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Quality Improvement Strategy to Defect Reduction with Seven Tools Method: Case in Food Field Company in Indonesia

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Abstract: The purpose of this study is to analyze the factors that cause defect in production, ways to reduce the number of defects that occur in the manufacture of the product and to determine the best solution that can be recommended to reduce production defects causes. The methods used in this research are literature study, observation, interview and documentation to collect primary and secondary data along with 7 tools of quality method for data processing, analysis and finding solutions. The result by using 7 tools of quality method finds that there are 6 types of production defects in the company in which 3 of them have high frequency of defect. These defects are caused by several major factors which are machines, men, measurement and environment. In addition, the results also show that the company's production processes are outside the control limits. Therefore, the company is advised to take immediate quality control steps by monitoring the productivity of two main factors that cause defect which are machines and men. If this action goes well, the company can decrease the number of production defects that occur.

Key words: Strategy, quality, improvement, seven tools of total quality management, measurement

INTRODUCTION

Food Field Company in developing countries must significantly increase productivity to remain competitive, as competition in the globalization era is very tight. In the pursuit of strategy product quality improvement, companies are often faced with the challenge of assessing the feasibility of large quality improvement investments in economic terms. Quality improvement strategy is limited to tangible costs, such as rework and warranty ignoring significant costs effects on unit sales due to customer satisfaction (Schiffauerova and Thomson, 2006: Tatikonda and Tatikonda, 1996).

Economic growth in 2014 continues to increase, the implementation of multilateral free trade agreements ACFTA (ASEAN-China Free Trade Agreement) which may cause a threat to the local industry, the food industry fluctuating condition and the number of Indonesia's population which is >240 million people are also some backgrounds that encourage the company to conduct quality control actions to reduce the number of production defects and improve their product quality.

Empirical study in this research in a company has produced soft candy product, since 2006 which its distribution has covered all areas of Indonesia. Their biggest competitor is PT. Yupi Indo Jelly Gum which has been built and operated since 1900s. Yupi has become the confectionery market leader in Indonesia and Southeast Asia, since 1996 (http://www.yupindo.com/). Recently, the company experienced some problems, starting from October 2013, the company received complaints from the sales agents, wholesaler, retailer and reseller that the products they receiced have defect in a quite big number. In addition, the production which produces many defected products can hamper the company to produce qualified product for consumer. This will cause the company to lose the distributor and consumer's trust and interest of their product. Effective analysis of quality defects is vital to reach the proper conclusions concerning how to handle defects when they occur or how to prevent them from happening (Brussee, 2006). A trend in the literature on defect analysis is that the use of >1 approach is required to make the analysis most effective (Finlow-Bates *et al*., 2000).

These problems will be studied by using 7 tools of quality in which there are seven tools of them that can solve the problem of quality. They are flow chart, check sheet, histogram, scatter diagram, statistical process control, Pareto diagram and cause and effect diagram. Based on the previous studies by Shahm *et al*. (2010) they stated that by using the 7 basic tools of quality, 95% of quality problems can be solves.

Literature review: Quality traditionally has been viewed, as the goodness of the product or service (Heizer and Render, 2011), the degree to which the product or service meets the specifications (Brussee, 2006). A broader view

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of quality is emerging in worldwide manufacturing that encompasses both the degree of conformance to specifications and the degree to which specifications reflect customers true needs and desires (Gaspersz, 2012). To compete in international markets, quality must reflect the goodness of the product or service design as well as conformance to specifications (Gaspersz, 2007).

According to Mukhopadhyay (2005), product quality has some related aspects which are compliance with the specifications, reliability, proper operation at the first time (right first time, every time) and no error (zero defects). Besides, according to the previous research by Andrejiova and Kimakova (2012) quality is not only seen from consumer's perspective but also from producer, distributor and other parties perspective. Strategy to improvement quality is considered as an important tool to maintain consumer satisfaction and company's competitive advantage.

Seven basic Quality tools (QC7) include check sheet, histogram, Pareto chart, Cause and effect chart, graphical tools, scatter plot and control chart. Seven new quality tools (or the seven management tools; M7) as a strategy for improve the quality of production include affinity diagram, relation diagram, tree diagram, matrix diagram, matrix data analysis (prioritization matrices), Process Decision Program Chart (PDPC) and procedure diagram. By using a combination of tools and techniques, it is possible to highlight the improvement strategy areas that cause the most problems; give direction for areas to be prioritized; show relationships between variables; establish causes for failure, show distribution of data and determine whether the process is acting in a state of statistical control and highlight the effect of special causes of variation where present (Dale, 2003).

Seven basic tools and techniques as strategy for improve the quality is a designation given to a fixed set of graphical techniques identified as being most helpful in troubleshooting issues related to quality (Chiarini, 2011). They are called basic because they are suitable for people with little formal training in statistics and because they can be used to solve the vast majority of quality-related issues (Ishikawa, 1985). The basic tools make quality improvement and monitoring activities and giving feedback to quality improvement team much easier (Ahmed and Ahmad, 2011). So, the suitability of QC7 tools to aid and support problem solving is generally accepted. A set of effective approaches for decision makers is the seven new quality management tools and techniques which is proved as very useful. They are not new but in the last 20 years have grown in popularity in engineering and manufacturing applications (Fapohunda, 2012).

MATERIALS AND METHODS

This research is an exploratory and analytical study which aims to determine the causal factors that occur in an object of research. This study was also conducted to improve and enhance the conditions or the circumstances and also the system. This is a quantitative research that was conducted from February 2014 until June 2014. The data that have been conducted are primary and secondary data. The primary data was obtained from direct interviews conclusion and direct observation's results. The secondary data which is used in this research was obtained from the documentation process (which are company's production number data and defect number data) and literature study. Analysis data in this study using 7 tools of quality which is supported by Minitab Version 17, SPSS Version 16 and Ms. Excel 2007.

RESULTS AND DISCUSSION

The research was started by knowing the production process of the company, as seen in Fig. 1, production number data and defect number data from June 2013 to May 2014. The data processing was begun from flow chart, check sheet, histogram, scatter diagram, statistical process control, pareto diagram to cause and effect diagram.

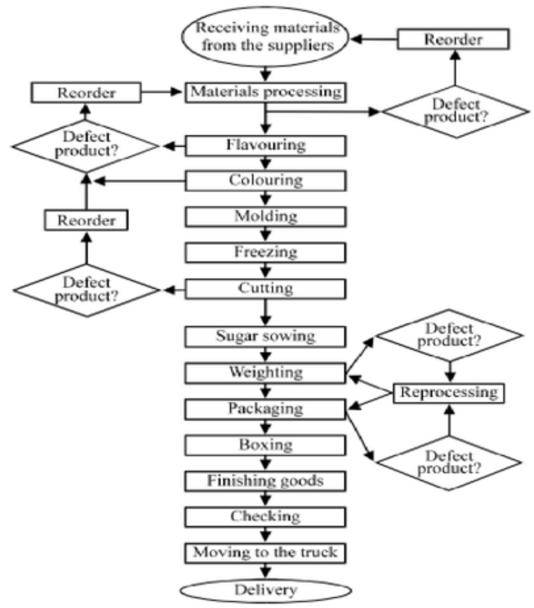

Fig. 1: Flow chart of production

Table 1: Defective item check sheet

	Defect types/event occurrence						
Months	Hard dough	Unequal flavor	Uneven colour	Wrong cut	Incorrect weight	Damaged packaging	Total
June	23	156	2,753	2,806	232	2,805	8,775
July	30	134	2,635	2,834	209	2,350	8,192
August	71	283	4,071	3,744	385	4,640	13,194
September	24	121	2,347	2,305	194	2,759	7,750
October	11	114	2,085	2,545	106	1,947	6,808
November	22	140	2,216	2,318	189	2,749	7,634
December	48	244	3,199	3,340	229	3,957	11,017
January	43	259	3,483	3,265	264	3,940	11,254
February	39	227	2,992	3,271	277	3,986	10,792
March	35	126	2,760	2,381	197	2,954	8,453
April	34	128	2,353	2,783	186	2,910	8,394
May	30	131	2,577	2,799	195	2,969	8,701
Total	410	2,063	33,471	34,391	2,663	37,966	110,964

Table 2: Checkup confirmation check sheet

Procedures	Implementation
Performing machine's testing	√
Performing machine's setting according to work order	×√
Always performing dummy production	×√
Submit a report to the manager before production process	√
Control the machine and the output during production process	×√
Determine the feasible of production according to work order	√

√ = Always; × = Never; ×√ = Sometimes

Check sheet: Two kinds of check sheet which are used is defective Item check sheet that is used to identify defect types that occurred in the production process, as seen in Table 1 and checkup confirmation check sheet, as seen in Table 2 that is used to determine and ensure that any existing procedures are implemented well. Here is a check sheet for the defect amount data collection.

From defective item check sheet June 2013 until May 2014 period earlier, it showed the total amount of six types of defect problems that has been found by flow chart and the total amount of defect in each month. The highest number of defect was in August 2013 (13,194 unit) and the lowest total number of defect was in October 2013 (6,808 unit).

Based on the check sheet earlier, it can be seen that there are procedures that have never been performed before by the operator marked with an × and procedures that are sometimes done by the operator marked with ×✓. In fact, these procedures must be implemented in order to perform qualified and controlled production process.

Histogram: Histogram is used to show coverage value of a calculation and the frequency of each value that appears. Here is the histogram for the 6 types of defects that occur in the company (Fig. 2).

Scatter diagram: The next tool in the seven tools of quality is scatter diagram. This tool is used to determine the relationship between two variables. In this research, two relations are observed which is the level of machine operator's attendance with the production productivity level, as seen in Fig. 3 and the relationship between the production productivity level with the defect level, as seen in Fig. 4.

From the scatter diagram above, it can be seen that the direction of mix diagram leads to the upper right which means there is a direct and positive relationship between the levels of machine operator's attendance level with the production productivity level. The positive relationship explains that if the attendance level increases, the company's productivity level will also increase. So, the high level of machine operator's absence can lead to production productivity decreases and can cause problems such as defects in the company's production.

Furthermore, after it is known that there is a positive relationship between the levels of machine operator"s attendance with the production productivity level, this research will continue to make a scatter diagram of the relationship between the production productivity levels with the defect level as seen in Fig. 4.

From the scatter diagram earlier, it can be seen that the direction of mix diagram leads to the upper right which means there is a direct and positive relationship between production productivity levels with the defect level. The positive relationship explains that if the amount of the company's production increases, the production will also increase its number of defect. This is a bad result, so the company has to find a solution, so that despite a high level of production productivity, the company will not increase the number of defects as well.

Statistical process control: Statistical Process Control (SPC) is one of the most important tools in this study. SPC is intended to control and identify a process that occurs beyond the control of the company, so that the production of all kinds of variation that occur can be

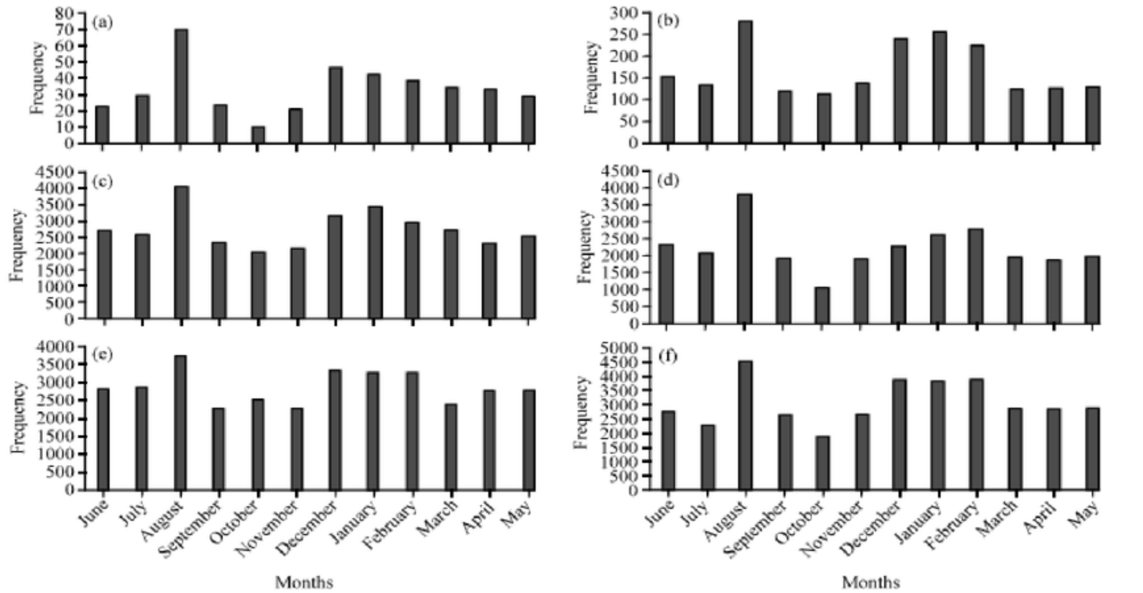

Fig. 2: Six types of defect histogram: a) hard dough histogram, b) unequal flavour histogram, c) uneven colour histogram, d) incorrect weight histogram, e) wrong cut histogram and f) damaged packaging histogram

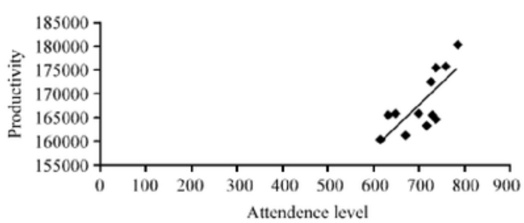

Fig. 3: Productivity scatter diagram

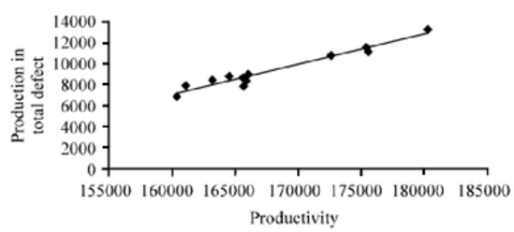

Fig. 4: Total defect scatter diagram

known and can be taken steps to resolve the problem quickly. Because of the production data that has been obtained were varied, the writer use the SPC calculation with diagram p and u. P diagram is used to evaluate the proportion of defects while u diagram is used to determine the average number of defects per unit produced by a process, as seen in Fig. 5. Here are the results of SPC data processing with Minitab Version 17.

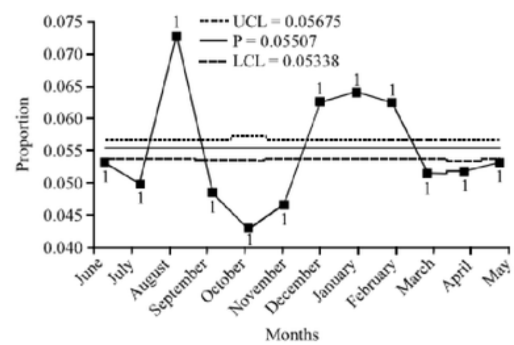

Fig. 5: P chart of total defect

Based on diagram p and diagram u earlier, it can be seen that during the 12 months of production from June 2013 to May 2014 all the production was all outside the control limits, so the company needs to conduct an improvement and further control toward the production process of the company. The control limits are the Upper Control Limit (UCL,) and Lower Control Limit (LCL,). On the diagrams earlier, the red box that is outside the top line (UCL) and the bottom line (LCL) showed that the production of that month is outside the control limits. If the production is in the control, it will be marked with a black box that was between the UCL and LCL/'s line, as seen in Fig. 6.

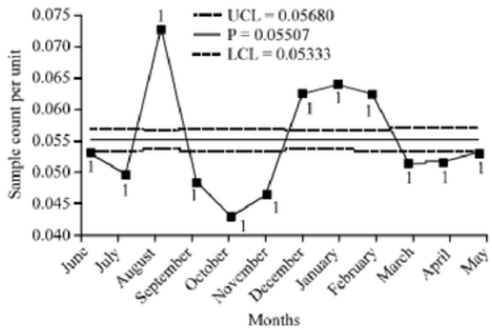

Fig. 6: U chart of total defect

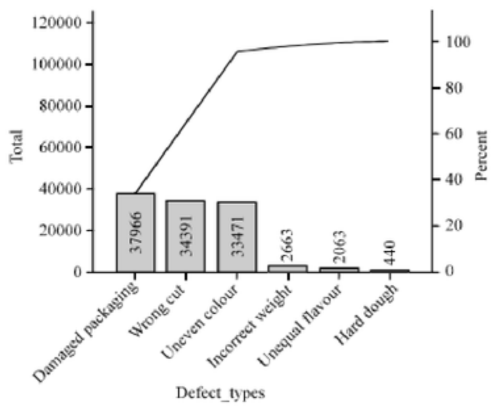

Fig. 7: Defect types pareto diagram

Pareto diagram: The next tool used in this research is pareto diagram. This diagram has a concept that 80% of the existing problems are caused by 20% causes. This diagram is used to organize the defects into an existing level, so that it's easier to focus on the major problems that exist. In other words, the purpose of using pareto diagram is to determine the 20% causes that occur and lead to the 80% of problems, as seen in Fig. 7.

From the pareto diagram earlier, it can be seen that there are three main problems that take the biggest role in the damage suffered by the company during June 2013 to May 2014 period. Those problems are damaged packaging (34.2%), wrong cut (31%) and uneven colour (30.2%). These three main problems will be prioritized to be solved 1st because they are the 20% production defect causes, so if these factors were gone, the 80% company's problems will be solved.

Cause and effect diagram (fishbone): The last tool used in this research is cause and effect diagram. Cause and effect diagram is used to determine the root causes of the

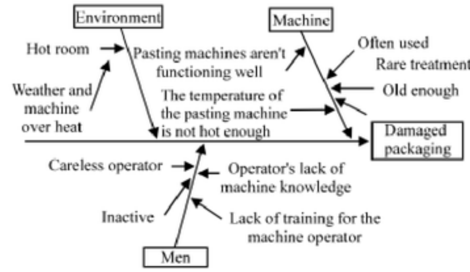

Fig. 8: Damages packaging cause and effect diagram

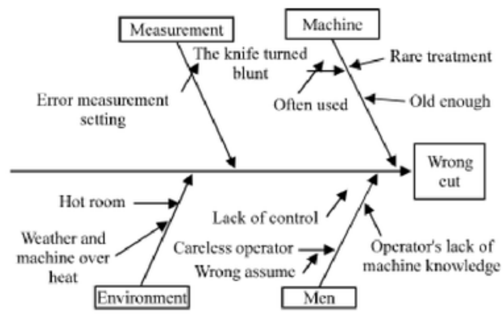

Fig. 9: Wrong cut cause and effect diagram

existing problems that have been found, especially the three major problems which have been found before with the help of pareto diagram. In the making of this diagram, there are six major categories (5M+1E) which are measurement, materials, men, methods, machines and environments.

But in reality, not all the major categories in the making of cause and effect diagram are used. The uses of these main categories are based on the actual situation on the field. Here is a diagram and its discussion for every problem that exists (Fig. 8).

Based on the analysis of the damaged packaging result with cause and effect diagram earlier, it can be seen that there are three categories of the defect causes which are machine, men and environment where machine is the most contributed category (Fig. 9).

Based on the analysis of the wrong cut result with cause and effect diagram earlier, it can be seen that there are four categories of the defect causes which are machine, men, measurement and environment where machine is the most contributed category.

Based on the analysis of the uneven colour result with cause and effect diagram earlier, it can be seen that there are four categories of the defect causes which are machine, men, measurement and environment where men are the most contributed category (Fig. 10).

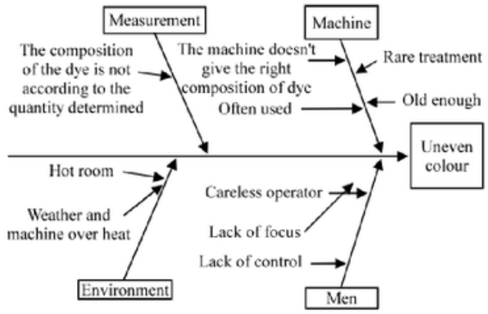

Fig. 10: Uneven colour cause and effect diagram

Overall, there are four production defect factors of the company which are men, machine, measurement and environment where machine and men are the biggest causes of defects that occur in the company. Therefore, company needs to take action to remedy the factors that cause defects by conducting control of the operator's performance, conducting repairmen for the machines that are not functioned optimally and performing regular maintenance for the machines.

CONCLUSION

Based on the result and discussion earlier using data that has been collected from direct observation of the production process, the company's documents from June 2013 to May 2014 period and some interviews with the company officials, there are some conclusions that can be drawn as follows. The factors that cause defects in candy production are machine, men, measurement and environment. The ways to reduce the number of defects that occur in the manufacture of product in order to improve the quality of the product are by conducting continuous improvements especially on the machine and men factors because all of the problems identified are mainly caused by these two factors. The best solution that can be recommended to company to reduce the cause of the production defects causes are to replace the damaged machines with the new ones, repair the machines that can still be used, conduct a performance monitoring system to the machine operators, impose a reward and punishment system, make written and strict rules, so the machine operators will always remember to do the machine settings before performing the production process and installing safe air-conditioning equipment in order to create a safe working place and conducive environment.

SUGGESTIONS

The suggestions that can be recommended for company and also to further research activities related to the improvement of production quality in order to reduce the production defects rate are: clear implementation of SOP, conducting a strict control system, conducting reward and punishment system, replace, repair and periodically conduct maintenance to the machines, installing safe air-conditioning equipment, producing written rules to always conduct a machine setting.

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