INTEGRATION OF SIX SIGMA AND LEAN PRODUCTION SYSTEM FOR SERVICE INDUSTRY

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Abstract: Six Sigma is one of the most popular quality initiatives recently. Lean Production System is the world famous production system developed and practiced by Toyota mobile company for a long time. It is based on two concepts: "Just-In-Time" and "Jidohka". Both are based on varying thinking to improve the business process, enhance quality, production and competitive position. Besides, the integration of them is viewed as a new trend in the next management wave.

Keywords: *six sigma, lean production system, service industry*

1. INTRODUCTION

Nowadays, the development of industrial core intrinsic technologies is more and more important due to the dynamic competition in the global market. Companies have to keep and continuously upgrade their intrinsic technologies in the professional field to gain the sustainable competitive advantage. However, they also have to continuously upgrade their management technologies, and keep sensitive to the latest issues as well as their integration with company's current system. Otherwise, they still cannot survive in the market even though their intrinsic technologies are advanced.

No matter how the management technologies be developed, they must emphasize their contribution to business performance, customer satisfaction and continuous improvement of the products or services. Moreover, the integration of different systems is an important issue today and tomorrow.

This research will focus on "Six Sigma" and "Lean Production System" to discuss their integration based on the background and thoughts mentioned above. Six Sigma is one of the most popular quality initiatives recently. Lean Production System is the world famous

production system developed and practiced by Toyota mobile company for a long time. It based on two concepts: "Just-In-Time" and "Jidohka". Both are based on the variation in thinking in order to improve business process, enhance quality, production and competitive position. Besides, the integration of them is viewed as a new trend in the next management wave.

Moreover, regarding the industry characteristics, service industry is quite different from manufacturing industry. Even though there are more wastes and improvement opportunities, the application of Six Sigma, Lean Production System or their integration in service industry is quite few neither in literatures nor practice.

This research proposes the Lean Six Sigma integration model based on the research gap and the practical need, and then adapt it for service industry. The model is named as "Lean Six Sigma for Service (LS^3)" in this research. It balances the viewpoints of internal and external customers, and gives consideration to the Lean speed as well as Six Sigma high quality. Also, this research tries to contribute to the enhancement of management technologies.

2. Introduction to Six Sigma

Six Sigma is the major focus of many companies for its powerful breakthrough performance demonstrated in GE, Motorola etc. recently. Six Sigma can help companies to reduce cost, increase profits, keep current customers and create new customers. In brief, Six Sigma is a methodology

to reduce the variation of every process and their interfaces to achieve a very high quality level.

In statistical theory, six sigma is an ideal target value, and expressed as: 6σ. It means when the process or product we observed under a normal distribution, the probability of a specific attribute value shifts from the mean about positive or negative six standard deviation would be 0.002 part per million (ppm). Motorola company found a phenomenon that the process mean would shift around the center point of specifications in a long-term processing, and the shifting range would be about positive or negative 1.5 standard deviations from the center point of specifications.

Hence, Motorola company modified the statistical meaning of six sigma. The definition can allow the sample mean shifts from the center of the population, and the observed process or product would out lie the six sigma limits only 3.4 times per million operations under the original specifications. In addition, the sigma performance can also be expressed by "Defect Per Million Operations (DPMO)" shown as Table 1.

Yield	DPMO	Shift from Mean	Popular Age
6.68 %	933200	± 0σ	
30.9 %	690000	± 1σ	
69.2 %	308000	± 2σ	1970s
93.3 %	66800	± 3σ	1980s
99.4 %	6210	± 4σ	Early 1990s
99.98 %	320	± 5σ	Mid 1990s
99.9997 %	3.4	± 6σ	2000s

Table 1. DPMO and Sigma Performance

Six Sigma means the world leading quality level. More and more companies understand to use Six Sigma to improve the process quality so as to achieve the business dramatic performance. This is because Six Sigma requires the quantitative measurements and analyses of the core business processes as well as suppliers' involved processes.

Originally, Six Sigma methodology is applied to manufacturing industries. However, the applications of Six Sigma are no longer be limited in manufacturing processes today. Keim (2001) demonstrated Six Sigma is very suitable to improve the service performance by two real cases. Paul (2001) pointed that the recent trends in Six Sigma are: emphasis on cycle time reduction, smaller business deployment, and integration with other initiatives.

As the Six Sigma market grows, so does the availability of organizations to assist in deployment and integration. This availability of technical expertise allows smaller businesses realistically consider Six Sigma deployment with minimal economic investment. Besides, due to the central concern of Six Sigma is to pursue the customer satisfaction and business performance, we can view Six Sigma a main structure while integrating with other initiatives. As for the integrating initiatives such as Lean Production System, Total Quality Management or Quality Costs etc. depend on the different requirements of each company.

2.1 Introduction to Lean Production System

Lean Production System (also called Toyota Production System) is the world famous production system developed and practiced by Toyota mobile company for a long time. It based on two concepts: "Just-In-Time" and "Jidohka". This kind of production system is very flexible to the dynamic change of market demands, and Lean Production System is established by many small group improvement activities to eliminate all kinds of wastes in the business.

An important literature written by Spear and Bowen (1999) published in Harvard Business Review pointed that, the Toyota Production System and the scientific method that underpins it were not imposed on Toyota – they were not even chosen consciously. The system grew naturally out of the workings of the company over five decades. As a result, it has never been written down, and Toyota's workers often are not able to articulate it. That's why it's so hard for outsiders to grasp. In the article, Spear and Bowen attempted to lay out how Toyota's system works. They tried to make explicit what is implicit. Finally, they described four principles – three rules of design, which show how Toyota sets up all its operations as experiments, and one rule of improvement, which describes how Toyota teaches the scientific method to workers at every level of the organization. It is these rules –and not the specific practices and tools that people

observe during their plant visits – that in their opinion form the essence of Toyota's system. Hence the two authors called the rules as the DNA of the Toyota Production System.

These rules guided the design, operation, and improvement of every activity, connection, and pathway for every product and service. The rules are as follows:

Rule 1: All work shall be highly specified as to content, sequence, timing, and outcome.
Rule 2: Every customer-supplier connection must be direct, and there must be an unambiguous yes-or-no way to send requests and receive responses.
Rule 3: The pathway for every product and service must be simple and direct.
Rule 4: Any improvement must be made in accordance with the scientific method, under the guidance of a teacher, at the lowest possible level in the organization.

All the rules require that activities, connections, and flow paths have built-in tests to signal problems automatically. It is the continual response to problems that makes this seemingly rigid system so flexible and adaptable to changing circumstances.

2.2 Four Characteristics of Service Industry

Recently, due to the economic and international trading environmental change, the structures of many companies are also changed. The growth of service industries rapidly chases the growth of manufacturing industries. Especially for the current situation in Taiwan, many factories are moving to mainland China. Hence, the needs for service industries to fill in the space of economic activities become very huge. That's why service industries play an important role in the economic development recently.

This research concludes the four characteristics of service industries based on the literatures written by Kotler (1997), Regan (1963) and Zeithmal, Parasur& Berry (1985) as follows:

1. **Intangibility**: It means that services can be consumed and perceived, but they cannot easy to be objective measured like the manufactured products. That's why there is usually a perception gap between the service provider and consumer.
2. **Variability**: It means that services are delivered by people, so the service quality may change depending on different time, people and consumer perception. That is, the variability of services.
3. **Perishability**: Unlike the tangible manufactured products, services cannot be inventoried. They are delivered simultaneously while the demands from consumers appear. Once the demands disappear, the services perish.
4. **Inseparability**: Since the delivery and consumption of services almost be done simultaneously. Hence the interactions between servers and consumers play an important role on the evaluation of service quality. Consumers evaluate the service quality on the moment of consuming the service.

2.3 MODEL CONSTRUCTION

This research proposes an integration model of Six Sigma and Lean Production System for service industry called as "Lean Six Sigma for Service (LS^3)". In practice, the first stage is to "Lead" the process improvement project by hearing the "Voice of Customer (VOC)". The project identification and its scope must be clarified so as to serve the customers more efficiently and effectively by the improvement.

The "Lead" stage provides the project team a well-defined scope of the problem they are faced. Hence the major mission of the "Study" stage is to measure the current status or level by quantitative data, and then to analyze how the problem affects the process. By the collection of "Voice of Process (VOP)", the project team can try to converge the problem and begin to find out its root causes.

Moreover, no matter what the process indicators are, the project team has to well define them first, and to explain the purpose as well as the use of each indicator. Most important of all, the performance indicators' definition and their evaluation methods must be agreed and confirmed by the people involved. It's very important to detail record the performance levels and action

results for the further enhancement of service processes.

After studying and analyzing the current status of the service process targeted, the third stage is to draw up problem solving countermeasures. The countermeasures must be transformed to the "Voice of Server (VOS)" so as to "Smooth" the whole service process. It is hoped to reduce the defects and speed up the service delivery by the verification of performance indicators. Therefore, the project team will propose some education and training plans for the coming countermeasures' conduction.

The project team can measure if the project target achieved or not by the proposed countermeasures so as to continuously monitor and control the better results. At this time, the project team has to "Sustain" the operating stability of the service process. Therefore, the purpose of this stage is to confirm the result, the effectiveness of the countermeasures and if there is any side effect. Once these things are confirmed feasible, the project team can view the knowledge and experiences as the base of knowledge management and technology accumulation. Finally, the knowledge and experiences must be diffused and deployed throughout the organization so as to be the "Voice of Business (VOB)".

The LS^3 operating model proposed by this research shown as follows:

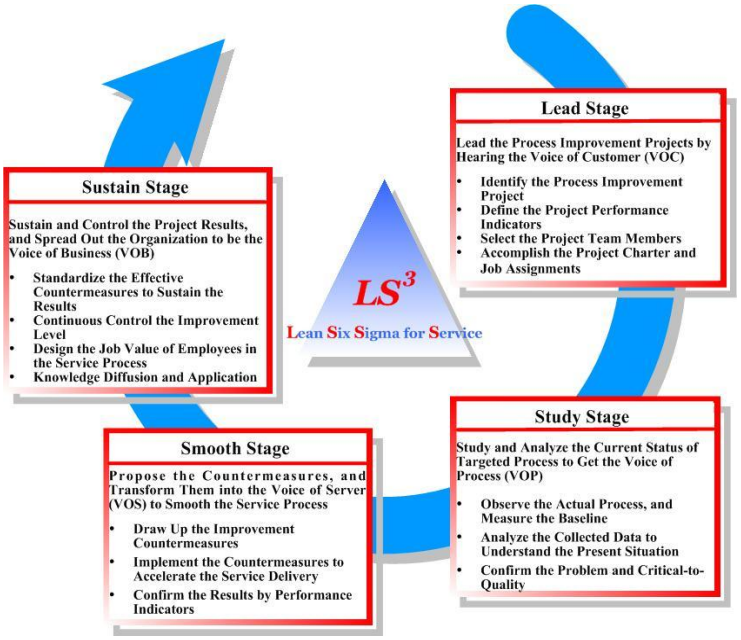

Figure 1. Structure of Implementing LS^3

The key points and tools of implementing LS^3 are concluded by this research and shown as Table 2. Moreover, the tools of LS^3 are also shown as Figure 2.

Table 2. Key Points and Tools of Implementing LS^3

LS^3	Activities	Tools
Lead	**Lead the process improvement projects by hearing the voice of customer (VOC)** - Identify the process improvement project - Define the project performance indicators - Select the project team members - Accomplish the project charter and job assignments	- Market survey - Project charter - Annual police deployment - Quality function deployment - Value stream analysis
Study	**Study and analyze the current status of targeted process to get the voice of process (VOP)** - Observe the actual process, and measure the baseline - Analyze the collected data to understand the present situation - Confirm the problem and critical-to-quality	- Process mapping - Measurement system analysis - Motion and time study - Multi-vari analysis - Cause and effect matrix - Process capability analysis - Time value analysis

Smooth	**Propose the countermeasures, and transform them into the voice of server (VOS) to smooth the service process** - Draw up the improvement countermeasures - Implement the countermeasures to accelerate the service delivery - Confirm the results by performance indicators	- 5S - Operation balancing - Rapid operation switching - Visual management - Eliminate, combine, rearrangement, simplify - Process reengineering - Failure mode and effect analysis
Sustain	**Sustain and control the project results, and spread out the organization to be the Voice of Business (VOB)** - Standardize the effective countermeasures to sustain the results - Continuous control the improvement level - Design the job value of employees in the service process - Knowledge diffusion and application	- Control chart - Check list - Process standardization - Error proofing - Education and training

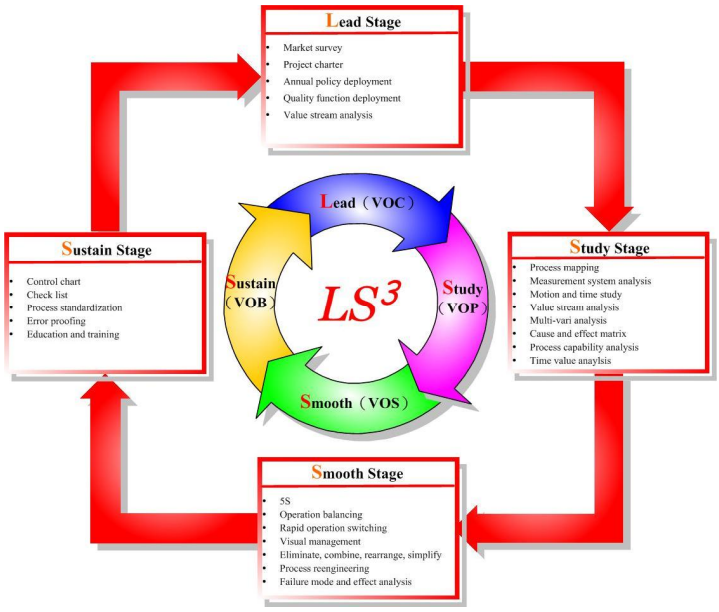

Figure 2. Tools of Implementing LS^3

2.3. CONCLUSIONS

Due to the limitation of practical resources, the LS^3 model demonstration by a real case could not be included in this research. Therefore, this research used the questionnaire survey to verify the theoretical logic and feasibility of LS^3 structure. We interviewed several Lean Production and Six Sigma experts and consultants, and we expect to provide a base of verification by their experiences and knowledge. Finally, we conclude the agreements and suggestions of the experts as follows:

1. All the experts and consultants agreed the theoretical structure of the proposed model by this research, and expressed the "very much agree" level on the logic, implementing steps and their contents.
2. All the experts and consultants expressed the "very agree" level on the proposed model with PDCA management cycle.
3. All the experts and consultants expressed at least the "agree" level on the fitness for use of the proposed tools.

Some experts considered that the names of some tools originally be applied in manufacturing industry should be changed to be well understood in service industry. In addition, all the experts and consultants considered that the tools mostly applied in manufacturing industry should also be applied to service industry. This is because there are huge demands and expectations of these tools in service industry based on their experiences and observations. Hence they deeply agreed the proposed model by this research contains the tools for reference.

4. All the experts and consultants expressed the "very agree" level on the proposed model really integrated the principles of Six Sigma and Lean Production System. Some experts suggested we could emphasize the principles of Lean Production System a little more.
5. All the experts and consultants expressed the "very agree" level on the feasibility of applying this model to the service industry.
6. All the experts and consultants expressed the "very agree" level on the practical value of this proposed model, and they also expressed that they will refer the structure to demonstrate it if there is any suitable opportunity in the near future.

Therefore, i conclude the agreements and suggestions by the experts as follows: all the experts agreed the proposed model by this research on the whole structure, implementing steps and tools planned. They also expressed the practical value and operational feasibility of this model is very high. Moreover, all the experts agreed this model on the fitness for use in the service industry, and they will refer this model to demonstrate it when there is any opportunity in the near future.

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