

The Study of Process Improvement toward the Cycle Time of AR Activities by Six Sigma Management

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ABSTRACT

The application of the Six Sigma management approach has become widespread in Taiwan manufacturing industries in recent years. However, the majority of the Six Sigma application is locally focused on the improvement of the manufacturing spot inspections instead of the supportive improvement activities related to the field. Thus, the purpose of this paper is to demonstrate the continuous improvement for the supportive activity, the account receivable (AR) process, by adopting Six Sigma DMAIC (Define-Measure-Analyze-Improve-Control) approach in an equipment assembly company. First, in the definition phase, the process map of the account receivable activity is reviewed and then the project objective and defect-judgement standards are defined. Secondly, the measurement of the as-is process capability is conducted. Thirdly, the cause-effect diagram is investigated to reveal the major causes contributing to process deficiency. Furthermore, the brainstorming is conducted to decide the appropriate improvement strategy. Finally, the account receivable process is effectively improved by eliminating non value-added part in the activity. The results prove that the application of Six Sigma approach performs effectively in the improvement of supportive activities as well as the improvement of manufacturing spots.

Keywords : Six Sigma; process improvement; project effectiveness

INTRODUCTION

The Six Sigma approach has now been well recognized as an effective methodology of attaining excellence in the quality of products and services. It's a disciplined application of statistical problem-solving tools to identify and quantify waste and indicate steps for improvement (Greg, 2005). A successful Six Sigma strategy will move an organization toward zero defects (Mikel and Schroeder, 2000).

This article explains, in a management language, the rationale and mechanics of process improvement as seen in its deployment of Six Sigma toward the case study of account receivable activities analysis. Basically, the case study outlines the way which the *chosen industry gases* company has been utilizing the Six Sigma management for improving quality level, culminating process capability since it is crucial for the chemical industry to search for zero defects due to high safety requirements in the industry.

On the other hand, as the application of the Six Sigma management in Taiwan, the majority of research focuses on the process improvement of manufacturing spots, but fails to discuss the management performance of the Six Sigma approach from the viewpoint of supportive activities fields. Therefore, the purpose of this paper is to demonstrate the effective improvement for supportive activities, the account receivable process, by adopting the Six Sigma DMAIC approach in a representative industry gases company. The results demonstrate that the application of Six Sigma approach performs an effective progress on cost saving and process improvement in the supportive activities as well as those in the manufacturing spots.

The Six Sigma Management approach

The application of Six Sigma as a quality improvement initiative has been widespread, with an increasing amount of literature explaining its rationale, implementation, and impact on the quality profession (Harry, 1998; Hoerl, 1998; Hahn *et al*, 2000; Snee, 2000a; Snee, 2000b). As the pervasiveness of searching for excellence, a good appreciation of the methodologies deployed in the Six Sigma would contribute to the effectiveness of its application. In this section, a brief review is given to the major phases and tools used in Six Sigma, leading to an explanation of the practical management approach.

The Six Sigma strategy originated with Motorola and became popular by Jack Welch, former CEO of General Electric. The Six Sigma strategy focuses on the elimination of hidden costs generated as a result of producing defective products and services. These costs are often difficult to measure, but their elimination can add 30 to 40 percent to the companies' profits (Mikel and Schroeder 2000). These costs include poor training, rework time, process bottlenecks, litigation, lost credibility, prevention costs, customer dissatisfaction, delays, defective work, misused resources, communication problems; and costs prevalent when product/service quality does not match consumer expectations. The focus of Six Sigma is to create processes that only have random causes of variations present. An organization operating at six-sigma level can expect its products and services to attain no more than 3.4 defective parts per million. Achieving this level of quality output means reducing process variation through a technique called DMAIC - Define, Measure, Analyze, Improve, and Control. Generally, after the project Definition phase, key process characteristics are identified and benchmarked in the Measure and Analyze phases; this is followed by the Improve phase where a process is modified for better performance, and then the Control phase aims at monitoring and sustaining the gains. For showing the logic of the Six Sigma DMAIC model, the main activities and major tools are summarized In Table 1 based on the study of Goh (2002) and Greg (2005).

Table1. Summary of main activities and major tools in Six Sigma

Phases	main activities	Major tools
Define phase	<ol style="list-style-type: none"> 1. Identify the important problems in processes 2. Select a project to combat one or more problems and define the parameters of the project 3. Determine the vital few factors to be measured, analyzed, improved and controlled 	<ol style="list-style-type: none"> 1. Project selection 2. Impact and benefit analysis 3. Project road-mapping 4. Project Charter
Measure phase	<ol style="list-style-type: none"> 1. Select CTQ (critical-to-quality) characteristics for your product or process (the CTQ Y's, where Y=CTQ characteristic) 2. Define performance standards for Y 3. Validate the measurement system for Y 4. Establish the process capability of achieving Y. 	<ol style="list-style-type: none"> 1. CTQ identification 2. Quality function deployment 3. Failure mode and effects analysis 4. Target and specification formulation 5. Quality benchmarking 6. Descriptive statistics 7. Measurement system analysis
Analyze phase	<ol style="list-style-type: none"> 1. Define the improvement objectives for Y. 2. Identify the sources of variation in Y 3. Screen potential causes for change in Y and identify vital few initial X's (where X=key variable in the process) 	<ol style="list-style-type: none"> 1. Capability analysis 2. Hypothesis testing 3. Identification of causes of variation 4. Analysis of variance 5. Correlation analysis 6. Regression analysis
Improve phase	<ol style="list-style-type: none"> 1. Discover variable relationships among the vital few initial X's 2. Establish operating tolerances on the vital few initial X's 3. Validate the measurement system for the vital 	<ol style="list-style-type: none"> 1. Design of experiments framework 2. Factorial designs 3. Fractional factorials 4. Balanced block designs 5. Nested designs

	few initial X's	6. Mathematical modeling
Control phase	1. Determine your ability to control the vital few initial X's 2. Implement a process control system for the vital few initial X's	1. Control plans 2. Process monitoring and control 3. Mistake proofing 4. Quality system documentation

CASE STUDY

The specific case study in this research is a practical project involved in improving AR efficiency related with the equipment assembly supplied in a representative mechanic company. The me-tech company, A company, is a leading provider of equipment assembly business in Taiwan. For nearly five years, A company has provided efficient products to Taiwanese local company as well as foreign company. With the scale of over 400 employees in Taiwan, A company adopts a strategic plan “to make services quick and on time delivery for all customers.” In 2005, due to the hyper-competition in equipment assembly business, the top management of A company determined to further strengthen its competence of on time-based competition by utilizing the Six Sigma management approach. The account receivable process improvement project in this article was one part of a larger project the company targeted for cost savings by shortening the process cycle time. The representative activities of the Six Sigma application in this research are demonstrated as follows:

Phase 1-Define:

Step1: Project selection- according to the historical data of A company, it takes a much longer time to handle the account receivable process for some customers as compared to others who need additional time to prepare, check and re-confirm. Consequently, the days of account receivable of those customers turns to be much longer. Thus, for better capital turnover efficiency, according to the voices of inner customers, the project title is identified as “to shorter the cycle time of account receivable process for customers.”

Step2: Define project scope-based on the step 1, the project team analyzes the process of related activities as Figure1, and sets up the project scope as the circle area in the right part of Figure 1.

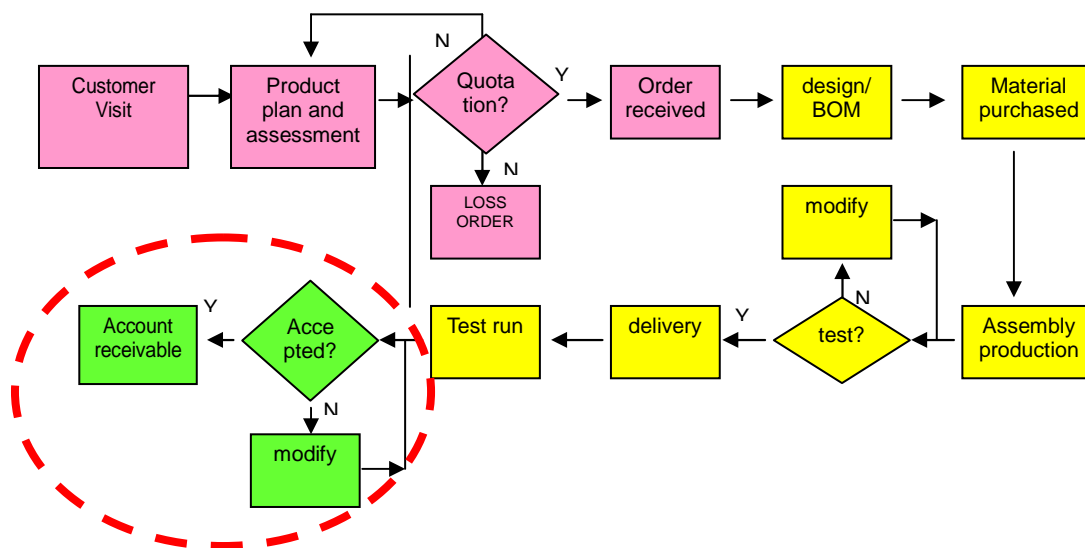


Figure1. The sub-process map with project scope

Step3: Define defects- according to the data analysis, there are approximately 40% more than 150 days of account receivable activities for most customers. For in-scope, the project team defines “more than 120 working days of account receivable cycle time” as one defect in this case.

Phase 2-Measure:

Step1: Data collection plan- in order to understand the process capability before improvement, a data collection plan is deployed to gather sample data from actual account receivable activities.

Step2: Measure **as-is** process capability- according to data analysis of latest 15 samples, the results of current-state process capability show Ppk= -0.18 and Cpk= -0.38 as Figure2 demonstrated, while setting Upper Specification Limit on 120 days. Moreover, the average is approximately 135 days.

Process Data

USL	120
Target	*
LSL	0
Mean	135.4
Sample N	15
StDev (Within)	13.4597
StDev (Overall)	29.3329
Potential (Within) Capability	
Cp	1.49
CPU	-0.38
CPL	3.35
Cpk	-0.38
Overall Capability	
Pp	0.68
PPU	-0.18
PPL	1.54
Ppk	-0.18

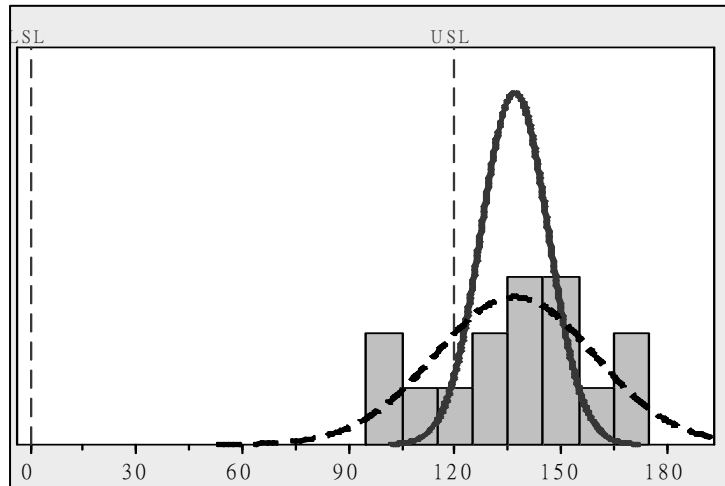


Figure2. Process capability before the introduction of Six Sigma

Phase 3-Analyze:

Step1: Identify root causes- the root causes of the problem of long processing cycle time are identified by using the cause and effect diagram as shown in Figure3.

Step2: Identify vital few initial X's- among the root causes as depicted in Figure3, the project team concludes that the vital few initial X's are (1) payment process of customer, certain date of closing entries, (2) AR paid on time, but due to the check clearance, (3) customer paid overdue AR, (4) contract is not ready and cause invoice uncreated, (5) delay because of equipment test procedure.

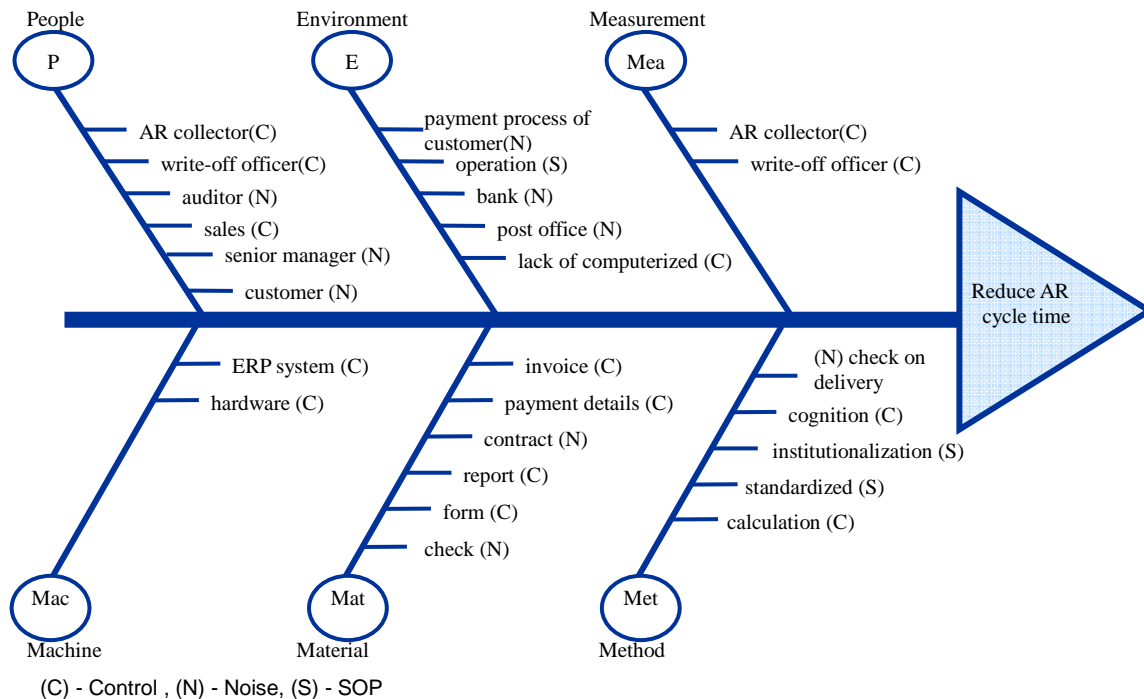


Figure 3. The root causes analysis based on cause and effect diagram

Phase 4-*Improve*:

Step1: Develop solutions- based on the findings of the significant causes in the Analyze phase, the solutions are proposed by project team members through brainstorming tactics and expressed as the improvement actions in Table2.

Step2: Implement improvement plan- after the step of solutions development, an improvement plan which contains improvement actions, respective in-charge departments and introduction schedule is profiled in Table2.

Table2. The improvement plan of account receivable activities

Root causes	Improvement Action	In-charge Dept	Schedule
payment process of customer, certain date of closing entries	data in ERP system has corrected to actual collection date	Sales	January 2006
AR paid on time, but due to the check clearance	data in ERP system has corrected to actual collection date	Sales	January 2006
customer paid overdue AR	discuss with customers	Sales	January 2006
contract is not ready and cause invoice uncreated	extend contract, no goods delivery without a contract	Sales	January 2006
delay because of equipment test procedure.	set up the "Standard Operational Procedure"	Sales and Finance	January 2006

Step3: Identify the new process capability- after the improvement plan has progressed for approximate six months, the project team collects the latest 20 samples to calculate the new process capability in order to observe the improvement effectiveness. The results of analysis shows that the average cycle time is reduced dramatically from 134 to 100 working days. Furthermore, the process

capability of Ppk and Cpk are enhanced from original -0.18 and -0.38 to 1.86 and 2.75 finally.

Step4: Compare the differences before and after the improvement plan- as shown in Figure 4, the trend chart demonstrates that there is tremendous progress after the implementation of the improvement plan. Not only has the average cycle time been reduced, but also the variance of cycle time is smaller. Moreover, according to Figure5, the short term Z value is promoted from -1.14 to 6 as well.

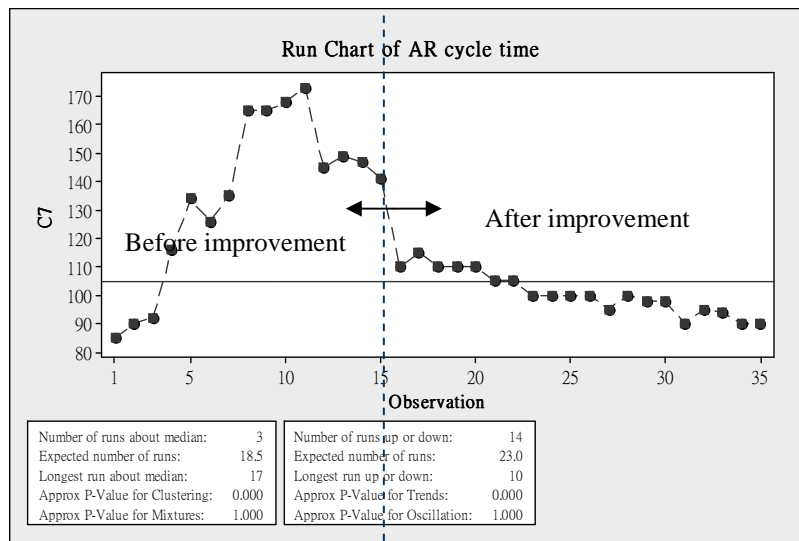


Figure4. The trend chart before and after Six Sigma

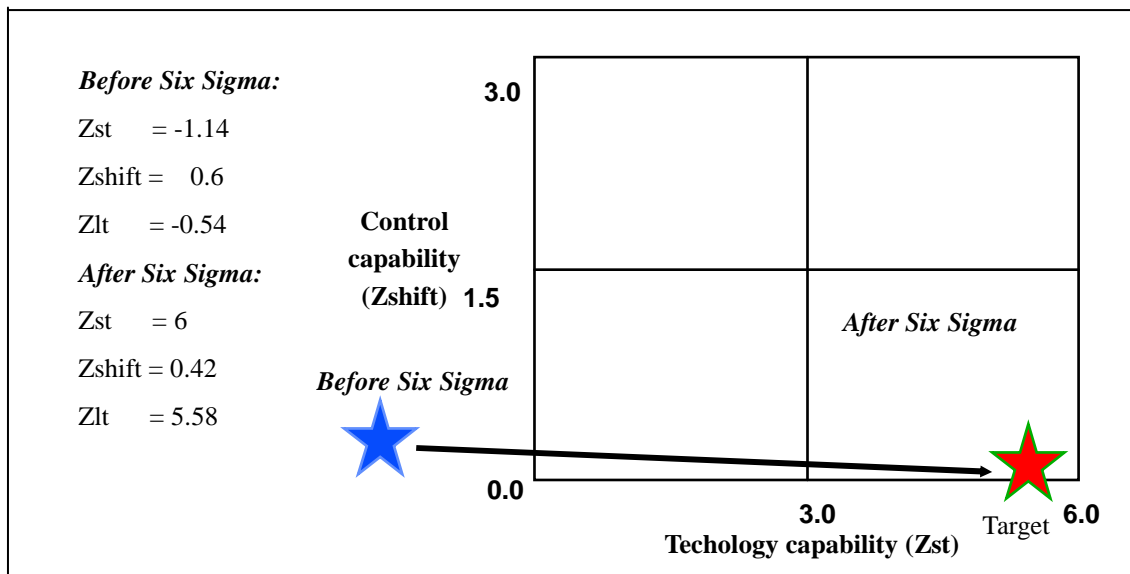


Figure5. The change of process control capability and technology capability

Phase 5-**Control**: Establish the control plan of risk management- for preventing system failure, it is crucial to establish a robust control plan of risk management. In this research, the project team uses possibility point and influence point, which ranks from 1 to 9 points individually, to determine the final risk score, which is formed by possibility multiplying influence. The representative example is demonstrated as Table3.

After the adaptation of Six Sigma management approach, the cycle time is reduced from averaging 134 working days to 100 working days. Additionally, the revenue of 2005 is NTD 174,000,000 and the annual interest is 3.8%. Moreover, since the cost saving effect equals (sales revenue) * (reduced AR cycle time) * (market annual interest) = NTD (174,000,000) * (134-100)*(3.8%)/365 = NTD 615,912.

Table3. Example of risk management in the control plan

Risk causes	Possibility	Influence	Risk score	Prevention actions
Employees withdrawal	3	5	15	Establish the document of processing guide
Inconsistence between computer key-in records and actual document	2	6	12	Check the difference and build mistake-proofing key-in system

CONCLUSION

The fact is the majority of the Six Sigma application in Taiwan is focusing on the improvement of the manufacturing spots instead of the supportive activities fields. The purpose of this paper is to demonstrate the improvement effectiveness of utilizing Six Sigma approach on the supportive activities, the reduce cycle time of account receivable process, in an equipment assembly company. Basically, for Six Sigma to work smoothly, managers at all levels must commit to invest the resources to initiate, promote, actualize, and support the program. In other words, providing employees with training, resources, knowledge, and authority to solve problems is crucial for the success of the Six Sigma project.

Thanks to the skillful execution of DMAIC phases, the case study company, A company, successfully eliminates wasteful variation, modifies business cultures and creates the infrastructure to initiate and sustain greater productivity and profitability. The concrete performance of utilizing Six Sigma in A company shows the cost saving of NTD 615,912 and obvious enhancement of long-term process capability from -0.18 to 1.86. The results prove that the application of Six Sigma approach performs an effective progress in the improvement of supportive activities as well as the improvement of manufacturing spots.

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