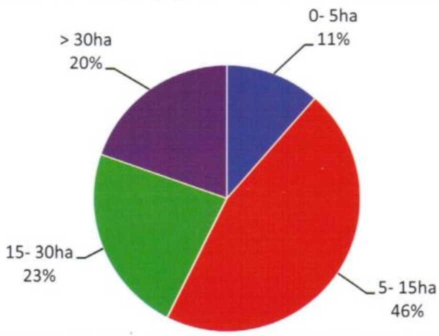


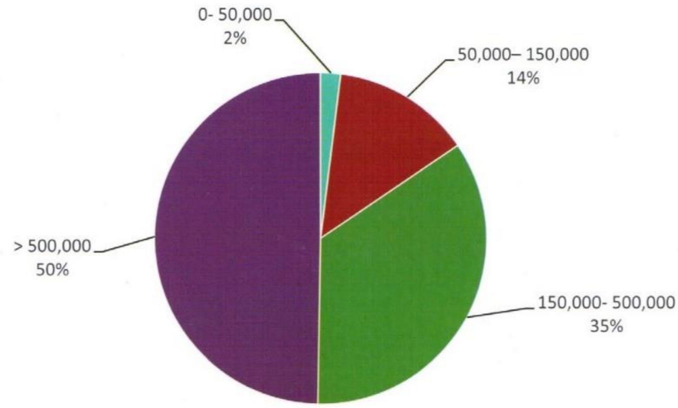

**Figure 5.3.2 National Planted Area (%) by Orchard Size (hectares) 2012**



## Table 5.4 Packhouses by Export Volume (TCEs) 2006-2012

| TCE Export Volume | | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| 0- 50,000 | No of Packhouses | 20 | 13 | 21 | 17 | 15 | 13 | 15 |
| | Total TCE's Packed | 517,785 | 336,870 | 505,005 | 463,999 | 448,757 | 305,098 | 314,384 |
| | Proportion of total | 3% | 2% | 3% | 3% | 3% | 2% | 2% |
| 50,000– 150,000 | No of Packhouses | 25 | 23 | 18 | 20 | 19 | 24 | 23 |
| | Total TCE's Packed | 2,469,752 | 1,958,848 | 1,697,665 | 2,023,236 | 1,843,616 | 2,084,904 | 2,172,092 |
| | Proportion of total | 16% | 12% | 12% | 12% | 12% | 12% | 14% |
| 150,000- 500,000 | No of Packhouses | 22 | 26 | 24 | 18 | 22 | 23 | 20 |
| | Total TCE's Packed | 6,292,228 | 7,222,279 | 6,035,646 | 5,000,626 | 6,786,701 | 5,865,674 | 5,584,148 |
| | Proportion of total | 42% | 44% | 41% | 29% | 46% | 35% | 35% |
| > 500,000 | No of Packhouses | 6 | 6 | 7 | 7 | 6 | 7 | 7 |
| | Total TCE's Packed | 5,693,142 | 6,893,808 | 6,494,523 | 9,630,232 | 5,670,258 | 8,648,248 | 7,980,332 |
| | Proportion of total | 38% | 42% | 44% | 56% | 38% | 51% | 50% |
| Total TCE's | | 14,980,000 | 16,411,804 | 14,732,839 | 17,118,093 | 14,749,332 | 16,903,924 | 16,050,956 |

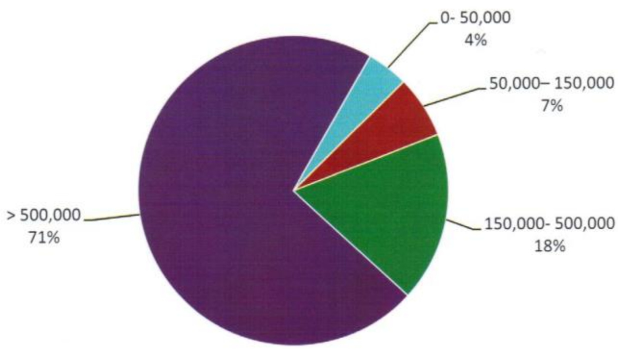
## Figure 5.4.1 Packhouses by TCE Export Volume (%) 2012



## Table 5.5 Exporters by Export Volume (TCEs) 2006-2012

| TCE Export Volume | | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| 0- 50,000 | No of Exporters | 62 | 58 | 58 | 58 | 58 | 54 | 56 |
| | Total TCE's Exported | 600,000 | 666,598 | 591,079 | 510,918 | 654,738 | 550,918 | 694,811 |
| | Proportion of total | 4% | 4% | 4% | 3% | 4% | 3% | 4% |
| 50,000– 150,000 | No of Exporters | 14 | 10 | 16 | 16 | 13 | 11 | 12 |
| | Total TCE's Exported | 1,300,000 | 855,216 | 1,296,095 | 1,453,484 | 1,191,795 | 972,088 | 1,044,198 |
| | Proportion of total | 9% | 5% | 9% | 8% | 8% | 6% | 7% |
| 150,000- 500,000 | No of Exporters | 15 | 15 | 12 | 12 | 12 | 14 | 11 |
| | Total TCE's Exported | 4,220,000 | 4,216,406 | 3,444,885 | 3,534,596 | 3,744,724 | 3,854,347 | 2,845,221 |
| | Proportion of total | 28% | 26% | 23% | 21% | 25% | 23% | 18% |
| > 500,000 | No of Exporters | 5 | 7 | 7 | 9 | 7 | 11 | 9 |
| | Total TCE's Exported | 8,860,000 | 10,673,584 | 9,400,780 | 11,619,095 | 9,158,075 | 11,526,571 | 11,466,726 |
| | Proportion of total | 59% | 65% | 64% | 68% | 62% | 68% | 71% |
| Total TCE's | | 14,980,000 | 16,411,804 | 14,732,839 | 17,118,093 | 14,749,332 | 16,903,924 | 16,050,956 |

## Figure 5.5.1 Contribution to National Exported Volume by Exporter Size 2012



*Appendix 11: ARO: Pruning procedure and visual aid example*

| 1. Establish Customer Demand through Exporter: Complete by 15th May | | | |
|---|---|---|---|
| Process | | Procedure | Who, When |
| | | | |
| Determine customer demand | 1. | Confirm global trading trends. Consider:<br>• Shift in exporting countries<br>• Northern hemisphere production information<br>• Other factors such as exchange rate influences | Exporter |
| ↓ | 2. | Detail known <u>customer demand</u> for next season<br>• By Customer<br>• By Variety<br>• By Colour specifications<br>• By Preferred size profile<br>• By Quality specifications<br><u>Note</u>: Assess projected demand (Volume) for each variety/size/colour/quality combination | ↓ |
| | 3. | Detail preferred <u>demand by country</u> for market access<br>• Assess projected demand (Volume) for each variety/size/colour/quality combination by country | |
| | 4. | Add other essential criteria such as timing by volume<br><u>Note</u>: Use a database model to facilitate multiple variables (variety, sizes, colours, specifications etc.) | |
| | | | |
| Communicate to orchards | 5. | Communicate preferred customer demand to orchard sector<br>• Also communicate initial picture to post-harvest planning | Exporter |
| ↓ | | | |
| Completed | | | |
| | | | |

| 2. Plan pruning strategy for all orchards/varieties (complete in May) | | | |
|---|---|---|---|
| Process | | Procedure | Who, When |
| | | | |
| Initial Planning preparation | 1. | Confirm orchard production details for the past season<br>• Volume by variety<br>• Quality details (colour, size profiles, pack-outs) | Orchard Planning |
| ↓ | 2. | Receive forecasted demand | May |
| Operationalize demand | | | |
| 3. Plan pruning for sector | | | |

| Process | | Procedure | Who, When |
|---|---|---|---|
| | | | |
| Plan pruning | 1. | Receive production targets from planning by sector, by orchard block | Sector manager |
| | 2. | Confirm required manpower requirement | |
| | 3. | Confirm required personal pruning equipment requirement<br>Note: Uniquely identify each item of equipment and hand out on name. Maintain equipment record for the season. | |
| | | **Lean Note**: Customer value is achieved by actual pruning (i.e. cutting). Maximise actual pruning time to minimise waste! | |
| | | | |
| | | | |
| Plan equipment | 1. | Determine need for capital equipment such as hydraladas for each block | Sector managers |
| | 2. | Coordinate use of company hydraladas in coordination with orchard planning<br>**Lean Note**: Avoid unnecessary travel as this leads to waste | |
| | 3. | Coordinate use of other equipment in coordination with orchard planning<br>**Lean Note**: Avoid unnecessary travel as this leads to waste | |
| Completed | | | |

## 4. Execute pruning plan by orchard block

| Process | | Procedure | Who, When |
|---|---|---|---|
| | | | |
| Determine cycle time (TAKT time) | 1. | On each block: Select five typical trees by variety/age/growing method for pruning quality examples and to determine pruning tree cycle time | Sector Manager |
| | 2. | Clearly mark sample trees so that pruners can go back and look | |
| | 3. | Prune some sample trees to specification while recording time<br>Note: Use existing pruning specification | |
| | 4. | Check that trees were pruned correctly<br>Note: Use orchard technical advisor to confirm | |
| | 5. | Prepare simple pruning instruction for pruners<br>Note: Ensure that instructions plus filed book provide adequate detail | |

**Page 5**

## Leader Removal

**Badly angled 1 year old wood**

## Leader Removal

**Page 6**

**Space Clutter spurs**

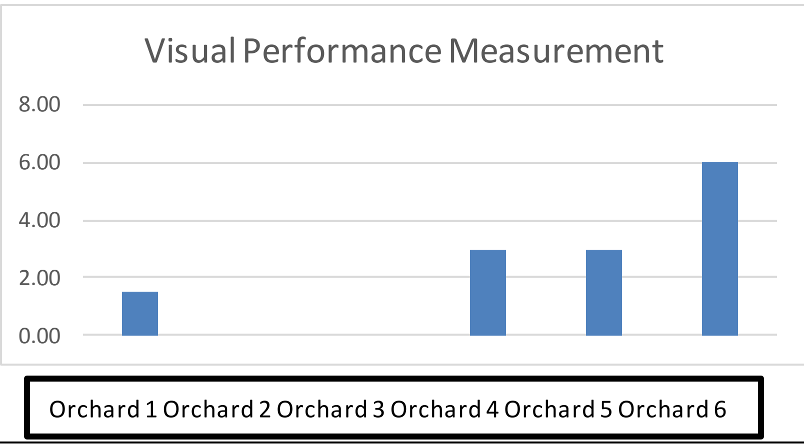
*Appendix 12: ARO Lean audit draft (2014)*

| 6 | Improvement of the Lean Orchard Concept | Observation, documented, recorded, other evidence | *Not found anywhere* | *Only found in some areas (<25%)* | *Commonly found but not in majority (<60%)* | *Very typical, some exceptions (<85%)* | *Found everywhere, no exceptions (100%)* |
|---|---|---|---|---|---|---|---|
| 1 | Orchard staff provide ideas and concepts that adapt, add to and/or improve the Lean orchard concept; the ideas are based on Lean as a production system to satisfy customer demand, improve flow and even production and reduce waste in production processes. | | 0 | 1 | 2 | 3 | 4 |
| | *Reason for score:* | | | | | | |
| | Total of circled scores: | | | | | | |
| | Weight (Indicating relevance to operational 'Leanness' (select from: 1, 1.1, 1.2, 1.3, 1.4, 1.5): | 1.4 | = Lean Score = | 0 | (total times weight) | | |

| 12 | Total Productive Tree Maintenance | Observation, documented, recorded, other evidence | *Not found anywhere* | *Only found in some areas (<25%)* | *Commonly found but not in majority (<60%)* | *Very typical, some exceptions (<85%)* | *Found everywhere, no exceptions (100%)* |
|---|---|---|---|---|---|---|---|
| 1 | There is an effort to plan productive tree maintenance schedules by mapping tree and orchard maintenance requirements by orchard block and variety. | | 0 | 1 | 2 | 3 | 4 |
| | *Reason for score:* | | | | | | |
| 2 | Planned orchard maintenance is communicated via visual management, both for the next few days as for the next few months. | | 0 | 1 | 2 | 3 | 4 |
| | *Reason for score:* | | | | | | |
| 3 | Each orchard block has a record of poorly producing trees (which are marked in the orchard) and a plan to improve production of each of those trees. | | 0 | 1 | 2 | 3 | 4 |
| | *Reason for score:* | | | | | | |
| | Total of circled scores: | | | | | | |
| | Weight (Indicating relevance to operational 'Leanness' (select from: 1, 1.1, 1.2, 1.3, 1.4, 1.5): | 1.475 | = Lean Score = | 0 | (total times weight) | | |

# Audit categories

| | |
|---|---|
| 1 | Visual Management |
| 2 | Visual Performance Measurement |
| 3 | Workplace Organisation |
| 4 | Standardising Work |
| 5 | Orchard Layout |
| 6 | Improvement of the Lean Orchard Concept |
| 7 | Error Proofing (Preventing Human / Method Errors) |
| 8 | Quick Change-over (Quick Setup) |
| 9 | Flexible Operations (Process and Worker Flexibility through Continuous Flow) |
| 10 | Orchard and orchards Team work |
| 11 | Total productive Equipment Maintenance: Planned Maintenance & Safety |
| 12 | Sequential Productive Tree Maintenance |
| 13 | Total Even Production Orchard |
| 14 | Production Information flow and accuracy (supply chain) |
| 15 | Pull Systems (Material and People) |
| 16 | Waste |
| 17 | Lean Discipline |
| 18 | Continuous Improvement (Small, Regular Improvements by all) |
| 19 | Work-Culture Awareness (Customer Focus - Worker Awareness) |
| 20 | Management Support |

<table>
<tr><th colspan="3">Example of an audit outcome</th></tr>
<tr><td>2.</td><td>Visual Performance Measurement</td><td>Observation, documented, recorded, other evidence, notes:</td></tr>
<tr><td></td><td>Visual performance management intends to communicate how well people or teams are performing. <u>This is not financial performance</u>! Up-to-date operational performance indicators allow staff to improve their performance. This can include H & S data, pruning data, daily pruning performance, quality of product etc.</td><td>There were only a few orchards that had some visual performance data. Several orchards had displayed pruning scores. Some had a pruning ‘worm’, a performance against budget tool that has a financial focus. It creates urgency but does not focus on or assist with performance improvement. One orchard had general H & S data on the notice board.<br>Orchards struggled with the concept of Lean indicators versus budget driven indicators.<br><br></td></tr>
</table>

*Appendix 13: Pipfruit Lean Cluster Summary*

## HB Pipfruit Lean Business Cluster

In summary, the Hawke's Bay Pipfruit Lean Business Cluster encompasses the following:

1. The cluster and its members:
    a. A group of between six and twelve pipfruit companies.
    b. Members can be growers, packers (incl. coolstores), exporters or vertically integrated.
    c. Cluster members are considered representative for the industry; they are considered reasonable experts in their fields who intend to professionalise their organisations.
    d. Further members can be added during the year.
    e. Important: The cluster is run by its members, i.e. cluster members take ownership of the cluster and determine its direction.
2. Role of Pipfruit NZ Inc.:
    a. Cluster is organised under auspices of Pipfruit NZ Inc.
    b. Pipfruit NZ Inc. will assist e.g. by making printed material available.
    c. Pipfruit NZ Inc. is represented by Hans Doevendans from QMAC Systems, who is also a full-time Lean PhD student, specifically looking into Lean for the pipfruit industry.
    d. Pipfruit NZ Inc. may use its relationship with NZTE to assist cluster activities.
3. Meetings:
    a. Six two-monthly meetings of a maximum of 4 hours each.
    b. Members are expected to attend most meetings, also during the season.
    c. Attendance can be with one or two people; the same person does not need to attend all the time.
    d. Meetings are on-location, the location swapping around from one cluster member to another.
    e. About two meetings per year may be organised around visiting other (non-pipfruit) Lean companies.
4. Learning:
    a. Open exchange of information.
    b. Cluster is there for all members to learn from each other.
    c. Cluster members can ask for specific information.
    d. Hans Doevendans will be available to address any queries about Lean.
    e. Cluster members may be offered to try specific methodologies and report on effectiveness.
5. Research report:
    a. Cluster activities may be mentioned in research reports, without identifying organisations.
    b. Research findings are shared with the participants, NZ pipfruit and may be shared with the university and wider academic community.
6. Further principles may be added to this list.

*Appendix 14: Pipfruit Lean Cluster Summary Feedback example (Sic.)*

Pipfruit NZ Lean Cluster Meeting: 25th Feb 2014 (Company 1 Coolstores)

Follow up questionnaire

| Feedback Performance: | |
|---|---|
| **No. of members attending (organisations):** | 5 |
| **No. of feedback forms received:** | 3 |
| **Received within two weeks:** | 2 |

What did you learn from the visit:

- It is good to see other operations take on Lean and see the differences in the way they have implemented things. The Haka meeting board at seen is a good example. While we report on similar things at our meetings we are not as visual and don't use boards like this.
- Another very good point was what is considered waste–we are told movement is waste but the host pointed out that they will move a lot of pallets if needs be to get the right ones to market. His take on the waste being fruit going to wrong markets.
- Another good idea was having the red lines painted on the floor to show when bin stack height needed to change to avoid hitting evaporators.
- Keep it simple.
- Let the teams take ownership–improvements will then just happen
- Invest in the resources to collect the data to support what the teams are doing and demonstrate gains
- Very impressed with battery management and the hazard signs inside a room where height levels reduce

Have you implemented anything from the visit?

- Will put some visuals up for the line Haka meetings
- Not yet...
- We have adopted the battery management and had this in place a week after the visit

Other Comments:

- Great to be able to visit sites and see others ideas on how to follow Lean principles.
- Excellent overview. Learnt a lot about alternative ways to do the same thing. The field trips are very informative
- Currently our toolbox meetings cover the remainder of lean management and would like to thank our hosts for their sharing of lean practices.

Do you plan to implement anything from the visit?

- We have been looking at the issue of pallet movements needed to load containers with the correct fruit. We will continue with this but may look at another measure of correct fruit getting to correct market.
- The Whiteboard concept and storage system for the clamps and locks for doors are on the agenda for implementation
- We will be introducing the hazard signs inside coolstores, when these are not in use. This requires floors to be marked, which in effect cannot be done until rooms are switched off and dry. However we can mark the wall with hazard strips where applicable

## *Appendix 15: Future State Lean Activity Planner*

| ***Principle/method/ tool*** | **Use** | **Grower/Orchard** | **Packer/Packhouse/ Coolstore** | **Exporter** |
|---|---|---|---|---|
| *Customer Value* | Current | Not specifically communicated to orchards or communicated late, most commonly around December of January. | Expressed in exporter or customer specifications that are communicated before packing to the packer. | The exporter is the closest to the customer but does not communicate timely to orchards (i.e. before pruning starts); the industry sells an estimated 50% in programmes (where the customer is known) and the balance on consignment (where the customer is unknown). |
| | Future state | Growers can affect what is grown (production) if they know what the customer requires and in which country the customer is based (in order to get access to that market). The ideal state communicates customer value just before pruning. | Pack as the customer requires. The future state is that the packer knows all customers and customer value for each well before the time of packing all sizes and colours of a variety. This facilitates timely ordering of packaging. | Sell to the customer what the customer requires. A future state includes 100% customer programmes which allows the exporter to provide customer value specifications to grower and packer. |
| | Example | Growers arrange to hear from their selected exporters no later than June each year what the customer requires, in which country he trades and what the exporter recommends to grow. | Packers set up a calendar communication process with exporters to work towards a complete set of specifications that is communicated timely to packaging manufacturers. | Work with customers on achieving more programmes and reduce the number of consignment sales without sacrificing returns. |
| *Value Stream Mapping (VSM)* | Current | Not used at all. Research company had a look at it. | Trialled by some of the research companies but not embedded. | Not known to be used by exporters in |

| *Principle/method/ tool* | Use | Grower/Orchard | Packer/Packhouse/ Coolstore | Exporter |
|---|---|---|---|---|
| | | | | general. Not used by sample companies. |
| | Future state | Valid tool but needs assessing for orchard use. The future state includes value stream mapping to identify and reduce waste. | Standard tool to identify and eliminate waste in the packing/storing process. The future state sees value stream mapping used in all departments for all activities. | Valuable as VSM deals with processes, information and product flow. The future state sees VSM used by exporters identifying waste in all logistics. |
| | Example | Orchard staff map a value stream around one activity (e.g. harvest) as practice to identify waste and gain understanding. | Packhouse and coolstore staff map a single process (e.g. load-out) to identify waste so that they gain understanding. | Exporters use a consultant to learn about value stream mapping and develop a value stream for a product family to reduce waste and gain understanding. |
| *Creating Flow* | Current | Some flow used but low applicability as production is nature-dependent. | Apples flow from orchard to coolstore to packhouse to coolstore to shipping with numerous batching interruptions in the process caused by inventory peaks. | Not known to be used except some information and documentation flow. |
| | Future state | Low applicability. Flow of staff from one orchard to another causes no waste. Harvest flows from one orchard to the next as fruit matures. No flow between production stages. | Used by research packhouses with some variation in methods. In a future state, product will flow from orchard to coolstore via treatments, to packing to cooling to shipping with minimal transfers. | In a future state, information flows seamless from orchard to coolstore to packhouse, to coolstore and to shipping and exporting. |
| | Example | Orchard plans flow for change of processes and change of orchard blocks, e.g. where possible move pruners to an adjacent block, not a remote block. | Product is packed to demand after pre-sizing and shipped immediately, reducing packed stock inventory and thus reducing rework. | Relates to information only. Set up a live information process that streams information to packers and coolstores and v.v. to reduce unnecessary actions. |
| *Creating Pull* | Current | Not applicable for | Packhouse calls for fruit | Exporters |

| ***Principle/method/ tool*** | **Use** | **Grower/Orchard** | **Packer/Packhouse/ Coolstore** | **Exporter** |
|---|---|---|---|---|
| | | fruit; is used for tree and fruit quality (e.g. sprays). | in stock to pack and reasonably packs to exporter demand. Similarly calls for (pulls) packaging materials as required to maintain low stocks. | provide load-out instructions as packed products become available in inventory and as they are sold. Exporters are aware of inventory issues. |
| | Future state | Pull only materials/services as and when needed to reduce inventory, e.g. chemicals, fertilisers, irrigation and labour. Typical VSM. | In a future state, the packhouse pulls only materials/services as and when needed (refer Kanban systems). Typical VSM. | In an ideal state, fruit would only be instructed to be packed if sold. Typical VSM. |
| | Example | Complete a soil test, order the right fertiliser in the right quantity and apply holding no leftover stock. | The information flow with the exporter ensures that fruit is packed that will be shipped without delay to reduce packed stocks. | Align sales with packing instructions. When a line of fruit is packed, sell all sizes and pull from coolstore to ship. |
| *Continuous Improvement* | Current | Not seen as philosophy; small improvements are not 'enough'. Difficult to adjust to the mind-set. | Not seen to be encouraged to workers except by the research companies. | Not known to be used as philosophy but exporters try to improve product. |
| | Future state | Essence of Lean; In the ideal state, all workers are involved in continuous incremental improvements; breakthroughs are bonus. | | |
| | Example | Make visible those improvement suggested and executed, including the difference they make to encourage staff to experience intrinsic value of improvements. | | |
| *Load-levelling / Level scheduling (Mura)* | Current | Used by planting different varieties and using products such as Hi-Cane and Retain to advance or delay harvest. | Packhouse/coolstore accelerate from the season start and remain at full pace during the season and not afterwards; MPI rules create multiple change-overs each day. | Not known to be used. Exporters are outcome focussed and unconcerned about load-levelling. |
| | Future state | Achieves production smoothing. In an ideal state, pruning, hand-thinning and harvesting is spread evenly over the seasons. | Reduces pressures if achievable but depends on fruit quality and exporter demands. In an ideal state, all fruit would be of consistent quality and sales would be even during the season. | In a future state, exporters would coordinate the direct supply chain/value stream. |

| *Principle/method/ tool* | Use | Grower/Orchard | Packer/Packhouse/ Coolstore | Exporter |
|---|---|---|---|---|
| | Example | Create a matrix showing variety by block and normal harvest time. Consult with exporter and advance or delay harvest to level load on pickers. | Pack at a consistent speed by variety. Plan runs so that size and quality permits this. | Integrate exporter with coolstore, packer and grower information flow to facilitate better planning. Work towards selling all sizes of a packing run. |
| *Preventing overburdening (Muri)* | Current | Significant burden on staff during harvest time. Increase in seasonal staff reduces the load. | Significant burden on staff during submission to load-out. Increase in seasonal staff reduces the load. | Not considered a significant factor under the current model. Increase of staff not usually necessary. |
| | Future state | Flexible seasonal staff multiplication to cope with variation in hand thinning and harvest requirement. Information flow is well integrated and timely, reducing any late changes which often create overburdening. | | No or little seasonal staff. Information flow is well integrated and timely, reducing any late changes which often create overburdening. |
| | Example | Train pickers to pick the right fruit and use the right technique to improve performance. | Combine packing runs in such a way that the number of changes during a packing shift is reduced. | Plan packing for packhouses with the least number of change-overs. |
| *Identifying wastes* | Current | Not deliberately used as Lean tool but consciously considered to achieve efficiency. Lack of education around what constitutes waste. | | |
| | Future state | Essential for continuous improvement; in an ideal state, all employees identify all forms of wastes and minimise or remove these. | | |
| | Example | Explain a single form of waste to staff and get staff to identify that form of waste within their area of operations for 30 minutes. Exchange results to reinforce learning. Repeat regularly. | | |
| *Cellular Production* | Current | Not applicable in annual tree crops. | Apples are washed, graded, packed in cartons and palletised in the packhouse. Equipment layout is in essence one large cell. | Not applicable. |
| | Future state | Applicability in annual tree crops questionable. | Could be applied in a pre-sizing environment where washed and graded apples are first batched, followed by rapid packing in individual cells. | Not applicable. |
| | Example | Not applicable. | Uncertain if current | Not applicable. |

| *Principle/method/ tool* | **Use** | **Grower/Orchard** | **Packer/Packhouse/ Coolstore** | **Exporter** |
|---|---|---|---|---|
| | | | process can be much improved other than through pre-sizing first. | |
| *One Piece Flow* | Current | Not applicable in annual tree crops. | A form of one piece flow applies; apples from 400 kg bins are continuously packed into different cartons of 18 kg, which are packed sequentially. | Not applicable. |
| | Future state | Applicability in annual tree crops questionable. Harvesting by size and colour could lead to a form of one-piece flow in the packhouse but is impractical. | Questionable if improvement can be made when assembly follows disassembly. One piece flow can be applied after pre-sizing, allowing packing to demand. | Not applicable. |
| | Example | Not applicable. | Pre-sized product is packed by single bin with quick change-over leading to packing complete product in low volumes. | Not applicable. |
| *Quick Change-over* | Current | Change-overs in orchards include trees, sprayers and people. Orchards can plan for quick change-over of trees. Filling up sprayers requires quick change-over. More time consuming is the changing of pruners, thinners and pickers from block to block. | Applicable and used in packhouse packing runs. MPI requirements and packaging make this difficult. Applicable to coolstores; Smart-Fresh and CA room changes. | Not researched. |
| | Future state | Trees are pulled, soil fumigated and trees re-planted in high density fast maturing plantings, reducing non-productive period to minimum. Spray filling combined with refuelling or other. Setting up blocks before staff arrive, getting staff to take own ladders and buckets to new blocks. | Timely planning allowing setting up of bins to pack and packaging. Running packing run changes (no stopping). Running packaging changes. Running variety changes. Continuous flow from bins in and out of Smart-Fresh rooms. | Not seen to be applicable. |

| *Principle/method/ tool* | Use | Grower/Orchard | Packer/Packhouse/ Coolstore | Exporter |
|---|---|---|---|---|
| | Example | A grower trained staff that they must take their picking ladders to the end of the row to make pick-up for removal less time consuming. The next phase is that the harvesters move in a grower provided van and tow the ladders themselves, saving time and making change-over much quicker. | A change of packing run is announced and prepared, with all packaging attributes pre-arranged before the change-over takes place. This reduced standard change-over time by several minutes for each change-over. | Not applicable. |
| *TAKT time* | Current | TAKT time for producing an apple is one year; TAKT time is not used in orchards except by some research companies. | TAKT time is not used in packhouses or coolstores except by some research companies. In broad terms, increased staff number relate to TAKT time. | Not researched. |
| | Future state | TAKT time for producing an apple cannot be manipulated; TAKT time can be used for pruning trees, hand thinning trees and filling bins. | TAKT time can be used to determine emptied bins or packed cartons per time-unit. TAKT time can also be used for filling and emptying Smart-Fresh rooms. | Not researched. |
| | Example | Measure the time it takes to prune 5 trees and provide the TAKT time to the pruners. This TAKT time is not directly related to customer demand. | A coolstore appointed dedicated staff to load and unload SmartFresh rooms to keep up with demand. | Considered not applicable. |
| *Cycle time* | Current | Cycle time for producing an apple is one year; not applicable. | Cycle time is not used in packhouses or coolstores except by some research companies. | Not researched. |
| | Future state | Pace of production; not applicable. | Cycle time set to pack a bin of apples varying with variety, quality and packaging requirements. | Not researched. |
| | Example | Not applicable. | A packhouse plans its packing season duration based on volume by variety and known cycle | Considered not applicable. |

| Principle/method/ tool | Use | Grower/Orchard | Packer/Packhouse/ Coolstore | Exporter |
|---|---|---|---|---|
| | | | time for packing. | |
| *Total Productive Maintenance (TPM)* | Current | Loosely planned maintenance during the off-season; corrective maintenance during the season. Research company making a start with TPM. | Research companies trending towards better maintenance planning; some operator involvement. | Office equipment only; no TPM philosophy. |
| | Future state | Effective TPM planning and execution leading to no breakdowns and therefore superior flow in production. Off-season offers ideal opportunity for maintenance. | | |
| | Example | Orchards plan off-season maintenance but make operators responsible for daily maintenance to ensure operational effectiveness of equipment. | Coolstores make forklift drivers responsible for daily maintenance checks. | Office equipment only. |
| *Total Productive Tree maintenance (TPTM)* | Current | Individual dead trees and low producing trees generally accepted as normal. Research companies making a start with TPTM. | Not applicable | Not applicable |
| | Future state | Dead or low producing trees immediately replaced using proper soil preparation. Reflecting cloth used for colouring fruit, Drainage and irrigation controlled and monitored. Soil health monitored and controlled. | Not applicable | Not applicable |
| | Example | An orchard develops a process flow for the immediate replacement of dead or diseased trees and executes it decisively. There are never many dead or diseased trees in the orchard. | Not applicable | Not applicable |
| *Overall Equipment* | Current | Not known to be | Not known to be used. | Applicable to |

| *Principle/method/ tool* | Use | Grower/Orchard | Packer/Packhouse/ Coolstore | Exporter |
|---|---|---|---|---|
| *Effectiveness (OEE)* | | used. | | software inventory and shipping programmes only. |
| | Future state | Measurement of OEE available, performance and output quality of equipment measured; relates to tractors, sprayers, hydraladas. | Measure availability, performance and output quality of equipment; relates e.g. to cooling equipment and packing equipment. | Little relevance to exporters as agents. |
| | Example | Record each event where equipment does not perform to facilitate improvement. | Record each event where equipment does not perform to facilitate improvement. | Not applicable |
| *Overall Tree Effectiveness (OTE)* | Current | Not known to be used. Overall block effectiveness is monitored. | Not applicable | Not applicable |
| | Future state | Measurement of OTE available, performance and output quality of each tree measured; relates to trees only. | Not applicable | Not applicable |
| | Example | Measure in increasingly smaller units of trees (e.g. rows) to facilitate fine-tuning of cropload. | Not applicable | Not applicable |
| *Just-In-Time* | Current | Production is a single annual cycle and not based on customer demand. Some other supplies have intuitive JIT. | Coolstores store inventory as it arrives. Packhouses order stock-to-pack from coolstores as required (JIT). | Exporters already focus on getting product from ship into market without delay and JIT. |
| | Future state | Ordering chemicals and fertiliser and labour only when needed. Reduces inventory in a standard production setting. | Pipfruit can be packed on demand with bins in coolstore ready for packing. Applicable for programmes and fixed sales; not for consignments. Packaging materials ordered JIT. See Kanban. | The exporter confirms customer demand and adjusts the timing of the demand with shipping options and fruit availability. |
| | Example | Decide on spraying days and product to | Align packing programme with | As above. |

| *Principle/method/ tool* | Use | Grower/Orchard | Packer/Packhouse/ Coolstore | Exporter |
|---|---|---|---|---|
| | | use. Pick up from supplier or arrange with supplier to deliver the day before. | exporter sales programme. | |
| *Kanban* | Current | Used incidentally as reactive inventory management for consumables (e.g. chemicals). | Used by research packhouses with degree of success. Not many applications in coolstore environment. | No known usage by exporters. |
| | Future state | Bins, chemicals and labour are ordered in sufficient small numbers 'automatically' by using kanban. | Packaging, labels, packaging attributes and all other consumables are replenished in sufficient small numbers 'automatically' by using signal cards. | For exporters this relates to office supplies; exporters can see inventory but 're-ordering' is based on sales rather than minimum stock levels. |
| | Example | Decide on bins required for next harvest day and order. May be delivered as backload to reduce waste. | A packhouse has a Kanban system for all packaging requirements. The system requirements are aligned with the volume of fruit to be packed. | Kanban can be used for office supplies. |
| *Autonomation (Jidoka)* | Current | No known application in the orchard. | Coolstore alarms, automatic sizer stoppage if missing cups detected. | No known application. |
| | Future state | Equipment is partially automated and designed to stop automatically if defects are identified. Possible application in sprayer setup. | Definite application in packhouses, e.g. if packing stations are too full with apples; automatic tree feeding; recycling of un-allocated apples; set-height forklifts. | No known application in the office. |
| | Example | Non available. | Forklifts are programmed to stop at specific heights to stop forklift drivers from misjudging the height of stacks of bins. | Not applicable |
| *Mistake/error proofing* | Current | Many application options; rows numbered and vital information shown, storing herbicides away from insecticides; marking last row sprayed etc. Trees can be loaded with | Many application options; visual management, numbering of lanes, scanning bin-cards before packing; confirm spray certificate before packing. Numerous examples, often prevented by software | Application options for service delivery and general administration. |

| Principle/method/ tool | Use | Grower/Orchard | Packer/Packhouse/ Coolstore | Exporter |
|---|---|---|---|---|
| | | pheromones to discourage insects. Have thinners wear a sizing sample apple. Use of bin cards. | warnings or blockers. | |
| | Future state | Production processes designed with error prevention and detection to achieve zero mistakes/zero defects. Concerns trees, fruit and machines. | See orchards; The culture must develop so that any error is evaluated and a root cause identified and eliminated or an error proofing measure put in place. | Equally applies to exporters, particularly as part of the integrated direct supply chain/value stream. |
| | Example | Marking the last tree sprayed before spray ran out with an arrow sign, pointing in the direction the driver was heading. | Automatic software blockers preventing load-out to a country the product is not suitable for. | No specific examples. |
| *Cause and effect / Root cause* | Current | Not generally used. Reactive fixing of immediate problems | Not generally used. Reactive fixing of immediate problems | Not researched. |
| | Future state | Root cause resolution resolves underlying causes for problems; not the symptoms. Applies to orchards, coolstores, packhouses and exporters equally. All staff trained in root cause analysis and applying every time. | | |
| | Example | Start-up after automatic sizer shutdown was delayed because the operator did not know which switches to reset. Root cause identified and start-up procedure placed on wall for all to see. | | |
| *Problem solving (e.g. PDCA)* | Current | Problem solving techniques are not known. PDCA is unknown. | Problem solving techniques are not known. PDCA is unknown. | Problem solving techniques are not known. PDCA is unknown. |
| | Future state | All staff trained in PDCA and applying every time. PDCA is an iterative methodology for identifying and implementing improvements, e.g. PDCA involves a Plan (establish plan and expected results); Do (implement plan); Check (verify expected results achieved); Act (review and assess; do it again). Applies equally to orchards, coolstores, packhouses and exporters. | | |
| | Example | Incorrect label placed on fruit. The symptom is fixed by pulling the label off and replacing it with the correct label. The root cause can be identified and a permanent solution found using a PDCA approach. | | |
| *5-S (Sort, Straighten, Shine, Standardise, Sustain)* | Current | Generally not used as tool except by research company. Appears problematic in the field. | Generally not used as tool except by research companies and some known 'tidy' organisations but not as 5-S. | Not known to be used. |

| Principle/method/ tool | Use | Grower/Orchard | Packer/Packhouse/ Coolstore | Exporter |
|---|---|---|---|---|
| | Future state | All staff trained in 5-S to organise the work area using five approaches: Sort (eliminate that which is not needed); Set In Order (organize remaining items); Shine (clean and inspect work area); Standardize (write standards for above); Sustain (regularly apply the standards). 5-S eliminates wastes resulting from a poorly organised work area. Equally applies to all value chain elements (orchards, coolstores, packhouses, and exporters). | | |
| | Example | A company started on 5-S and found it had a lot of material and equipment without purpose. The 5-S exercise took about 6 months and made the company unrecognisably tidy. | | |
| *Visual management* | Current | Generally poorly used as a tool. Research orchards are making progress. | Generally poorly used as a tool. Research packhouses have significantly improved visual management with positive results. | Exporters have not been assessed. |
| | Future state | All orchards have visual guidance, locations, displays, controls etc. communicating useful information to everyone effortlessly. Applicable to orchards. | All packhouses/coolstores have visual guidance, locations, displays, controls etc. communicating useful information to everyone effortlessly. Applicable to coolstores and packhouses. | All exporters have visual guidance in their offices, locations, displays, controls etc. communicate useful information to everyone effortlessly. Applicable to office environments. |
| | Example | Use a fixed display at each block for standard information. Use a mobile board if staff are not coming to a central point. | Get staff to think about measures that help with their performance, not 'after-the-fact' measures, e.g. packing planning for the day with approximate bin numbers and times. | Not available |
| *Stand-up meetings* | Current | Not commonly found, often because of people start times and locations. | Not used by industry. Used by research organisations with varying degrees of effectiveness. | Not known to be used. |
| | Future state | All organisations have brief daily stand-up meetings for each shift, with a focus on operational items from a Lean perspective (e.g. Lean indicators) to coordinate activities. | | |
| | Example | One company is known to have sequential stand-up meetings from the top down so that information flows to all who need to know. | | |
| *Traffic lights* | Current | Not used in orchards. | Used in some packhouses for grading. | Not used by exporters. |
| | Future state | Traffic lights provide real time, immediate visual feedback on | Quality status is shown using traffic lights. Production status is shown using traffic | Exporters use traffic light systems for export available |

| *Principle/method/ tool* | **Use** | **Grower/Orchard** | **Packer/Packhouse/ Coolstore** | **Exporter** |
|---|---|---|---|---|
| | | production status and relevance in the orchard has not been assessed. | lights. Coolstores use traffic lights to indicate available storage space. | stocks that assist their decision making. |
| | Example | Not considered | Use manual traffic light for manual graders. | Not applicable |
| *Walking the 'shop floor'* | Current | Orchard managers spend considerable time on the shop floor | Packhouse/coolstore managers generally spend time on the shop floor. | Exporters are known to spend time on the orchard shop floor but are outcome focussed and cannot interfere with the orchard operation. |
| | Future state | All orchard managers walk the orchard floor with an added focus on flow, waste etc. Fundamentally important, also for staff support. | All packhouse managers walk the packhouse floor and know how to identify the three forms of waste and do so. Assists with continuous improvement. | Exporters walk the orchard floor, know the product and its development, know the people and communicate customer value. |
| | Example | Orchard manager monitors pruning quality and speed. | Packhouse manager stands back and observes where the waste is during palletising. | The exporter helps the grower to strike the right balance between customer demand and load levelling for future plantings. |
| *Empowerment* | Current | Some empowerment present on research orchards but seasonal staff generally not involved. | Some empowerment present but seasonal staff generally not involved. Permanent packhouse/coolstore staff easier to involve in research companies. | Not assessed. |
| | Future state | Critical element of a lean culture, pushing decision making to the lowest possible level, and encouraging and empowering employees at all levels to take action to solve value chain problems and improve the organisation. | | |
| | Example | A company explains what a 'just-do-it' is and encourages staff to just do it and report afterwards. These are small improvements with low cost. | | |
| *Cross training* | Current | No formalised cross-training observed within research companies but permanent workers perform different seasonal jobs. | Not much formalised cross-training observed within research companies but permanent workers perform different seasonal jobs. | Not assessed. |

| *Principle/method/ tool* | **Use** | **Grower/Orchard** | **Packer/Packhouse/ Coolstore** | **Exporter** |
|---|---|---|---|---|
| | Future state | All organisations have built flexibility in the workforce by training workers to perform several or all the other operational steps required within each team. Applicable specifically in cellular production, but also in orchard and coolstore/packhouse environment. | | |
| | Example | An orchard trained operators to spray fixed blocks, creating problems when the person was away. | | |
| *Flow charts / Control charts* | Current | Flow charts have been introduced by the research orchards. Control charts have not been assessed. | Flow charts are used by some packhouses/coolstores. Control charts are generally not used. | Not assessed. |
| | Future state | All organisations use flow charts that visually represent a process to better understand it and identify opportunities for improvement. All control charts are used to monitor outputs and identify variability, reducing sub-standard outputs. | | |
| | Example | An orchard uses a pruning 'worm' to monitor progress. The orchard uses a flow chart to explain the pruning sequence of actions. A coolstore uses a flow chart to load the stores for optimum value. | | |
| *Spaghetti diagram* | Current | No known trials completed with spaghetti diagrams. | No known trials completed with spaghetti diagrams. | Not researched as considered not applicable. |
| | Future state | All orchards have used spaghetti mapping for all main processes at least once to reduce waste. | All packhouses and coolstores have used spaghetti mapping for all main processes at least once to reduce waste, e.g. excessive forklift movements due to selecting pallets for export. | Not applicable |
| | Example | Use spaghetti mapping to verify how much distance pruners, thinners or pickers have to cover walking and determine the waste in motion. | Use spaghetti mapping to verify how much distance packers and palletisers have to cover walking and determine the waste through motion. | Not applicable |
| *Pareto chart* | Current | No known use of Pareto charts | No known use of Pareto charts | No known use of Pareto charts |
| | Future state | All organisations use Pareto charts for all main processes to determine priorities. Pareto Charts graph data in order of frequency or relevance and assist decision making. Not researched but has general applicability. | | |
| | Example | Introduce Pareto charts as part of problem solving training. Packhouse maintenance can be prioritised using a Pareto chart. | | |

*Appendix 16: ARP exercise in identifying waste*

# LEAN

All pens/whiteboard markers etc... returned back to where they belong.

Another calculator

Packing supervisers whiteboard pens velcro'd @ lane #1 & #24 - put back @ end of each shift so easy to find and always know where they are.

- REMOVE ALL UNNECESSARY CRAP FROM SOD CORNER - PUT LABEL CABINET IN CORNER Actioned.

FQP Coffin should have an advanc remote also where trays are feed in.
-Fix feed for Trays

Paper work for Each Run Kept up @ Console Then Taken to Site Admin office after shift.

Lanes fixed that trays catch on.

Another QC computer at or near Random drop.

## *Appendix 17: Concerning the originality of the Lean apple tree model*

### *Introduction*

The Lean pipfruit model in this thesis is partly based on an apple tree and inspired by Professor Peter Hines' iceberg model and the need to contextualise the model for the industry. Having completed the chapter on the model, I sent a picture of the apple tree model to Professor Hines who responded that he had seen the analogy used before. This appendix intends to provide evidence that the Lean apple tree model developed in chapter six of this thesis is original and not based on any form of copying or plagiarism.

### *Background*

On the 22nd September 2014, after completion of my chapter on a Lean pipfruit model, I emailed Professor Peter Hines to ask what he thought about the model I created, as it was inspired by the iceberg model. Professor Hines had spent some time with me at the start of my PhD and I was curious about what his thoughts would be (Reference: Email dated 22 September 2014). I used our last communication (6 December 2012) to respond to his direct email address.

Professor Hines responded on the 25th September 2014 (Reference: Email dated 25 September 2014), asking for a copy of the final thesis and agreeing with the apple tree model. In that email, he mentioned that he had seen an apple tree being used as an analogy before.

As I was concerned about the originality of my apple tree model, I responded to his email on the 25th September 2014 and, amongst other matters, asked if he could recall whether he saw an apple tree used in a published document or presentation, or something else (refer email sent on 25-9-2014).

Professor Hines responded promptly (refer email received 25-9-2014), sending me a copy of a presentation by a conference participant during a Lean business system conference in Sydney on the 1st and 2nd September 2014 (see conference-related screen-dumps in folder).

### *History of the development of the Lean apple tree model in this thesis.*

In June and July 2014, I presented three papers, based on the work completed for this thesis, at Euroma 2014, PMA 2014 and ANZAM 2014. After my return from these conferences in early July 2014, I started playing around with ideas for an industry model. I intended the model to be symbolic because a detailed model would be too elaborate and not find any following in the NZ pipfruit industry as it is known to me. I had identified by this time that a number of critical factors were required in order to become Lean and had already sent a literature review chapter identifying those critical factors to my supervisors in September 2013.

Looking for a symbolic representation of visible and invisible components of Lean that would very likely be understood by the industry, I felt that a tree would contextualise the visible and invisible components of Lean for the industry. I downloaded pictures of trees from the internet on the 10th July 2014 (refer picture files; first picture files are dated 10 July 2014) while the idea was in my head. One file was from a book from 1903 from the US archives and thus copyright free, while the other one was more what I wanted but from a commercial site. I asked my wife, who is an artist, to draw me a tree along the lines of the second tree and explained why. In addition, I asked her to draw some younger trees to be able to show development. She did draw a simple set of trees and I have the original calligraphy pen drawing in my possession (refer picture files; file dated 24 July 2014). This all happened in July 2014.

I did a little more work on the chapter about the model towards the end of July 2014, using various tree models including the one drawn by my wife to see what it would look like. However I put it away for some time while I continued working on the results section of the thesis.

During August, I continued working on the results and discussion chapters of the thesis and in September I picked up the chapter on the model and started completing the chapter. I sent a draft Lean apple tree model to the action research orchards manager to get his view on the model on the 4th September 2014 (refer email sent to ARO manager, dated 4 September 2014). The first draft of the chapter was completed and was sent to Massey University on the 19th September 2014. This was followed by my email to Professor Hines on the 22nd September 2014.

During all of this time I was not aware of the Sydney conference or any other conference as I had just returned from three academic conferences and was determined to have no further distractions while completing my thesis. For all previous conferences I had obviously communicated with my supervisors. As I like to plan my study, my supervisors had a copy of my study planning, including the planned completion date of each chapter; the list also included dates of my planned visits to Massey University to discuss progress. My supervisors can confirm that I generally keep to the study plan.

### *Possible explanations for two Lean apple tree models*

The apple tree model in this thesis was conceived by me before—and without any knowledge of—the Sydney conference. Conversely, I do not believe that somehow my apple tree model might have 'leaked' to the creator of the apple tree model presented in Sydney 2014. In my view, the parallel development of the two similar models is coincidental or could be referred to as a case of synchronicity. The difference between coincidence and synchronicity is that there is no psychic 'inner experience' involved in coincidence; coincidence is an aggregation of facts that, although astonishing, do not share meaningfulness. Synchronicity involves meaningfulness.

### *Synchronicity:*

Jung first used the term 'synchronism' in a seminar in 1928 (McGuire 1982, in Donati, 2004) in order to account for what he called non-causal coincidences, and place these non-causal events into an ordered framework that would offer a more complete picture of our phenomenological world (Storm, 1999). According to Jung, several events form synchronicity when a meaningful connection or association can be made between the events, but it is only synchronicity when meaningfulness is the connecting principle between the events in the absence of causal connections (Jung, 1960, para. 849-850 in Storm, 1999). Jung makes the connection between the individual psyche and the collective unconscious—usually involving archetypes—to explain synchronicity. Synchronicity is not time-dependent in the causal sense (cause must precede effect): The physical event may occur at the same time as an experience in the psyche (an internal image), or even after this experience. Also, synchronicity is not dependent on spatial factors.

### *Final statement*

I unconditionally confirm that my Lean apple tree model was conceived before—and without any knowledge of—the Sydney conference. The essence of this appendix is to claim the originality of the Lean apple tree model for this thesis and serves to prove that the Lean apple tree model in this thesis is not a form of plagiarism. I accept that it is unlikely that the apple tree model presented at the Sydney conference is plagiarised from the Lean apple tree model developed for this thesis. In my view, the parallel development of the two similar models is attributable to coincidence or, possibly more likely, synchronicity.