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TOTAL QUALITY MANAGEMENT ANALYSIS IN PRINTING INDUSTRY

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ABSTRACT

Manufacturing industry nowadays operates on certain basis to ensure products produced are good in quality and quantity. In this research, the problems faced by the printing company are identified and the data collected from the company is analyzed by using statistical process control approach. The accepted range of product quality is calculated. By using the house of quality, it is also found that there are few design characteristics of the products need to be modified. The organization is suggested to implement Total Quality Management (TQM) in order to improve the quality of the products and hence improve the performance of the company.

Keywords: TQM, Lean

INTRODUCTION

The company involved in this study is ABC Sdn Bhd which is a small and medium enterprise (SMEs) in printing industry found in year 2002. The products of the company are a wide variety of labels and stickers. ABC is equipped with high-tech machines which allow the company to commit in providing high quality products to the extensive labeling requirement from the clients.

There are few problems faced by ABC in their production floor. The working environment in the factory area is untidy where the used tools and materials are scattered all around the production area and not properly stored. This causes the delay on identification and placement of tools used. Wastes caused by overproduction and defects are another problem faced by the company which shows that the production flow is not well organized.

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It is also found that there is only limited space in the company where the layout of the machines is not in ordered manner. The disorder layout has caused the discontinuous flow of production. On top of that, most of the employees in this company have insufficient experience and knowledge to operate the machines. They are not able to troubleshoot the causes that contribute to the faults of the machines.

The company's production flow and customer's satisfaction level were identified in this research. We aim to solve the problems of the negative feedbacks from the customers by conducting the house of quality. The scopes of this study focus on the tidiness and cleanliness of the company, especially on the machine internally or externally and the working area of the production floor. Also, this study will focus on the improvement of the products quality.

In this research, the main objective was to identify the company's production flow and customers' satisfaction level. A further objective was to solve the customer problem by conducting the House of Quality. The research will focus on the tidiness and cleanliness of the company and aim to improve the quality of the products produced. We will analyze the products that do not meet the requirement to determine whether the production process is in control. As a summary, the objectives of this research are to identify the causes of poor quality product produced in the factory and solve the problems by implementing 5S and Kanban tools in the production floor. Also, to improve the products quality by using the house of quality.

Total Quality Management (TQM) is an integrated philosophy for managing an organization to achieve continuous improvement on the quality of products and services (Ross, 1993). The working of various methods of TQM can be found in Kanji & Asher (1996) and Mann & Kehoe(1994). Since the introduction of TQM in the early of 20th century, many large corporations have practiced the principles of TQM. However, much of the researches and advancements of TQM focus on large businesses, relatively few has been done on SMEs. TQM stresses on continuous improvement by all the employees in an organization. In addition, it is a principle that can help the business process of an organization which it involves mutual cooperation of everyone and all the stakeholder and shareholder of an organization (Dale et al, 1994).

Kanban is a Japanese word where "Kan" means visual and "ban" means board. Composition of the two Japanese characters represents signboard or bill board. Kanban is a technique used to control the logistical process. It facilitates just-in-time (JIT) delivery and maintains high production level. Kanban is known as a "pull" system, where the quantity of the products is based on the actual demand rate.

Quality Function Deployment (QFD) is a system used for planning and designing a product based on customer's demand (Maddux et al., 1991). QFD was first implemented in Japan in 1972, in which the design of an oil tanker by Mitsubishi Heavy Industries Kobe Shipyard was recognized as a milestone for QFD to be adopted by other Japanese companies. It was then developed to become a comprehensive quality design system for both product and business processes. An overall description of QFD can be found in Day (1993) and Cohen (1995).

A study is carried out for ABC Company by using the abovementioned three concepts (TQM, Kanban and QFD) of lean manufacturing. The environment of the company is observed upon factory visit. 5S is implemented by carrying out some simple moves such as cleaning, sorting, maintaining and sustaining. 5S is described as a simple housekeeping tool in Japan and it is very useful because of its simplicity to implement. By using the Kanban system,a signboard is designed. The signboard includes details such as top priority job, job in progress, job to be verified, job that is done and in production. Employees should refer to this signboard for the works in progress (WIP) and works to be verified.

RESULT AND DISCUSSION

Figure 1 shows the fishbone diagram for the causes of lack of quality products. The causes are categorized as 6M's in the manufacturing industries: Manpower, Methods, Machines, Management, Materials and Milieu/ Mother Nature (Environment). With less than 50 employees in ABC Company, there is insufficient manpower to produce all the products ordered by the customers. However, the main cause for poor quality products is due to the method used for printing. The employees print the labels while they are setting the alignment to match with customer's requirement. Thus, the labels that are out of alignment will be treated as wastes and are thrown away. Another factor that affects the quality of the products is that the breakdowns of the machines are not properly filed out. Materials and ink used in printing also contribute to producing poor quality products. If the materials of labels do not absorb the ink easily, the pattern or picture of the labels will become unclear. Also, if the ink used to print onto the labels requires long time to dry, it will affect the quality of the labels too. On the other hand, in order to improve the quality of the products, the management should implement lean manufacturing into the organization. Lastly but not least, the company needs to provide a safe and clean environment for the worker to perform their work efficiently and effectively. The workplace in ABC Company is messy, untidy and having limited workspace.

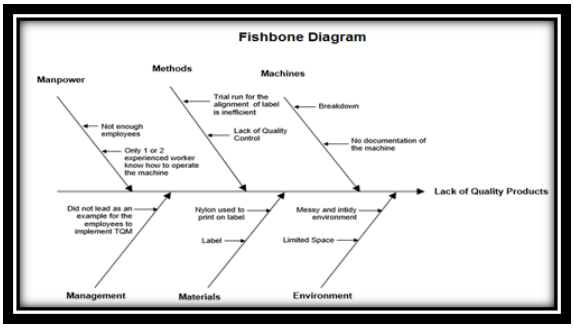

Fig.1. Fishbone diagram

Of all the causes identified, some of the problems can be solved by implementing lean manufacturing tools. It is suggested that the manager to implement 5S to make the workplace more tidy and clean. Furthermore, it is suggested that the workers fill out the reports for the machines used so that the repair and service can be scheduled properly. Most importantly, the researcher suggested to implements TQM to the management in order to increase and improve continuously the overall performance of the company. Hence, the customer's requirement can always be fulfilled and possibly exceed the expectation.

HOUSE OF QUALITY

The first section of the house of quality is the customer requirement. A survey is conducted among the customers to investigate their needs and requirements for the labels. Each question has a rating scale of 1–10, where 1 is "not at all important" and 10 is "very important". From the survey, it is found that the most important feature required by the customers is that the labels can be easily stick on the surface and the labels can be easily removed from the surface is the least important feature.

The second section of the house of quality is competitive assessment. In this section, the quality of the labels produced by ABC Company is compared to two of its competitors. Due to confidentiality, the two competitors are renamed as company A and B, while company ABC as company X in Figure 2. By comparing the labels from the three companies, the customers are required to rate the features of the labels. Each question has a rating scale of 1–5, where 5 is "the best". It is found that the product of ABC Company has the highest readability and the price is cheaper compared to the other two companies. However, the labels produced by ABC Company are harder to stick onto and to remove from the surface.

Figure 2 shows the first and second sections of the House of Quality.

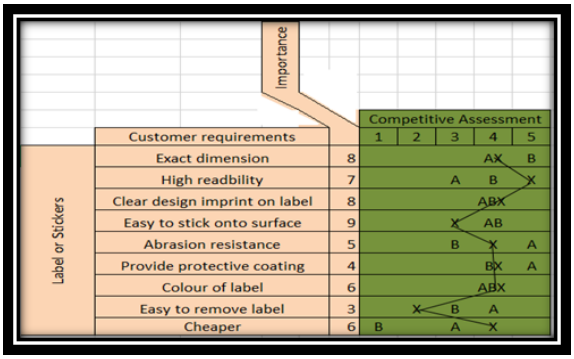

Fig.2. Customer Requirements and Competitive Assessment

The third section of house of quality is design characteristics in which the customer requirements are being translated into the consideration of design so that the products produced meet the customer requirements. The design characteristics and the customer requirements are shown in the relationship matrix in Figure 3, where relationship matrix is the fourth section of house of quality. If the relationship between customer requirements and design characteristics are positively related, a "+" symbol is plotted and "–" otherwise. If the customer requirement is strongly related to design requirement, the plus symbol will be circled and same case applied to strongly unrelated. From the relationship matrix, it is found that the label materials and the ultra-violet curing are the two factors that strongly related to customer requirements. The drying time of the ink is considerably slower for some of the materials. At the end of production line, if the inks have not completely dried, the operator may accidentally smear the paper or rub off the ink which may affect the final appearance of the design. Besides, the ultra-violet radiation curing is another important factor as it enables the ink to dry faster. The ultra-violet radiates the ink such that the ink undergoes some chemical reaction to dry faster and penetrate into the materials. The ultra-violet radiation also provides a protection layer on top of the surface of the label to protect the label from abrasion and chemical reaction.

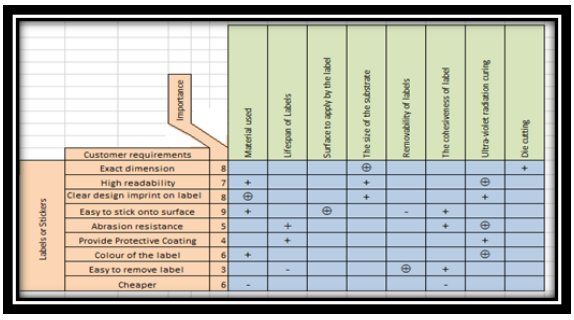

Fig.3. Design Characteristics and Relationship Matrix

Among the design characteristics of the products, some of them are interrelated. This is the fifth section of the house of quality where the roof of the house is formed. Cohesiveness is the internal strength of a label. When the cohesive strength is higher than the adhesion, the label will not be easily ripped into pieces when being removed. Thus, if the cohesive strength of the label is high, the label can be removed and stick onto a new surface provided at the adhesion of the label is strong enough. Hence, from the results obtained, it is found that the increase of the cohesive strength of the labels will greatly increase the lifespan of the labels. This shows that the cohesiveness and lifespan of the labels are positively related. However, the removability of the labels is negatively related to the lifespan of the labels. The roof of the house is shown in Figure 4.

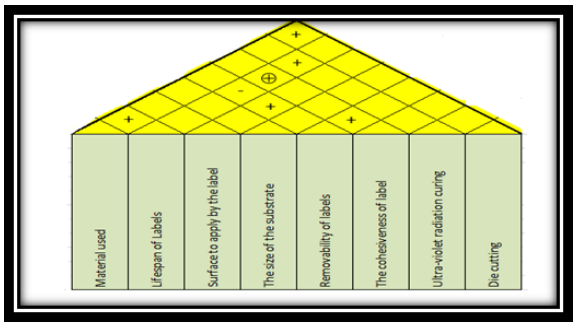

Fig.4. Trade-Off Matrix

The last section of the house of quality is the target value. In this section, the measurement of ABC Company products is carried out to the design characteristics. Benchmarking is used in this section by comparing the products with its competitors, company A and B. To decide which design characteristics need to be modified and revised, the estimated cost is compared with the estimated impact of the design characteristics. The estimated cost and estimated impact have a rating of 1–5, with 5 being "the most". If the rate of the estimated impact is lower than or same as the estimated cost, no change or modification is needed. On the other hand, if the rate of the estimated impact is higher than the estimated cost, the design characteristics of the products need to be changed or modified. The asterisk "*" sign indicate that the design characteristics have to be modified. Thus, the materials, lifespan of labels, removability of labels and cohesiveness of labels have to be improved for ABC Company products.

Figure 5 shows the targeted measure and changes in design characteristics for ABC Company.

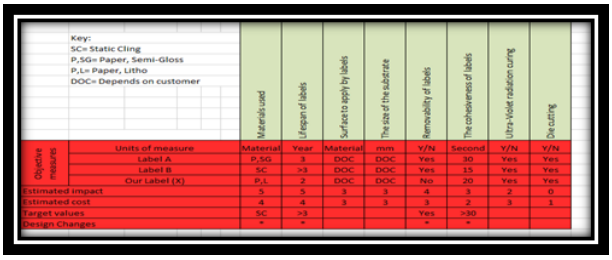

Fig.5. Targeted Measure and Changes in Design Characteristics for ABC Company

The label materials used by ABC Company is paper, litho. This material is uncoated white paper stock. Meanwhile, the materials used by company A and B are paper, semi-gloss and static cling, respectively. The uncoated paper is less protective compared to the materials used by company A and B. The lifespan of the products produced by ABC Company is only two years, which is shorter compared to company A and B. Also, the labels produced by ABC Company will split into pieces when being removed from the surface. This shows that the cohesive strength of the label is weak. Hence, the cohesiveness of the label needed to be improved.

Figure 6 shows the overall house of quality for ABC Company by combining all the six sections.

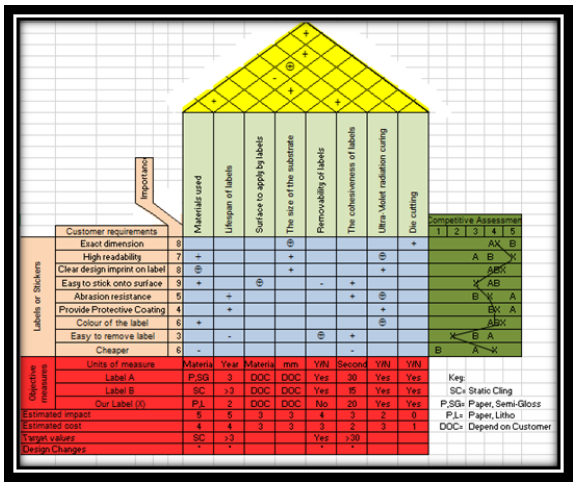

Fig.6. Overall House of Quality for ABC Company

Statistical Process Control

We use the control chart (Shewhart chart) in the Statistical Process Control (SPC) to maintain and control the production process. If the observed point is within the range of upper and lower limit, it indicates that the process is in control and no action is needed. Otherwise,

investigation is carried out to identify the causes of the problem and corrective measures is applied to rectify the problem. In this research, P-chart is used to monitor the proportion of defective units. With 20 samples in each observation, we inspected 10 observations with 1 minute time interval between each observation.

By using the following formulas, the total average proportion of defective items ( ), upper control limit (UCL) and lower control limit (LCL) are calculated.

$$\bar{p} = \frac{\text{Total number of defective items}}{\text{Total sample} \times \text{Sample size}} \quad (1)$$

$$\text{Upper Control Limit (UCL)} = \bar{p} + z\sigma_p \quad (2)$$

$$\text{Lower Control Limit (UCL)} = \bar{p} - z\sigma_p \quad (3)$$

where

z = number of standard deviation from the average.

$\bar{p}$ = average proportion of defective items, central line on the chart

$\sigma_p = \sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$, standard deviation and n = sample size.

Table 1 shows the values calculated using formulas (1), (2) and (3). The control chart is then plotted and shown in Figure7.

Table 1. Number of defective items in each observation (each observation has 20 samples) and proportion of defective items in each observation

Observation	Number of Defective Items	Proportion of Defective Items
1	3	0.150
2	0	0
3	1	0.050
4	1	0.050
5	0	0
6	2	0.100
7	0	0

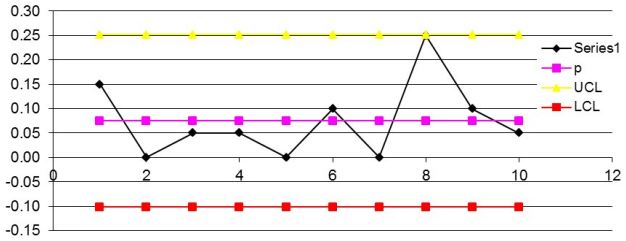

Fig.7. Control Chart for the Process of Particular Machine for ABC Company

Based on the calculations, the total average number of defective items is 0.075. The UCL and LCL of this process are 0.252 and –0.102, respectively. The graph is plotted by using the value of proportional defectives. Figure 7shows that all the points are within the range of UCL and LCL. This indicates that the process is in control. Although no modifications and changes are required, the management still needs to improve consistently to meet the customer satisfaction and possibly exceed their expectation.

CONCLUSIONS

In this research, the Statistical Process Control, House of Quality, and some of the lean manufacturing tools such as Kanban and TQM have been studied and applied in the printing company. It is suggested that the company to implement TQM. The Systematic Preventative Maintenance is an essential step to prevent the machines from breaking down. This can increase the productivity process and improve the quality of the products.

It is also suggested that the company to add quality control station at the end of all the production lines. Early detection of defective labels can reduce wastes. A final quality control station should also be set up where products are randomly chosen and inspected to check if there is any defective label. If all the randomly chosen products are in good condition and meet the requirements, the products are then ready to be delivered to customers. This will assure the quality of the products and increase customer satisfaction level.

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