

“Managerial measures of Lean production in the manufacturing sector: perspectives on implementation and outcomes”

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Managerial measures of Lean production in the manufacturing sector: perspectives on implementation and outcomes

Abstract

The manufacturing sector contributes significantly to the Australian economy, specifically contributing 12.2% to the Australian Gross Domestic Product (GDP) (Australian Bureau of Statistics 2007). As such, in order to enable this industry to maintain its competitiveness, the Australian State and Federal Government encourages Lean manufacturing by providing Lean organizational training.

This study analyzes the effects of Lean manufacturing on, supplier relationships, customer involvement, production line efficiency, employee empowerment and financial results. Using a questionnaire administered to managers of Lean manufacturing firms in New South Wales, Australia, employee empowerment and financial results were highly regarded by managers as outcomes of Lean implementation. The overriding results showed that the implementation of Lean manufacturing processes was perceived by managers to have a positive effect on production line efficiency. This study will assist the Australian Government in its decision making regarding its ongoing support for Lean manufacturing training within organizations.

Keywords: Lean production, managerial measures, Lean organizational training.

JEL Classification: M41.

Introduction

The manufacturing sector is the second largest industry in Australia, equating to 12.2% of the Australian Gross Domestic Product (GDP) and exhibiting a growth rate of 2.2%, as at 2006-07 (Australian Bureau of Statistics, 2007). As this industry is important to the Australian economy, the Australian Government is committed to “building Australia’s competitive advantage” specifically through providing incentives and assistance for organizational training so that organizations can “continuously upgrade workforce skills to remain competitive” (Australian Apprenticeships, Incentives & Assistance, 2008). One of the manufacturing initiatives which the Government is currently supporting is Lean manufacturing processes, through providing incentives and assistance for Lean training within organizations.

The aim of this study is to analyze the effects of Lean manufacturing on, supplier relationships, customer involvement, production line efficiency, employee empowerment and financial results. The empirical research will utilize a correlational field study design and employ a questionnaire as the data collection technique. The research will focus on a sample of small, medium and large manufacturing firms that operate within Australia. This study hopes to assist both the Australian federal and state Government in decision making regarding its ongoing support for Lean implementation through its provision of grants for Lean training within the Australian manufacturing industry.

1. Literature

Lean production processes originated from the development of the Toyota Production System (TPS). The TPS was established in the early 1950’s by Taiichi Ohno, a Toyota production executive (Alukal, 2007; Krafcik, 1988; Womack, Jones & Ross, 1990). The primary objective of TPS is the cost reduction through the absolute elimination of waste, called *muda* (Ohno (1988) cited in Shah & Ward (2007)). The three sub goals of *muda* are “quantity control, quality assurance and respect for humanity” (Monden, 1983, p. 2).

The foundation of TPS to enable products to flow continuously through the production process to the greatest extent possible (Ohno, 1988). TPS enables organizations to produce the types of goods needed, in the necessary quantities, when they are required, to allow unnecessary inventories to be eliminated (Monden, 1983).

Reduction in inventory costs can result in a number of improvements which can increase the profitability of an organization. For instance, it can impact on the firms ROA (Return on Assets) as lower inventory levels reduce the asset base and thus can improve the asset turnover in the short term (Fullerton, McWatters & Fawson, 2002).

TPS is conceived to be the first, the idealistic example and the current benchmark of a working Lean manufacturing system. Krafcik (1988) first coined the term ‘Lean’ to describe TPS and other operations where, low inventory levels were attained, continuous flow of production was achieved, employees worked as teams and where products exhibiting high levels of quality were produced (Womack & Jones, 1990).

Lean abolition of waste is intended to lead to increased customer value and the increased overall profitability of the organization (Burton & Boeder, 2003; Narsasimhan, Swink & Kim, 2005; Womack, Jones & Ross, 1990). Lean manufacturing initiatives combine the benefits of craft production and mass production, as Lean avoids the costly nature of the former and avoids the inflexibility of the latter (Krafcik, 1988; Womack & Jones, 1990). Therefore, the purpose of the research is to test the relationships between Lean and supplier relationships, customer involvement, production line efficiency, employee empowerment and financial performance.

It is evident from academic literature that Lean can be defined from two different perspectives. Firstly, Lean can be defined from a philosophical perspective concerning the guiding principles of Lean (Womack & Jones, 1990, 1996, 2005; Spear and Bowen, 1999). Womack and Jones (1996) devised the set of five guiding principles pursued through Lean implementation, these are:

1. *Principle 1* – Accurately specify value from the customer’s perspective for both products and services.
2. *Principle 2* – Identify the value stream for products and services and remove non-value-added waste along the value stream.
3. *Principle 3* – Make the products and services flow without interruption across the value stream.
4. *Principle 4* – Authorize the production of products and services based on pull by the customer.
5. *Principle 5* – Strive for perfection by constantly removing layers of waste (Womack & Jones, 1996, p. 5).

These principles have been widely adopted within academic literature and often used as the basis for further discussion or examination (Li et al., 2005; Maleyeff, 2006; Tracy & Knight, 2008).

The second perspective, from which Lean is discussed within the academic literature, is from a practical perspective specifying management procedures, tools, or techniques (Li et al., 2005; Shah & Ward, 2003, 2007).

Although the two differing approaches to define and discuss Lean are compatible they do cause some ambiguity as to the overall concept of Lean and the roles of its components. Recent literature has addressed this concern by proposing a comprehensive list of conceptual definitions and measures to be adopted by future researchers (Shah & Ward, 2007). These measures form the basis of this research and include supplier relationships, customer involvement, production line efficiency, employee empowerment and financial performance (Shah & Ward, 2007).

With the exceptions of Li et al. (2005) and Shah and Ward (2003; 2007) there is limited academic literature specifically dedicated to measuring the holistic effects of Lean production. Although many previous studies have focussed on measuring the effects of one or two Lean components (Flynn et al., 1995; Mc Kone et al., 2003).

Shah and Ward (2007) devised a comprehensive set of measures which reflect the holistic and multi-dimensional nature of Lean. As such, these measures have been adopted within this study. These measures have been categorized into the five outcomes of Lean manufacturing being, supplier relationships, customer involvement, production line efficiency, employee empowerment and financial performance. Hence, this research will fill a gap in the literature as it will test the relationships between Lean and each of the five operational outcomes.

1.1. Lean. For the purpose of this study, Lean will be considered from both the principle perspective and the practical perspective evident within the literature. As such Lean manufacturing is defined as an “integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer and internal variability” (Shah & Ward, 2007, p. 795). Each of the underlying constructs have been grouped, in Figure 1, according to whether they are externally or internally related constructs.

1.2. Supplier related. Lean practices have become an integral aspect of effective supply chain management (Handfield & Nichols, 1999; Mason-Jones & Towill, 1997). The externally related underlying construct ‘supplier related measures’ is made up of three operational constructs that will be discussed, namely supplier feedback, developing supplier relationships and JIT delivery.

The first supplier related operational construct relates to supplier feedback which is important as providing frequent feedback on quality and delivery performance enables Lean firms to reduce variability of supply (Shah & Ward, 2007). As such the level of supplier involvement has been identified in previous studies as a key measure of Lean implementation (Shah & Ward, 2007).

The second supplier related operational construct is supplier development. Lean companies often focus on developing a small supplier base and establishing close relationships with suppliers. This is achieved through the sharing of information, and by providing further training and development for improvement (Shah & Ward, 2007).

Successful development of supplier relationships aids in the implementation of the third operational

construct, JIT delivery. Effective implementation of JIT delivery is essential for Lean organizations as Lean emphasises the importance of reducing variability of supply (Womack et al., 1990).

Recognizing that supplier relationships are an integral aspect of Lean implementation, the first research question seeks to test the relationship between Lean manufacturing processes and its effect on supplier relationships.

1.3. Customer related. The operational construct of customer involvement, is vital to the success of Lean implementation, as one of the key principles of Lean is that the level of production is to be 'pulled' by the customer (Womack & Jones, 1996). Customer involvement entails Lean organizations focusing on their customers and their needs (Shah & Ward, 2007). Lean managers aim to focus their organization around their customers, as such customer orientation forms part of the basis of Quality Management (QM) practices and customer needs drive manufacturing priorities (Dean & Terziovski, 2001).

It is essential for organizations to define 'value' according to the customer, as this will lead to the identification of which activities across the value chain are *muda* and which are value-added (Pyzdek, 2003). Value can be viewed as, what customers 'want or need and are willing and able to pay for' (Pyzdek, 2003, p. 706). Therefore, the second research question seeks to assess whether the outcomes of Lean manufacturing processes have a positive effect on customer involvement.

1.4. Production line efficiency. The implementation of Lean is commonly associated with operational performance improvements (Krafcik, 1988; Narasimhan et al., 2006; Shah & Ward, 2003). The areas of operational performance that will be evaluated in the proposed study are flow, pull, reduced setup times, TPM and SPC.

Lean organizations aim to achieve flow, having their products or service flow without constraint to the customer (Pyzdek, 2003). To achieve a continuous flow of products, it is important to consider the entire process simultaneously (Pyzdek, 2003). The process encompasses activities beginning with the customer order and ending when the customer receives the order (Pyzdek, 2003). Enabling flow involves establishing techniques that allow products to flow through the process continuously and with ease (Shah & Ward, 2007).

A pull system controls the flow and quantity produced and therefore facilitates JIT production (Pyzdek, 2003; Shah & Ward, 2007). Pull systems utilize tools such as Kanban, which is used to control inventory levels (Flynn et al., 1995). Kanban cards are attached to every container of parts, where the number of cards

permitted is pre-established (Flynn et al., 1995). Therefore, the system works by using a visual signal used to start and stop production (Shah & Ward, 2007).

Setup time reduction practices serve to reduce process downtime due to machine changeovers (Flynn et al., 1995). Reducing setup times is necessary due to Lean use of smaller lot sizes, and as it enables organizations to better correspond production with customer demand (Flynn et al., 1995).

TPM is designed to maximize equipment availability through the design and implementation of a comprehensive productive maintenance system (McKone et al., 2001; Shah & Ward, 2007). TPM is essential for Lean organizations to ensure that the desired level of production is not affected by equipment or machine stoppages.

SPC aims to ensure that defects from production are eliminated (Shah & Ward, 2007). SPC provides operators with information on production variability which forms the basis for their subsequent decision making (Flynn et al., 1995).

Therefore, the third research question aims to identify if Lean manufacturing processes have a positive effect on production line efficiency. This will be achieved by examining each of the operational constructs, flow, pull, reduced setup times, TPM and SPC.

1.5. Employee related. Lean aims to empower employees through developing employees' skill sets and giving them the authority necessary to solve problems and to continuously improve their work processes (Patterson, West & Wall, 2004). Employee empowerment is important to effective Lean implementation and outcomes. By supplying employees with information, organizations empower employees to participate in decision-making which subsequently affects organizational outcomes (Lawler, Mohrman & Benson, 2001, cited in Kennedy & Widener, 2008).

There have been mixed results reported in academic literature regarding the implementation of the Lean components TQM and JIT and their effect on employee empowerment (Patterson et al., 2004). Therefore, the fourth research question seeks to ascertain whether Lean manufacturing processes have a positive effect on employee empowerment.

1.6. Financial results. Finally, the proposed study will examine the relationship between Lean processes and financial results. Previous findings within Lean literature indicate contrasting results as to the effect of Lean and its components on organizational profitability. Patterson, West and Wall's (2004) findings suggested that there is no significant relationship between the implementation of TQM and JIT, and improvements in organizational productivity and profit.

In contrast, Fullerton et al. (2003) and Callen, Fader and Krinsky (1999) found that there was a significant relationship between the measures of profitability and the degree of specific JIT practices used. Also, Meade, Kumar and Houshyar (2006) found that the reduction of inventory levels, as caused by Lean, have a significant effect on net profit. Therefore, the fifth research question will seek to assess the effect of Lean on the overall financial performance of the entity.

As previous research has identified that implementation of Lean practices results in general operational improvement (Krafcik, 1988; Narasimham et al., 2006; Shah & Ward, 2003) the proposed research will test whether implementing Lean manufacturing processes have a positive effect on supplier relationships, customer involvement, production line efficiency, employee empowerment and financial results. The study will specifically relate to manufacturing firms within Australia.

In view of the discussion in the previous section, the research questions and hypotheses are:

1. Do Lean manufacturing processes have a positive effect on supplier relationships?

H₀: Lean manufacturing processes do not have a positive effect on supplier relationships.

H₁: Lean manufacturing processes do have a positive effect on supplier relationships.

2. Do Lean manufacturing processes have a positive effect on customer involvement?

H₀: Lean manufacturing processes do not have a positive effect on customer involvement.

H₁: Lean manufacturing processes do have a positive effect on customer involvement.

3. Do Lean manufacturing processes have a positive effect on production line efficiency?

H₀: Lean manufacturing processes do not have a positive effect on production line efficiency.

H₁: Lean manufacturing processes do have a positive effect on production line efficiency.

4. Do Lean manufacturing processes have a positive effect on employee empowerment?

H₀: Lean manufacturing processes do not have a positive effect on employee empowerment.

H₁: Lean manufacturing processes do have a positive effect on employee empowerment.

5. Do Lean manufacturing processes have a positive effect on financial results?

H₀: Lean manufacturing processes do not have a positive effect on financial results.

H₁: Lean manufacturing processes do have a positive effect on financial results.

2. Method of enquiry

In account of the multi-faceted nature of Lean manufacturing, numerous factors must be considered when measuring its overall impact upon an organization. These factors or operational components have been categorized under five operational constructs, which form the basis of the questionnaire research questions. These categories have been established based on previous academic findings (Shah and Ward, 2003, 2007), and consist of supplier relationships, customer relationships, production efficiency, employee related and financial outcomes.

By virtue of the research problem being related to the holistic effects of Lean processes upon organizations, consequently a questionnaire method has been determined as the most appropriate methods of collecting data relevant to these matters. It is recognized that the research method selected will determine the suitable information collection method to be utilized (Aaker, Kumar & Day, 2004). The basis of selection of the suitable research method is the specific circumstances of the research objectives. The five identified research methods are case study, experimental research, archival research, observational research and questionnaire research (Yin, 1989; McBurney, 1994).

The research has been conducted utilizing a quantitative research method. This method has been selected in accordance with Creswell's (2003) proposition that, a quantitative research method is most appropriate when the research is aiming to verify a theory and test the relationships between variables. The specific research questions addressed within this study aim to test the relationships between the independent variable (Lean processes) and each of the dependent variables (supplier relationships, customer involvement, production line efficiency, employee empowerment and financial results).

2.1. Part 1 questionnaire. Part 1 of the questionnaire sought background and demographic information pertaining to both the participant and the organization for which they work. Participants were selected from 8 independent organizations, operating in the manufacturing sector, in the state of NSW, Australia. The results are the background information is shown in Appendix.

2.2. Part 2 questionnaire. In order to ascertain the majority of responses, the following process has been utilized:

1. Agree + Strongly agree = Total *positive* (agree) responses.
2. Neutral = No positive or Negative response.
3. Disagree + Strongly disagree = Total *Negative* (disagree) responses.

Table 1. The effect of Lean manufacturing on supplier relationships

As a result of implementing Lean	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	#	Total
1. We give our suppliers more feedback on quality and delivery performance	0.0% (0)	0.0% (0)	62.5% (5)	25.0% (2)	0.0% (0)	12.5% (1)	100% (8)
2. We strive more to establish L-T relationships with suppliers	0.0% (0)	0.0% (0)	37.5% (3)	50.0% (4)	0.0% (0)	12.5% (1)	100% (8)
3. Our key suppliers deliver to plant JIT basis	0.0% (0)	25.0% (2)	50.0% (4)	12.5% (1)	0.0% (0)	12.5% (1)	100% (8)
4. We have taken active steps to reduce the number of suppliers	0.0% (0)	12.5% (1)	37.5% (3)	37.5% (3)	0.0% (0)	12.5% (1)	100% (8)
5. We have corporate level communication on important issues with key suppliers	0.0% (0)	0.0% (0)	62.5% (5)	25.0% (2)	0.0% (0)	12.5% (1)	100% (8)
Total	0.0% (0)	7.5% (3)	50.0% (20)	30.0% (12)	0.0% (0)	12.5% (5)	100% (40)

Note: # indicates missing data.

Table 2. The effect of Lean manufacturing on customer involvement

As a result of implementing Lean	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	#	Total
1. We are frequently in close contact with our customers	0.0% (0)	12.5% (1)	25.0% (2)	37.5% (3)	12.5% (1)	12.5% (1)	100% (8)
2. Our customers give us feedback on our performance	0.0% (0)	12.5% (1)	37.5% (3)	37.5% (3)	0.0% (0)	12.5% (1)	100% (8)
3. Our customers are involved in current product offerings	0.0% (0)	0.0% (0)	25.0% (2)	62.5% (5)	0.0% (0)	12.5% (1)	100% (8)
4. Our customers are involved in future product offerings	0.0% (0)	12.5% (1)	37.5% (3)	37.5% (3)	0.0% (0)	12.5% (1)	100% (8)
5. Our customers frequently share current and future demand information with marketing department	0.0% (0)	12.5% (1)	62.5% (5)	12.5% (1)	0.0% (0)	12.5% (1)	100% (8)
Total	0% (0)	10% (4)	37.5% (15)	37.5% (15)	2.5% (1)	12.5% (5)	100% (40)

Note: # indicates missing data.

Table 3. The effect of Lean manufacturing on production line efficiency

As a result of implementing Lean	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total
1. Our overall production line efficiency has improved	0.0% (0)	0.0% (0)	12.5% (1)	75.0% (6)	12.5% (1)	100% (8)
2. We have lowered the number of products needed to be reworked	0.0% (0)	0.0% (0)	50.0% (4)	50.0% (4)	0.0% (0)	100% (8)
3. We have reduced setup times	0.0% (0)	0.0% (0)	25.0% (2)	50.0% (4)	25.0% (2)	100% (8)
4. We have improved the effectiveness of our maintenance activities	0.0% (0)	0.0% (0)	37.5% (3)	37.5% (3)	25.0% (2)	100% (8)
5. We have increased the quality of goods produced	0.0% (0)	0.0% (0)	75.0% (6)	25.0% (2)	0.0% (0)	100% (8)
Total	0% (0)	0% (0)	40% (16)	47.5% (19)	12.5% (5)	100% (40)

Table 4. The effect of Lean manufacturing on employee empowerment

As a result of implementing Lean	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total
1. Employees are more likely to drive suggestion programs	0.0% (0)	0.0% (0)	37.5% (3)	50% (4)	12.5% (1)	100% (8)
2. Employees are more likely to lead product/process improvement efforts	0.0% (0)	12.5% (1)	12.5% (1)	62.5% (5)	12.5% (1)	100% (8)
3. Employee absences have reduced	0.0% (0)	12.5% (1)	87.5% (7)	0.0% (0)	0.0% (0)	100% (8)
4. Employee turnover has decreased	0.0% (0)	12.5% (1)	75.0% (6)	0.0% (0)	12.5% (1)	100% (8)
5. Shop-floor employees are encouraged to help in problem solving	0.0% (0)	12.5% (0)	25.0% (2)	37.5% (3)	37.5% (3)	100% (8)
Total	0% (0)	7.5% (3)	47.5% (19)	30% (12)	15% (6)	100% (40)

Table 5. Effects of Lean manufacturing on financial performance of the entity

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	#	Total
1. After the first year of Lean did the entity's financial performance improve?	0.0% (0)	0.0% (0)	75.0% (6)	12.5% (1)	0.0% (0)	12.5% (1)	100% (8)
2. After the second year of Lean did the entity's financial performance improve?	0.0% (0)	0.0% (0)	62.5% (5)	25.0% (2)	0.0% (0)	12.5% (1)	100% (8)
3. After the fifth year of Lean did the entity's financial performance improve?	0.0% (0)	0.0% (0)	12.5% (1)	0.0% (0)	0.0% (0)	87.5% (7)	100% (8)
4. In the last fiscal year do you think Lean assisted in your entity's performance?	0.0% (0)	12.5% (1)	37.5% (3)	50.0% (4)	0.0% (0)	0.0% (0)	100% (8)
5. Will the continual use of Lean assist in your entity's future performance?	0.0% (0)	12.5% (1)	12.5% (1)	25.0% (2)	50.0% (4)	0.0% (0)	100% (8)
Total	0% (0)	5% (2)	40% (16)	22.5% (9)	10% (4)	22.5% (9)	100% (40)

Note: # indicates missing data.

Table 6. The entity's focus within the implementation of Lean

(F) Within the implementation of Lean, our organization to a large extent focussed on	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total
1. The development of supplier relationships	0.0% (0)	12.5% (1)	50.0% (4)	25.0% (2)	12.5% (1)	100% (8)
2. The development of customer involvement	0.0% (0)	12.5% (1)	75.0% (6)	12.5% (1)	0.0% (0)	100% (8)
3. Improvements in production line efficiency	0.0% (0)	0.0% (0)	12.5% (1)	62.5% (5)	25.0% (2)	100% (8)
4. Increasing employee empowerment	0.0% (0)	0.0% (0)	37.5% (3)	50.0% (4)	12.5% (1)	100% (8)
5. Increasing financial performance	0.0% (0)	0.0% (0)	50% (4)	37.5% (3)	12.5% (1)	100% (8)
Total	0 (0)	5% (2)	45% (18)	37.5% (15)	12.5% (5)	100% (40)

3. Comment on the findings

3.1. Supplier relationships. From the data it has been ascertained that, 37.5% indicated that their organization focussed on the development of supplier relationships to a large extent. Overall for Part A, 34.29% of respondents indicated that they agreed indicating that Lean implementation had positively affected their supplier relationships. These two statistics align well and it appears that almost all firms that aimed to improve supplier relationships through the implementation of Lean, were able to achieve this.

3.2. Customer involvement. It has been gathered that 12.5% indicated that their organization focussed on customer involvement to a large extent within their Lean implementation. Overall, 40% of respondents indicated that the implementation of Lean had had a positive effect on the organizations' customer relationships. These differing figures may be a reflection of the holistic nature of Lean manufacturing processes; although the organizations did not focus to a large extent on improving customer involvement they still experienced a positive effect in this area.

3.3. Production line efficiency. 87.5% indicated that to a large extent their organization focussed on

improvements in production line efficiency within their implementation of Lean. Therefore, it appears that this was the primary motivation for this sample of firms to implement Lean processes as the greatest majority of respondents indicated that this was the area of focus within their organizations implementation of Lean. Overall, the majority of respondents (60%) agreed that the implementation of Lean manufacturing processes had had a positive effect on production line efficiency.

This finding is consistent with the Lean literature as Lean's link to superior performance and its ability to lead to a sustainable competitive advantage has been well established (Krafcik, 1988; MacDuffie, 1995; Phil & MacDuffie, 1996; Shah & Ward, 2003; Wood et al., 2004).

3.4. Employee empowerment. 62.5% indicated that their organization to a large extent focussed on increasing employee empowerment through the implementation of Lean. Overall, there was no clear majority of responses as 47.5% of participants gave neutral responses and 45% agreed that Lean had had a positive effect on employee empowerment.

3.5. Financial performance. 50% stated that their organization, to a large extent, focussed on increasing their organizations financial performance. Over-

all, 42.2% agreed that Lean had had a positive effect on their entity's financial performance. It is likely that as this initiative is of a long-run nature, the cost benefits of it would also be of a similar nature, due to the initial investment costs. As the majority (62.5%) of respondents work for organizations that have been implementing Lean for less than two years, these firms may be yet to experience the financial benefits of Lean.

Conclusion

This study has examined the effects of Lean implementation on its five underlying constructs, supplier relationships, customer involvement, production line efficiency, employee empowerment and financial results. Of the five hypotheses formulated, investigated and evaluated within this study, this research has supported one of the hypotheses.

References

1. Alukal, G. (2007). 'Lean kaizen in the 21st Century', *Quality Progress*, Vol. 40, No. 8, pp. 69-71.
2. Australian Apprenticeships, Incentives & Assistance (2008). Australian Apprenticeships, accessed on June 10, 2008, <http://australianapprenticeships.gov.au/employer/incentives>.
3. Australian Bureau of Statistics (2007). *Australian System of National Accounts*, Australian Bureau of Statistics, accessed on June 10, 2008, <http://www.abs.gov.au?ausstats/abs@.nsf?Latestproducts/5204.0Main%20Features502>.
4. Burton, T. & Boeder, S. (2003). *The lean extended enterprise: Moving beyond the four walls to value stream excellence*, J. Ross Publishing, Boca Raton.
5. Callen, J.L., Fader C. & Krinsky I. (2000). Just-in-time: A cross-sectional plant analysis, *International Journal of Production Economics*, Vol. 63, No.3, pp. 277-301.
6. Dean, A. & Terziovski, M. (2001). 'Quality practices and customer/supplier management in Australian service organizations', *Total Quality Management*, Vol. 12, No. 5, pp. 611-621.
7. Flynn, B., Schroeder, R. & Sakakibara, S. (1995). 'Relationship between JIT and TQM: practices and performance', *Academy of Management Journal*, Vol. 38, No. 5, pp. 1325-1360.
8. Fullerton, R.R., McWatters, C.S. & Fawson, C. (2003). 'An examination of the relationships between JIT and financial performance', *Journal of Operations Management*, Vol. 21, No. 4, pp. 383-404.
9. Handfield, E.L. & Nichols E.L. (1999). *Introduction to Supply Chain Management*, Prentice Hall, Upper Saddle River, New Jersey.
10. Kennedy, F.A. & Widener, S.K. (2008). 'A control framework: Insights from evidence on lean accounting', *Management Accounting Research*, Vol. 19, No. 4, pp. 1-23.
11. Krafcik, J. (1988). 'Triumph of the Lean Production System', *Sloan Management Review*, Vol. 30, No. 1, pp. 41-49.
12. Li, S., Rao, S., Ragu-Nathan, T. & Ragu-Nathan, B. (2005). 'Development and validation of a measurement instrument for studying supply chain management practices', *Journal of Operations Management*, Vol. 23, No. 6, pp. 618-641.
13. MacDuffie, J.P. (1995). 'Human resource bundles and manufacturing performance: organizational logic and flexible production systems in the world auto industry', *Industrial and Labor Relations*, Vol. 48, No. 2, pp. 199-221.
14. Maleyeff, J. (2006). 'Exploration of internal service systems using lean principles', *Management Decision*, Vol. 44, No. 5, pp. 674-689.
15. Mason-Jones, R., Towill, D.R. (1997). 'Information enrichment: designing the supply chain for competitive advantage', *Supply Chain Management*, Vol. 4, pp. 137-148.
16. McKone, K.E., Schroeder R.G. & Cue K.O. (2001). 'The impact of total productive maintenance practices on manufacturing performance', *Journal of Operations Management*, Vol. 19, No. 1, pp. 39-58.
17. Meade, D.J., Kumar, S. & Houshyar, A. (2006). 'Financial Analysis of a Theoretical Lean Manufacturing Implementation Using Hybrid Simulation Modelling', *Journal of Manufacturing Systems*, Vol. 25, No. 2, pp. 137-154.
18. Monden, Y. (1983). 'Toyota Production System: A Practical Approach to Production Management', *Industrial Engineers and Management Press*, Norcross, GA.
19. Narasimhan, R., Swink, M. & Kim, S. (2006). 'Disentangling lean and agility: An empirical investigation', *Journal of Operations Management*, Vol. 24, No. 5, pp. 440-457.
20. Patterson, M.G., West, M.A. & Wall, T.D. (2004). 'Integrated manufacturing, empowerment and company performance', *Journal of Organizational Behaviour*, Vol. 25, pp. 641-665.
21. Phil, F.K. & MacDuffie (1996). 'The adoption of high-involvement work practices', *Industrial Relations*, Vol. 35, No. 3, pp. 423-455.
22. Pyzdek, T. (2003). *The Six Sigma Handbook*, McGraw-Hill, United States.

H₁: Lean manufacturing processes do have a positive effect on production line efficiency.

It is recommended that team leaders should be given more information pertaining to the overall effects of Lean manufacturing processes. Specifically, it is recommended that team leaders should be given access to the financial results of their company particularly when changes have occurred due to improvements, which the team leaders have contributed to (i.e. Lean manufacturing processes). As this information may encourage and inspire team leaders to achieve even greater results as they will be able to see the organizational outcomes of their work. As this sample size was limited to 8, within the region of NSW Australia, it is recommended that future research be encouraged to support this important manufacturing sector for the Australian economy.

23. Shah, R. & Ward, P. (2003). 'Lean manufacturing: context, practice bundles, and performance', *Journal of Operations Management*, Vol. 21, No. 2, pp.129-149.
24. Shah, R. & Ward, P. (2007). 'Defining and developing measures of lean production', *Journal of Operations Management*, Vol. 25, No. 4, pp. 785-805.
25. Spear, S. & Bowen, H. (1999). 'Decoding the DNA of the Toyota Production System', *Harvard Business Review*, Vol. 17, No. 9, pp. 97-106.
26. Tracy, D. & Knight, E. (2008). 'Lean Operations Management: Identifying and Bridging the Gap between Theory and Practice', *Journal of American Academy of Business*, Vol. 12, No. 2, pp. 8-14.
27. Womack, J. & Jones, D. (1990). *Lean Thinking*, Simon & Schuster, London.
28. Womack, J. & Jones, D. (2005). *Lean Solutions*, Simon & Schuster, New York.
29. Womack, J., Jones, D. & Ross, D. (1990). *The Machine that Changed the World*, HarperCollins, New York.
30. Wood, S.J., Stride, C.B., Wall, T.D., Wall, C.W. (2004). 'Revisiting the use of effectiveness of modern management practices', *Human Factors and Ergonomics*, Vol. 4, No. 14, pp. 413-430.

Appendix

Table 1A. Gender

Gender	Total	Percentage
Male	8	100%
Female	0	0%
Total	8	100%

Note: All of the respondents were male employees.

Table 2A. Level of education

Education	Total	Percentage
High School certificate	3	37.5%
Higher School certificate	1	12.5%
Diploma/Tafe certificate	1	12.5%
Bachelor degree	1	12.5%
Masters	1	12.5%
Post Graduate studies	1	12.5%
Total	8	100%

Table 3A. Participants position within the company

Position	Total	Percentage
Team leader	3	37.5%
Middle manger	2	25%
Senior manger	3	37.5%
Other	0	0%
Total	8	100%

Table 4A. Participants position within the company and education level

	Team leaders	Middle manager	Senior manager	Total	Percentage
High School certificate	1	1	1	3	37.5%
Higher School certificate	1	0	0	1	12.5%
Diploma/ Tafe certificate	1	0	0	1	12.5%
Bachelor degree	0	0	1	1	12.5%
Masters	0	1	0	1	12.5%
Post graduate	0	0	1	1	12.5%
Total	3	2	3	8	100%
Percentage	37.5%	25%	37.5%	100%	

Table 5A. Duration of employment

Duration in years	Total	Percentage
0-1 year	0	0%
1-5 years	0	0%
5-10 years	3	37.5%
More than 10 years	5	62.5%
Total	8	100%

Table 6A. Employees position and duration of employment

Duration in years	Employees position			Total	Percentage
	Team leaders	Middle managers	Senior managers		
0-1 year	0	0	0	0	0%
1-5 years	0	0	0	0	0%
5-10 years	2	1	0	3	37.5%
More than 10 years	1	1	3	5	62.5%
Total	3	2	3	8	100%
Percentage	37.5%	25%	37.5%	100%	

Table 7A. The number of employees within the company

Number of employees	Total	Percentage
0-5	1	12.5%
5-20	0	0%
20-50	4	50%
50-200	0	0%
More than 200	3	37.5%
Total	8	100%

Table 8A. Length of time since implementation of Lean

Time	Total	Percentage
0-2 years	5	62.5%
2-5 years	3	37.5%
5-10 years	0	0%
More than 10 years	0	0%
Total	8	100%