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A Study on Introducing Six Sigma Theory in the Library for Service Competitiveness Enhancement

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Abstract

By evaluating "user satisfaction index" for provided services, libraries are now collecting data which can be a basis for library management. This promotes research on reasonable and efficient evaluation tools for "user satisfaction" and "performance measurement." LibQUAL+ usage is currently increasing, which can be found in many documents. This study set out to draw and implement scientific and systematic improvement plans for a service area that failed to meet its goal or caused users' complaints.

Six Sigma means "a systematic innovative activity to statistically measure and analyze causes of defects that happen in all parts of management, and then remove those causes." According to Six Sigma, defects include all causes that interrupt process or service. It is a methodology to define a problem from the viewpoint of managers or

users as a defect and ascertain its causes in order to solve it.. As a theory it was originally used in manufacturing,. Today it applies to service areas.. This study is not only to do a simple quantitative analysis to evaluate library service but also to find out user complaint factors and reduce them. In this regard, this study intends to identify the application plans of Six Sigma and its significance in the library field.

The purpose of this study is to search for applications of Six Sigma as a solution for efficient knowledge management. It also aims to establish information infrastructure and secure service competitiveness, and finally to improve user satisfaction, the ultimate goal of libraries, through setting up and carrying out Six Sigma projects as well as continuing evaluation.

I. Introduction

A transformation is needed for libraries from focusing on the traditional information provider in the service operation system to focusing on the information recipient, that is, the customer. In particular, libraries are faced with radically changing user demands as well as environment changes. Thus new management strategies and techniques are required for libraries.

Knowledge management as a process can facilitate innovation for the library to acquire and store information and knowledge in the organization either internally or externally, to create and share knowledge, and to utilize, accumulate and reuse such knowledge. In short, knowledge management is a series of processes of the knowledge transformation and circulation. It should be regarded as the highest priority that the user is the center of all the processes from the initial phase of service planning to the final phase of evaluation, so the changing needs of the user are met and new ones are created. Along with consideration of the user priority, it is also important to secure a sufficient amount of information for decision making and to define and comprehend the cause based on the statistical analysis of this information. Moreover, it is essential to clarify knowledge elements relevant to the future core capacity, comparing it with the standard of the current organization and restructuring based on the result.

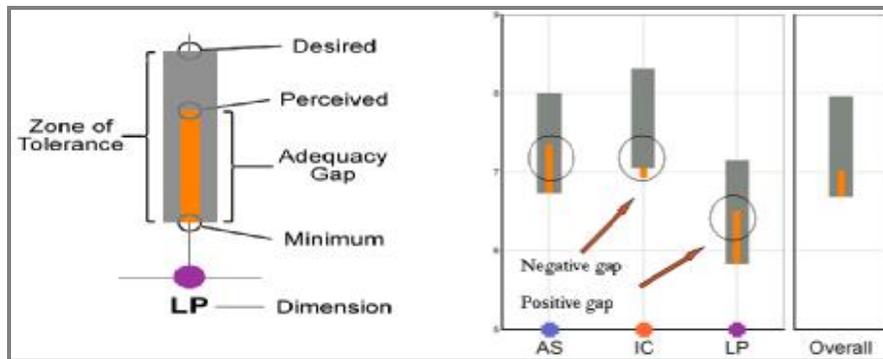
Accordingly, the purpose of this study is to present post-evaluation follow-ups which in general have been overlooked. At the moment, it is important to plan and execute new goals while evaluating and correcting errors and defects. Hence this study aims to apply a statistical management technique and new quality management theory different from a conventional one to examine the possibility and viability of such application. To achieve this goal the theoretical background is reviewed including philosophy, key concepts and the application of the 'Six Sigma' method. Subsequently, the process is examined which enables user satisfaction improvement due to 'sigma quality' maintenance of the service.

II. Service Quality Evaluation

Service Quality Evaluation of the library is an analysis of service efficacy. Efficacy of the service quality evaluation is not restricted to the fact that service is simply provided to the user. It also focuses on the degree of utilization by the users demand for information and their satisfaction in terms of quality and quantity. If quality evaluation is the number of inquiries and answers recorded in the resource center of the library then service quality evaluation can be defined as how precisely the user inquiries are answered and how many answers actually helped the users. In fact, assessing the service quality is the most difficult phase of the evaluation.

Unlike tangible commodities that can be evaluated objectively, ‘service’ cannot be easily defined and measured due to its distinctive features. Therefore, service quality is a subjective quality rather than an objective one. It is defined as ‘perceived service quality by user’. Regarding evaluating the service quality of the library, a new evaluation method was required which focuses on the user. Accordingly, research has been conducted on the service quality evaluation model which has been studied in the service marketing field of management studies. Such research was applied to the library service quality evaluation and subsequently LibQUAL+ was developed as a new evaluation measure.

The evaluation factor of LibQUAL+ is the perceived difference or gap between user expectation and actual satisfaction after using the service. LibQUAL+ analyzes the difference (Figure 1). When a user intends to use library service, he or she is bound to have a certain level of expectation on the content and quality of the service, even if the aspects or types of such expectation might vary among individuals. Users hold such expectation unconsciously in various ways and it is called ‘pre-expectation.’ It exists prior to the actual experience of the library service. On the other hand, user satisfaction is evaluated after the user receives the library service. By comparing the pre-expectation and actual experience of the user, quality recognition of the library service can be measured.



<Figure 1> LibQUAL+ gap analysis

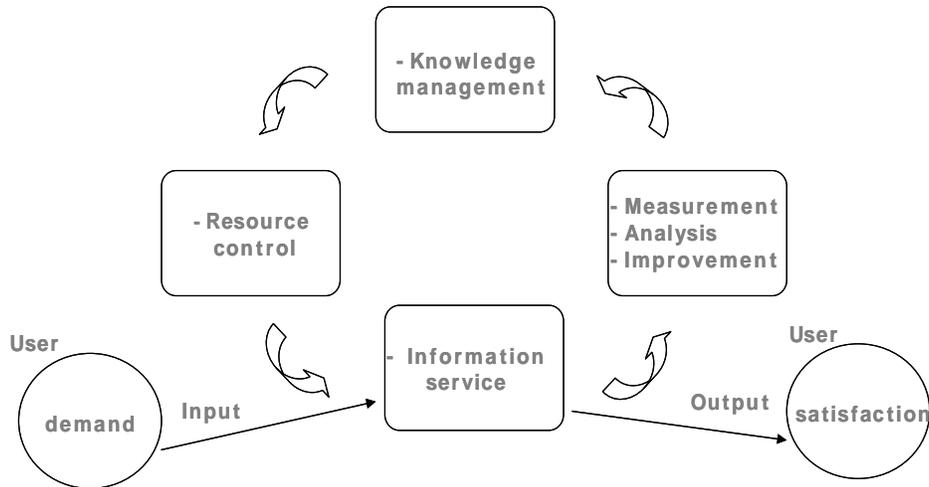
Meanwhile the user demands must be examined in order to evaluate efficacy of the library. They can be identified based on the user service that is currently conducted in the library. User demands are defined in accordance with following categories: the degree of satisfaction regarding the current service and any particular demand or suggestion from the user relevant to the library objectives. In short, user satisfaction with the library can be assessed through the quantitative measurement of the difference between user expectation or customer desire and the actual service experienced by the

user and production of the measurement index. User satisfaction varies by the degree of pre-expectation and actual service quality. The higher pre-expectation is, the greater the difference becomes on the service result. It is difficult to objectively evaluate service quality, for such service is assessed rather subjectively depending on the user. Thus recognizing the difference between pre-expectation of the user and actual service satisfaction experienced and perceived by the user is a preceding condition of the quality evaluation.

There are several reasons for the user to recognize a discrepancy between expectation and actual quality of the service provided by the library. For example, when the service provider's perception fails to meet the user expectation regarding library service or when the service provider fails to effectively provide services which fully satisfies user expectations. The ultimate goal of the library is to satisfy every demand of every user. However, it is impossible to fully and perfectly satisfy each and every user demand. Consequently, it is reasonable to define the categories of the service relevant to the library objectives and reflect immediate demands which realistically maximize the user satisfaction within the limited resources of the current environment.

The basics of the service quality evaluation include the premise that the best result is obtained by the user who is satisfied with the library service and who evaluates the service positively. If the user expectation is not met with satisfaction, the library should improve the service quality. This should produce higher user satisfaction when evaluated in the future. Service quality improvement is always in a cycle that reflects the reciprocal relation and it aspires to fulfill the ideal objectives of the library. Thus libraries should keep devising plans to enhance their service quality and focus on providing institutions which support or finance them with significant and convincing accomplishments.

As a tool for measuring the quality of library service it is suitable for the new library environment. The LibQUAL+ model measures and compares the service expectation provided for the user and the actual service quality perceived by the user. If the result of the measurement is 'unsatisfactory' with a significant discrepancy between the service expectation and actual experience then causes of such discrepancy and problems should be identified, studied and analyzed. Accordingly, suggestions can be made to enhance the user satisfaction and service quality improvement (Figure 2).



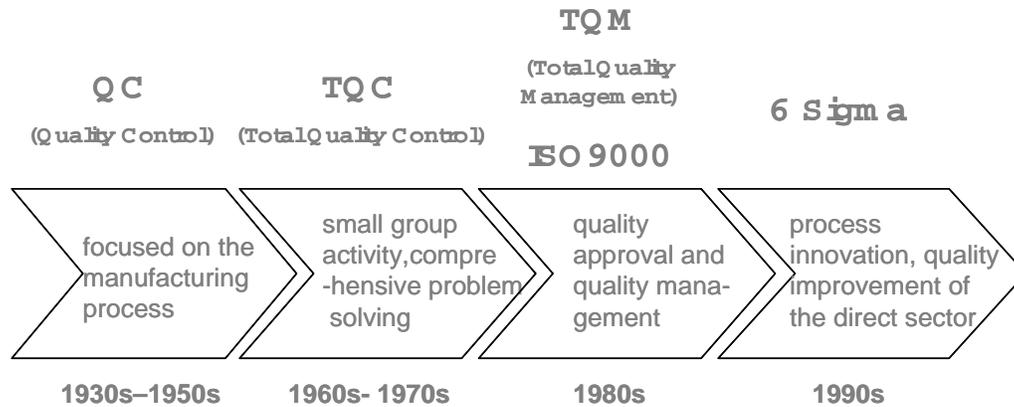
<Figure 2> Quality management process in library

In general, libraries are interested in ‘quality management’ focused on the customer satisfaction as a new management strategy for the improvement of their current ‘quality level’ which is fallen far behind. Quality management is an approach to improve management efficiency and resilience as a whole. It emphasizes people who produce products tailored to the customer demands and process of such production. In other words, quality management is the management philosophy highlighting the importance of perfectly fulfilling customer demands and of performing such task based on the proper procedure from the very beginning. Within the context of such development ‘Six Sigma Movement’ for quality innovation was recently introduced to the service sector and ‘Six Sigma Theory’ is regarded as a systemic and innovative quality control method. Through the evaluation of the library service quality and the improvement plans made as a follow-up measure, libraries can enhance their competitiveness which will facilitate realization of knowledge management.

III. Six Sigma for the Service Quality Improvement

‘Six Sigma Management’ is defined as follows : it is a systemic and innovative activity that assesses the causes for the defects and errors occurred in every sector of the management based on the statistical measure, analyzes the causes and ultimately eliminates them. Definition of the ‘defects’ in the Six Sigma Management includes all factors that hinder process or service. Unlike the conventional innovation methodology which focuses on minimizing defects in the manufacturing venue or on the problem-solving in the specific field, the Six Sigma defines defect as any problem arising in all sectors of the company that is perceived problematic by the management or by the

customer. Thus the Six Sigma is a methodology that thoroughly pinpoints the causes of such defects and eliminates them fundamentally.



<Figure 3> Evolution and Development of the Six Sigma

Quality Control (QC) played important role in improving the product quality of Japanese manufacturers in the 1980s. However, Quality Control was applied only to the manufacturing venue. It focuses on the proficiency of the work performance for a specific process. Total Quality Control (TQC) and Total Quality Management (TQM) expanded the criteria of the quality improvement movement in order to overcome the limit of QC. Nevertheless such expansion was applied partially. On the other hand, the Six Sigma is ‘innovation’ activity for the entire management sector as a whole, instead of focusing on the specific sector.

Introduction of the ISO 9000 Series and the development of the TQM did not attract much attention of the quality management. It failed to develop into a proper management strategy for the work procedure standardization. Under this circumstance the Six Sigma emerged as a scientific quality innovation strategy at Motorola in the USA. The Six Sigma approaches quality innovation based on the statistics and systematically conducts personnel training and quality improvement activities as a management strategy.

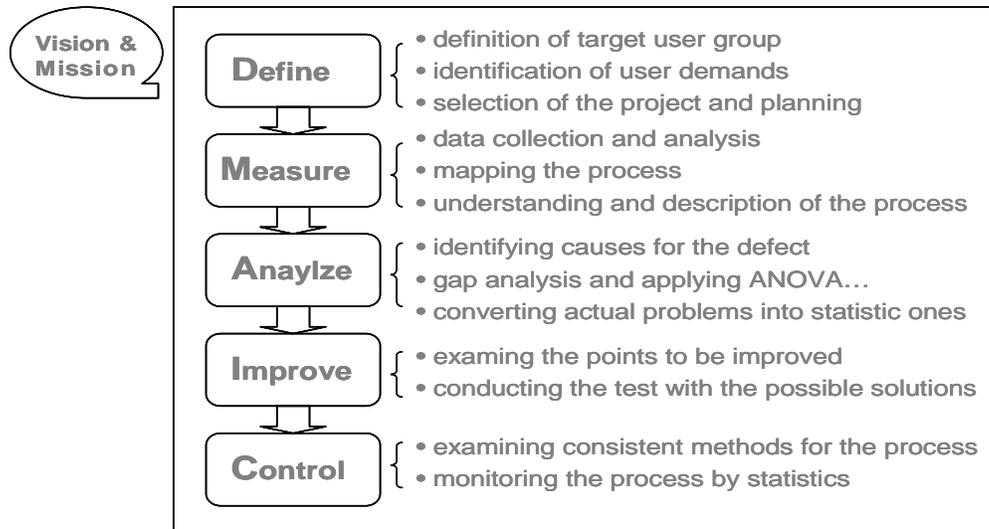
Regarding the concept of ‘defect,’ the Six Sigma is distinguished from QC, TQC and TQM. The major difference of the Six Sigma from the existing quality improvement movements is the fundamental elimination of the possibility of defects. It aims to eliminate defects from the very beginning thus it is a total quality improvement movement true to its literary meaning. In short it is a method to control the cause instead of reviewing the result afterwards. It also emphasizes scientific management

based on the objective data. In the Six Sigma all the processes are evaluated quantitatively and it is required to calculate 'Sigma Quality' standard. The ultimate goal of the Six Sigma is to achieve 'Six Sigma Level'.

The term, Sigma, is a sign indicating values that measure dispersion in statistics and it originates from the small letter sigma in the Greek language. The premise of the Six Sigma method is to understand this statistic terminology, sigma, as a 'target value' to be achieved by corporate management. Accordingly, the Six Sigma as a management technique is a long-term corporate strategy in which a superior goal of the minimum defect or error ratio is set to the level of 3.4 / 1,000,000 and the company strives to achieve such high standard. Furthermore it is defined as a statistical method in which the customer demands are identified, transformed into the task to be solved and optimal specification is determined based on the interrelation among each task (Defeo, 1999). It refers to a management innovation technique that applies scientific statistical techniques in all processes for the user satisfaction, achieves high product quality and contributes to the enhancement of the management performance.

One of the most significant characteristics of the Six Sigma application is the importance of the 'measure'. Regardless of the objects subjected to the improvement, something should be 'measured' first in order to be improved. Similarly it is difficult to define or understand if something cannot be articulated as numbers and objective data. It is the core philosophy of the Six Sigma that the project or task must be clearly defined first in order to control it.

Through the transformation of the attitude and work culture in the organization, the Six Sigma encourages employees to work 'smart' instead of merely emphasizing hard-work. It does not demand high standard improvement immediately but it prompts employees to explore and realize the problems to be improved. It is one of the most important factors for the successful management of the company.



<Figure 4> Five Steps of the Six Sigma (DMAIC)

The Six Sigma is conducted with a project-centered method that is fundamentally based on the ‘Blackbelt’, the problem-solver. This ‘problem-solving’ phase is called DMAIC (Figure 4). First projects are defined from the perspective of customers or regarding process(Define). Second based on the defined projects, the current level of the product quality is measured into sigma level(Measure). Third causes of the problems are detected through the analysis so as to improve the sigma level(Analyze). Fourth efforts are made to improve the situation by working with the causes of the problems(Improve). Finally the optimal condition generated by the above mentioned phases are controlled, maintained and monitored(Control).

1. Define

It belongs to a process that selects and controls the project. Projects are defined including the demands of the user and the content of the internal process. It is the initial stage of starting the project and the most significant aspect of this stage is whether the defined project is something ‘measurable’ or not.

2. Measure

As a phase to examine the current state of the process, it precisely pinpoints the area causing problems to use it as a basis of the problem-solving. Fault or defect of the project, unit and opportunity must be clearly and precisely defined and all possible and potential causes for such problems must be identified in this step. Subsequently such problems are analyzed statistically, direction of the project and precise standard of the projects subjected to the analysis must be determined.

3. Analysis

There is a step for analyzing why, when and where the defect occurs. The objective of this step is to characterize the projects statistically and to minimize various aspects of the causes for projects. When the selection process is made to detect major causes of the project, ANOVA and statistical hypotheses test are frequently used. In this step, the scientific verification process of the causes as well as Gap Analysis in which the discrepancy of the target value and the actual goal achieved are conducted. Major elements to be performed in the Analysis step is as follows: first projects must be statistically and precisely defined in terms of the mean, standard deviation or regularity; second the gap between the goal and actual state in reality must be clearly defined based on minimizing variance and moving average; third comprehensive list of the potential causes of the problems must be produced; fourth statistical analysis must be made to reduce the listed items for potential causes, into a few key factors; fifth based on such analysis, objective prediction of the financial performance and re-examination must be made; sixth plans must be made for the final step of Improve. To determine the priority of each project, common analysis means are used first, possibly with the palette chart. Subsequently more complicated statistical means are used to examine major variables causing defects.

4. Improve

It is a step to improve a few key factors confirmed in the previous Analysis process and pursue a method to improve realistic problems to be ultimately resolved. It is also a phase to explore the solution how to change, fix and modify the process. A pilot test is to be made in the actual work for a month to test the improvement plans and an analysis is to be made on the effect before and after applying the improvement plans through statistical analysis as in the previous Analysis step. If the result is unsatisfactory additional improvement plans must be carried out.

5. Control

It is a step for the actual control and maintenance of the improved states. It is also a step to systemize practical plans -which are selected as statistically optimal- to be realistically applied, maintained and improved. The result and accomplishment of all improvement activities must be made into the document and stored as the background material and basic data for the future maintenance or improvement. It should be monitored whether the constantly improving process is well maintained and developed.

First there is a stereotypical notion that service is difficult to measure due to its characteristics as a product of the service industry. Concepts such as transience and abstraction that characterize service industry might not be agreeable to the concept of

the Six Sigma which emphasizes physical data of the product with accurate measurement. Second considering the characteristics of the service industry, there is no urgent need for the management innovation program since the corporate demands for internal process innovation are invested only to guarantee the market share. Third it is difficult to define CTQ(Critical to Quality: critical elements to the product from the customer's perspective) in the service sector, however it is necessary to define CTQ and conduct projects to improve it. Fourth there are more non-metric data that are difficult to analyze statistically than metric data.

Nevertheless it is highly significant for the library to make an effort to improve its service quality. Thus efficient library management must be practiced based on the concepts of the Six Sigma management, process element and technique. By maintaining the Six Sigma quality level, libraries can enhance the level of satisfaction of the students and professors as well as library employees beyond the usual user expectation.

As it is already mentioned in this study, the Six Sigma includes DMAIC cycle. Similarly there is PDCA (Plan-Do-Check-Act) cycle for the quality control and CSUE cycle for the knowledge management. It is a process of creating and capturing, storing and sharing, utilization and evaluation. Each phase can be substantiated and enriched through the DMAIC process. Consequently it is suggested that knowledge management can be finally accomplished through the quality maintenance of the Six Sigma level.

IV. Prospect of the Six Sigma Application in Library

If the library service is evaluated from the user's perspective through quality evaluation tools such as LibQUAL+, how will the follow-up process improve service, the organization, the attitude of the librarian and the process which are below the user expectation? If the improvement plans based on such evaluation are not successful in the following year, the next evaluation will produce the same results. Therefore, it should be examined how the Six Sigma theory as a follow-up of the evaluation can be applied more scientifically and systematically to the library process.

First it is essential to establish process-centered management based on the comprehensive knowledge of the process executed inside the library. Improvement plans of the LibQUAL+ such as investment on the collection of books and improvement of the communication with the user include elements that could be or could not be defined as a process. In this study illustrations will be made that are controlled as a process. By understanding the process, it is possible to pinpoint the cause of the discrepancy between the plan and the actual result and the process to be improved the most in terms of the general quality improvement and user satisfaction.

It is of the utmost importance to utilize process analysis method and Six Sigma

statistical method for the successful Six Sigma management of the library. The Six Sigma management originally used for the manufacturing industry must be modified and characterized as the process apt for the service industry. The process is an assembly of activities which convert input such as information and human resources into output such as product and service. In particular its priority in task process analysis is to identify a key process by concentrating on the satisfaction of the user needs. Following is the LibQUAL+ evaluation items and processes that must be improved due to the low quality based on the evaluation result.

1. Process Control

(1) Define

LibQUAL+ questions to define as a process “improving communication with users”

AS2 : Giving users individual attention

AS4 : Readiness to respond to users’ questions

AS7 : Employees who understand the needs of their users

(2) Measure

Measuring defect unit/ result analysis according to the age, sex, scholarship, occupation and frequency of the library visit

information provided by and attitude presented from the librarians are reliable

there is no channel for suggestions from the user concerning library services

library fails to act immediately upon the user comments and suggestions

it takes too long to provide information for the user after the reference inquiries are made

librarians are not actively engaged in collecting feedback on their service quality

poor or insufficient understanding of the user demands

(3) Analysis

Defining potential causes for the defects, brainstorming with the personnel in charge of the process, using various techniques

examining communication channels, methods and reference consultations between librarians and users

librarian as an information expert must be active and aggressive in this dynamic interaction with the user

interactive communication channels must be established including real-time reference service through e-mails, electronic board, FAQ or chatting
such service must be available on time and efficiently
contents provided by the librarian must be reliable
importance of the non-linguistic communications such as attitude should be recognized

(4) Improve

Pilot test for a month, analysis of the statistics before and after the test on the satisfaction level

Improving communication with users

Examining the gap between the actual state and optimal solution

Plans for overcoming such gap

Devising strategies relevant to the regulations with careful preparation

(5) Control

Examining persistent method to improve the process, public relation for the improvement plans

strong leadership of the CEO is essential and he or she must share the vision with all the members of the company and challenge the conventional

professional staff must be hired with 'belt system' through the innovative training program. Human resources must be fully utilized, quality control personnel should be trained and quality improvement activity should be promoted scientifically and systematically

master plan must be drawn

However, there is a problem that extra staff in charge of the Six Sigma process on top of the existing library task must be delegated. The Six Sigma process needs Champion(chief management head), MB(expert on the Six Sigma management activity), BB(active party and agent conducting improvement plan), and GB(support the 'Blackbelt') to define improvement objectives and process, and apply improvement plans. The Six Sigma team is to be composed of a strategy team, knowledge team and task process team that cooperate with one another for the improvement tasks. If the transference of the Blackbelt is difficult under the current library circumstances, it is possible to adopt the Blackbelt system with a 'dual work strategy' (managing both jobs simultaneously) that is considered more realistic.

2. Statistical Control Technique : controlling user satisfaction and sigma level

Not only the statistical analysis of the LibQUAL+ such as ANOVA, t-test and factor analysis but also the Six Sigma quality value should be used simultaneously so that diverse analyses can be made. Accordingly easier quality control can be achieved through the sigma level control.

Defects per unit (DPU) is an important parameter serving as a standard of the process which is needed to be improved. There are several processes until a final product is packed for the delivery. DPU is calculated for each process and the process with the highest DPU can be selected as the object to be improved first. DPU indicates average defects per unit, however it does not indicate the number of holes in which the defect occurs per unit. In this regard, DPU is produced to indicate defects per unit in quantity and it is defined as follows:

$$\text{DPU} = \text{total defects} / \text{total products per unit}$$

When the product quality of process is evaluated, questionnaires are used sometime. In this case it is neither measurement type nor coefficient type, but a special type: it is called 'categorical type'. Regarding the categorical type, an example of the calculation of the sigma level is as follows. A company in Texas, USA made a survey on the customer satisfaction. In each question item, 'very dissatisfied' was counted as 0 point and 'very satisfied' as 9 point. Total 10 tiers from 0 to 9 points were calculated to examine the customer satisfaction. In the questionnaire filled out by the customer, a customer with the total point below 5 was considered as having dissatisfaction with the company. Such case was assessed as a defect. DPU was calculated from the number of 'defect customers' and it was converted back to the sigma level. As a result of the customer satisfaction survey, 7 customers out of 286 turned out to have below 5 point total, hence dissatisfied with the company in that survey.

Accordingly, $\text{DPU} = 7/286 = 0.02448$ and corresponding ratio thereof is $e^{-0.002448} = 0.9758$. The sigma level was calculated as follows.

$$Z_s = \Phi^{-1}(0.9758) + 1.5 = 1.97 + 1.5 = 3.47$$

Thus calculation of the sigma level with the categorical type data of the survey requires objective standard which determines defects.

V. Conclusions

Six Sigma is an integrative management strategy with total quality control that uses statistic measure called 'sigma' to evaluate all the quality levels quantitatively under the strong leadership of CEO, provides efficient quality control environment including problem-solving process and professional training, and promotes quality innovation and customer satisfaction. It evaluates process, determines priority of the quality improvement activities and efficiently controls the process according to the priority. Focused on the user perspective, the Six Sigma detects problem of process and proposes the solution in which the project is solved through the statistically-inclined procedures. In this study the possibility of such a solution is examined in order to apply it as a follow-up improvement task after the library evaluation.

Opinions of the user can be recorded through a user survey or library environment analysis and subsequently internal capacity can be assessed. CTQ of the user is selected so that improvement plans suitable for the library objectives can be devised. After the CTQ is selected, DMAIC steps are performed in accordance with the Six Sigma promotion strategy. Meanwhile it is essential to identify features of the library process, user definition and user demand. In particular it is important to define CTQ which satisfies user demands. Moreover application of the scientific and objective 'statistical technique' should not be limited as a mere number based on the theory. Instead it should contribute to the more practical control of the service quality and attention must be paid to detect causes and problems through daily tasks in the library.

Precise understanding of the library quality and quality control is essential and CEO's will-power and support for the Six Sigma application are also necessary. Furthermore the vision of the library should be shared by all members and put into practice in daily routine. The efforts should not be limited merely to improve quality control. The ultimate goal must be the change of the perception on library value management and enhancement of the user satisfaction through a constant quality control.

Libraries in the process of applying Six Sigma must perceive the factor that satisfies users as an ideal quality and try to find key factors that affect quality from users' point of view. Moreover, libraries are made to collect objective and reliable data and employ methods of statistic analysis in order to gather data and information within the organization and use them for decision-making. As a characteristic of library service, however, there are generally distributed factors which are impossible to control or hard to quantify. Therefore, it is necessary to consider the respect that it is difficult to define problems of the current service and users' complaints. Accordingly, in drawing and implementing improvement plans, it is needed to separately prepare a process modeling

for the field of library management, which is different from general manufacturing. In this study, Six Sigma theory is used in order to review various aspects of library management, conduct evaluation and find a service process necessary for improvement to raise customer satisfaction. In addition, it suggests what should be done in the future in association with strategies and visions for library management.

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