Relationship Between Lean Production and Operational Performance in the Manufacturing Industry

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Abstract. Nowadays, more and more manufacturing firms have started to implement lean production system in their operations. Lean production viewed as one of the mechanism to maintain the organisation’s position and to compete globally. However, many fail to apply the lean concepts successfully in their operations. Based on previous studies, implementation of lean production in the manufacturing industry is more focused on the relationship between Lean and Operational Performance of one dimension only. Therefore, this study attempted to examine the relationship between Lean Production (LP) and Operational Performance in 4 dimensions which are quality, delivery, cost and flexibility. This study employed quantitative study using questionnaires. Data was collected from 50 manufacturing industries. The data was analysed using Statistical Package for Social Science (SPSS) 22.0. This study is hoped to shed new understanding on the concept of Lean Production (LP) in regards of Operational Performance covering the 4 dimensions.

1. Introduction
In the era of globalisation, organisations focus on maintaining its competitiveness at the global level by offering quality products and good services. Lean production is one of the mechanism used by many organisations that is said can improve operational performance. Many benefits of lean production are now well recognised, such as improved productivity and reduced costs through the removal of waste in operations.

Many firms implement lean production to enhance competitiveness, but the majority of them were disappointed with results [1]. This happened to be in the developed country which has long implemented it which might reduce the implementation in the developing country as the results are discouraging. In order to avoid that, with still flourishing hope as Malaysia also implement Lean Production, a positive relation between LP and Operational Performance might stop that from happening as LP promises many improvements towards Operational Performance. The aim of this study is to fill the gap by reviewing the relationships between Lean Production (LP) and operational performance in the manufacturing industry in Malaysia.
2. Literature Review

2.1 Lean Production

Lean is a form of continuous improvement with the main aim to identify and eliminate waste. Waste refers to the activities that do not affect value aspect of a product or service based on customer’s perception [2]. According to [2], waste in this context refers to excess in production, waiting time, inventory, process scrap, transportation, damage or defect of the product and movement.

Excess in production can be defined as waste took place when excess order from the customer happened or producing the product earlier, prior to the customer’s order. The next type waste is the waiting time, it would be considered as waste if idle time, storage time and waiting time for delivering the product to customer or transfer time for semi-finished product from department to department for assembly occurred. While inventory can be considered as waste, if the raw material is not used in the production, work-in-process, finished materials and operational supply excess.

Besides that, excess in production took place when the work done in producing the product does not contribute towards any benefits or value to the company. Transportation is the allocation of an item from one spot to the other and movement of product more than once is considered as waste. Product defect is such as warranty claim and returned product. Movement on the other hand refers to the unnecessary tools or workers movement in executing the given task.

Lean has been used broadly in most industries because this practice gives a lot benefits towards the organisation in increasing the work pace, reduce work capital, increase financial flow, increasing inventory turnover, market domination, increasing profit and finally fulfilling the demand from customers [3]

2.2 Lean Production

Lean Production originated from the Just-in-time (JIT) concept a few years back. There were a few companies in the world which failed to adopt this concept in the 1980s, even when all of the benefits is clear from the implementation of the JIT concept [5].

LP often implemented as proxy in Toyota Production System (TPS), where it flourished from the experiments and initiatives of Taiichi Ohno for three decades in the Toyota Motor company. Later, TPS officially being introduced in the United States of America in 1984 when New United Motor Manufacturing Inc. (NUMMI) was established and initially taken over as a partnership with the United States of America [6].

According to [7], LP can be defined as a system of business to organise and manage product development, operation, suppliers and customer relations with the aim of reducing the usage of human power, space capital and time in the production of product and reducing defects in satisfying the customer in comparison with previous mass production approach.

Aside from that, based on the research from the International Motored Vehicles Programme (IMVP) in the Massachusetts Institute of Technologies (MIT) showed that LP combined both the characteristics of mass production and craft production. From this combination, LP had the ability to reduce cost per unit and improving quality dramatically. At the same time, it also prepares a wider array of product and form of production system that is flexible which is essential in meeting the ever changing customer demand [8]. Many practitioners and researchers stated that investment in LP can reduce the cost greatly, productive work force, reducing lead time and even better quality [9] & [6].
2.3 Operational Performance

Operational performance conventionally discussed from the aspect of priorities of strategic operational competition in the manufacturing industry [10]. Competition priorities is a critical operational dimension for any process or supply chain in fulfilling internal or external customer’s satisfaction, both or future customer. Competition priorities is planned for processing and creating supply chain [11]. Based on previous study, most of the researcher adopt four (4) main elements in measuring operational performance in the manufacturing industry which covers quality, delivery, flexibility and cost [12],[13],[14].

2.4 Quality

Quality is the ability of a product or service to meet the customer’s demand and satisfaction [3] (Heizer dan Barry, 2011). In measuring operational performance, quality were discussed in the form of product performance, product endurance and product’s acceptance within the limit of design specifications [13].

In the manufacturing industry, product durability usually being measured by the time consumed to produce output. The longer it takes for a product to last or the longer it takes for it to be malfunctioned, the higher the durability of the product. Therefore, companies always measure product durability through the average time in between production [15].

2.5 Delivery

Product delivery refers to the time taken for a product to be delivered to the customer. Reduction of the lead time, faster delivery than the competitors and on time product delivery to the customer had been used to measure operational performance in the manufacturing industry [13] & [14].

2.6 Flexibility

Flexibility of production can be defined as how far the manufacturing operation react to the constant change of number of order, type and characteristics of the produced product. Flexibility allows the company to react promptly to the change in the market such as in reacting to the competitors, customer and reducing the waiting time between the product’s order and delivery [15]. Based on [3], flexibility refers to the ability of a company to react with penalty in term of time, cost and customer’s value.

2.7 Cost

Cost refers to the needed payment to produce product. Workers productivity, production cost and reduction in inventory is used in measuring the operational performance in the manufacturing industry [14]. While according to [15], workers productivity is the cost or the amount of working hours needed to produce per unit of output. In other word, the lower the labour cost used to produce an output, the higher the workers productivity.

2.8 Lean Production and Operational Performance

In order to increase operational performance, lean production essentially need to be practiced by the higher management in the organisation. As an example, Just in Time (JIT) is one of the LP elements which can eliminate waste in the manufacturing process [3]. A few studies also found that LP has a significant relation with the operational performance in the manufacturing industry [14] & [16].
2.9 Lean Production and Quality

Based on the study by [14] & [16], lean production implementation has a positive relation with quality in affecting operational performance. As an example, [17] found that LP helped to increase product’s quality and durability [16]. While according to [3], LP affects work force, inventory reduction, quality, and flexibility.

2.10 Lean Production and Delivery

Lean production also has a positive relation in regard to the operational performance and the delivery performance in the manufacturing industry [14] & [16]. This is because one of the objective of LP implementation is to reduce variation and overcoming activities that does not contribute to value development in the manufacturing process which will increase the processing time. As an example, LP will positively affect the delivery time punctuality, average cycle time, reducing waiting time in the manufacturing process and reducing the time taken to deliver the product to the customer [16].

2.11 Lean Production and Flexibility

Lean Production also has a positive relation in regards to the flexibility performance. As an example, LP can increase speed, reduce the manufacturing cost, ease introducing new product and at the same time helping the company to produce output in accordance to the real market demand and not based on forecast. This situation can increase variation of product, amount of flexibility and the ability to assimilate product to the market. Reduction in the waiting time is an important element in increasing productivity [16].

2.12 Lean Production and Cost

Eventhough the relation is not that apparent, there is positive relation between LP and cost in manufacturing company. The level of relation between LP and cost is slightly good. In practice, LP will reduce inventory level [16]. Besides that, according to [18], he found that LP practise can reduce the waiting time and production cost effectiveness aside from increasing the quality of product and productivity.

![Figure 1: Conceptual framework of the affect of Lean Production on Operational Performance](image-url)
Based on the past literatures, theoretically LP should have a positive relation with Operational Performance as it positively affect quality which is the first dimension of Operational Performance. Figure 1 shows the relation between LP and the other three dimensions of Operational Performance aside from quality which are delivery, flexibility and cost.

3.0 Methodology

This research adopted a quantitative approach as a way to measure the relation between Lean Production and operational performance. In alliance with that approach, a sample need to be selected from a population. According to [19], sampling framework is a methodology being used in selecting the sample from a population. In this study, purposive sampling was chosen to collect the precise data. According to [20], sampling is a procedure where a group of subject with a certain characteristic was chosen as the respondent. In this study, only manufacturing companies that practise Lean Production were chosen in answering the questionnaire.

3.1 Population and Sample

Population for this study consist operation manager, director of a company, production manager and knowledgable individual in Lean Production (LP) in the manufacturing industry. Based on the data base from Federation of Malaysian Manufacturers (FMM) 2012 there are 206 manufacturing company from the selected sample area. From the population, the sample size of the study was determined based on [21]. As much as 136 were purposively selected. The selected standard error for this research is 5 percent which brings towards the degree of freedom of 95 percent. Thus, the selected chi-square value equals to 3.84. Below is the formula showing the method to calculate the sample size based on [21]:

\[ s = \chi^2 N P (1 - P) + \chi^2 (N - 1) + \chi^2 P (1 - P) \]  

\( s \) = Needed sample size. 
\( \chi^2 \) = Chi-square value for the level of freedom towards the desired freedom (3.841). 
\( N \) = Population size. 
\( P \) = Proportionality of population (assumed as 0.50 since the sample size is not maximum) 
\( d \) = Level of accuracy is expressed as a proportion (0.50).

3.2 Data Collection Instrument

Questionnaire was used as the study instruments in collecting the data.

3.3 Data Collection Procedure

Data were collected from primary and secondary data source. The primary data was from the survey and the secondary data was from the literature review. This will be used in the analysis part.

4.0 Data Analysis

Statistical Package for Social Science (SPSS) 22.0 version was used in analysing the data. After the data has been collected, normality test was conducted to justify whether the data is normal or not. If the data is normal, then Pearson Regression method will used in explaining correlation between Lean Production and
operational performance. If the value exceeds 0.01 then there is positive correlation between the tested variables which in this case is between LP and operational performance.

4.1 Normality Test

According to [20], normality test is to identify whether a data set for a study is normally distributed or not. In this study, skewness and kurtosis is used in identifying the data normality. In SPSS, the measurement of skewness and kurtosis should not far from zero. Z value is used in testing the normality. The data is normal if the Z value is in between -1.96 and +1.96 [22], [23], [24]. The statistical value is divided with the standard error to obtain the Z value in the skewness and kurtosis.

| Details           | N  | Min  | Standard deviation Statistic | Skewness Standard error | Z Value | Kurtosis Standard error | Z Value |
|-------------------|----|------|------------------------------|-------------------------|---------|-------------------------|---------|
| Lean Production   | 51 | 3.782| 0.589                        | -0.346                  | 0.333   | -1.039                  | 0.546   |
| Quality           | 51 | 4.0327| 0.681                       | -0.387                  | 0.333   | -1.161                  | 0.546   |
| Delivery          | 51 | 4.000| 0.686                       | -0.186                  | 0.333   | -0.558                  | -1.132  |
| Flexibility       | 51 | 3.719| 0.734                       | -0.581                  | 0.333   | -1.742                  | 0.772   |
| Cost              | 51 | 3.510| 0.563                       | -0.092                  | 0.333   | -0.275                  | -0.747  |

Based on Table 1, Z value on skewness shows no elements exceeding the Z value as dictated by [22], [23], and [24]. The Z value for Lean Production in term of skewness, is -1.039 and Kurtosis, Z = 0.546, which confirm that the data is normal.

The Z value for quality is -1.161, while the Z value for kurtosis is -0.530. This indicates that data for quality is normal. The next one is delivery where the Z value is, -0.558 for skewness and Z = -1.725 for kurtosis which is normal. While the Z value for flexibility for skewness and kurtosis each is -1.742 and 1.176 which confirm that the data is normal. The last one in the normality test is cost. The Z is -0.275 at skewness and for kurtosis, Z is -1.139, which is the indication that the data is normal. As a conclusion all of the collected data is normal and can be proceeded for analysation.
4.2 Relation Between Lean Production (LP) and Operational Performance

Table 2: Pearson correlation between Lean Production (LP) and Operational Performance

| Variable          | Lean Production (LP) | Quality | Delivery | Flexibility | Cost  |
|-------------------|----------------------|---------|----------|-------------|-------|
| Lean Production   | Pearson Correlation  | .608**  | .387**   | .439**      | .486**|
| (LP)              | Sig. (2-tailed)      | .000    | .01      | .00         | .00   |
| N                 | 51                   | 51      | 51       | 51          | 51    |
| Quality           | Pearson Correlation  | .608**  | .628**   | .592**      | .530**|
| Sig. (2-tailed)   | .000                 | .000    | .01      | .00         | .00   |
| N                 | 51                   | 51      | 51       | 51          | 51    |
| Delivery          | Pearson Correlation  | .387**  | .005     | .450**      | .420**|
| Sig. (2-tailed)   | .005                 | .000    | .001     | .001        | .002  |
| N                 | 51                   | 51      | 51       | 51          | 51    |
| Flexibility       | Pearson Correlation  | .439**  | .592**   | .450**      | .547**|
| Sig. (2-tailed)   | .001                 | .000    | .001     | 1           | .000  |
| N                 | 51                   | 51      | 51       | 51          | 51    |
| Cost              | Pearson Correlation  | .486**  | .530**   | .420**      | .547**|
| Sig. (2-tailed)   | .000                 | .000    | .002     | .000        | 1     |
| N                 | 51                   | 51      | 51       | 51          | 51    |

**. Correlation is significant at level 0.01 (2-tailed).

Pearson Regression method was used in analysing the data from the respondents in stating whether there is significant correlation between LP and Operational Performance. Based from the result in Table 2, there is a positive correlation between LP and Operational Performance which can be seen as follows. The correlation value which is (r) between LP and quality is 0.608, delivery (r = 0.387), flexibility (r = 0.439) and cost (r = 0.486). Hence, all of the correlation values are more than 0.01 which indicates there is a significant positive correlation between LP and Operational Performance.

4.2.1 Lean Production (LP) has a positive relation with quality in affecting Operational Performance in manufacturing industry.

Positively, from the result it shows that the implementation of LP had a positive relation with quality in affecting Operational Performance in the manufacturing industry. This result is in line with the study done by [14], [16].

4.2.2 Lean Production (LP) had a positive relation with delivery in affecting the Operational Performance in the manufacturing industry.
In term of delivery, the result from the survey indicated a positive relation between LP and Operational Performance in the manufacturing industry which is in conformity with study conducted by [14], [16].

4.2.3 Production (LP) had a positive relation with flexibility in affecting the Operational Performance in the manufacturing industry.

Lean Production had been confirmed to have a positive relation with flexibility in the manufacturing industry as being apposed by [16].

4.2.4 Lean Production (LP) had a positive relation in reducing cost in affecting the Operational Performance in the manufacturing industry.

It has been confirmed by implementing Lean Production, it will positively reduce cost in affecting the Operational Performance. This finding is in line with other previous study from [3], [16] & [20].

4.3 Discussion

In the first dimension, LP is positively related with quality. In LP, product conformity with the specifications begins since the early stage in order to avoid waste and increase the quality. This is because the worker must strictly follow the guidelines, procedure and specifications in producing a product as a way to eliminate the possibility of waste and subsequently the quality of a product will be kept assured. As an example, if a products being produced from aluminium with the cutting dimension of 30cm X 21cm, the procurement department must order the right metal that is aluminium. The subsequent department which is production department must cut the aluminium based on the specifications to avoid problem in the next process since the aluminium is not fit for processing since it is not the meant size. These are some of the examples of how LP practise in a manufacturing company can affect quality since the initial stage.

This practise will then affect the delivery (second dimension) as when the production runs smoothly with quality, there will be no delay in delivering the product to the customers. The combination of quality product and on time delivery will then affect costs (third dimension). When there is no issue of quality such as defects and delivery is on time, there will be no extra cost of reproduction to replace defect product and send it back again to the customer which will save cost tremendously.

When there is no complaint from the customer on the quality and delivery, the manufacturing company can create new product since they have more time to improve what they are producing instead of wasting time repairing mistakes that is avoidable. This is exactly as being said in [25], when operational performance is increased new product development will come next. They also can produce more products as everything is as planned. This is the flexibility (fourth dimension) of a manufacturing company which is affected positively from the LP practise.

5.0 Conclusion

As a conclusion, the four dimensions of Operational Performance is positively related with the Lean Production practise in the manufacturing industry. This thus conform the finding to the previous studies on LP and operational performance. It is important to confirm this finding as an encouragement for other industries in other nations whether developed or soon to be developed as LP carries multiple dimensions benefits which cover quality, delivery, flexibility and cost.

Practically the four dimensions of Operational Performance will be positively affected by the LP practise. Nevertheless nothing is perfect, problems might occur here and there in the manufacturing
company. This is where LP comes in handy as it avoids problems and increase Operational Performance since it promotes conformity with specifications to deliver result and avoid waste both in the workforce and the products.

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