Research on Using Six Sigma Tool to Reduce the Core Process Time*

Yi-Chan Chung[1], Tieh-Min Yen[1], Yau-Wen Hsu[1], Chih-Hung Tsai[1†] and Ching-Piao Chen[1]

[1]Department of Industrial Engineering and Management
Ta-Hwa Institute of Technology
1 Ta-Hwa Road, Chung-Lin
Hsin-Chu, Taiwan, ROC
Tel: +886-3-5927700~2953
E-mail: ietch@thit.edu.tw

Abstract

When facing the global severe competition, the enterprises all try their best to upgrade the quality, reduce the costs to reach the goal of customer satisfaction. Motorola was the earliest firm creating the term Six Sigma (6 σ); GE was the enterprise successfully fulfilling Six Sigma. The success of these two firms revealed the prominent effects and became the world-class model enterprises. The main purpose of promoting Six Sigma activity was to reduce the possible defects in the business process to the least through designing and monitoring business process in order to reach the goals such as the best quality and efficiency, the lowest costs, the shortest circular process time, maximum profits and customer satisfaction. This research used the Six Sigma technique to improve the business process of ceramics manufacturing plant and find out the major factors of slower core task time by the analytical process of Process Mapping, Pareto Chart, Simul8 simulation software and figures and proposed the improvement measures. Through the confirmation of the case companies, it successfully reduced the core process time and the organizational costs and increased the capacity.

Key Words: Six Sigma, Core process time, Capacity

1. Introduction

With the advancement of technology and rise of quality consciousness, the customers have more requirements on the quality of the products and the life cycles of products become shorter. The development process of new products and the reduction of time to the market

† Corresponding Author

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are particularly important. Therefore, when facing the environmental pressure of severe competition, how to operate Six Sigma (6 σ) activities to rapidly develop the products meeting the customers' requirements and reduce the market time of products have become the key points emphasized by many corporate operational strategies. When operating the core process, the enterprises must consider several factors, such as process, duties, resources, facilities, control methods, time, employees, etc. Each factor of core process would affect the process. Therefore, successful change of factor performance would accelerate the process of the whole plan and avoid the defect costs of long and incomplete business process and the low customer service standard caused by the insufficient competitiveness. This research operated Six Sigma system tool and with regard to the business process of ceramics manufacturing plant, it found out the major factors of slower core task time by the analytical process and figures of Process Mapping, Pareto Chart and Simul8 simulation software and proposed the improvement measures. The research purposes were to help the ceramics manufacturing plant reduce the process time and organizational costs and increase the capacity.

2. Literature Review

Eckes (2002) indicated that Six Sigma was a set of managerial philosophy. It aimed to improve customer satisfaction and reached higher level of customer satisfaction through the culture of process improvement. Mast (2003) thought that Six Sigma was a kind of basic customer-oriented method which meant to use quantitative methods and the priority for saving money to make the decisions. Blakeslee (1999) described the definition of Six Sigma from these three kinds of different views: statistics, corporate management and business process. Hahn *et al.* (1999) indicated that the quality concept of Six Sigma simply meant that with the quality level of Six Sigma, the defect or error would not be more than 3.4 ppm. Pande *et al.* (2000) defined Six Sigma through three dimensions: (1) statistical assessment upon process, service or product performance: treating Six Sigma as the first step of assessment standard. In other words, we should first confirm what the customers really expected (Critical to Quality, CTQ) and assess the process according to the customers' critical requirements; (2) nearly perfect performance indicator: Six Sigma was committed to reducing the possibility of error and treated the nearly perfect performance (only 3.4 times of error out of every million times of operation) as the target of the firms; (3) Performance management system of corporate sustainable operation: with the spirit of Six Sigma, quality was not examined, instead, it was designed and made. The real content purpose was to reach the goals of eliminating potential costs, creating the customers' value and increasing the corporate competitiveness through the improvement of Six Sigma and combing the strategies and principles of the firms.

Snee and Hoerl (2003) proposed that the executive steps for promoting Six Sigma included: (1) having Six Sigma project activities; (2) managing the results of Six Sigma project; (3) maintaining and assessing the effects of Six Sigma; (4) making Six Sigma into corporate culture. Lynch *et al.* (2003) pointed out that five steps for accomplishing Six Sigma were Define, Measure, Analyze, Improvement and Control. Slater (2000) reorganized executive steps of Six Sigma in GE as: (1) Measurement: measuring each operating step and process; (2) Analysis: analyzing each operating step and process; (3) Improvement: making effort to improve each operating step and process; (4) Control: once these operating steps and processes are improved, the strict control should be managed to maintain them. Mach and Guagueta (2001) proposed Six Sigma DMAIC problem-solving model practiced by the well-known firm Motorola: (1) Define: confirming the core process, customers' needs and setting up the goals; (2) Measure: confirming the problems and process, measuring critical steps and involvement; (3) Analyze: developing cause-and-effect assumption and confirming the sources of several critical questions and validating the hypotheses; (4) Improve: trying to eliminate eth problems, testing the solutions, standardizing the solutions and assessing the results; (5) Control: establishing the assessment standard to maintain the performance and modifying the problems if necessary. This research applied five executive steps of Six Sigma proposed by Lynch *et al.* (2003): Define, Measure, Analyze, Improve and Control to reduce the core process time of the ceramics firm.

3. Problem Description and Solving

The Saint Chinas Enterprise Co., Ltd. was established in Hsinchu City, Taiwan in April 1988. The major business items of the company were various artistic ceramics design, manufacturing, production and export. The R&D department drew and designed the new products according to the fashion and trend, involved foreign designers to develop fashionable goods and owned complete production line and techniques. Currently, the firm focuses on the development of ceramics articles in the bathroom. In recent years, because of the increase of orders and in order to reduce the core process time to increase the capacities and the overall competitiveness, Saint Chinas Enterprise Co., Ltd. intends to re-assess the process through Six Sigma system tool, Process Mapping, Pareto Chart and process simulation software Simul8 and re-plan the corporate core process and reduce the core process time.

The executive steps DMAIC of practicing Six Sigma technique included: (1) Define phase; (2) Measure phase; (3) Analyze phase; (4) Improve phase and (5) Control phase. This research applied DMAIC technique to reduce the core process time of the ceramics firm.

(1) Define phase: Process Mapping and the staff distribution of each work station was shown in Figure 1 and Figure 2. The time needed for the business in each work station before the improvement was shown in Table 1. In order to reduce the core proc-

ess time for upgrading the corporate operational performance, we must first find out the tasks influencing the core process. Through on-site interview and the results of figure analysis, this research found out that the major core processes influencing ceramics manufacturing time included bisque firing, glost firing and packaging.

(2) Measure phase: This research used Pareto Chart to find out the major reasons resulting in the slower work time of bisque firing, glost firing and packaging and further manage the improvement. According to Figure 3, as to the factors resulting in slower work time of bisque firing and glost firing, insufficient facilities referred to 47%; old facilities referred to 24%; bad moving line referred to 10%; unbalanced manpower was 10% and employees' neglect of SOP was 9%. The major factors affecting the work time of bisque firing, glost firing were old facilities and insufficient facilities; bisque firing, glost firing took plenty of time and there were only two old facilities which would lead to the slower future work speed in the work stations. According to Figure 4, we realized that the factors resulting in slower packaging business included unbalanced manpower distribution, incomplete examination of the previous work station, bad moving line, narrow work environment and overly complicated packaging process. Unbalanced manpower was 47% of the factors; incomplete examination of the previous work station was 24%; bad moving line was 10%; narrow work environment was 10%, overly complicated packaging process was 9%. The major reason affecting packaging time was unbalanced manpower distribution and incomplete examination of the previous work station, (the defect in the products will result in the delay of delivery examination).

(3) Analyze phase: According to Pareto Chart of Figure 3 and Figure 4, we realized that the major factors influencing bisque firing and glost firing task time were old and insufficient facilities; the major factors influencing packaging time was unbalanced manpower distribution and incomplete examination of the previous work station. Based on the simulation analysis of Simul8 software, we realized that (see Table 2) the manufacturing obstacles were at three work stations: bisque firing, glost firing and packaging. Through figure simulated analysis, the percentage of the manufacturing time of three work stations all reached over 90% and comparing with other work stations, the idle time percentage was the shortest. With regard to these three work stations (manufacturing obstacles), this research proposed the improvement measures to reduce the core process time. The improvement measures included: (1) strengthening the educational training, reducing the defect rate of each station, reducing repetitive works to reduce the task time; (2) as to bisque firing and glost firing tasks, we suggest the switch to two rotations to increase the use rate of the kiln in order to reduce the core process time; (3) reducing the unbalance tasks of the staff and deploying the examiners to support the packaging work station to reduce the core process time.

(4) Improve phase: After practicing the above improvement measures, this research acquired the task time of each work station after improvement as shown in Table 3. After improvement, the task idle time percentage of each work station after improvement was shown in Table 4. The total task time after improvement was reduced by 368 minutes. Under the condition in which the work staff was the same, the reduction of work time indirectly reduced the organizational costs and increased the capacity.

(5) Control phase: This research operated according to the improvement measures. Through the actual practice of the ceramics firm, core process time and organizational costs were reduced. In long term, DMAIC and PDCA techniques were needed to constantly improve the corporate process.

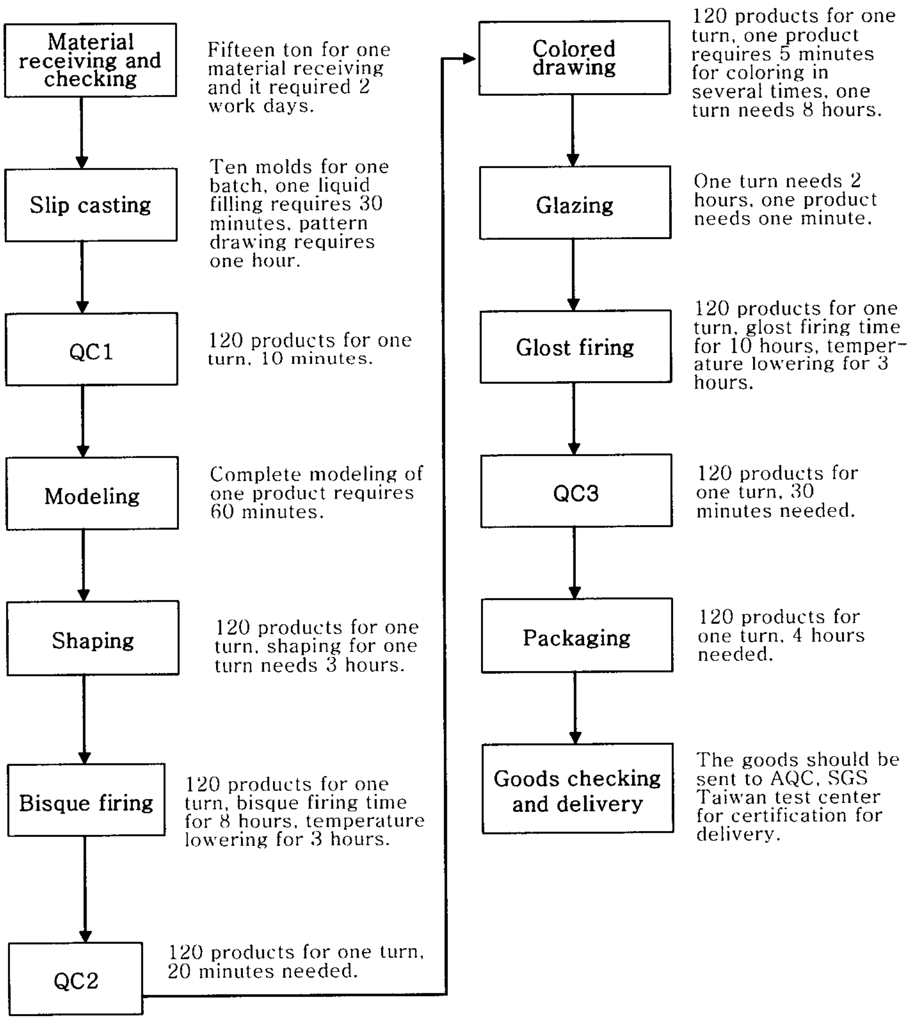

Figure 1. Process Mapping figure

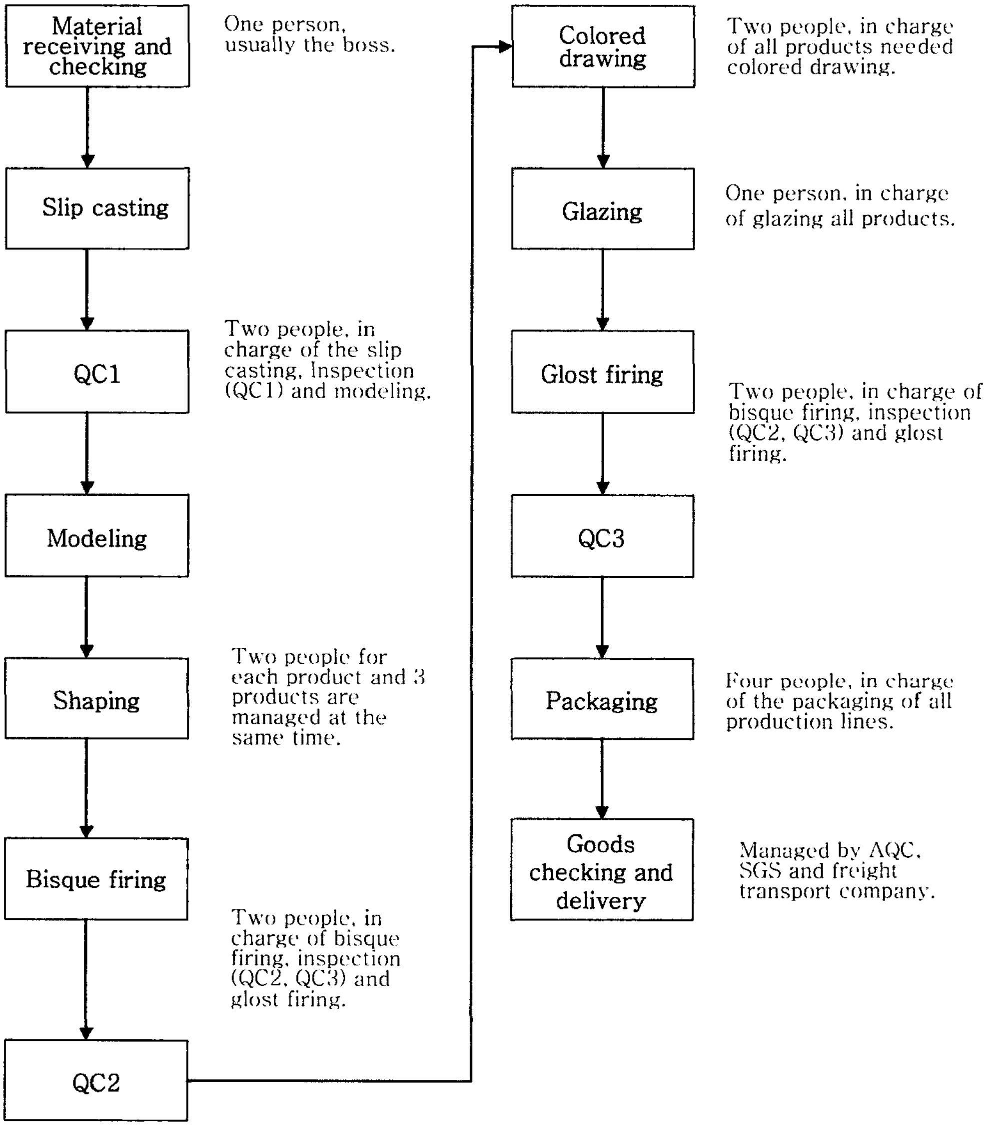

Figure 2. Worker distribution of each work station

Table 1. Each work station task time before improvement

Work stations	Slip casting	QC1	Molding	Shaping	Bisque firing	QC2	Colored drawing	Glazing	Glost firing	QC3	Packaging	Total
Task time (minute)	63	10	60	240	660	20	480	120	680	20	240	2,593

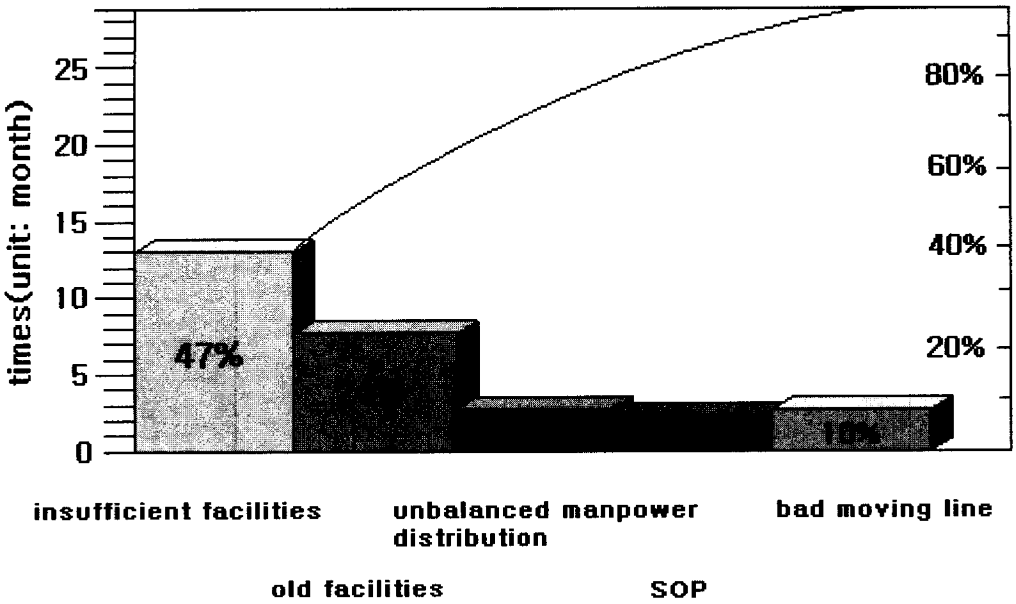

Figure 3. Pareto Chart of factors influencing bisque firing and glost firing task time

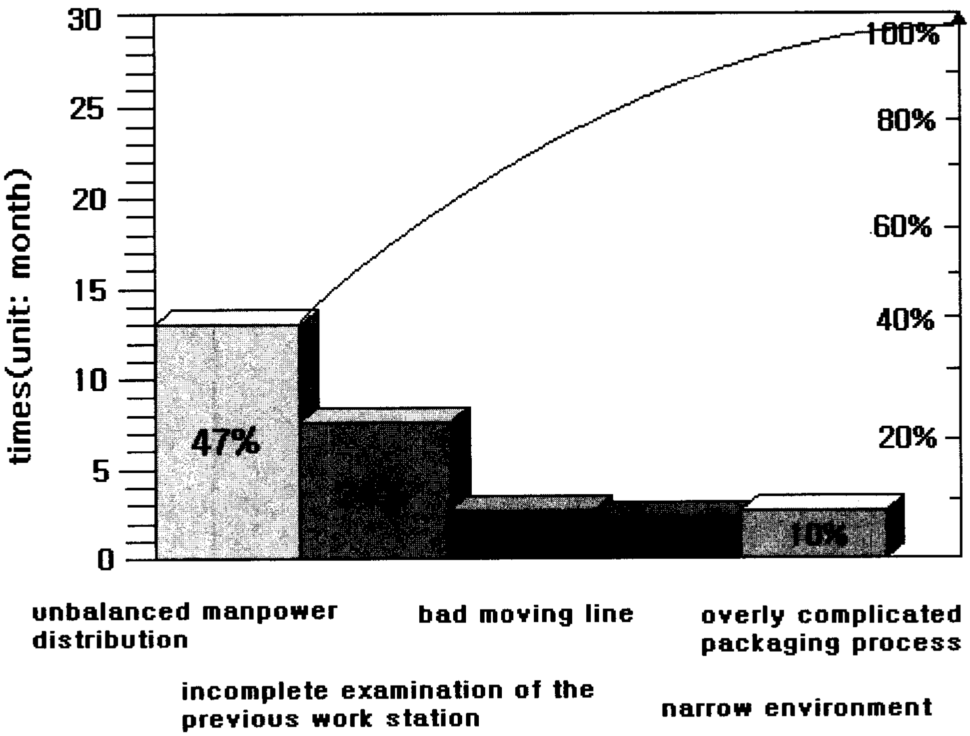

Figure 4. Pareto Chart of factors influencing the packaging task time

Table 2. Percentage of business idle time in each work station before improvement

Work station	Simulated work hours (hours)	Task time (%)	Idle time (%)
Slip casting	640	78.17	21.83
Molding	640	72.89	27.11
Shaping	640	75.42	24.58
Bisque firing	640	93.55	6.45
Colored drawing	640	73.91	22.09
Glazing	640	69.67	30.33
Glost firing	640	91.21	8.79
Packaging	640	92.05	7.95
QC1	640	69.37	20.63
QC2	640	67.87	22.13
QC3	640	70.12	29.88

Table 3. Task time of each work station after improvement

Work station	Slip casting	QC1	Molding	Shaping	Bisque firing	QC2	Colored drawing	Glazing	Glost firing	QC3	Packaging	Total
Task time (minutes)	61	10	58	235	540	18	470	115	520	18	180	2,225

Table 4. Percentage of business idle time in each work station after improvement

Work stations	Simulated work hours (hours)	Task time (%)	Idle time (%)
Slip casting	640	79.21	20.79
Molding	640	74.89	25.11
Shaping	640	75.12	24.88
Bisque firing	640	80.35	19.65
Colored drawing	640	74.57	25.43
Glazing	640	70.67	29.33
Glost firing	640	81.59	18.41
Packaging	640	85.12	14.88
QC1	640	71.42	28.58
QC2	640	72.22	27.78
QC3	640	70.12	29.88

4. Conclusions

This research applied Six Sigma system tool to the business process of ceramics manufacturing plant and found out the main factors of slower core task time through the analytical process of Process Mapping, Pareto Chart and Simul8 simulation software and figures and proposed three improvement suggestions to reduce the core process time. The improvement measures included: (1) strengthening the educational training, reducing the defect rate of each station and reducing repetitive tasks to reduce the business time; (2) as to bisque firing and glost firing, we suggest the switch to two rotations to increase the use rate of the kiln in order to reduce the core process time; (3) reducing the unbalance tasks of the staff and deploying the examiners to support the packaging work station to reduce the core process time. After this research practiced the improvement measures, the total task time was reduced by about 6 hours. Under the condition in which the work staff was the same, the core process time was successfully reduced, the capacity was increased and the costs were reduced.

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