Implementation Selected Tools of Lean Manufacturing

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Abstract. This study aims to understand the general perspective of industrial company operating in Sabah, regarding the implementation selected tools of lean manufacturing. The objectives of this paper are to evaluate the implementation of lean manufacturing and its tools among manufacturing company located in Sabah. Apart from that, it will also identify the problem and factor in implementing lean manufacturing tool as well as the benefits experienced after the adoption of lean manufacturing tools. The scope covers manufacturing company of any types of industry that is actively operating in Sabah, regardless of size. Instrument of study is a survey questionnaire that contains open and closed ended questions, sent out to target respondents. Data analysis is done using descriptive statistics to explain the trends in dataset and Cronbach’s Alpha to test the internal reliability of the instrument. This study finds significant evident of the implementation of lean manufacturing and its tools among manufacturing companies in Sabah, as well as the problem faced in implementation, factors of implementation and benefits experienced after the adoption of lean manufacturing tools.

Keywords: lean manufacturing, lean manufacturing tools

1. Introduction
The current strategy used by most companies nowadays is a traditional manufacturing approach that focused on producing a set number of products each period and kept them reserved in the inventory in case of unexpected demands or shortages. This caused companies to hold a large amount of inventory and overproduction. In addition, employees only do jobs/works that are assigned to them without any systematic management, in which this particular method causes employees to perform unnecessary works [1]. This affects the product development of the company and cause slacks which therefore, lead to failure in tracking manufacturing process in details, in terms of activities, and affects the ways of information transmission including how and when the next step should be taken. This is an indication that approaches in management has a vital role to the companies’ production line.

In conjunction, Malaysian Productivity Corporation (MPC) has been introducing lean management since 2011 to various organisation and since then, MPC has held seminars which attended by 1,587 participants from 376 companies. Government departments and companies in the State has been advised to consider implementing the lean management system in their organisation [2].

Most study that have been done based on lean manufacturing implementation are focused on peninsular region. Wong et al. (2009) examined the adoption of lean manufacturing in the Malaysian electrical and electronics industry [3]. Noraini Nordin et al. (2010) investigated the lean implementation in Malaysian Automotive industry [4]. Ng et al. (2015) studied the analysis of lean
manufacturing tools in Malaysia’s manufacturing industry [5]. On the other hand, review made based in East Malaysia, Sabah to be specific is still lacking. Therefore, there is a gap in reviewing the level of understanding and status of implementation of lean in manufacturing companies which originates in Sabah are still unknown although it has been long introduced in Sabah.

While some may have perspective about lean concepts in general, there has been less review about the status of implementation of specific tools listed in lean manufacturing. Acknowledgement in implementation of lean tools and the characteristic such as problem in implementation, its factors and benefits among Sabah Manufacturing industries are still not identified. Due to lack of support and advices, these organisations might not be able to experience lean manufacturing’s benefits.

2. Literature review

Lean manufacturing has a very long history, depending on how lean is defined. Although, the first person to truly integrate an entire production process was Hendry Ford when he first design Model T Ford. He puts together many ideas regarding production line which soon, came to invention of the Toyota Production System by Kiichiro Toyoda, Taiichi Ohno and others at Toyota [6].

Generally, Toyota is known as the birthplace of lean. Due to shortage of capital and resources, overproduction had to be avoided thus Pull came to support production scheduling. Product/service is produced at the pull of customer, not pushed through the organisation without the concerns of customer’s need. Taichii Ohno introduced the concept of Total Production System (TPS), which was widely referred as just-in-time (JIT) manufacturing in the 1980s. Lean is developed principally from the TPS but including many other sources. It can be said that continuous learning aspects of TPS have made it a core concept of lean [6].

Lean manufacturing also known as lean production or simply “lean” is a business philosophy applied in managing companies as it implements several approaches and appropriate tools in order to achieve improvements that allows companies to reduce cost, improve processes and eliminate waste to increase customer satisfaction. In other words, it is the set of tools that assist in the identification and reducing of waste in design, manufacturing, distribution and customer service.

2.1 Problem in implementation

A case study by Abhay et al (2014) identified several barriers based on their observation in a manufacturing organisation [7]. Their observation listed significant barriers such as poor training, lack of awareness among the staff, lack of communication, and gap between top management and employees. In conjunction, according to One et al (2005), barriers in lean tools implementation are lack of commitment and leadership from top management, lack of proper training and education as well as resistance from the employees. In addition, they also included non-conducive environments in the adoption process as one of the challenges [8].

Atif Qamar Malik (2014) observed more details obstacles that raised during the process of implementing lean tools, which were workers only do a minimum effort in doing tasks, workers did not follow the guidelines given during the training programme, and management is reluctant on investing in employees’ training [9].

2.2 Factors of implementation

Nowadays, lean manufacturing tools is increasingly recognized as a management technique that enhances productivity and competitiveness [10]. In India particularly, the small-scale industries (SSI) contributes a vital segment of the Indian economy in terms of industrial production, exports, employment and creation of an entrepreneurial base. Simply, small manufacturing firms face massive challenges in this world that is always transforming. Hence, the pressure to rapidly introduce new creation in an increased quality and reduced cost has led them to find a solution to improve their performance [11].

Due to tough competition worldwide, rejection/error in manufactured parts at various stages of manufacturing must be avoided in today’s production line. Manufacturing industries are heading towards the direction of zero-defect production. Varun Kumar (2016) further added that producing high quality of products and services is listed as one of the key concerns in order to compete in the
global markets [12]. They further explained that production of product in 100% without any defect is not only a challenge, but also a necessity for companies. This forces company to put great effort on preventing faulty products and services by any means, before customers received them. Consumers expect highest quality, reliable delivery and competitive pricing from the manufacturers. This challenged companies to look for new strategy to save costs, develop employees to face future obstacles and develop new culture at work place.

2.3 Benefits of implementation
It is important to note that, lean approach is to produce more while consuming less. In conjunction, a study by Wójcik et al (2015) on the impact of lean manufacturing tools to the company’s operation improvement, stated that the following phenomena are noticeable: an increase of employee’s motivation, development of a company’s organisational culture, reduction of costs associated with production of products as well as improvement in products quality. The study also concluded that waste in term of waiting is eliminated [13].

The benefits of lean implementation are the increased in customer satisfaction, workplace safety, efficiency and quality. Previous study noted that it reduced the cost of doing business, reduced inventory as well as improved employee morals. These are the benefits that are cited frequently Lean manufacturing are popular and widely applied to improve operational performance by reducing inventory and increasing quality levels [14]. Marodin (2018) also found that lean manufacturing practices have a positive impact on quality improvement in a way that it reduces process variability by standardizing work methods to ensure the availability of equipment, materials and trained workers [14].

3. Methodology
A questionnaire was developed to collect data for this study, which consist of two parts; (A) the background information of the respondent and the company itself, and (B) the lean manufacturing implementation. A five-point Likert scale was also included which identifies the problem face, factors of implementation and benefits obtained from the implementation of lean manufacturing.

The sample space was obtained from the database of Federation of Malaysian Manufacturers (FMM) and Federation of Sabah Industries (FSI) which only target on manufacturing companies in Sabah. Contact information, such as email address and phone number of respective companies is obtained from the official website. Questionnaire will be distributed, and a period will be given for the data collection. Main method of questionnaire distribution is through email however other alternative methods will be carry out to increase the response rate.

Data gathered will be processed and summarized by using descriptive statistics as well as analysed using Cronbach’s Alpha to measure its internal reliability using SPSS software. Descriptive statistics are tool that assist in organising and summarising data. To study the pattern that emerges from the data, descriptive statistics will be used to describe and summarise the data in a meaningful way. Data will be presented in a form of tables, graphs bar charts and frequency plots that detail the responses received.

A common first step in data analysis is to summarise the information of variables, such as measure of central tendency and measure of dispersion as they related to each other. Measure of central tendency is related to the measure of average value of the sample. It consists of mean, median and mode. While, dispersion refers to the spread of the value around the central tendency, specifically the mean value.

For the questions especially the form of Likert scale, Cronbach’s alpha is the common measure of its internal consistency or reliability. Reliability refers to the extent of consistency produced by a scale, for a repeated measurement. Having a measure with good reliability signifies the internal validity and ensures that the data obtained can be trusted to represent the participant’s performance. The general practice value of Cronbach’s Alpha, $\alpha$ is approximately 0.70, yet it can be as low as 0.6. Hence, $\alpha \geq 0.70$ is sufficient to assume that it is reliable [15].
4. Results

A total of 25 responses were obtained, which 15 of them was responded through the email, 6 from the online survey and 4 obtained from the company visit. The responses were representative of the type and spread of industries within Sabah, with West Coast being the location of most of the companies involved in manufacturing operations. Most respondents were representatives of in the position of engineers, with an approximate number of 40% from the respondent pool. The distribution of the manufacturing company included in this study among the various industries based on the product they manufactured portrayed that 28% of the manufacturing company belong to the Electricals & Electronics industry, followed by construction industry (20%). The respondents were mostly from small companies with less than 50 range number of employees which exhibits 40%, closely followed by those from big companies with more than 100 employees.

To further verify the extent of lean implementation in Sabah, the respondents are asked about their knowledge involving lean manufacturing. This is important to know their knowledge and awareness about lean manufacturing in general. Figure 1 shows the percentage of lean manufacturing awareness.

![Figure 1: Lean manufacturing awareness (N=25)](image)

Out of 25 total respondents, 8 acknowledged that they had a basic understanding of lean manufacturing. 68% (17 respondents) have no knowledge and no experience with lean manufacturing. This show that the awareness of lean manufacturing is still lacking.

To achieve the main objective of this study, respondents were asked about lean manufacturing implementation in their company. Questions asked about their implementation, period of implementation and tools that they have been implementing. The adoption of lean manufacturing among the manufacturing companies is shown as below.

| Location (Division) | Yes | No |
|---------------------|-----|----|
| West Coast          | 4/13| 9/13|
| Kudat               | 0/1 | 1/1 |
| Sandakan            | 1/2 | 1/2 |
| Tawau               | 1/3 | 2/3 |
| Interior            | 3/5 | 2/5 |
| Labuan              | 1/1 | 0/1 |
| **Total**           | 10/25 = 40% | 15/25 = 60% |
Among 25 manufacturing companies, only 10 of them or 40% implement lean manufacturing, which is contributed by 4 companies out of 13 from the West Coast division, 1 out of 2 companies from Sandakan division, 1 out of 3 companies from Tawau division, 3 out of 5 companies in Interior division and lastly a company from Labuan. Majority of the respondents (15 out of 25, 60%) do not apply lean manufacturing in their company.

**Table 2: Period in engaging lean manufacturing (N=10)**

| Lean manufacturing implementation period | Frequency | Individual % | Cumulative % |
|-------------------------------------------|-----------|---------------|--------------|
| 2-3 years                                 | 6         | 60            | 60           |
| More than 3 years                         | 4         | 40            | 100          |

This survey investigated the number of year that the respondents’ company have been involved in lean manufacturing to indicate the maturity in the field. It can be observed that more than half of the respondents (60%) are engaged in lean manufacturing for 2-3 years, while 40% of them are involved for more than 3 years.

Table 3 shows the frequency of lean manufacturing tools that have been implemented in 10 companies, distributed with respective industries that the companies are involved in. The most used tools are 5 S and KPI which were applied by a total of 8 manufacturing companies.

**Table 3: Distribution of lean manufacturing tools based on the type of industry**

| Lean Manufacturing Tools | Industry types | Total implementation |
|--------------------------|----------------|----------------------|
|                          | Constructio n | E&E                  | Metal | F & B | Agricultur e | Total |
| 5S                       | ///           | /                    | /     | /     | /            | 8     |
| Bottleneck Analysis      |               | /                    |       |       | /            | 2     |
| Continuous flow          |               | /                    |       |       | /            | 1     |
| Heijunka                 |               | /                    |       |       | /            | 2     |
| Hoshin Kanri             |               | /                    |       |       | /            | 2     |
| Jidoka                   |               |                       |       |       | /            | 1     |
| JIT                      |               | /                    |       |       | /            | 2     |
| Kaizen                   |               | /                    |       |       | /            | 2     |
| KPI                      | ///           | /                    |       |       | /            | 8     |
| OEE                      | /             | /                    | /     |       | /            | 4     |
| PDCA                     | /             | /                    |       |       | /            | 4     |
| Root Cause Analysis      |               | /                    |       |       | /            | 2     |
| SMART Goals              | /             | /                    | /     |       | /            | 3     |
| Standardized work        |               | /                    |       |       | /            | 2     |
| Tact Time                |               | /                    |       |       | /            | 3     |
| TPM                      |               | /                    |       |       | /            | 3     |
| Value Stream Mapping     |               | /                    |       |       | /            | 1     |
| Visual factory           |               | /                    |       |       | /            | 1     |

Table 4 displays the value of Cronbach’s alpha coefficient of all the items is within the range of 0.774 to 0.813. This indicates that all the items have a good degree of internal consistency. Furthermore, the “Cronbach’s Alpha if item deleted” column estimates the value of Cronbach’s Alpha if that particular item is deleted. As shown in the table, some of the values in that columns are higher.
than the Cronbach’s Alpha hence that item can be removed to improve internal consistency for more accuracy.

| Variables                                      | Cronbach’s Alpha if item deleted | Cronbach’s Alpha |
|------------------------------------------------|----------------------------------|------------------|
| Problem faced in implementing lean manufacturing tools |                                  |                  |
| 1 Lack of training                            | .604                             | .774             |
| 2 Lack of resources                           | .707                             |                  |
| 3 Resistance from staff/employees             | .610                             |                  |
| 4 Adoption/maintenance is complicated and costly | .845                             |                  |
| Factors of implementing lean manufacturing tools |                                  |                  |
| 5 Pressure from top management                | .675                             | .783             |
| 6 To increase business opportunities          | .683                             |                  |
| 7 Desire to employ world best practice        | .747                             |                  |
| 8 The drive to focus on customers satisfaction | .649                             |                  |
| 9 To reduce waste in production               | .899                             |                  |
| Benefits of implementing lean manufacturing tools |                                  |                  |
| 10 Helpful in increasing business opportunities | .781                             |                  |
| 11 Organisation become more productive        | .739                             | .813             |
| 12 Any operation become more effective        | .739                             |                  |
| 13 Efficiency in meeting customer satisfaction increased | .806                             |                  |
| 14 Waste in production decreased              | .826                             |                  |

5. Discussion

Out of 25 respondents, only 10 of them implemented lean manufacturing in their company. Those companies were mainly located in the West Coast division, to be specific Kota Kinabalu. This is because of Kota Kinabalu being the capital city and the economic centre of the Sabah. Although majority of the companies still have lack of awareness and do not implement lean manufacturing and its tools, it is a fair conclusion that companies around Sabah had already been implementing lean manufacturing. This statement is proved by the result; 3 companies from West Coast division, 1 from Sandakan division, 1 from Tawau division, 3 from interior division and 1 from Labuan. Kudat division on the other hand has only one representative because Kudat is mainly focused in tourism sector. In addition, majority of the companies have already been implementing lean manufacturing for a period of 2-3 years. However, by looking at the number of companies that have not implemented lean manufacturing, it indicates the need to increase lean manufacturing awareness and encourage more company to implement it.

With 5S and KPI being most applied tools, each company implemented at least 2 lean manufacturing tools in their company. 5S was viewed as the easiest lean strategy to implement as 5S is the gateway for companies to begin the transformation to lean manufacturing. Implementing the 5S strategy sets up the change in culture required for structured continuous improvement. 5S allows for a visible and disciplined change where employees can recognize a lean manufacturing method in action that focuses on workspace organisation and the elimination of non-essential equipment [16]. While, KPI is highly implemented because it can be used in all areas of business as it is a measurable value applied to business objectives. In simple words, KPI can tell whether the company is moving forward or backward, which is useful in the decision-making process and help to drive the growth of the company forward [17].
The least applied tools are visual factory, value stream mapping, Jidoka, and continuous flow. This may due to high level of difficulty in implementing these tools, which reduces the chance for success. Among all the mentioned tools, continuous flow has been listed as the most difficult lean tools to implement based on [16]. However, it is important to note that all industry have been implementing at least 2 tools of lean manufacturing, which indicates that the industry is rapidly involved in lean manufacturing and is not restricted to using only 1 tool in their company.

5.1 Problem faced in implementing Lean Manufacturing
Lack of resources has the highest agreeability which can be further postulated as financial constraints that the company may face, due to company size as majority of the respondents come from small companies. It is also important to note that there is a significant agreeability that companies faced problem in implementing lean manufacturing tools due to lack of training and resistance from staffs. Question number 4 is removed in order to improve internal consistency if item deleted, based on the Cronbach’s alpha result.

5.2 Factors of implementing Lean Manufacturing
For factor of implementing lean manufacturing tools, the highest agreeability is due to pressure from top management and the drive to focus on customers’ satisfaction. These two factors correlate with each other as to compete in today’s rapidly transforming worlds, manufacturing companies face massive challenges hence the pressure to introduce new techniques is necessary to improve company’s performance [11]. Identifying consumer’s needs and demands are the first principle of lean manufacturing in order to strive for perfection. Question 9 is removed in order to improve internal consistency if item deleted, based on the Cronbach’s alpha result.

5.3 Benefits gained in implementing Lean Manufacturing
There is a significant evident that companies benefit from implementing lean manufacturing tools however this statement is arguable by looking at the amount of “neutral” and “disagree” responses. Even though some company agree that lean manufacturing tools implementation are beneficial in their company, the same amount of neutral or unsure responses were received. This may be due to lack of knowledge and awareness of the representative regarding the company’s performance and productivity. Other reason such as incorrect implementation might as well contribute to the amount of neutral and disagreed responses. Question 14 is removed in order to improve internal consistency if item deleted, based on the Cronbach’s alpha result. Figure 2 provides a graphical overview of the data collected.
6. Conclusion

Study of lean manufacturing implementation assists individuals in understanding how companies are pursuing improvements initiatives in real world situation. It explores how lean concepts are being implemented and applied in a practical setting rather than detailing an idealistic situation. Based on the data collected, conclusion can be used to help identify the strengths and deficiencies. This study may benefits companies that participate in this study, especially companies that have not implement any lean tools, to learn and educate themselves from companies that have already engaged in lean tools. This research is valuable because it gathers data from both lean and non-lean facilities in real world, allowing an evaluation of effectiveness and direction in implementing lean manufacturing. Future research and development can relate to the ideas stated and studied here for new, improved and more efficient manufacturing system especially around the scope of study.

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