Lean Production and Business Performance in Malaysian Manufacturing Industries

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***Abstract*—The primary purpose of this study is to empirically examine the relationships between lean production and business performance in Malaysian manufacturing industries. Grounded by the Socio-technical System Theory and the Program Theory, this study formulates and examines a conceptual model that links socially-oriented lean production, technically-oriented lean production, operational performance and business performance. This study utilizes two hundred and five manufacturing companies, selected randomly from the Federation of Malaysian Manufacturers Directory. The study measures senior production or lean managers' perception of the lean production and the level of performances in their companies. This study applies structural equation modelling (SEM) method for data analysis using AMOS package. The result indicates that both socially-oriented lean production and technically-oriented lean production significantly contribute to the operational performance of the companies. The finding also suggests that operational performance partially mediates the relationship between lean production (both socially-oriented lean and technically-oriented lean) and business performance. The result also demonstrates a significant relationship between operational performance and business performance. This study presents empirical evidence in the field of management, particularly in the context of operations management. The findings would further enrich the existing knowledge in this field. Finally, this study would provide useful guidance for the managers to plan and maintain lean production in the organization as well as to generate new measures of lean production in order to enhance business performance at the company level.**

Keywords*—Lean Production, operational performance, business performance, Malaysian Manufacturing Industries.*

1. Introduction

Lean production has received a lot of attention in the manufacturing companies worldwide and in academic research since 1980s (Monden [1]; Womack et al. [2]; Katayama and Bennett [3]; Shah and Ward [4],[5]; Liker [6]; Li et al. [7]; Matsui [8]; Pham et al. [9]). It is also claimed to be the universal practices for the 21st century (Womack, et al. [2]). The core of lean production practices lies on the premise that it has brought changes in management practices by enhancing customer satisfaction as well as improving organizational effectiveness and efficiency (Ferdousi and Ahmed [10]).The findings from extensive reviews of past literature on operation management have suggested that empirical research on lean production is still at an immature stage. For example, Ferdousi and Ahmed [10] claim that the empirical study of lean production is still at the early stage. Furthermore, Wong et al. [11] also affirm that the study of lean production is not fully explored, especially in the Malaysian manufacturing industry context.

To the best of researcher's knowledge, there is no explicit empirical evidence verifying the relationship between lean production, operational performance and business performance in the context of Malaysian manufacturing industries up to this point of time. In other words, the study of the association of these constructs is yet to be empirically established in Malaysia. Furthermore, Cua et al. [12], Papadopoulou and Ozbayrak [13] , Shah and Ward [4], [5] and Pettersen [14] affirm that the level of the empirical studies on lean production and business performance is still yet to be fully explored. The primary objective of this study is to examine relationships between lean production practices, operational performance and business performance. Although the theories imply that there is a positive relationship between lean productions with organizational performance, some results from recent studies suggest that the relationship is not conclusive.

2. Literature Review

Liker [6] defines lean production as a manufacturing philosophy that when implemented,

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is able to reduce the lead time from customer order to delivery by eliminating sources of waste in the production flow. It is claimed that lean production is the only system that considered the expenses of resources for any goal other than the creation of value for the end customer to be wasteful. Theoretically, lean production has two fundamental goals, namely waste reduction and respect for people. Meanwhile, Shah and Ward [4],[5] describe lean production as an integrated social-technical system, whose main objective is to eliminate waste by concurrently reducing or minimizing variability in supplier, customer and internal processes. Thus, they suggest lean production should be regarded as a configuration of practices or tools that is aimed to reduce variability in all aspects of business processes. Hence, lean production should be regarded as a system that composes of multi-component structure (including tools and practices) that should be implemented in totality in order to realize its benefits. This study defines lean production as a manufacturing strategy that integrate social (human) and technical (technology) practices with the primary goal of enhancing business performance through increasing operational performance by continually reducing and eventually eliminating all forms of waste in the production process.

Table 1 outlines the matrix table showing various lean production practices as proposed by different researchers from past literature. Having extensive reviewed of previous studies on lean production, this study incorporates eight elements that have been mostly cited in the literature as lean production practices, namely: (i) Supplier focus, (ii) Employee focus, (iii) Continuous improvement, (iv) Customer focus, (v) Quality at source, (vi) Just-in time, (vii) Flow system and (viii) Technology and innovation

Table 1. Lean production practices and their appearance in key references

Lean Practices	1	2	3	4	5	6	7	8	9	10	11
1. Supplier focus	*	*	*		*	*	*	*	*	*	
2. Employee focus	*	*		*	*		*	*	*	*	
3. Continuous improvement	*	*	*	*	*		*	*	*	*	*
4. Customer focus	*	*			*		*			*	*
5. Quality at source	*	*			*		*			*	*
6. Just-in time	*	*			*		*	*	*	*	
7. Flow system	*	*	*	*	*		*		*	*	*
8. Technology and innovation		*			*		*		*		*

(1) Shahram (2008); (2) Shah and Ward (2007); (3) Bhasin and Burcher (2006); (4) Woorley and Doolen (2006); (5) Liker (2004); (6) Wu (2003); (7) Shah and Ward (2003); (8) Sanchez and Perez (2001); (9) Cua et al. (2001); (10) Karlsson and Ahlstrom (1996); (11) Katayama and Bennett (1996).

Grounded by Socio-technical System Theory (STS), this study classified those practices into two dimensions, namely Socially-oriented Lean Production (SLEAN) and Technically-oriented Lean Production (TLEAN). This study incorporates Customer Focus (CF), Supplier Focus (SF), Employee Focus (EF) and Continuous Improvement (CI) into Socially-oriented Lean Production (SLEAN); meanwhile, Just-in time (JIT), Flow System (FS), Quality at source (QAS) and Technology & Innovation (TI) are grouped under Technically-oriented Lean Production (TLEAN).

Operational performance is defined as how well the process in the company performed in accordance with its operational standard (Cua et al. [12]; Shah and Ward [4] [5]. There are many ways of measuring operational performance in the company. According to Cua et al. [12] the most cited approach in the literature to measure operational performance in the manufacturing industry is to use 'cost', 'quality', 'delivery' and 'flexibility' as the four basic dimensions. As such, this study proposes operational performance should be viewed from three broad perspectives, namely 'quality performance', 'delivery performance' and 'operational effectiveness' point of views.

According to Yamin et al. [15], Cua et al. [12] and Li et al. [7] business performance is defined as the degree of the company's achievement in its market-oriented goals as well as its financial goals. For the purpose of this study and adapted from the measurements proposed by Cua et al. [12] and Li et al. [7], three indicators are chosen to represent business performance, namely 'return on sales' (ROS), 'return on investment' (ROI), and 'profitability' (PFT). *Return on Sales (ROS)* is defined as a measure of a company's profitability, equal to a fiscal year's pre-tax income divided by total sales. For the purpose of this study 'Return on Sales' is measured by the manager's perception on the statement "return on sales (ROS) of our plant

has increased over the past three years". *Return on investment (ROI)* is defined as the monetary benefits derived from having spent money on developing or revising a system. ROI is a measurement that evaluates the efficiency of a certain project. For the purpose of this study 'return on investment (ROI)' is measured by the manager's perception on the statement "Overall return on investment (ROI) of our project has improved in the past three years". *Profitability' (PFT)* is defined as the profit earned from a company's normal core business operations. This value does not include any profit earned from the company's investments (such as earnings from firms in which the company has partial interest) and the effects of interest and taxes. For the purpose of this study 'profitability' (PFT) is measured by the manager's perception on the statement "our company's profit has increased compared to our competitors for the past three years.

3. The Conceptual Framework: The Model and Hypothesis

The development of the conceptual framework for this study is hold by Program Theory which accentuates that business performance is a primary organizational goal that can be achieved through an effective operational process with the implementation of superior management practices. Program theory links inputs (lean production practices) with activities to outcomes (business performance). Consequently, this study proposed a conceptual framework as depicted in Figure 1. The proposed model is based on four main constructs namely (i) SLEAN, (ii) TLEAN, (iii) Business Performance (BP) and, (iv) Operational Performance (OP).

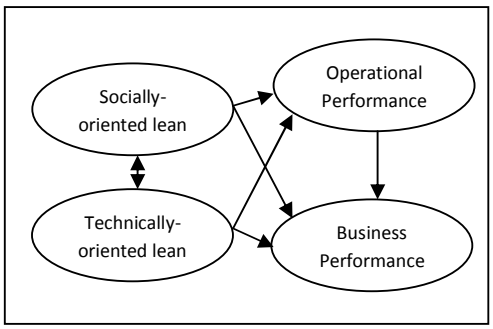

Figure 1. The conceptual model showing the relationship between lean production, operational performance and business performance

In order to investigate the linkage between lean production, business performance and operational performance, this study proposes the following hypothesis:

H1: Socially-oriented lean practice (SLEAN) is positively related to business performance (BP).
H2: Technically-oriented lean practice (TLEAN) is positively related to business performance (BP).
H3: Socially-oriented lean practice (SLEAN) is positively related to operational performance (OP).
H4: Technically-oriented lean practice (TLEAN) is positively related to operational performance (OP).
H5: Operational performance (OP) is positively related to business performance (BP).
H6: Operational performance (OP) mediates the relationship between socially-oriented practice (SLEAN) and business performance (BP).
H7: Operational performance (OP) mediates the relationship between technically-oriented practice (TLEAN) and business performance (BP).

4. Research Methodology

This study deployed a quantitative, cross-sectional research methodology utilizing primary data collection. The unit of analysis chosen for this study was company level and each company was represented by senior manager as the respondent. The sampling frame was derived from the Federation of Malaysian Manufacturing Companies Directory. The samples were randomly selected using a simple random sampling method. Two hundred and five useable responses were analyzed by Structural Equation Modelling (SEM) technique using SPSS and AMOS package.

The research instrument used in this study was a structured survey questionnaire, which was designed to assess the companies in term of the described dimensions. The survey instrument designed consisted of three major parts. The first part comprised several constructs measuring lean production practices, and the second part captured several performance measurements. The last part retrieved information about each company's profile. To enable respondents to indicate their answers, seven–point interval scales were used in measurement. The performance measure namely business performance also used a seven-point interval scale, representing a range of agreement with statements whether over the past three years these performances were high relative to competitors after implementing lean production. The primary data were collected through various means such as face-to-face interview, ordinary mail service, email, telephone call and fax.

Validity and reliability tests were used to select and assess the final items of the main constructs that were used for further statistical testing. The critical variables of lean production in this study had content validity because an extensive review of the literature was conducted in selecting the measurement items and the critical constructs; and all the items and factors had been evaluated and validated by professionals in the area of operation management or lean production (face-content validity). In addition, the draft questionnaire was pre-tested with academicians to check its content validity and terminology and modified accordingly. Before creating the final scales, the data were checked for normality and outliers; and were found to be satisfactory.

5. Result and Discussion

This study utilized the structural equation modelling technique to analyze the linkages between lean production practices, operational performance and business performance. Having completed Confirmatory Factor Analysis (CFA) on the measurement model, this study executed SEM on the structural model using AMOS. Result of structural relationship on the selected model was exhibited in Table 2.

Table 2. Results of structural Relationship of the proposed model

Structural Path	Std. Loadings	Std. errors	Critical Ratio	Probability
SLEAN ⟶ BP	0.027	0.370	0.147	0.883
TLEAN ⟶ BP	0.281	0.447	1.669	0.095
SLEAN ⟶ OP	0.541	0.219	3.346	0.000**
TLEAN ⟶ OP	0.349	0.278	2.243	0.025*
OP ⟶ BP	0.377	0.286	1.960	0.050*

**significant at p≤0.01; *significant p≤0.05

H1 and H2 assumed that the relationships of both SLEAN and TLEAN with business performance are positively significant. However, the result indicated that the relationship between SLEAN and business performance (BP) was not significant (critical ratio = 0.147; p=0.883). Similarly, the result also exhibited that the relationship between TLEAN and business performance (BP) was not significant as well (critical ratio 1.669; p=0.095). Therefore, hypothesis H1 and H2 were not supported. A logical explanation to this phenomenon is that the initial execution of lean production program in a company requires investment and the outcome from the program was not directly associated with monetary term. Meanwhile, H3 and H4 hold that the relationships of both SLEAN and TLEAN with operational performance (OP) are positively significant. The result demonstrated that the relationship between SLEAN and operational performance (OP) was significant (critical ratio = 3.346; p=0.000**). Likewise, the relationship between TLEAN and operational performance (OP) was also significant (critical ratio = 2.243; p=0.025*). Hence, hypothesis H3 and H4 were supported. Additionally, this study hypothesized that the relationship between operational performance (OP) and business performance (BP) is positively significant (H5). The result illustrated that the relationship between operational performance (OP) and business performance (BP) was significant (critical ratio = 1.96; p=0.050*). Therefore, hypotheses H5 was also supported.

To test hypotheses H6 and H7 regarding the mediating effects of operational performance (OP) in the linkage between lean production and business performance (BP), the nested model strategy was performed. Three models were tested namely, (i) partially-mediated model, (ii) fully mediated model and (iii) non-mediated model whereby predetermined constraint was assigned to each model. Result of fit indices of the tested model was demonstrated in Table 3

Table 3. Fit Indices of the tested model

Statistics	Values			Recommended values for good fit
	Partially mediated model	Fully mediated model	Non-mediated model	
Chi-square	**103.949**	253.018	252.072	-
Probability Level	**0.060**	0.006	0.004	≥0.05
Degree of Freedom	**71**	73	72	-
χ^2 / df	**1.464**	3.466	3.501	≤3.00
Incremental Fit Index (IFI)	**0.972**	0.871	0.870	≥0.90
Tucker & Lewis Index (TLI)	**0.964**	0.864	0.861	≥0.90
Comparative Fit Model (CFI)	**0.972**	0.871	0.869	≥0.90
Normed Fit Index (NFI)	**0.917**	0.815	0.814	≥0.90
Goodness of fit index (GFI)	**0.929**	0.827	0.827	≥0.90
Root mean square error of approximation (RMSEA)	**0.048**	0.088	0.070	≤0.05
****** Assuming partially-mediated model to be correct				
Delta-Chi-square ($\Delta\chi^2$)		149.069	148.123	≥6.64
Probability Level		0.217	0.142	≤0.05
Degree of Freedom		2	1	-

As illustrated in Table 3, all indices of model fit for partially mediated model met the recommended values for good fit as suggested by Hair et al. (2006). Therefore, this study concluded that partially mediated model met the best model fit criteria and therefore H6 and H7 were supported.

6. Conclusion and Implication

Although several researchers have provided empirical evidences on the linkage between lean production and performance, some might have overlooked that performance indicator varies. This study recognizes performance indicator is twofold, i.e. operational performance (OP) and business performance (BP). The statistical result indicates that SLEAN and TLEAN have significant positive relationship with operational performance (OP). This suggests that manufacturing companies that implement lean production practices would likely to experience the enhancement in operational performance i.e. improvement in product quality, delivery performance and operational effectiveness. Meanwhile, the relationships between both orientations of lean namely SLEAN and TLEAN and business performance are positive but not significant. This implies that manufacturing companies that implement lean production practices would not likely to experience the improvement in business performance (i.e. ROS, ROI and PFT) significantly. Therefore, expectations of the direct impact on business performance indicators specifically return on sales (ROS), return on investment (ROI) and profit (PFT) by implementing lean production practices should be interpreted with caution. The evidence does not support a strong direct relation between them. However, the benefits are indirectly gained through the increase in operational performance measures such as quality performance, delivery performance and operational effectiveness. Thus, in order to gain the full benefits from lean production implementation, managers should also give attention to non-business performance measurement, particularly quality performance, delivery performance and operational effectiveness (reducing in cycle time). Hence, manufacturing companies that implement lean production would benefit from the improvement of operational performance, which in turn would affect the overall business performance in a positive way.

The limitation of this study is that it employs a cross-sectional design in which data are collected from respondents at a single point in time. One of the weaknesses in this method is that it does not allow us to draw firm conclusion regarding the causal direction of the relationships among the predictor and outcome variables. Given this limitation, future research should utilize longitudinal designs which will ensure the continuity of the response.

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