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A Study on Relationship between Lean Development, Market Productivity and Success

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***Abstract*— Notable evidence is that the concepts of lean manufacturing in Japan were deliberately imported by the US and European manufacturers from the early 1980's to seek to duplicate the performance of their introduction in the Japanese automotive industry. Still, Krafcik (1989) recognised that high efficiency depends on lean output. Lean Production is accepted as a gold standard in industrial organisational management by Hofer, Eroglu, and Hofer (2012). Recently, lean technology has proved its utility well outside its initial industry; it is now used not only in manufacturing but also in service industries in a number of diverse sectors (Furlan et al. 2011a; Boyle and Scherrer-Rathje 2009).**

***Keywords*— Lean Development, Market Productivity, Success**

I. INTRODUCTION

Notable evidence is that the concepts of lean manufacturing in Japan were deliberately imported by the US and European manufacturers from the early 1980's to seek to duplicate the performance of their introduction in the Japanese automotive industry. Still, Krafcik (1989) recognised that high efficiency depends on lean output. Lean Production is accepted as a gold standard in industrial organisational management by Hofer, Eroglu, and Hofer (2012). Recently, lean technology has proved its utility well outside its initial industry; it is now used not only in manufacturing but also in service industries in a number of diverse sectors (Furlan et al. 2011a; Boyle and Scherrer-Rathje 2009).

Automotive manufacturing firms in multiple countries or territories frequently diverge in product categories, customer base and customer segmentation (Digermenci, 2008). In Malaysia in particular, the automotive industry obviously has some variations in the same industry as other countries with similar potential. In Malaysia, this sector is facing a wide range of difficulties in terms of being listed as world-class development companies as well as being viable in this dynamic global market climate. Although there are various supporting companies in the sector, changes can be made and maintained in the entire industry by combining excellent organisational processes and exchanging enhanced intercompany structures. A more flexible overall framework solution will be necessary to keep these continuously changing requirements in line.

Many manufacturers were urged to adapt or adjust their current manufacturing processes to LMS in order to build more efficient strategies to enhance their corporate results, optimise productivity and increase competitiveness. The Malaysian government promotes the Lean Manufacturing policy (Wong et al., 2009; Rasli Muslimen et al., 2011) towards a world class standard of productivity that could be of great competition in the global market. In the Malaysian automotive industry, the introduction of LMS is thus deemed very useful in order for the industry to boost its operating efficiency and stay competitive (Noor Azlina et al., 2011). While multiple companies in this industry are involved in Lean Manufacture and are attempting to introduce lean tools, previous studies have shown that Malaysia has yet to reach a higher degree of adoption and implementation of Lean Manufacturing in some phases and fields alone (Noor Azlina et al., 2011; Wong, et al., 2009).

II. LITERATURE REVIEW

Automotive manufacturing firms in multiple countries or territories frequently diverge in product categories, customer base and customer segmentation. In Malaysia in particular, the automotive industry obviously has some variations in the same industry as other countries with similar potential. In Malaysia, this sector is facing a wide range of difficulties in terms of being listed as world-class development companies as well as being viable in this dynamic global market climate (Noor Azlina et al., 2012b; Norani et al., 2008). Although there are various supporting companies in the sector, changes can be made and maintained in the entire industry by combining excellent organisational processes and exchanging enhanced intercompany structures. A more flexible overall framework solution will be necessary to keep these continuously changing requirements in line.

A LMS is versatile in design, and can allow changes both within an enterprise and between organisations that are

prepared to take their specific features and work hard to retain the benefit and achieve greater organisational efficiency (Shah & Ward, 2007). LMS (LMS) is one of those proven techniques and is considered a cure for sustainability and competition in this global market. The ultimate aim of lean development is to develop a smooth and high-performing organisation, which will reliably deliver finished goods that satisfy the consumer demand of quality while ensuring that resources are lost minimally.

Many manufacturers were urged to adapt or adjust their current manufacturing processes to LMS in order to build more efficient strategies to enhance their corporate results, optimise productivity and increase competitiveness (Andrea et al. 2011). The Malaysian government promotes the Lean Manufacturing policy (Noor Azlina et al., 2011; Wong et al., 2009; Rasli Muslimen et al., 2011) towards a world class standard of productivity that could be of great competition in the global market. In the Malaysian automotive industry, the introduction of LMS is thus deemed very useful in order for the industry to boost its operating efficiency and stay competitive (Noor Azlina et al., 2011). While multiple companies in this industry are involved in Lean Manufacture and are attempting to introduce lean tools, previous studies have shown that Malaysia has yet to reach a higher degree of adoption and implementation of Lean Manufacturing in some phases and fields alone (Noor Azlina et al., 2011; Wong, et al., 2009).

Several scholars, have found that lean production methods can behave as a framework. If both activities work together they will make a major contribution to success. Feld (2001) clarified the idea of holistic lean production practises application. The holistic implementation means, according to him, inter-connectivity between activities. The activities should then be applied holistically in order to maximise their advantages. More specifically, the principles of lean production packages were intensively explored by Furlan et al. (2011b) and Furlan et al. (2011a), and Dal Pont et al. (2008). They found that lean manufacturing strategies complement each other. In other words, the cumulative influence of practise as a set is better than its scattered adoption. In short, it is better to incorporate these procedures together rather than individually or in small subsets.

Several studies have been performed on the effect of lean production on efficiency. Previous research such as Anand and Kodali (2009), Bonavia and Marin-Garcia (2011), Ahmad et al. (2004), show that lean production methods have a substantial effect on efficiency. Furlan et al. (2011a) showed the improved degree of efficiency after lean production. Similarly, Sun (2010) revealed that lean manufacturing as a daily activity could improve overall productivity. The reduction of lot sizes allows a consistent output flow and allows easier refilling of equipment and materials. It could minimise lead time and improve efficiency (Wong et al., 2009).

Ahuja and Khanba (2007) and Wong et al. (2009) proposed that the introduction of TPM in a sleek production environment would improve efficiency because it avoids unexpected downtime of the machine. Further, according to Dal Pont et al. (2008), and Rogers (2008) lean production efforts to improve manufacturing flexibility are expected to increase manufacturing efficiency and the use of the computer until manufacturing flexibility has improved

III. PROBLEM STATEMENT

Lean manufacturing was believed to boost business efficiency as a powerful strategy. Although its strength is unquestionable, slender development is not beyond reproach, and its influence on efficiency continues to be much debated. Positive and important effect of lean manufacture on operational efficiency has been shown in prior studies such as Matsui (2007), Hallgren and Olhager (2009), DalPont, Furlan and Vinelli (2008), Khanchanapong et al. (2014), Singh and Ahuja (2014), Rahman et al. (2010). The positive influence on company success was postulated on industry achievement and financial results by Yang, Hong and Modi (2011), Kannan and Tan (2005). This remains a key question: "*Why did some scientists suggest lean production helps boost operational efficiency, while others believed that lean production improves operating performance?*"

The present research therefore discusses the parallel and synergistic impact of broad production activities on multi-dimensional measurements of operational efficiency and market performance in order to address this void.

IV. RESEARCH QUESTION

Centered on the research history and issue statement presented in the previous pages, "*how can lean manufacturing contribute to improved organisational performance*?" The analysis was performed in two phases in order to direct the author to gain an understanding of the issue. The author tried in the first phase i.e., quantitative phase) to analyse statistical correlations between the variables (i.e. lean production practise, process efficiency and market performance). The four key research questions listed below therefore directed the first phase of the thesis;

1. How does lean production, market performance and corporate performance interact?

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V. RESEARCH OBJECTIVE

Quantitative research in the context of Malaysian manufacturing firms was presented:

- To look at the relation between lean development, market productivity and success.

VI. RESEARCH HYPOTHESES

This section addresses the research hypothesis covering the quantity process of the analysis, based on the research issues, theoretical structure and associated theories discussed earlier. According to the technique used in this mixed methods study, a set of recommendations will be generated after the quantitative research to direct the qualitative process of the study:-

H4: Lean production actively and implicitly impacts market efficiency as a mediating aspect by operational performance.

VII. DESCRIPTIVE STATISTICS OF VARIABLES

This section discusses the vector descriptive statistics used in this report. These figures are essential for the assessment of the general condition of Malaysian manufacturing firms in regard to lean manufacturing, organisational efficiency and market performance. This section contains details about the minimum value, maximum value, mean and standard deviation of the main components. Table 1 lists the descriptive statistics.

Table 1
Descriptive Statistics of Variables

Construct	Minimum	Maximum	Mean	Std. Deviation
Lean Manufacturing				
Flexible resources	2.630	6.000	4.914	.744
Cellular layouts	2.380	6.000	4.846	.777
Pull system	2.330	6.000	4.810	.873
Small lot production	2.440	6.000	4.869	.700
Quick setups	2.000	6.000	4.936	.783
Uniform production level	2.140	6.000	4.853	.743
Quality control	2.750	6.000	5.061	.742
Total productive maintenance	2.710	6.000	5.120	.720
Supplier network	2.290	6.000	4.892	.803
Operations Performance				
Quality	2.250	6.000	4.622	.774
Manufacturing flexibility	2.500	6.000	4.817	.825
Lead time reduction	2.710	6.000	4.810	.753
Inventory minimization	2.430	6.000	4.623	.848
Productivity	2.130	6.000	4.763	.765
Cost reduction	2.170	6.000	4.667	.810
Business Performance				
Profitability	2.000	6.000	4.747	.785
Sales	2.130	6.000	4.804	.777
Customer satisfaction	2.500	6.000	4.973	.660

As indicated earlier, both measuring components used a six-point likert scale perceptual scale. The minimum and maximum figures, as shown in Table 1, could vary from 1.000 to 6.000 depending on the scale used. The minimum values for lean production vary from 2000 to 2750 and the highest values for all lean production practises are 6.000. For operational efficiency, the minimum values range from 2.130 to 2.710; for all operational performance tests the highest values are 6.000. In comparison, the minimum values for business results are from 2.000 to 2.500 and the highest values for all the business performance metrics are 6.000. The maximum values of all the manifest element are 6.000, as seen in Table 1. At the earliest stage of the data screening, the highest values of 6.000 were found by numerous respondent companies.

Mean values are used for determining the extent of lean production and the level of efficiency of businesses. Apart from the mean values, standard deviations express a homogenous or uniform application and efficiency in lean manufacturing. The descriptive figures indicate that the mean lean development activities are between 4.810 and 5.120 with standard deviations between .700 and .873, based on the data provided in Table 1. Total production maintenance is the highest medium for lean production activities and the lowest is for pull system. These statistics suggest that lean production practises in manufacturing firms in Malaysia have been introduced at a marginally high pace.

Table 1 reveals that TPM reaches its highest manufacturing standard (i.e. 5.120) in Malaysia, followed by quality assurance (i.e. 5.061). This indicates that the businesses surveyed have placed more focus on these two activities than others. In other words, both activities were introduced more commonly in Malaysia manufacturing firms. Interestingly, TPM is one of the lowest quality procedures. This reveals that TPM has been applied uniformly in Malaysian manufacturing firms. In comparison, the pull method obtained the lowest standard deviation among activities (i.e. 4.810) (i.e., .873). This indicates the broad differences in this activity within the businesses surveyed. It may mean that a number of manufacturers in Malaysia often ignored the pull system.

Moreover, there is a broad standard deviation in the supply network, which indicates that in some businesses studied, it was widely implemented and in others, not. Most organisations have in general reached a substantial degree of lean execution, although some activities do need to be more developed.

In terms of operational efficiency, Malaysian factories have a reasonably high average mean score ranging from 4.622 to 4.817 with a low norm variance ranging from .753 to .848. However a closer analysis of the findings revealed a disparity in the efficiency of the operations. This analysis showed that the highest average outcomes of output

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versatility and lead time reduction were obtained (e.g. 4.817 and 4.810 respectively). Interestingly, output flexibility has a high standard deviation (e.g., 0.825), which after inventory depletion is the greatest benefit (e.g., 0.848). This meant that some businesses were highly resilient, but others were not. In view of the reduction in lead time, this operational efficiency metric has the lowest standard deviation (i.e., 0.753), which means the reduction in lead times among the producers surveyed was at a standardised amount. The respondents should also prioritise maintaining more flexible production procedures and shorter production time. In comparison, output among the interviewees was the lowest average score of operational metrics (i.e. 4.622). It indicates that efficiency was not the main concern of Malaysia's producers, relative to other indicators. Stock minimization in the lower score was considered, among other factors, close to consistency (i.e. 4.632), but with the maximum standard deviation (.848). This may mean that some of the companies do well in the inventory, but some may ignore this test. In terms of market efficiency, as seen in Table 4.5, the mean values of 4.747 to 4.973 with a low standard deviation are often considered to be slightly high (i.e., from .660 to .785). The best overall score was the lowest (i.e. 4.973) standard deviation for consumer loyalty (i.e., .660). This meant that producers' consumer loyalty became reasonably uniform. Simultaneously profitability rated the smallest average (i.e. 4.747) and the highest standard deviation (i.e., 0.787) indicating that the greatest difference in such company success metrics among the firms surveyed is apparent. In general, the businesses surveyed earned relatively consistent standards of market performance measures.

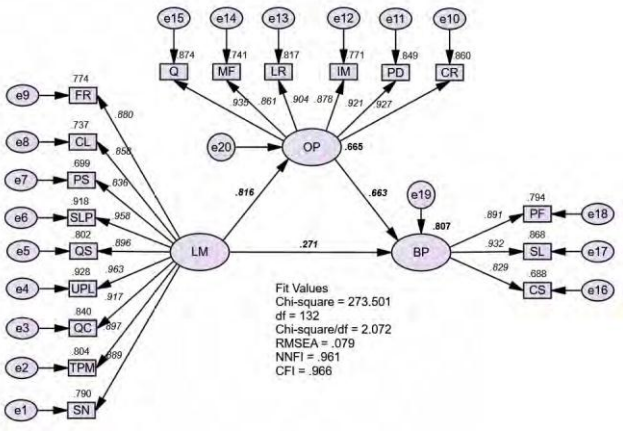

Figure 1: ***"Standardized Estimate of Structural Model***

Table 2: ***"Relationships among Latent Variables"***

Hypothesis: Path	Std. β	Std. Error	Confidence Intervals*	CR**
"H1: Lean manufacturing - Operations performance"	0.816	0.064	.735 - .877	13.388
"H2: Lean manufacturing - Business performance"	0.271	0.06	.129 - .413	3.489
"H3: Operations performance - Business performance"	0.663	0.062	.526 - .789	7.846
"H4: Lean manufacturing - Operations performance" - Business performance	0.541	0.059	.434 - .666	9.169

Several studies recently have proposed that the nature of mediation or indirect effects can be calculated on the basis of the significance of Path A commodity, i.e. the link between lean manufacturing and operations efficiency, and Path B (i.e., relationships between operation performances) based on the significance of Path a (i.e., relationship between lean manufacturing and operational performance). If the product varies considerably from zero, mediation or indirect effects occur within the model. Table 2 reveals that the direct impact on operating efficiency of lean production is perceived to be strong (i.e., Path a = .816), and is close to the direct effect on market efficiency of operations (i.e. Path b=.663). Both values are statistically important (one-tailed) at the 0.05 mark. Therefore lean manufacturing's indirect impact on market efficiency has a substantial critical coefficient of 0.541 (i.e., 816 x 663) (i.e. 9. 169). The indirect effect has an interval of confidence between 0.434 and 0.666. Since the spectrum does not contain zero, the theory that no indirect correlation between lean produce and market success can be dismissed. Therefore this condition means that the indirect effect at the 0.05 (one-tailed) stage is statistically important.

Drawing on the appraisal findings, while the presence of organisational efficiency as a mediating variable is favourable, the direct relationship between lean output and market performance. With this fact, the model fulfils parameters of complementary mediation (Zhao et al., 2010) and is accompanied by a substantial uniform indirect effect where both an indirect effect (a x b), and the direct effect (c) occur and point in the same direction i.e. positive). This means that lean development has a positive effect on direct and indirect market results.

Therefore the last statement (H4) is confirmed empirically. Furthermore, with the data approach the multivariate normal distribution for the triangulation of the mediation effect of model operations, a two-tailed Sobel test was conducted (Sobel, 1982, 1987). The statistics of Sobel

test 6.748 have been found to be important at p<-05. This finding clearly reinforces the bootstrapping result that organisational success mediates the connection between production productivity and market performance. In addition, Table 4.8 records the overall effects of lean manufacture on company performance. The table indicates that the cumulative influence of lean manufacture has a .812 effect, which is a direct effect (β=.271) and indirect effect (β =.541). The normalised β of the cumulative effects ranges from 727 to 876. This spectrum does not include zero, so the hypothesis that no substantial net impact is to be dismissed. It leads to the fact that the cumulative impact of lean output on market efficiency is important in the presence of organisational performance as a mediating element. In comparison, this situation means that market output improves by 0.812, if lean production increases by 1 standard deviation.

Table 3: *"Standardized Effects of Latent Variables"*

Path	Direct	Indirect	Total
"Lean manufacturing - Operations performance"	0.816	-	.816
"Operations performance - Business performance"	0.663	-	.663
"Lean manufacturing - Business performance"	0.271	0.541	.812

Figure 1 displays R^2 which implies the contribution of the independent variable to the dependent variable. The standardised estimation of the structural model indicates that lean manufacturing describes approximately 66.5% of the variation in operational efficiency. In comparison, both lean production and market efficiency describe 80.70% of the difference in business performance.

VIII. CONCLUSION

There were positive correlations between the structural relationships between two variables with uniform β-value, normal error, .062-fixed and important critical ratios (i.e., 7.846). Furthermore, the standardised β value is inside the range of .526 to .789. "This led to the" "conclusion that H3 was supported"; market success leads favourably to "business performance".

The positive relation between the two variables is confirmed by the qualitative analysis process. The stronger the efficiency of operations, the higher the company performance. It is understood that profitability, revenue and consumer loyalty reflect market success. The operational conditions (quality, flexibility, inventory, lead time, efficiency and cost) must first be strengthened to produce outstanding results for these three metrics. The success of operations is therefore a precedent of corporate performance.

The findings of the analysis partly describe the mixed results of previous research analysing the lean manufacturing efficiency impacts. The present study may of course, be a step towards resolving production problems, especially in developing countries such as Malaysian. The research can also technically and actually lead to manufacturers world-wide with the important and necessary advantages for global competitiveness.

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