The Effectiveness of Lean Manufacturing Tools in Maintaining Quality Control (Assurance): A Case of a Door Manufacturing Company in Malaysia

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Abstract— This paper highlighted on the effectiveness of lean manufacturing tools in maintaining quality control or assurance in a door manufacturing company in Malaysia. The company has experience producing defective product at an alarming rates. Hence, Poka Yoke has been applied to reduce waste or defective door components produced in the manufacturing plant. After the application of Poka Yoke method, it has reduced from 29% to 6%. Hence, Poke Yoke method can be used to reduce defective production of a door components at the door manufacturing plant in Malaysia.

Index Terms— effectiveness, lean manufacturing, quality, control, assurance, poke yoke, waste reduction, management.

1 INTRODUCTION

IN a manufacturing plant producing defective products are not acceptable due to increase in waste that lead to increase production cost and reducing profitability of the company. Hence, quality assurance is highly needed in order to ensure high efficiency rate, and reduce of cost and waste from producing defective products.

In industrial manufacturing most companies receives complaints on product quality from customers. In manufacturing industry, quality is defined as anything that adds value to the end product from the customer's perspectives [6]. Manufacturer have to maintained low operational cost, and at the same time able to produce high quality products without defects [6],[12],[13]. Hence, this is a huge challenge for most manufacturing companies.

The objectives for this study is to identify the total rejection for the last three months operations, and to propose poke yoke tool in reducing production rejection. Poka yoke is one of the lean manufacturing tools which can be used or applied to reduce the number of rejections during production process.

2 LITERATURE REVIEW

2.1 What is Lean?

Lean is a manufacturing philosophy in manufacturing that incorporates principles, tools, and techniques into the business processes in optimizing time, human resources, assets, and productivity that will enhance qualiy level of products and services delivered to the customers [11].

According to [2] by applying lean, it can improved processes and eliminate waste in terms of excess of work, capacity, time, and cost. Further, it can be applied to any processes and type of industries due to its principles which are value creation, waste elimination, integrity building, continuous learning, localize responsibility, fast delivery, delay commitment, and optimizing the whole. It should add more values to the customers as it will allow continuous improvement from a standard at the point of activity by everyone, everywhere, and everyday [10].

[9] had proposed five lean thinking fundamentals that include:

1. Specify value from the customer perspective.
2. Identify the value stream by eliminating steps that do not create value.
3. Make value flow continuously by eliminating causes of delay.
4. Pull value through customers and avoid pushing work into the next process or department by letting work and supplies be pulled as and when needed.
5. Pursue perfection via continuous process improvement.

2.2 Lean Manufacturing

Lean manufacturing systems was started at Toyota Motor Company, whereby they had devised a new and more disciplined process oriented system that is now known as "Toyota Production System" or "Lean Manufacturing". The focus of the system is to identify the major sources of waste and using the JIT, production smoothing, setup reduction and other systems to eliminate the waste [17].

Lean manufacturing is a systematic approach to identify and eliminate wastes (non-value added activities) through continuous improvement processes in producing products or rendering services in meeting customers demand or requirements [4], [14]. This suggests the existence of a synergistic work practices environment in the compa-

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ny to fulfill quality requirements and added value to products produced or services rendered. In addition, lean manufacturing may eliminate problems associated with poor production scheduling and line balancing, In return, companies are also seen to have a competitive edge since customers know that the companies will produce value added quality products.

The waste-elimination concept of Lean manufacturing has a significant impact on various industries including factories, healthcare, and hotels. The waste could be in terms of:

- Transport (moving products that are not actually required to perform the processing),
- Inventory (all components, work in process, and finished product not being processed),
- Motion (people or equipment moving or walking more than is required to perform the processing),
- Waiting (waiting for the next production step, interruptions of production during shift change),
- Overproduction (production ahead of demand),
- Over Processing (resulting from poor tool or product design creating activity), and
- Defects (the effort involved in inspecting for and fixing defects) [4].

Application of lean manufacturing leads to gaining competitive advantage in the world market by being able to eliminate waste (non-value added activities). The main aim of lean manufacturing is to reduce non-value added activities while continuously improve productivity, product quality, and deliver on-time to the customers [6].

Usually, lean manufacturing is used to eliminate poor production scheduling and line balancing, and most suitable for companies without ERP systems or weak material requirement planning (MRP), that includes production scheduling or production allocation systems.

2.3 Benefits of Lean Manufacturing Tools

There are few benefits can be gained from the lean manufacturing tools, as discuss below:

2.3.1 To Improve Response Time to Customer Demand

Lean manufacturing allow for more efficient production with less lead times, with high quality products as it reduce defects and waste. The application of JIT allows for faster production to meet demand on time, with greater efficiency and higher product quality [6].

2.3.2 To Reduce Inventories

Lean manufacturing tools allow for more efficiency, and less storage needed to store inventories. As along the way, unnecessary stock will be reduce via KAIZEN [15].

2.3.3 To Reduce Working Capital Requirements

Raw materials will be received Just in Time for production and will be send out to customer Just in Time for their consumption [6].

2.3.4 To Simplify and Visual Control

Unnecessary work or repetive works will be eliminated in order to increase efficiency, and less manpower intervention in order to speed up the production process [12], [13].

2.3.5 To Improve Productivity

Every single minute is count for more efficiency, and all error eliminated earlier before production, and well maintain machine enable greater efficiency as it will eliminate factory shutdown at the manufacturing plant [1],[3], [12],[16].

2.4 Tools in Lean Manufacturing

Tools for lean manufacturing are continuous improvement (KAIZEN), just in time (JIT), single minute exchange of die (SMED), and poka yoke.

2.4.1 Continous Improvement (KAIZEN)

In KAIZEN, the 5S is used for effective lean company which are Seiri (Sort), Seiton (Straighten), Seiso (Sweep and Clean), Seiketsu (Systemize), and Shitsuke (Standardize). The main focus of KAIZEN is to ensure minimal waste of time to retrieve information or files or materials for continuous production efficiency in case of sudden death or leave of any production employees. In other words, this tool can be used to identify waste and to eliminate them to achieve zero deficiency. Waste could be in the form of defective parts, execessive time taken, defect mahines, obsolete machines and etc. This is an excellent organizing technique or housekeeping to make workplace in order and will involve workers in the improvement process. Hence, this is one of the fundamental processes for continuous improvement in lean manufacturing [15].

2.4.2 Just in Time (JIT)

Just in time delivery in can be a pull or push delivery system, whereby pull will be coming from the company from the supplier. Whereas, push will be from the manufactrusing company to the customer. Customer for a company can be categorized as supplier or buyer. Just in time production is to allow minimal storage of finish products, in order to reduce damage in the warehouse, and will reduce cost of storing finished products or raw materials in the manufacturing plant [6].

2.4.3 Single Minute Exchange of Die (SMED)

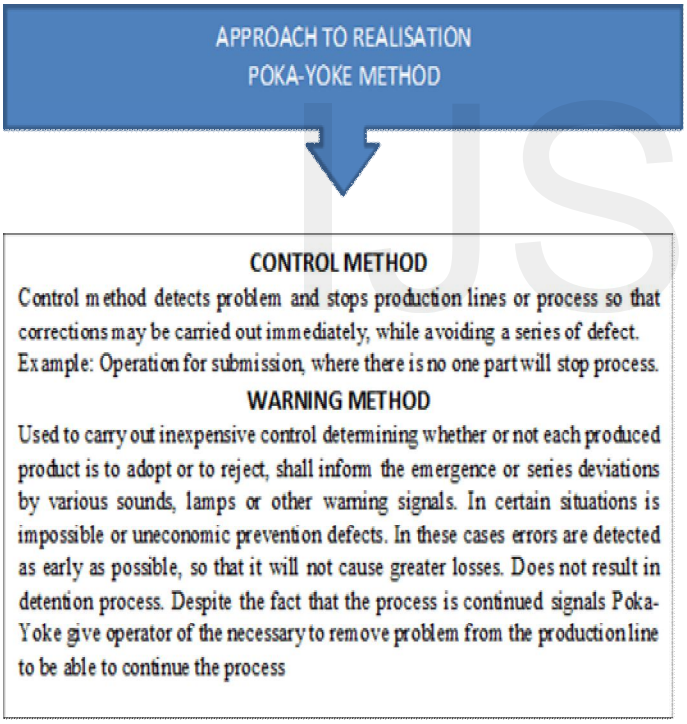
SMED is one of the lean production method to reduce waste in a manufacturing process, and it provides rapid and efficient way of converting a manufacturing process from running the current product to running the next product. Single minute is referring to quick changeover that should be less than 10 minutes or a single digit of minutes. Implying that the time needed to set up the

equipment should be within single digit which is considered as good. The need for SMED and quickchangeover programs is more popular now than ever due to increase demand for product variability, reduce product lifecycle and the need for significant inventories reduction [16]. H owever, as study has shown that SMED can be more effective if apply together with another tool such as ECRS (eliminate, combine, reduce, and simplify) [12].

2.4.4 Poka Yoke

According to [5], poka yoke is used to detect errors and defects, which is to inspect 100% of the production piece, working independently on the operator's attention span. Hence, manufacturing company must be able to detect the propensity of errors resulted from human, and eliminate it earlier before production [3]. Further, poka yoke also known as a technique for avoiding simple human error at the workplace.

FIGURE 1
POKA YOKE METHOD



Source: [8]

There are three basic function of Poke-Yoke method which are (Figure 1):

1. Shutdown Poke-Yoke – this is a prevention method to checks upon critical process parameters and to shut down the process immediately when defects reached intolerance zone.
2. Control Poke-Yoke – here, devices are regularly inspect to ensure installed process equipment and/or work piece are in order to avoid defects product being produced or non-conforming product move to next process.
3. Warning Poke-Yoke – devices should be installed with warning capability in order to inform machine operators when there is something wrong so that the operators can stop the process and resume the process as needed [7].

2.4.5 Total Productive Maintenance (TPM)

The total productive maintenance is referring to machine breakdown. The reliability of the equipment on the production line is very important since if one machine break down the entire production process will be affected. This denoted that production machine needs to be reliable in order for a factory to fulfil ordered products. Machines in the factory are expected to work smoothly with the expectation of few breakdown.

One of the usage of TPM is to encounter sudden machine breakdown. Hence, a scheduled maintenance must be in place in order to ensure uninterrupted production process (preventive maintenance), decision whether to buy new or fix the machine (corrective maintenance), and to buy the right machine with minimal maintenance needs or costs (maintenance prevention).

TPM is also identified as a tools that can helps organizations in organizing their maintenance activities based on the following actions [1]:

1. Cultivate a sense of ownership in the operator by introducing autonomous maintenance – the operator takes responsibility for the primary care of his/her workstation.
2. Uses cross functional teams consisting of operators, maintainers, engineers and managers to improve individual employee and equipment performance.
3. Establish an optimal schedule of clean-up and productive maintenance to extend the plant's lifespan and maximize its uptime.

3 METHODOLOGY

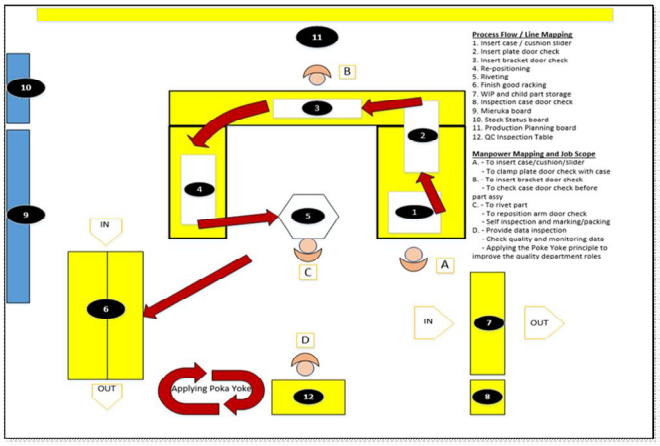
A manufacturing company at Shah Alam, Malaysia that is involved in producing car door parts was chosen for this study. A data on the last 3 months performance of the company before the application of poka yoke were collected for comparison purposes. The duration of the observation in total were 6 months.

4 FINDINGS

4.1 Process Flow after Application of Poka Yoke

The process process flow and manpower mapping was done to show the application of poke yoke into the process, and was used as the blueprint for the workflow. The workflow at workstation D, was modified to reduce waste at the production process, and to enhance quality of the production as shown on Figure 2.

FIGURE 2
PROCESS FLOW ENHANCEMENT AFTER POKE YOKE



4.2 Rejection 3 Months before Poka Yoke

In Table 1, it showed the number of rejection for the last 3 months before the application of Poka Yoke. As can be seen the quality control of this manufacturing plant are inconsistent through out the last 3 months before the application of the poka yoke into the work process.

TABLE 1
REJECTION 3 MONTHS BEFORE POKA YOKE

Parts Name	Sept -14	Oct-14	Nov-14
Cover 2CT/2WF	193	180	160
Case Door Check 2CT/2WF	16	10	14
Cover 2XP	8	4	4
Case Door Check 2XP	8	6	10
Patch 2XP Rear	8	6	50
Bracket Door Check	205	190	140

4.3 Rejection 3 Months after Poka Yoke

In Table 2, it showed the number of rejection for the last 3 months after the application of the poka yoke. It showed that the first month after the application of poka yoke, there was no significant difference in terms of the product quality. However, there was an improvement in the Case Door Check 2XP, as there was no rejection at all in the second month and also third month of the application. Surprisingly, during the third month the Cover 2XP also has shown improvement.

TABLE 2
REJECTION 3 MONTHS AFTER POKA YOKE

Parts Name	Feb-15	Mar-15	Apr-15
Cover 2CT/2WF	75	70	60
Case Door Check 2CT/2WF	10	8	6
Cover 2XP	4	4	2
Case Door Check 2XP	4	2	2
Patch 2XP Rear	4	4	2
Bracket Door Check	100	90	50

5 DISCUSSION

5.1 Comparison Rejection Data Before and After Poka Yoke

Referring to Figure 3 and Figure 4, there were significant improvement for overall production after the application of poka yoke at workstation D. Thus, the ability to identify the area that might lead to the most human errors, and identify ways to improve it usually lead to production improvement as proven in this study.

5.2 Incremental Improvement

As can be seen the improvement does not take place immediately, however, it happens gradually overtime. This might be due to adjustment period for the employee, as it is quite difficult for any person to change overnight, especially for routine tasks. Hence, production manager must allow the employee to learn from their mistakes, and eliminate it in the future, and take it as a learning curve for all.

FIGURE 3
REJECTION 3 MONTHS BEFORE POKA YOKE

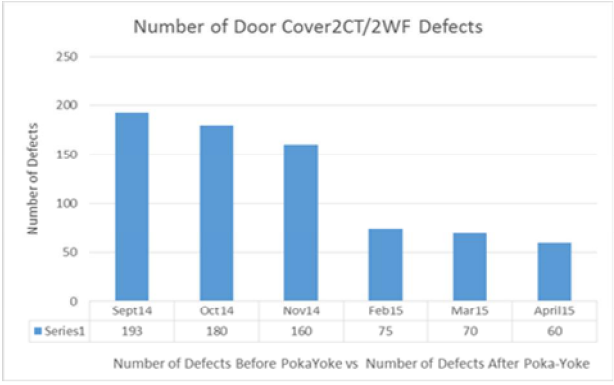
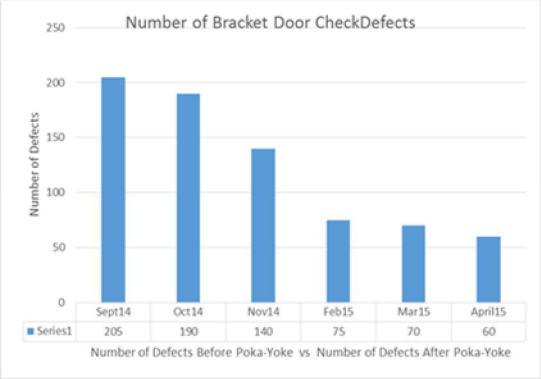


FIGURE 4
REJECTION 3 MONTHS AFTER POKA YOKE



7 CONCLUSION

7.1 Future Research Recommendation

The overall research was on the implementation of a specific lean manufacturing tool that is known as Poke Yoke for the quality work station in a manufacturing plant of a car door manufacturing company at Shah Alam, Malaysia industrial park. So, the findings only relevant to this type of manufacturing plant, future studies should be done to few other manufacturing plant in order to evaluate the suitability of the poka yoke or the application of all lean manufacturing tools to enhance any manufacturing plant processes.

7.2 Conclusion

The lean manufacturing tools is usable tool to be used in enhancing manufacturing plant operation, provided that the implementer understand the concept and how to apply it at their manufacturing plant. From this study, improvement at one particular single point of the operation had tremendously improved overall production that had reduced the number of waste for each components produce.

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