Applying Kaizen in Quality for Reducing Dent Defect per Unit

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Abstract. Continuous improvement (Kaizen) is considered as a main concern and prerequisite for competitiveness in today’s manufacturing. One form of continuous improvement is in the field of product quality. The continuous quality improvement is the key to long-term success and high performance of the organization. A case study was conducted in a manufacturing company. In the year 2019, company has not yet reached the target in particular on cylinder head part. One of the defects that still occur is dent. Research carried out using Toyota Business Practices (TBP) approach. Toyota Business Practices is a method for applying kaizen in daily work. This study aims to reduce the number of defect using Toyota Business Practices. By applying Toyota Business Practices, the results of the improvement made were obtained improving the position of shutter table, installing slipper stand, and improving the design of slipper stopper. With these improvements, the average dent defect per unit reduced by 4.35 %. Furthermore, it will get the new standard to ensure the quality of product in the future.

1. Introduction
Many manufacturing and some service businesses today are using lean management principles and practices as means to improve business processes, which in turn improves productivity and competitiveness including quality, and delivers greater value to end-use customers [1]-[5]. Several studies have exhibited that companies could dramatically improve their performance by embracing the lean production approach [6], and preferred to many other conventional production models, including the mass production model, because of its ability to produce high-quality and diverse products to meet the needs of various customers [7]. Therefore, with the aim satisfy their customers, companies have to pursue their quality in products.

As in most countries within the region, the automotive industry was identified as a target for government support at an early stage of Indonesia’s industrialization [8]. Total installed capacity of car production in Indonesia has increased to 2,208,131 units per year in 2017 [9], and car sales from the factory reached 553,757 units in January-June 2018, the value increased by 20,251 units compared to the period January-June 2017 [10]. The increasing pressure and demands from the stakeholders are the reason leads towards the continuous quality improvement of the management system to become more flexible, effective, and competitive in the industry [11]. The continuous quality improvement is the key to long-term success and high performance of the organization [12]. Therefore, it is very important for the car manufacturing industry to achieve zero defects with continuous improvement (Kaizen). Kaizen was introduced by Imai Masaki in 1986 and used by Toyota to improve their performance for waste reduction as a form of implementing lean manufacturing. It has become one of
the important tools for getting improvement in any field i.e. production, process, quality, and maintenance in the manufacturing industry [13], [14].

A case study was conducted in engine production plant of “Company X” in Indonesia. Company X is a car automotive company which is engaged as a manufacturer and exporter of vehicles and parts. Zero defect is a matter that is highly prioritized by Company X in carrying out its production process. The good quality of the product can be achieved by practicing zero defects [15]. However, based on data of Defect per Unit (DpU) on November 2018-January 2019, the average defect per unit for cylinder head part is 7.33 %. The data shows that the production quality of Company X for cylinder head part is still very far from the target of 0.05 % (zero defect). Defect occurs on exhaust manifold has 6.74 % and intake manifold has 0.59 %. Defect that occurs in the cylinder head part is dent. Dent is a condition where the body is dented a certain point. In addition to having an effect on product aesthetics, large quantities of dent can affect production efficiency because it can cause high cycle time for rework. Rework is making corrections or scrapping work that has already been done before it will be sent to customer [15]. Those aforementioned problems have motivated us to develop suitable strategies for the purpose of reduce the number of defects per unit for cylinder head part in Company X.

In this research, we attempted to apply TBP to improve product quality in one of manufacturing company. Productivity and quality improvement are combined purposely to gain a competitive advantage for most manufacturing industries management [15]. An increase in quality does not only reduce cost, but also improves productivity by eliminating any rework and unnecessary inspections [16]. Toyota Business Practices (TBP) is a method to clearly apply kaizen in daily work developed by Toyota. We use TBP because it is the systematic pattern of work processes that integrates the wisdom of all members in pursuing continuous growth and satisfaction carried out continuously in eight steps and can be applied in various fields. Several studies confirmed that TBP can help businesses to achieve best results from existing problems [17], [18]. The direct contribution from this research are categorized into two categories, namely practical contribution and theoretical contribution. The practical contribution is the way improvements are made to reduce dent defect per unit for the Company X and can be emulated by other companies, and the theoretical contribution is the results of improvements made in the form of a reduction in the number of dent defect per unit as a further policy consideration for Company X to create the best quality products that are sustainable for the company. We provide the novelty of this research in the form of improvements made to reduce dent defects per unit. The repairs follow Karakuri Kaizen where the repairs do not use energy or large resources but instead use gravity, lever and cam utility, as well as inertia to move and transfer goods.

The rest of this paper is organized as follows. The second section contains the design of the research carried out to achieve the research objectives. The third section then demonstrates the case study result of applying Toyota Business Practices. Conclusion are finally drawn in the last section.

2. Research Design

2.1. Research Methodology

The objective of this research is to reduce the number of defects per unit for cylinder head part. The object of the research is engine production plant of Company X, a car automotive company which is engaged as a manufacturer and exporter of vehicles and parts which is located in Jakarta, Indonesia. The study was conducted during the period January 2019-April 2019. Data collection was carried out through interviews, observation in the field, and using secondary data obtained from the company. Secondary data collected is data of defect per unit, and production output for cylinder head part at engine production plant.

2.2. Toyota Business Practices

Toyota Business Practices (TBP) broadly applies the problem-solving philosophy to the entire enterprise [19]. In this study, data has been collected will be processed to help obtain information that
is useful in solving problem. Data of defect per unit, and production output for cylinder head part were processed so that problems can be clarified by describing current condition. It aims to make the problem clearer. At this stage the problem is described in the form of a gap between the current situation and the ideal situation which is the final destination. The second stage is breakdown the problem. It was used to see the problem become smaller so that the focus of research can be done to solve the problem that still has a major impact on the quality of the cylinder head part. The third stage is set a target as a goal achieved from solving the problem. Set a target was carried out to show the current condition with the ideal condition that were targeted at that time. The fourth stage is analyze the root cause. The results of observation are written in notes and investigated by asking directly to people who understand better or directly related to the object of observation. Root cause analysis is carried out on all aspects, i.e. man, machine, method, material, and environment. Root cause analysis aims to find the source of the problem that is dent defect on the exhaust manifold. The fifth stage is develop countermeasures as a form of planning to overcome the problems. The sixth stage is see countermeasures through as a form of the implementation of countermeasures according to the plan that has been carried out in the fifth stage. The seventh stage is monitor both results and processes. At this stage, total results achieved and the effect of activities in solving the problem are seen. The activities carried out when evaluating results and processes, i.e. : (1) check results using the same measuring instrument (tool, unit, time period, etc); (2) evaluation of side effects that are not expected either in the form of quality, cost, delivery, safety, etc; (3) summarize the benefits of improvement; (4) if the handling results are not satisfactory, check the work plan again (stage 5). The run chart can be used at the evaluation stage to be able to see more clearly the movement of defect number after repairs were made. The last stage is standardize successful processess. If the evaluation results show that the plan is achieved, then standardization of the system is made so that they can be permanently resumed in the production process, vice versa. In conducting standardization, there are three processes that need to be done, i.e. : (1) making new standards (standardization); (2) sharing new standards (yokoten); (3) starting next kaizen (improvement).

3. Case Study Result

3.1 Clarify The Problem
In accordance with Figure 1, there is a gap of 3.06 % between the target and the actual condition.

3.2 Breakdown The Problem
To get a deeper understanding, the problem is broken down by dividing dent defect according to the area as shown in Figure 2. Due to greater dent defect occuring on the exhaust manifold, repairs focused on the exhaust manifold area.
3.3 Set a Target
The next step is set a target to be achieved through the improvement that will be made. The target of reduce dent defect per unit to be achieved is 4.27% until the end of March 2019.

3.4 Analyze the Root Cause
The next planning stage is to find the root cause of the problem through root cause analysis and get the results as shown in Figure 3. There are three root problems found are as follows: (1) The distance of the

![Figure 3. Root Cause Analysis](image-url)

Figure 2. Breakdown the Problem

![Figure 2](image-url)
machine table with the shutter table is too far away. Shutter table is a table that is used as a cylinder head pedestal before entering the machine. The condition of the table is too far away from the machining table, causing collisions during loading and unloading. The loading activity is when the cylinder head is inserted into the machine for the machining process, while the unloading activity is when the cylinder head is pulled out of the machine to enter the next machining process; (2) The tip of datum slipper is not centered against the datum hole. Slipper is a tool or jig that is installed on the exhaust manifold which functions as a stand for the cylinder head or the base of the cylinder head during the machining process. However, the installation of the slipper so far is not right on the datum exhaust manifold hole, so that the movement of the cylinder head during the machining process causes dent between the slipper and the exhaust manifold; (3) Kiriko (cut glass) attaches to the slipper stopper. The current slipper can make the cylinder head move when the slipper is installed, so that kiriko can stick to the exhaust manifold area. Kiriko which sticks long during the machining process can leave marks on the exhaust manifold body. This can happen, because according to the slipper function that is as the base of the cylinder head so that it does not directly come into contact with the machine part during the postal displacement does not work perfectly.

3.5 Develop Countermeasures
After finding the root cause of quality problems that occur, the next step is to plan improvement as shown in Table 1.

| Problem                  | Root Cause                                                                 | Temporary Countermeasures          | Fixed Countermeasures               |
|--------------------------|---------------------------------------------------------------------------|------------------------------------|------------------------------------|
| Dent on Exhaust Manifold | The distance of the machine table with the shutter table is too far away   | Improve the position of shutter table | Improve machine management system   |
|                          | The tip of datum slipper is not centered against the datum hole            | Install slipper stand               | Install slipper stand at each post that needed it |
|                          | Kiriko attaches to the slipper stopper                                   | Improve the design of slipper stopper | Improve the effectiveness of kiriko cleansing |

3.6 See Countermeasures Through
Improving efforts are carried out according to the plans that have been made as follows:
1. Improve the position of shutter table
The design between the machine table and the shutter table is 45 cm. This distance is shortened by 20 cm to 25 cm. With a distance of 25 cm, the cylinder head’s range of motion is smaller and the possibility of impact can be minimized as shown in Figure 4.

Figure 4. Improve the Position of Shutter Table
2. Install stand slipper
The installation of the slipper stand is carried out in the last machining process before final inspection is carried out. The slipper stand is installed with a size of 78.5 cm x 9.5 cm x 1 cm. With a height has 1 cm at slipper stand, it can help operators to position the slipper more precisely to the datum hole, so the dent between slipper and the body of exhaust manifold can be minimized as shown in Figure 5.

![Figure 5. Install Stand Slipper](image)

3. Improve the design of slipper stopper
The current slipper is undergoing design changes because the old design can still make the cylinder head move when the slipper is installed so that kiriko can stick on exhaust manifold. The slipper is redesigned by creating a multilevel design on the slipper face stopper and installing additional datum as a “dead point” and clamping when the slipper is installed. This addition can support the cylinder head more strongly and make kiriko not in direct contact with the body of exhaust manifold as shown in Figure 6.

![Figure 6. Improve the Design of Slipper Stopper](image)

3.7 Monitor Both Results and Processes
After improvement efforts, an evaluation is carried out by looking at the target using the run chart as shown in Figure 7. Before repairs are carried out, the average dent defect per unit on exhaust manifold is 6.74% and after repairing the average dent defect per unit the exhaust manifold reduced by 4.35% to 2.39%.
3.8 **Standardize Successful Processes**

Based on the results of the evaluation that has been carried out, standardization of the repair process has been established so that the engine production plant can proceed properly. Improvements set to standard are as follows: (1) Change the position of the shutter table and machine table. Standardization takes the form of rules for the work elements of the machining process; (2) Installation of stand slipper. Standardization is in the form of rules on the work elements of the slipper installation process, because with the addition of a tool that is a stand slipper, the working elements that have been used in this post have changed; (3) Improve slipper stopper design. Standardization in the form of making basic rules or rules that must be considered in the process of moving the cylinder head using a slipper to effectively reduce kiriko attached on cylinder head.

4. **Conclusion**

The study employed TBP to reduce the number of dent defects per unit for cylinder head part. A case study has been performed in Company X, located in Indonesia. By improving the position of shutter table, installing slipper stand, and improving the design of slipper stopper; the average dent defect per unit on exhaust manifold reduced by 4.35 % to 2.39 %. The study also creates new standards to maintain product quality sustainability. The method that has been performed can be beneficial for directors of the company to solve existing problems. Through such method, we can use the results as a reference in the improvement of manufacturing company in the future.

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