The Relationship Between Lean Six Sigma and Organizational Performance: An Empirical Investigation

A Research Report from
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Abstract

The combined Lean Six Sigma approach to managing operations has become an increasingly popular option for businesses. However, the linkage between Lean Six Sigma implementation and superior performance improvement is not fully understood or well researched. Regardless, the current belief in the field that Lean Six Sigma can be associated with improved organizational performance is popular and widely accepted.

Utilizing a survey research methodology, an instrument was been developed to survey and interview multiple manufacturing firms in the New Zealand context which were identified as implementing Lean and/or a Six Sigma program. Various statistical techniques were used to investigate the differences in organizational performance between two groups of firms, the Lean implementer group and the combined Lean Six Sigma implementer group. The research suggests that for SMEs in New Zealand, Lean is a better choice than Lean Six Sigma as implementing Lean by itself is likely to lead to better business performance than implementing Lean Six Sigma.

Keywords: Six Sigma, Lean, Lean Six Sigma, Organizational performance, Empirical research

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Introduction

Lean and Six Sigma are two very successful process improvement systems, and joint implementation of Lean and Six Sigma is becoming increasingly widespread in contemporary business and industry. It is believed that the integration of Six Sigma and Lean system represents an evolution of the Six Sigma methodology and Lean Six Sigma is becoming a new continuous improvement approach in the business.

Research on Lean practices by themselves or standalone Six Sigma applications have demonstrated positive associations with multiple facets of organizational performance improvement. However, with respect to the combined Lean Six sigma approach, published articles largely provide *anecdotal* evidence regarding a positive relationship between the implementation of a Lean Six Sigma programs and higher performance. The literature consists exclusively of "success stories" and individual case studies with no analysis. A review of the literature reveals there has been no *empirical* research that confirms this positive relationship. This shortcoming in the research leaves the following questions largely unanswered:

- Do firms adopting Lean Six Sigma experience superior performance improvement over non-implementers?
- Can Lean Six Sigma be empirically tied to superior operating performance?
- Does the combination of Lean and Six Sigma generate a better result than when either model stands on its own?

Many practitioners and consultants believe that the answer to all three questions is yes. This research is an attempt to provide empirically-based answers to these questions.

Furthermore, a review of literature on business improvement programs reveals that a large body of existing empirical papers have mainly focused on large multinational corporations. Key findings regarding Six Sigma, Lean and the models' outcomes are primarily provided from studies based on data gathered from firms in the US with thousands of employees. Yet the research supports the idea that the level of benefit resulting from these programs varies considerably across different organizational contexts such as firm size. As a result, questions must be asked concerning whether what has been believed and found to be true for large firms is true for smaller firms. Practitioners must question whether programs like Six Sigma, Lean, and Lean Six Sigma can help SMEs effectively enhance their operating performance as they do for larger firms.

In summary, given the prominent role that Lean Six Sigma plays in industry, the aim of this research is to develop insights into the relationship between Lean Six Sigma implementation and its organizational performance improvement outcomes. It also provides new insights into the body of knowledge regarding the SME setting. From a practical standpoint, the outcomes of this study may assist practitioners in deciding whether they should include Lean practices into a Six Sigma structure as well as providing practitioners with a better understanding of how their peer organizations utilize Lean Six Sigma and the level of performance improvement benefits that are achieved.

Research Method

The aim of this study is to develop insights into the relationship between Lean, Six Sigma and Lean Six Sigma implementation and organizational performance improvement outcomes. To answer these questions, we employed a survey methodology. Following extensive review of the literature, a survey instrument was developed and employed to measure the extent of Lean and Six Sigma implementations in various firms and to gauge the nature and extent of these implementations' effects on organizational performance. The items in the survey were based on well-validated instruments giving us some confidence in the results.

Firms were asked for performance outcomes in two areas, the change in quality performance and the change in business performance. This data is combined for a measure of overall performance.

The research looks at individual New Zealand manufacturing firms who have been identified as adopting Six Sigma, Lean, and Lean Six Sigma. Firms with greater experience in Six Sigma and Lean are preferred candidates. Target respondents include firm managers and persons who are responsible for the implementation of the programs in firms, project managers, operations managers, quality managers, Six Sigma Master Black Belts, and Black Belts.

To identify Six Sigma, Lean, and Lean Six Sigma implementers, several consulting firms were approached directly and asked for recommended research sites. The consultants either contacted the firm on behalf of the study or provided email addresses of key personnel. Assistance was also provided by senior managers from New Zealand Government funded initiatives such as the CMI Consortium (Competitive Manufacturing Initiative) and New Zealand Trade and Enterprise (NZTE). This support was invaluable in approaching potential respondents and considerably increased the number of participant firms involved in the research.

An excellent response rate of 75% was achieved, which is very high in comparison to typical response rates for a mail survey. This unexpectedly high rate was attributed to the relevance of the research to the business community.

The study involves thirty-three manufacturing firms in New Zealand. Participant firms were from a diverse range of industries. In terms of firm size, half of the companies involved into the study have more than 100 employees, and most of these firms (82%) are smaller than 500 staff. Table 1 and Figure 1 provide a summary of the characteristics of the firms in the study.

NZSIC classification	Percentage of Firms in Study
Food, Beverage and Tobacco	27%
Textile, Clothing, Footwear and Leather	3%
Wood and Paper Products	18%
Printing, Publishing and Recorded Media	3%
Chemicals, Petroleum, Rubber, Plastics and Associated Products	6%
Metal Product Manufacturing	27%
Other	16%

Table 1 – Industrial Classification

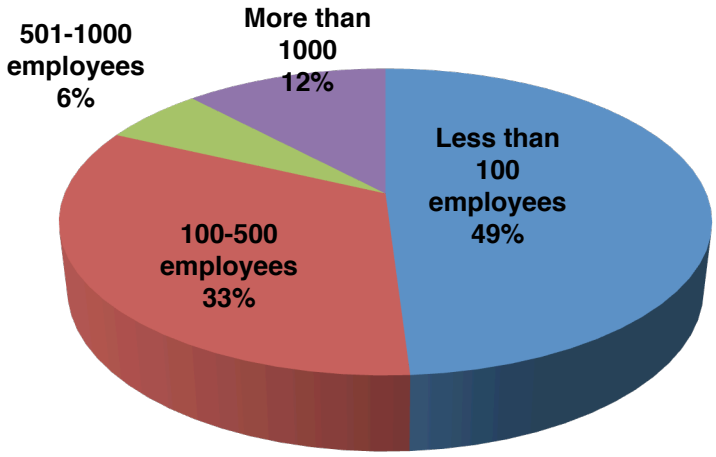

Figure 1 – Firm Size

Data and Analysis

The study aims to test the linkages between standalone Lean, Six Sigma, combined Lean Six Sigma programs and performance outcomes. The survey collected data from two types of implementers, standalone Lean and combined Lean Six Sigma

implementers. The research did not receive any feedback from firms adopting Six Sigma in isolation.

The primary goal of this research is to determine whether or not there is a significant difference in the performance levels of the combined Lean Six Sigma implementer group and the standalone Lean implementer group. The research also examines the effects of quality management practices on firm performance and provides an understanding of the relative changes in organizational performance attributable to the implementation of these practices.

With respect to Lean, Lean Six Sigma, and performance, the results of the statistical analysis of the data for the entire sample and for large firms only are presented in Tables 2 and 3. The statistically significant results determined by a standard *t*-test are highlighted.

Measurement	Overall mean	Means	
		Lean	Lean Six Sigma
Quality performance	5.4015	5.4379	5.1980
Business performance	4.9548	5.0836	4.2340
Overall performance	5.1958	5.2746	4.7540

Table 2 – Results for All Firms

Measurement	Overall mean	Means	
		Lean	Lean Six Sigma
Quality performance	5.5947	5.7600	5.1980
Business performance	5.0494	5.3892	4.2340
Overall performance	5.3441	5.5900	4.7540

Table 3 – Results for Large Firms

Lean's Impact on Organizational Performance Improvement

The study is also interested in which specific Lean-based practices have the biggest effect on firm performance in the field. The firms supplied information about the following practices.

- Supplier Feedback
- JIT Delivery by Supplier
- Supplier Development
- Customer Involvement
- Pull
- Continuous Flow
- Set Up Time Reduction
- SPC
- Employee Involvement
- TPM

Regression models were developed investigating the impact of each of these practices on quality, business, and overall performance. In terms of quality, the practices which most directly improved performance are JIT Delivery by Supplier and Customer Involvement. With respect to business performance, Supplier Feedback has the greatest impact on performance improvement. In terms of the overall performance of the firm, the best predictors are Supplier Feedback and TPM. Overall the study suggests that a small number of factors involving the relations with suppliers, customer involvement, and TPM significantly impact organizational performance. While the results shown are statistically significant, they do not predict a large proportion of the outcome variables. The best result is the ability of JIT Delivery by Supplier and Customer Involvement to predict about 59% of the Quality Performance outcome. Table 4 presents a summary of the regression results.

Outcome Variable	Quality Performance	
Predictor Variables	**R**	**R^2**
JIT Delivery by Supplier	.693	.480
JIT Delivery by Supplier, Customer Involvement	.770	.593

Outcome Variable	Business Performance	
Predictor Variables	**R**	**R^2**
Supplier Feedback	.613	.375

Outcome Variable	Overall Performance	
Predictor Variables	**R**	**R^2**
Supplier Feedback	.685	.469
Supplier Feedback, TPM	.734	.539

Table 4 – Summary Regression Results

Results and Discussion

The results of the analysis reveal an intriguing finding.

- ***Lean by itself results in superior performance to a combination of Lean and Six Sigma***

There is a statistically significant difference in the business performance levels of the Lean-only implementers compared to the Lean Six Sigma implementers. The group of firms implementing standalone Lean have better results on the business performance scale than Lean Six Sigma implementers. This result suggests that implementing Lean by itself is likely to lead to better business performance than implementing Lean Six Sigma.

There is no significant difference in quality performance between Lean by itself and the combined Lean Six Sigma implementer. It seems Lean and Lean Six Sigma practices can deliver about the same level of quality outcomes. This is not particularly surprising. Quality may be more a prerequisite for either of these approaches than an outcome. We were, however, curious to see if there were any differences. It doesn't seem so.

While the literature suggests there should be a difference between Lean-only and Lean Six Sigma implementation results, it uniformly presents the proposition that Lean Six Sigma will result in superior performance to Lean-only implementations. The current research reveals just the opposite.

In an attempt to better understand this result, an analysis was conducted separating large (more than 100 employees) and small firms. This analysis revealed that for the large firms the difference in performance improvement was even more soundly supported with Lean-only firms achieving superior results to the Lean Six Sigma firms. These firms exhibited improved results in both business and overall performance.

The greater differences shown by the larger firms suggest that the positive impact of these two programs on performance improvement is greater as firm size increases. There is some consensus among academics and practitioners in the field that business improvement initiatives have a greater impact on performance enhancement in larger firms than in smaller.

The regression results revealed that a very small number of factors seem to contribute to firm performance. These are all related to suppliers and customers with TPM as the only internal measure that is clearly linked to performance improvement. The literature suggests that measures such as SPC, Set Up Time Reduction, and Pull would also be significant but this was not the case in this study.

From a theoretical perspective, there are some possible explanations for this finding.

First, the research is looking at SMEs, a setting poorly represented in the current literature. Key findings regarding the programs Lean and Six Sigma are attributed solely to large firms. The question put forward is whether programs like Lean and Lean Six Sigma can help SMEs effectively enhance their performance as they do for larger firms. Alternatively, the question is if what has been believed or found to be true for large firms can be true for smaller firms. This study suggests that this is not the case.

Second, it is perceived that the benefits resulting from these programs vary considerably across different contexts. Different organizations have quality management programs at various levels of advancement. The critical contextual factors such as level of maturity of existing quality management systems and firm size, which influence the improvement power of either Lean or the integration Lean

Six Sigma, have not been investigated. The question of the extent and nature of performance enhancements that the adoption of either of the programs can yield for SMEs remains largely un-examined in the literature.

Third, the literature suggests that Lean is a less formal approach than programs like Six Sigma and Lean Six Sigma. An application of Six Sigma requires a massive investment in human, finance, effort, and time resources, which are more likely to be available in and affordable by large firms. The results of this study reveal that SMEs find more success with Lean adoption rather than the combined Lean Six Sigma approach.

As presented earlier, 82% of the participants in this study were firms with fewer than 500 staff and may clearly be considered SMEs. As New Zealand represents a relatively standard modern economy, the research findings provided by this paper should be applicable to SMEs in general. The study establishes that for SMEs, Lean by itself is better than Lean Six Sigma.

Research limitations and future research recommendations

First, this study was unable to answer the question regarding the effects of adopting Six Sigma by itself due to a lack of data for standalone Six Sigma implementation. This investigation is recommended for future studies.

Second, this study only represent a snap-shot of the complex relationship between Lean and Six Sigma practices and firm performance. Future studies should include longitudinal research and a more detailed investigation of the relationships.

Third, Lean and Six Sigma have been embraced in a wide range of business segments, including manufacturing and service settings, including financial institutions, education, hospitality, and health care organizations. Examining the research problems in non-manufacturing settings is recommended for future research.

Finally, the unexpected findings of this study have established an urgent need for a closer investigation of the organizational contexts that critically influence the implementation of manufacturing improvement programs.

Conclusion

The study presents a survey-based approach that seeks to verify the positive relationship between the implementation of Lean Six Sigma and organizational performance. The validated results of the study indicate that Lean standing by itself can yield significantly better business performance improvement than a combined Lean Six Sigma approach. The research findings provided by this study were primarily derived from data gathered from SMEs in the New Zealand business environment. They should be applicable to SMEs in other similar contexts.