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Study of six sigma management applied to Chinese shipping companies

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STUDY OF SIX SIGMA MANAGEMENT APPLIED TO CHINESES SHIPPING COMPANIES

By

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China

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DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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ABSTRACT

Title of Dissertation: **Study of Six Sigma Management Applied to Chinese Shipping Companies**

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Based on analyzing the successful experience of the companies applying Six Sigma Management and summarizing the characteristic of the shipping companies' operational process, this paper clearly shows a whole framework of Six Sigma Management in Chinese shipping companies. In order to prove validity and feasibility of the author' viewpoint, it carries out the following research work:

1. Put forward the organizing framework of Six Sigma Management and the project management & process improvement system of shipping companies applying Six Sigma Management.

2. Bring forward some Six Sigma tools and statistical tools to help the shipping companies analyze and solve problems.

3. Analyze cases of some shipping companies implementing Six Sigma Management, which proved that the statistical tools, methods, and technology this presented is useful and correct.

4. Give some recommendations to the Chinese shipping companies when they are implementing Six Sigma Management, which can help them avoid some errors.

KEYWORDS: Six Sigma Management, Chinese shipping companies, Six Sigma tool

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LIST OF ABBREVIATIONS

SPC	Statistical Process Control
PDCA	Plan-Do-Check-Act
MBB	Master Black Belt
CQO	Chief Quality Officer
PMP	Project Management Professional
PMI	Project Management Institute
VOC	Voice of Customer
BSC	Balanceable Score Card
FMEA	Failure Modes and Effects Analysis
RPN	Risk Priority Number
KPI	Key Performance Indicator
DMAIC	Define-Measure-Analyze-Improve-Control
GLM	General Linear Model
ERP	Enterprise Resource Planning

CHAPTER 1
INTRODUCTION

1.1 Importance of Six Sigma Management

1.1.1 Importance of Quality Management

Market economy necessarily brings with competition among the enterprises and the result of competition is survival of the fittest. Under the condition of serious competition, it is impossible for a company to realize and improve profits only relying on reducing cost or entrepreneurs' inspiration and force. The final effect is an enterprise' strength consisting of many contents, among which quality being the most direct and important factor. The companies surviving a long time in the market are those which recognize the importance of market competition and understand the profound meaning of "quality is the life of a company" (Jiao Shubin and Chen Yuntao, 2004, p.10). Today market competition has changed from the price competition to quality competition. Quality is the passport for a company to enter into market and participate in the competition (J.M.Juran, 2003, p.3). Without the quality advantage, companies consequentially will be in the inferiority.

Under the condition of market economy, enterprises are engaged in various economic activities, all of which are purposeful for pursuing profit (Liang Xiaomin, 2004, p.56). In order to realize and improve profits, no matter with what method,

enterprises must base on the quality advantage of their products and service to attract more customers. This can be explained by the Marx's theory of use value and value. The Prerequisite of the products accepted by the customers is that it must be useful for the customers (Marx, 2004, p.68), that is to say, customers buy products' use value and the companies gain the products' value. The quality level of the products directly decides its use value. Generally products with high quality can sell high price, which will bring high profit to companies. In other words, high quality means high profit. Therefore guaranteeing and improving products' quality is the foundation for companies' survival and development.

As realizing the importance of quality management, people are exploring an effective quality managing method all the time. Generally modern quality management goes through three stages:

Ⅰstage: This stage is called the stage of quality of inspection, which is the period before Second World War (He Xiaoqun, 2004, p.19). In this stage, people mainly use the way of inspection to control production and guarantee the quality of the products changed to the next process. The Taylor's theory of Scientific Management and the Shewhart's theory of Statistical Quality Control are very popular in this period. Taylor proposed that companies should divide its departments according to their different functions. At the beginning of quality management, most people regard quality inspection as a kind of management function isolated from production. Shewhart's theory of SPC (Statistical Process Control)is that using the statistical technology supervises and controls production in order to reduce the reliance on examination (Malin, 2004, p.3). The characteristic of this stage was that quality management is based on the examination, that is to say, companies used quality management on the condition that their products had been produced.

Ⅱ stage: The period from 1940s to 1950s is called the stage of statistical quality control. The characteristic of this stage was that mathematical statistical method integrated with quality management. It had changed from relying on quality inspection to process control (J.M.Juran, 2004, p.12). In this stage, Dodge and Romig proposed the method of Statistical Sampling Inspection, which was successfully applied in Bell Telephone Corporation and the American Army. This stage excessively emphasizes the statistical method of the quality control, but ignores the organizational management, which made people mistakenly think that quality management is a statistical method. Because the statistical method is very abstruse, people think that the quality management is also very difficult to understand and grasp, which seriously limit the popularization of the method of Statistical Sampling Inspection (Yang Yuejin, 2006, p.12).

Ⅲ stage: This stage began from 1960s and is called the stage of overall quality management. With the development of scientific technology and industry production, people had more and more demand on the quality, so many scholars proposed the concept of systematic project and studied the quality problem in overall environment (He Xiaoqun, 2004, p.19). People began to use quality management in the whole process of company's production. In this stage, many famous experts and theories of quality management appeared, such us W. Edward Deming's PDCA Cycle; Joseph H. Juran and Armad V·Feigenbaum's theory of Total Quality Management; Genichi Taguchi's Steady Design Method. In 1990s, ISO 9000 Quality Management System had influenced on the worldwide trade and economy. And in this stage, Total Quality Management had become successful experience of many large-scale companies, which also proved that it was a company's management strategy to gain core competitiveness.

1.1.2 Effectivity of Six Sigma Management in Quality Management

"World-class" enterprises benefited a lot from Total Quality Management. However a new quality management method called Six Sigma Management brought a revolutionary change to the enterprises. In 1980s, Motorola launched unprecedented quality revolution because of the high pressure from the Japanese electric products. In 1987, they proposed Six Sigma Quality Management strategy, which was later on successfully used and popularized by GE. Subsequently many companies of Fortune 500, such as Texas Instruments ABB, Honeywell, Kodak, Siemens, Nokia, Sony, responded this revolution (He Xiaoqun, 2003, p.15). These companies' behavior promoted quality management into a new stage. The fire of Six Sigma Management lighted among the worldwide companies. So we can say that the next step of quality management is from Total Quality Management to Six Sigma Quality Management.

1.1.3 Importance of Six Sigma Management Applied in Chinese Shipping Companies

In China several large companies including Lenovo, huawei, Haier, ZTE and Baosteel are popularizing Six Sigma management, but they are at the stage of entry level. Especially in transportation industry the number of companies applied it can be counted on one's fingers. The success of Six Sigma applied in a few airlines has proved its availability in transportation companies. In shipping industry, only COSCO is implementing Six Sigma management. Therefore study of the Six Sigma management applied in Chinese Shipping companies is very urgent and worthy.

With China's entry into WTO, Chinese international trade is flourishing, which will bring a bright future for Chinese shipping companies. However, following the

Chinese shipping market complete open to foreign shipping companies, domestic shipping companies feel high pressure from their competitors. In addition, traditional quality management method has not adapted modern shipping industry's development. Thus they are trying their best to find an effective management method, which can meet customers' requirement by the greatest extent, maintain high quality of products and service, and farthest save cost. The method of Six Sigma management may solve their problems and optimize their achievement.

1.2 General Introduction of Six Sigma Management

Six Sigma in many organizations simply means a measure of quality that strives for near perfection. Six Sigma is a disciplined, data-driven approach and methodology for eliminating defects in the process from manufacturing to transaction and from products to service (Lin Fei, 2003, p.68). Generally, people define Six Sigma from the statistical aspect and the managing aspect.

1.2.1 The Statistical Meaning of Six Sigma

The statistical implications of a Six Sigma program go well beyond the qualitative eradication of customer-perceptible defects. It's a methodology that is well rooted in mathematics and statistics.

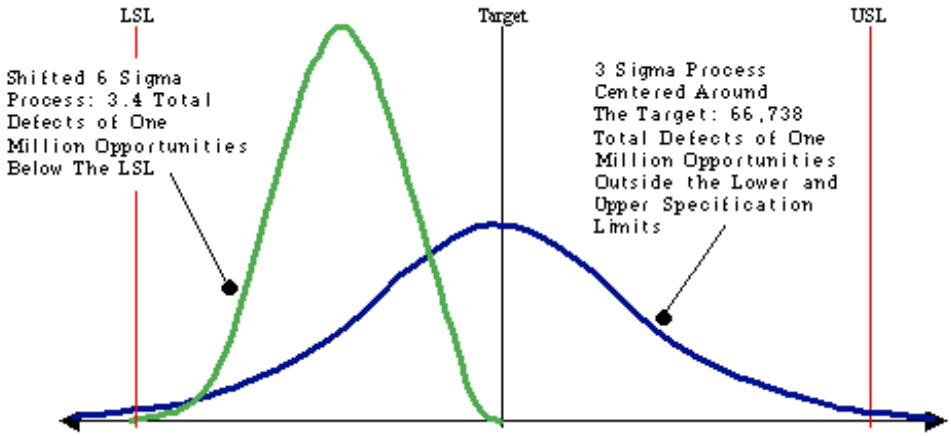

Figure 1.1 Statistical definition of Six Sigma

The statistical representation of Six Sigma describes quantitatively how a process is performing. To reach Six Sigma, a process must not produce more than 3.4 defects per million opportunities. A Six Sigma defect is defined as anything outside of customer specifications. A Six Sigma opportunity is then the total quantity of chances for a defect. Process situation can easily be calculated using a Six Sigma calculator.

1.2.2 The Main Ideas of Six Sigma in the Managing Respect

In the management respect, Six Sigma mainly has the following five ideas (Malin, 2004, p.22):

(1) It really concerns about the customer's demand. Conforming with the idea of customer relationship management, concerning about the customers is the most important aspect in Six Sigma Management. The evaluation of Six Sigma Management performance firstly began from the customers' demand and the level of improvement was influenced by the degree of customers' satisfaction. Not only the improvement but also the design of Six Sigma, customer demand run through the

entire process and its dynamic change influenced the enterprises' production process all the time.

(2) The process is the key point to be noticed. Management and improvement should match the process. Six Sigma Management can select the most important part of the whole process, analyze its influential factors with the statistical method, and then improve the process with the analytical results.

(3) Six Sigma Management is a method based on the data and facts, and corresponds with the idea of knowledge engineer. Six Sigma Management firstly makes clear that what is the key measurement of the operation performance standard and then uses the statistical data and analytical method to find out the key variables and optimal objective. Six Sigma Management helps the company solve what is the most important data and information and how to use them to maximize the company's revenue.

(4) It cooperates with all the parties in the whole supply chain without boundaries. Boundless cooperation doesn't mean unconditional sacrifice. It emphasizes that companies should exactly understand end-users' demand and the needs of the whole supply chain. More importantly, we should have an attitude to make almost every party gain benefits. Six Sigma Management can create a management structure and surroundings to support team cooperation.

(5) Six Sigma Management pursues perfection and endures failure. The companies applying Six Sigma Management need using the new methods and ideas, which will bring some risk to the companies. Though the system of Six Sigma Management has the tools to control the risk, we can't completely remove the risk. Thus we should

regard the Six Sigma level as the objective and bravely face and control the incidental failure.

1.3 Successful Experience of the Companies Applying Six Sigma Management

Today there is a large-scale Six Sigma quality storm blowing from the areas of Europe and USA to global areas. Following the pioneers, such as Texas Instrument, ABB, Honeywell, GE, almost manufacturing corporations of Fortune 500 began implemented Six Sigma Strategy. To be noticed, many Japanese companies, such as Kodak, Sony, Toshiba, which are the leaderships in the quality management field, had put Six Sigma into practice as their quality management strategy. In addition, more and more companies of service industry, such as CitiGroup, Amazon.com, had gained success in implementing Six Sigma management strategy (He Xiaoqun, 2004, p.15).

I have studied the successful Six Sigma Management experience of companies in service industry and concluded their general application framework of Six Sigma Management:

(1) Top managers' support
(2) Transition of the corporate culture
(3) Establishment of training system
(4) Good Six Sigma measurement system

1.4 Framework For Applying Six Sigma Management to Chinese Shipping Companies

1.4.1 Characteristic of the Shipping Companies' Operational Process

Shipping is a special service industry. The products it provides is that through sailing shipping companies help the shippers move their products to the places they required. The service shipping companies offer is composed of many sub-processes, which not only has the common characteristic of the service industry, but also has own specialty:

(1) The process is the output of single direction, and the products process provides can't be stored, such as freight producing process, function control process, and scheduled shipping process. Though they are input from a lot of different direction, the output is all in single direction, viz. provide freight transportation. Shipping companies offer the service which changes by time. Because the space and time can't be stored, this characteristic also adds the difficulty of the process control.

(2) It is very large of the shipping companies' moving region and time. The service of shipping companies is to provide a long displacement for the shippers' products. Ocean shipping needs spanning different continents and different countries, that is to say, one transportation operational process will cost a long period for the shipping companies.

(3) There are a lot of factors which can't be controlled in the process. In operational process, shipping companies will involve many outside process, such as inspection of the port, restriction of maritime space, passing the inside process of the port. These processes are not controlled by shipping companies, but they influence shipping companies' performance to a great extent. In addition, some environment factors also influence shipping companies' routine function, such as whether factors,

nature disasters and so on.

(4) Many service processes can't be distinguished by people' eyes: information, requirement, booking, suggestion, announcement, meeting, design, idea, which generally can't be directly monitored and checked. With the development of information technology, more and more service processes surround with the information of the computers and internet. Therefore, the products become imaginary, which will be very difficult to obviously distinguish different processes.

1.4.2 Framework of Six Sigma Management for Chinese Shipping Companies

Based on the above characteristics of the shipping companies' operational process and combining with the basic theory of Six Sigma Management, I think the framework of Chinese shipping companies' applying Six Sigma Management is like this:

(1) Do well in preparation work with top managers' support.

Before a new management method wants to be accepted by the employees, it must firstly be recognized by the company' top managers (Wen Huaifang and Zhang Chi, 2004, p.325). No matter what project, without the top managers' support, it will be terminated in the midway. Also in shipping industry, it is necessary for companies to gain the support from top and middle managers. It is impossible for top managers to participate in Six Sigma improvement project, but they can be as supporter and exponential to supervise and urge the projects smoothly process. The preparation work includes decision-making, strategy, organization, and resource.

(2) Select suitable Six Sigma project and do well in the project management.

The success of one Six Sigma project can set a good example for popularizing Six Sigma Management in the whole company. Meanwhile selecting suitable projects is also very important for final success of the project. Not all the projects can be selected as Six Sigma Project. Generally several principles can help companies' decision-makers to select a suitable Six Sigma project. After selecting a Six Sigma project, companies must do well in management work and conquer many handicaps to ensure that the project can be successfully applied in companies (Wang Rong, 2005, p.54).

(3) Identify process and its critical characteristics

Process management is always the core of Six Sigma Management (Yin Hong, 2003, p.78). Process improvement is generally as the carrier to gain the success of Six Sigma management. And the aim of process improvement is to change the process' incremental ability and level. Therefore, after selecting a suitable Six Sigma project, companies should analyze and identify its relevant process and the input & output variables, which are also the key point to gain the success of Six Sigma management. And finally it deposits as part of company management and become the magic weapon for company's persistent success.

(4) Companies can't regard Six Sigma management as a fashion, but should elaborately hatch it in strategy, put it into effect on organization, support it with enough resources, promote it in action, and fairly assess it in performance (Shen Yan, 2005, p.40). With the above efforts, Six Sigma management can be finally rooted in the company and become the basic form of company management.

CHAPTER 2
PREPARATION FOR INTRODUCING SIX SIGMA MANAGEMENT TO CHINENSE SHIPPING COMPANIES

The application of Six Sigma Management is a culture revolution, which involves nearly every aspect of the organization. In the face of challenge, companies should reform actively and make good preparation for all respects (Wen Huaifang and Zhang Chi, 2004, p.325).

2.1 Decision-making Preparation of the Top Managers

Top managers play an important role in application of Six Sigma Management. Only top managers have made a decision to popularize Six Sigma Management in the company, middle level leaders and employees can respond actively. Without top managers' support, any reform and project can be handicapped in the process or be involved in embarrassment. It is impossible for top managers to participate in Six Sigma Project every day, but with their help and support the champion can popularize it without hesitation. We can see the top managers' effects of some examples from the companies successfully applying Six Sigma. GE's CEO Jack Welch made a speech on popularizing Six Sigma in company' management meeting and proposed an objective to make GE become a Six Sigma company (Yang Yuejin, 2006, p.60). In the process of popularizing Six Sigma, Jack Welch overcame all kinds of resistance and mobilized the whole company to study Six Sigma. At last, Six

Sigma Management is successfully applied in GE.

In current Chinese shipping industry, many top managers come from the experienced sailors and captains, who have very rich experience in navigation, but don't have enough experience in managing a company. As Six Sigma management is a very new quality management method for most people, most top managers knowing it also needs some time. The first problem for Chinese Shipping companies applying Six Sigma is their top managers' strong decision and scientific strategic plan. Six Sigma successfully applying in COSCO proved the importance of top managers' decision and support. In 2000, COSCO' s president, Wei Jiafu, made a report to the State Council and claimed that COSCO plan to study GE and popularize Six Sigma. Wei Jiafu and his colleagues' determination is very firm. Though there are a lot of handicaps, with top managers' support, the whole company finally overcame kinds of difficulties in the process of popularizing Six Sigma. Therefore, I suggest that Chinese Shipping companies' top managers should firstly recognize the validity of Six Sigma Management and make a firm decision to apply it in their companies.

Generally top managers should well prepare the following things:

2.1.1 Corporation's Management Strategy Preparation

Six Sigma Management should combine with the company's mission and match the company's management doctrine. Top managers should adjust the company's operational strategy in time to cooperate with the application of Six Sigma Project in order to achieve company's performance (Wen Huaifang and Zhang Chi, 2004, p.325).

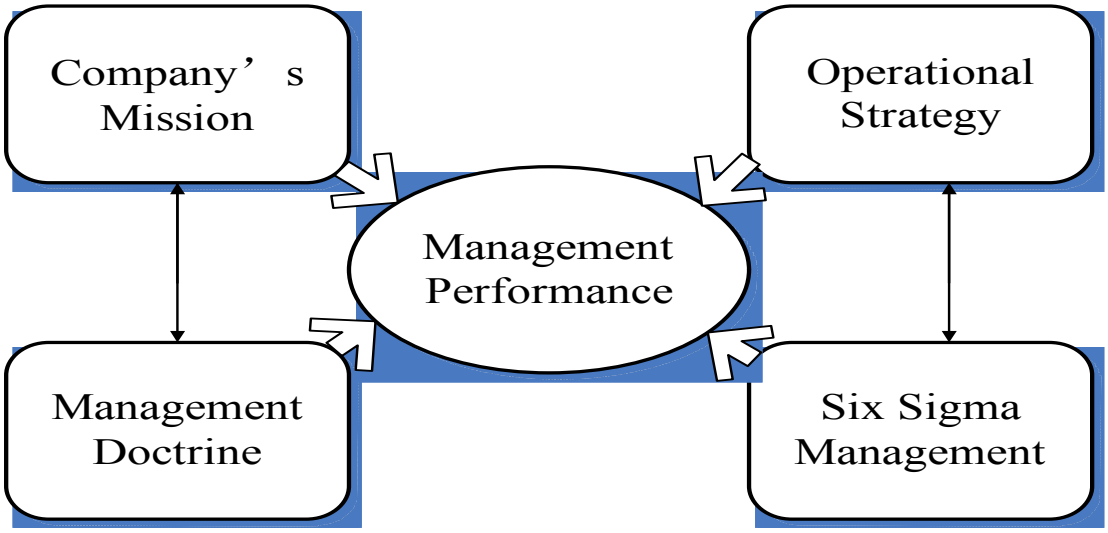

Figure 2.1: Six Sigma Management’s relationship with corporation’ strategy

I take COSCO for example to show the relationship of the above factors. COSCO’s strategy mission is to make COSCO become a well-known brand, promote enterprise’ international competitive strength and the sustainable development ability, change from global carrier to global logistics operator, transform from merely multinational management to multinational corporation. Its management doctrine is elaborate management and its operational strategy is to improve the process’ efficiency of production management and capital management. After spending many years’ time, COSCO finally found Six Sigma Management, which is based on data and facts, in other words,it is a elaborate management. And Six Sigma mainly concerns about the process, which also meet COSCO’s operational strategy. In addition, Six Sigma Management is a world-class quality management method, which matches its mission. All the above four factors influence the company’ management performance at the same time.

2.1.2 Preparation for the Organizational Culture Innovation

Because the application of Six Sigma Management is an in-depth culture innovation, companies must firstly analyze the organization's culture and confirm the culture factors to be innovated and then explicated it to the employees. And if the company can't popularize the new innovation, their survival will face the fatal threat (Wen Huaifang and Zhang Chi, 2004, p.326).

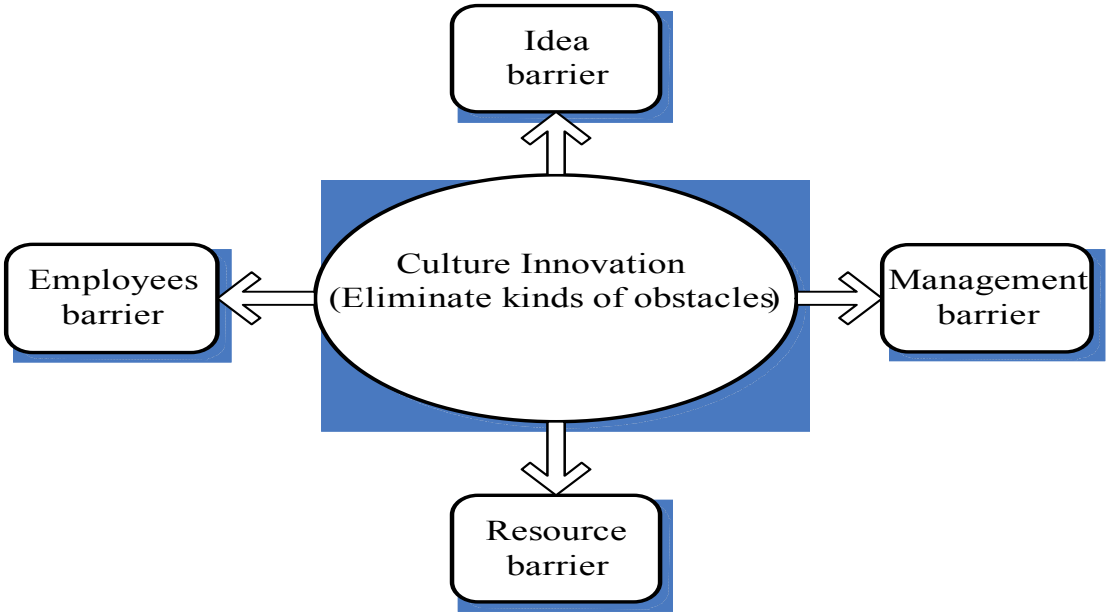

Figure 2.2: Corporation's internal barriers for Six Sigma Management

GE's Six Sigma popularizing method is to organize the employees to participate in the project (Yang Yuejin, 2006, p.34). But I think that in China we can't only ask the employees to participate in a project, because after accomplishing a project the employees will continue their previous working manners. We should make Six Sigma Management deeply be used in employees' routine work, not only for a project. In order to deeply popularize it, we should firstly change the employees' idea, in other words, let the employees know Six Sigma Management is a very useful quality management, which will greatly improve the company' operational efficiency. And this method is not an unattainable method as long as we have strong

determination and positive action.

2.1.3 Preparation for Organizational Structure

The application of Six Sigma Management is a systematic project. Project management and culture innovation is an omni-directional campaign. In the organizational structure, company should prepare corresponding employees, who will take the responsibility of leadership to impel the application of Six Sigma management. The chart of organizational structure is like the following:

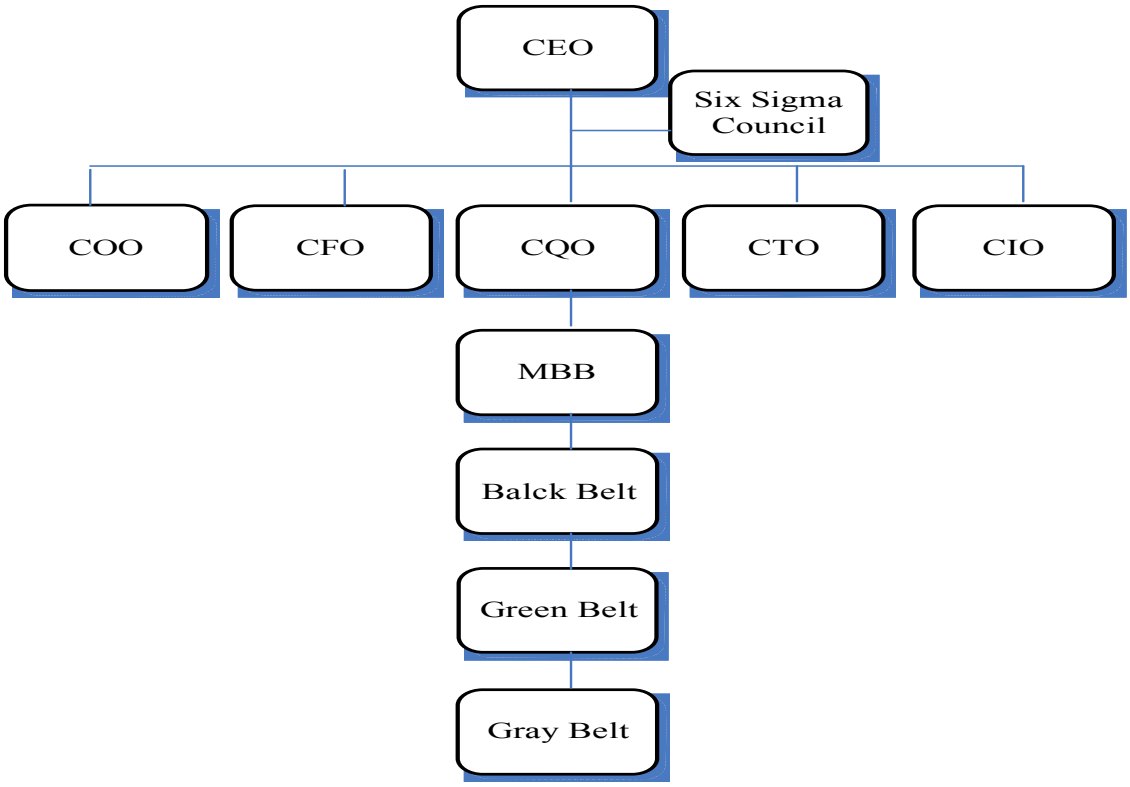

Figure 2.3: Corporation's organization structure for Six Sigma Management

I explain the main responsibilities of the above positions in detail:

a. The committee for carrying out Six Sigma is the highest managing institution for organizing the whole company to use Six Sigma. The leader of this committee can be pluralized by CQO or CEO, who is responsible for organizing employees, allocating resources, regulating organizational structure, and evaluating the results of applying Six Sigma. Then CQO lead several Master Black Belts.

b. Master Black Belt (MBB) is generally grown from Black Belt (Wen Huaifang and Zhang Chi, 2004, p.328). His main responsibility is to train Black Belt, provide consulting service, select Six Sigma Project, instruct and assist Black Belt to accomplish the important assignment of every step, and collect & analyze the data for the whole organization.

c. Black Belt plays the most important role in Six Sigma Management. They are the full-time employees for popularizing Six Sigma Management. They are the core force of the whole organization. Their struggling degree decides the success' possibility of Six Sigma Management. We can use the following words to sum up their main assignment:

1) Lead: Under the instruction of champion and MBB, the Black Belt defines Six Sigma Project and leads the whole group to accomplish the project.
2) Plan: Decide the content of every step' assignment.
3) Train: Train the members of the group to study and use the most effective Six Sigma technology and tools.
4) Discover: Find out the application opportunity of the new strategy and new tools, coordinate with the MBB to find the most valuable project, and then solve the resource problems.
5) Affirm: Cooperate with the other organizations and find out the new commercial

opportunity.

6) Influence: Make excellent relationship with the other colleagues and good organizing skill, and often make the group retain high morale and stable spirit.

7) Communicate: After achieving the project, Black Belt makes a project report to the top managers (Malin, 2004, p.21).

d. Green Belt is not the full-time job employee for participating in Six Sigma Management. They accept Six Sigma Management Training project similar to Black Belt, but the training content is very limited. In many companies applying Six Sigma Management, a big proportion of employees have ever accepted Six Sigma training, and their responsibility is to diffuse the new concept and new tools of Six Sigma into companies' everyday routine activities. Their main responsibilities include the following aspects:

1) Provide the professional knowledge of the relevant process

2) Establish Green Belt Project Group and communicate with the colleagues of group outside.

3) Promote the group' idea change

4) Spend time focusing on the project

5) Executive improvement plan to reduce the cost

6) Discuss with Black Belt on the executive situation and the future project

e. Compared to the other successful companies' organizational structure, I suggest that in China we should set up the position of Gray Belt in shipping companies. In general, time for training a Gray Belt is only one week .Then if the Gray Belt has excellent performance, he can be promoted to be a Green Belt. Because the number of trainees is large and time for training a Green Belt is more than two weeks, we can

spend shorter time training an employee as a Gray Belt, and then select the better ones to be Green Belt.

COSCO's Six Sigma organizational structure can be as a good example for Chinese shipping companies. COSCO establish the position of Blue Belt, whose responsibility is similar to my Gray Belt. Training a Green Belt needs two weeks time, but the time for training a Blue Belt is only one week. The Blue Belt with excellent performance will be promoted to be Green Belt. In COSCO, about 20 Blue Belts can be promoted to be Green Belt. COSCO plan to train 10 Master Black Belts, 100 Black Belts, and 1000 Green Belts. Their viewpoint is that it has a high losing rate and low successful rate for a Green Belt to become a Black Belt. Therefore, they hold elimination game step by step. Through training and doing project, they eliminate the unqualified ones among the Green Belts, such as those having poor communication ability may be eliminated. Generally technology aspect is evaluated by consultants and ability aspect is evaluated by directors.

2.2 Strategy Preparation

Six Sigma strategy is part of company's management strategy. A general process is like this: Analyze the problems of company's management plan, and then ascertain operational objective and strategy, finally make suitable management development plan (Wen Huaifang and Zhang Chi, 2004, p.328).

2.2.1 Analyze the Relevant Problems of Companies' Management Plan

Analyzing the problems needs considering the external environment factors, finding the key factors, discovering the problems' resolving breakthrough,and ascertaining Six Sigma Management' strategy idea.

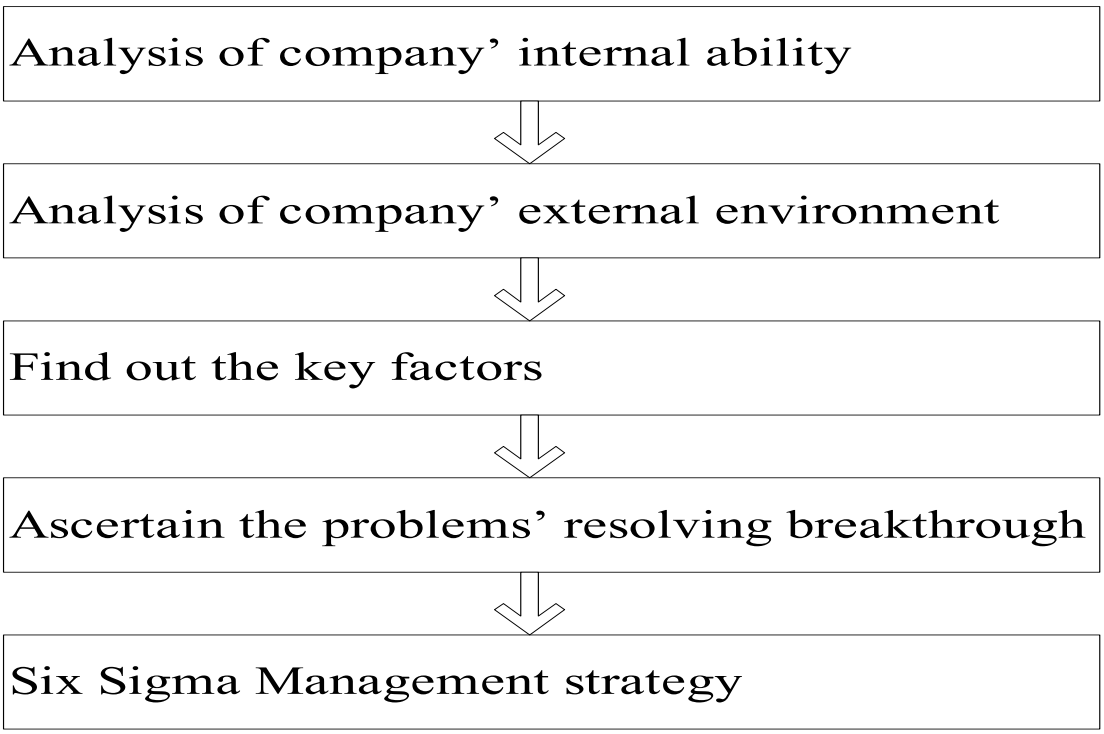

Figure 2.4: Steps for analyzing relevant problems of companies' management plan

2.2.2 Ascertain Companies' Operational Objective and Strategy

Ascertain companies' operational objective & strategy and combine with the application of Six Sigma project, which can reach companies' management performance very quickly.

Figure 2.5: Steps for integrating companies' strategy with Six Sigma Management

2.2.3 Make Management Plan

After confirming management objective and strategy policy, companies should make concrete management plan, which should integrate with Six Sigma strategy. The following chart illustrates the key factors for the success of management strategy.

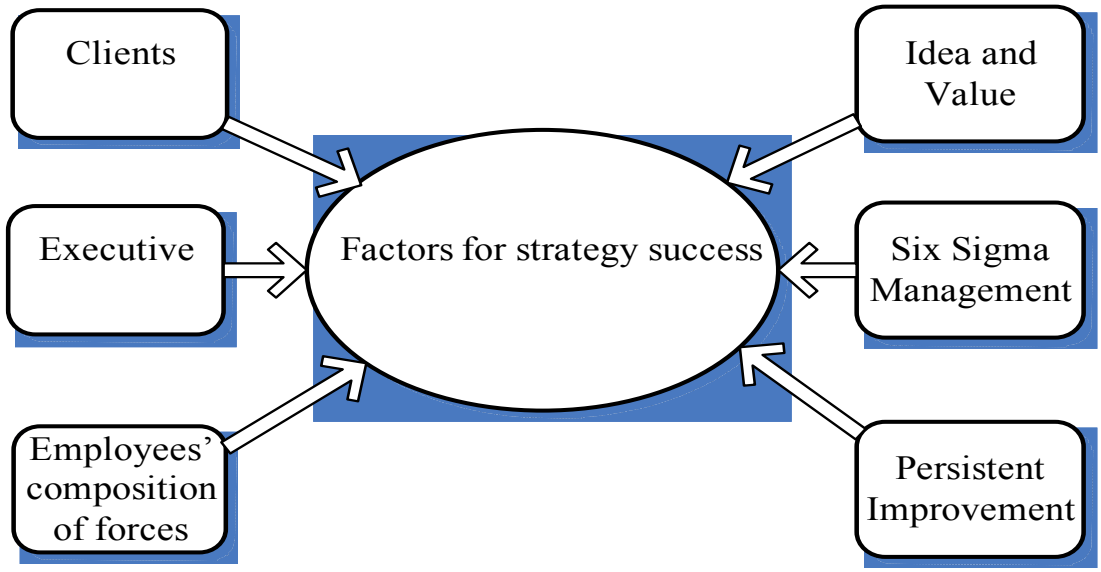

Figure 2.6: The factors influencing the success of a company' strategy

2.3 Resource Preparation

The application of Six Sigma management needs consuming a lot of resources. Certain input is the key point for ensuring the success of Six Sigma application.

2.3.1 Financial Input Preparation for Six Sigma Management

According to different situation and scale, different companies decide the financial input proportion. Based on the companies' specialty, they can input in installments, but the final return is striking. Generally the return of a Six Sigma project is 20 times of the initial input.

I take a 10000-employee company for example:

Table 2.1: An example of a company' financial input in Six Sigma Management

Input of startup Period	500,000
Input of first period	1,000,000
Input of second period	1,5,000
Latter input	2,000,000

Source: Wen Huaifang and Zhang Chi.(2004). *The Sigma Sigma Management For Servicing*（p.333）. Guangzhou: Guangdong Economic Press

In terms of GE' experience, in 1998, the initial investment of 0.5 billion USD brought with the financial saving of 0.75 billion USD. With Six Sigma deeply penetration into companies' routine business, this proportion enlarged continually.

2.3.2 Human Resource Investment Preparation for Six Sigma Management

Talent is the key factor in Six Sigma Management. Black Belt plays a very important role in the application process. Therefore, selecting the suitable people as Black Belt is a very important decision. An excellent Black Belt should have the following knowledge and ability: mathematic application ability, English use ability, training ability, innovation and management ability, team leadership, computer use ability, communication ability, solve problems independently, engineering background, knowledge of the products, and project management ability.

Because Black Belt is a special group, who are always pursued by Hunter Company .A lot of companies give Black Belt a very high wage and some of them give them companies' stock and option (Wen Huaifang and Zhang Chi, 2004, p.335).

2.3.3 Six Sigma Management Consultants' reparation:

Six Sigma project is the breakthrough of Six Sigma Management. Participation of consultants with rich experience is prerequisite for successfully applying Six Sigma Management (Malin, 2004, p.67). Deploying and applying Six Sigma is more difficult than training Black Belt, to a great extent, the final result is influenced by correct consultative work. I think the following principles, which are mainly used among the American companies, are very scientific.

a. Consultant group should have the people who have ever worked as president in the Fortune 100.
b. Consultant group should have the manager who have done the most basal work.
c. Consultant group should have the member who have ever participated in commercial reform.
d. Consultant group should have successfully instructed a certain number of companies' applying Six Sigma Management.
e. Consultant group should have the people who have worked as government advisor.
f. The members' performance of consultant group should be recognized by the industry which they engage in.
g. The member of consultant group should have published the articles in the industry' management journals and periodicals.
h. Consultant group should have the member who has ever worked as quality evaluator.
i. Consultant group should be recognized by Quality Association and have quality attestation.

Though the above requirement is very strict, the consultative expending is very high. Therefore, shipping companies had better base on the above requirement, which will be worth your expenditure.

CHAPTER 3
SIX SIGMA PROJECT MANAGEMENT IN CHINESE SHIPPING COMPANIES

In order to popularize Six Sigma Management, companies' first step is to do some Six Sigma Projects. Only do Project well one by one, Six Sigma Management can be ultimately popularized in the whole company. The Chairman of American PMP Authentication committee ever alleged that the whole shoot was project and the whole shoot would become project in current society (Jiao Shubin and Chen Yuntao, 2004, P.2). Practice has proved that project and project management has become the key for society progress and organization development. In 1970s, in the<<PMBOOK>> American PMI explained that Project Management is integrating kinds of systems, methods and personnel to achieve project' kinds of work in stated time, budget and quality objective scope (Zhong Qinglong, 2003, P.21). An effective Project Management can efficiently utilize the organization' resource, and guide & control the work.

Also shipping companies want to apply Six Sigma Management, they must firstly select and achieve some Six Sigma Projects. Though COSCO said that their Six Sigma Management is a routine work' Six Sigma Management, but its first step also is to select some projects to be experimented and applied.

3.1 Six Sigma Project Selection

3.1.1 General principles for selecting Six Sigma Project

(1) The principle for supporting the achievement of enterprise' strategy objective

Six Sigma Management ought to be an effective means to achieve enterprise' strategy objective, and every Six Sigma Project should support the enterprise' strategy achievement. That is to say, companies can regard Six Sigma Management as the bridge to accelerate its future strategy objective achievement.

(2)Financial principle

The income of Six Sigma Project is directly linked with companies' finance (Forrest W. Breyfogle, 1999, P.23). The selected project should be able to bring real benefit and financial return to enterprise. Generally most companies set down the lowest income standard for Six Sigma Project, such as Black Belt Project' lowest income is $250,000, and Green Belt Project' lowest income is $50,000.

(3) Customer satisfaction principle

Six Sigma Project Improvement should regard customer as the focus, and listen to customers' voice (VOC) and feedback (Blakeslee, Jerome A. Jr, 1999, p.77). Enterprises should duly correct the problems influencing customers' satisfaction and meet the customers' requirement and expectation to the best of their abilities.

(4)Time principle

Six Sigma Project is related to time. If a project has very big difficulty or has long-term problems, companies should divide the project into sub-projects or finish it stage by stage. Generally it is suitable for achieving a project in 3-6 months.

(5)Urgency principle

The application of Six Sigma Project should solve some urgent and crucial problems. The settlement of urgent problems means making the companies get rid of embarrassment fleetly.

(6) Low risk principle

Application of Six Sigma project should foresee the possible risk and unconfirmed result (Hunan, 2003, p.22). Companies should try hard to evade the risk & eliminate the risk, and select the low risk project as breakthrough.

(7) Rational allocating resources principle

Application of Six Sigma Project needs stated human resources, finance and material resources. Rational allocating resources can enhance companies' operational efficiency and improve management situation (He Xiaoqun, 2004, p.67).

(8) Manageable principle

Every Six Sigma Project should be manageable, that is to say, the problems in Six Sigma Project should be clear and measurable. If we can't measure the problems, we can't understand and solve it. If without data and facts, we can't analyze the Six Sigma Project. Therefore, measuring and understanding the problem is a very important premise for applying Six Sigma Project.

(9) Low resistance principle

Any reform will inevitably meet some resistances, which come from many aspects, such as enterprise' culture, tradition, policy and so on (Michael L. George, 2003, p.34). Generally we should choose the project of lower resistance to apply Six Sigma Management.

Shipping companies must seriously consider the above principles to decide and select a suitable Six Sigma Project.

3.1.2 The method of Project Choice Matrix

A project choice matrix can use the marks to quantization every principle and give the final evaluation for the project with marks. A project choice matrix is like the following chart:

Table 3.1: Project Choice Matrix

evaluation index	rank	Project1	Project2	Project3
principle 1	10			
principle 2	10			
principle 3	9			
principle 4	8			
principle 5	8			
principle 6	7			
principle 7	6			
principle 8	5			
principle 9	5			
project grade				
project sequence				

Project Grade= Project i * Evaluation Index j = $\sum_{i,j=1}^{n}$ i,j

Source: Wen Huaifang and Zhang Chi.(2004). *The Sigma Sigma Management For Servicing*(p.400). Guangzhou: Guangdong Economic Press

I take some projects of a shipping company for example to discuss which one should be selected as Six Sigma Project.

Project 1: Container Management

Project 2: Documentation Quality Improvement

Project 3: Terminal Loading& Unloading Process Improvement

Table 3.2: A shipping companies' Project Choice Matrix

evaluation index	rank	Project1	Project2	Project3
principle 1	10	8	9	8
principle 2	10	9	9	9
principle 3	9	5	8	6
principle 4	8	5	8	5
principle 5	8	6	7	5
principle 6	7	7	7	6
principle 7	6	5	7	4
principle 8	5	8	8	8
principle 9	5	7	8	5
project grade		457	543	435
project sequence		2	1	3

According to the above analysis, we can conclude that the project of Documentation Quality Improvement should be firstly selected as Six Sigma Project.

3.1.3 Introduction of the Balanceable Score Card (BSC)

Through the development of several decades, BSC has evolved from performance tool to an integrated management system for company strategy' establishment, implementation, track and evaluation (Malin, 2004, p.65). This tool's application involves many industries including manufacturing, banking, government agent and information industry. According to the investigation of Kenaissance, 60% of world Fortune 1000 companies have used BSC, and 70% of the world biggest 300 banks

are using BSC.

The research origin of BSC is that people find financial index invalid for modern companies' organization. The experts had explored many substitute methods, and finally they constructed a four-dimensional performance evaluation system, which combined finance, customer, internal operation process with companies' ability. This company performance evaluation system finally evolves into Balanceable Score Card method.

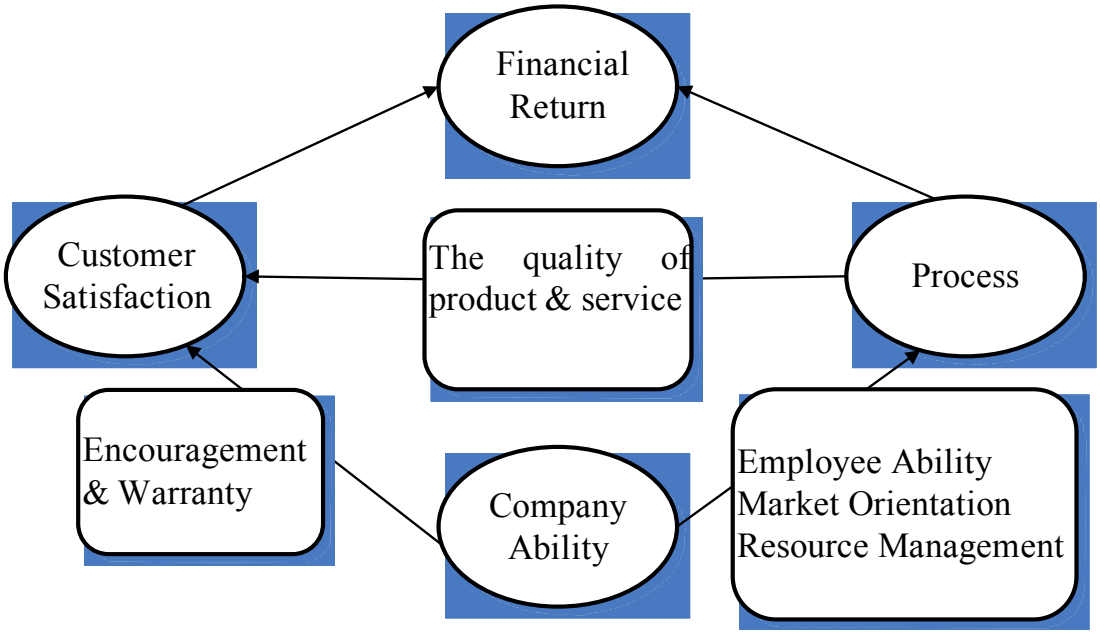

Figure 3.1:BSC' four-dimensional performance evaluation system

BSC is a business management mode of cause and effect. Strengthening enterprise' ability, improving process ability, reducing the ill cost, and improving customer satisfaction, will naturally increase companies' financial return (Wen Huaifang and Zhang Chi, 2004, p.352).

The contents of the four dimensions:

(1) Customer perspective

When designing evaluation index of customer perspective, companies must answer two questions: Firstly, who are our target customers? If we want to make our products meet all the customers' demand, we will not have some difference from our competitors (Yang Yuejin, 2006, p.35). Secondly, what is our value orientation? A suitable value orientation is also a big challenge for the companies. At present, customer perspective widely uses the following index: customer satisfaction, customer loyalty, market share and so on.

(2) Internal process perspective

In order to attract more customers and increase the shareholders' value, enterprises must distinguish their main processes and try their best to make the processes efficiently operate (He Xiaoqun, 2004, p.28)

(3) Learning and growth perspective

Learning and growth perspective is the Strengthen Pharmaceutical for realizing the other three dimension objectives. Fundamentally speaking, learning and growth perspective is the basis of the Balanceable Score Card (Malin, 2004, p.56). Once confirming the index of customer perspective or internal process perspective, you will find that current employees' skill have big difference with the index objective. The index of learning and growth will make the difference become smaller and smaller.

(4) Financial perspective

This dimension index tells us that whether the application of other dimension strategy will lead to result improvement. The typical index includes profitability, earning growth and so on (Ronald.D.Snee and Roger.W.Hoerl, 2003, p.34)

Every dimension of Balanceable Score Card can be selected as the general orientation of Six Sigma Project choice, which guarantees that the Six Sigma Project is identical to organization' current objective and future development. When confirming projects' concrete index, you need to consider the balance of four dimensions and avoid one index improvement will lead to bad consequences.

Finance	Customer
Unit cost Inventory level Production cost Bad cost (COPQ)	Customer satisfaction & CTQ Delivery in time Service quality (process output KPOV) Communication
Internal operation process	**Learning and growth**
Defect DPMO RTY Process cycle Key process input (KPIV)	Six Sigma method and the tools application Subject training Training of Six Sigma Green and Black Belt Mechanics of organization behavior The number of employees participation in Six Sigma Project

Figure 3.2: A shipping company's Balanceable Score Card

3.1.4 Example of COSCO's Six Sigma Project Selection

COSCO is doing the project of "document quality control", which mainly aims at improving the logistics operation. Document is the main linkage between COSCO and the shippers, thus the quality of document directly influences the whole supply chain process and the customers' satisfaction. If COSCO doesn't improve the

document quality, it will cause some problems in the whole process operation, influence the customers' satisfaction and finally it will make a loss in finance.

After confirming the project' general orientation Y, we need to analyze Y' main influential respects layer upon layer and finally confirm the improvement' main aspects. In COSCO' document improvement project, there are a lot of factors which will influence mistake rate of the project. For example, previously a lot of documents are input at Friday when the employees are very tired, which will directly influence the mistake rate. Based on the scope and influence degree, we regard some projects as Black Belt Projects, which need to be solved trans-department, and some projects as Green Belt Projects, which can be solved inside a department. In addition, some projects are called common projects, because they have low difficulty and don't need to use advanced statistics tool.

3.2 Six Sigma Project Management

3.2.1 Risk Management

3.2.1.1 General Introduction of Risk Management

As the complexity of the business environment and uncertain change aggravate day by day, the internal and external risk of the project become the key factor to determine the project success or failure. Similarly the risk management of Six Sigma Project is also indispensable contents of the project management system. Project risk management mainly emphasizes active control of the projects, and distinguishing& evaluating the risk and disturbing factors in the process of selecting and implementing the projects (Michael L. George, 2003, p.45). In Six Sigma

Management, there is a special risk management tool-FMEA(Failure Modes and Effects Analysis).

3.2.1.2 The Tool of FMEA

FMEA is a systematic tool to check and prevent the potential failure. This tool can improve the ability to forecast the problems in order to confirm the failure mode. FMEA is mainly used in the beginning stage of process and product & service' design (Wang Rong, 2005, p.12).

The measurement of FMEA

FMEA has four typical parameters to be measured: severity, occurrence, detection, and RPN (Wen Huaifang and Zhang Chi, 2004, p.344):

1) Severity: measure the influence of the potential failure to the system, frontal system and final customers.
2) Occurrence: Measure the causation and occurrence of failure mode.
3) Detection: Measure existing control method and check the possibility of failure mode.
4) RPN: RPN=SEV*OOC*DET. Higher the RPN, bigger of the failure' possibility. We should take measures to eliminate and reduce the risk, and decrease opportunity of the potential failure.

FMEA' basic step is on the following:

(1)Fix on process and product & service

.

(2)List the possible problems (Failure Mode).

(3)Evaluate the problems from Severity, Occurrence and Detection .Use the figures 1-10 to give the marks to the factors of the potential problems. Higher marks, more serious of the problem. Marking the problems is based on the history data and experience:

1) Calculate the RPN. RPN is the risk rate of the problem. We can sum up all the risk rate of the problems and then obtain the risk rate of the whole process or product & service.

2) Take measures to reduce the risk.

Table 3.3: Risk Evaluation Standard

RPN Evaluation	Influence/Action Demand
1<RPN<50	Small harmfulness for the product & service
50<RPN<120	Medium harmfulness for the product & service, need to concern
120<RPN<1000	Serious harmfulness for the product & service, need to prepare counter-measures

Source: Wen Huaifang and Zhang Chi.(2004). *The Sigma Sigma Management For Servicing* (p.346). Guangzhou: Guangdong Economic Press

In the process of applying Six Sigma, shipping companies can divide risk into technology risk, time risk and cost risk, and then give marks to the influencing rate and occurrence. At last calculate the risk rate (risk rate= influencing rate*occurrence) to decide whether companies should prepare the risk counter-measure.

COSCO is using FMEA to analyze the cause of mistake rate of documents. They found that mistake rate was very small when inputting a document continuously, while the mistake rate was very big when inputting a document one period by one

period. Therefore COSCO require that employees must input all the contents of a document, and then they can do the other things.

3.2.2 Scope Management

We need to manage the scope of the project in order to confirm a rational scope of the project and control the change of the project scope.

3.2.3 Time Management

Supervising the project plan and project progress can guarantee that the project can be finished in stated time. The project implementation process should be carried out step by step. COSCO's documentation project is divided into three periods: firstly, it aimed to improve the quality of documentation center operation; Secondly, it changed the system' usage situation; Thirdly, it used IT technology to secure the quality of the documents.

3.2.4 Cost Management

For implantation Six Sigma Project, time progress should make a good relationship with cost control (Yin Hong, 2003, p.223). Also we should try our best to lessen the circle time, which may incur the cost increase. Controlling cost strictly, managing the cost of the project and strengthening employees' cost consciousness will guarantee that the project cost can be controlled within the budget.

3.3 Project Implementation and Control

If a better project is not put into effect, it just fight only on paper. In the process of project implementation, it is inevitable to meet some unpredictable factors. In order to achieve the projects according to the set plan, we must supervise the implementation process (Yao Yuling, 2004, p.89). Generally shipping companies will meet the following handicaps:

(1) Internal barriers: Previous organization structure of command and control will bring with impassable obstacle to boundless cooperation which the Six Sigma Projects need. Therefore shipping companies must set up new pattern organization structure to adapt to Six Sigma Management (Wang Rong, 2005, p.66).

(2) External barriers: Because shipping companies is controlled by some government agencies such as Harbor Bureau and Maritime Safety Administration and so on. In the process of Six Sigma Implementation, it is inevitable to meet conflicts with them. Thus shipping companies must make a good strategy relationship with the external organizations and agencies.

(3) Employees resistance: As Six Sigma Management is a new management method and idea, employees will inevitably have resistance psychology, so we should penetrate the idea into the whole company and train our employees in order to remove the employees' barriers.

3.4 Six Sigma Project Evaluation

Evaluation of Six Sigma Project and round-off work is still very important for Project Management (Zhang Lijun, 2004, p.43). Through evaluation we can summarize the experience, confirm gain and loss, and improve the work in order to

ascertain project' emphases of the next step and guarantee work' persistent progress. Generally we can use Financial Evaluation Indicator, Key Performance Indicator, Customer Satisfaction and invisible income to synthetically evaluate a Six Sigma Project.

(1)Financial Evaluation Indicator

This is a rigid index of Six Sigma Project Evaluation. Finishing a project, financial personnel can clearly estimate how much the cost is and how much the financial return is, and then they can carry out the final financial analysis.

(2)KPI

How much the internal process ability of an organization has improved, how the result of improvement is, and how the organization performance of the department, all of which can be linked with Six Sigma Project (Wang Guowen, 2004, p.32). In addition, we can decompose the evaluation into every employee and give evaluation for every employee.

(3)Customer satisfaction

Customer satisfaction is also a very important evaluation indicator. If a company's customer satisfaction rises, its market share will enlarge, financial income will increase, shareholder' investment return rate will rise, the tendency of the stock price will be powerful, company's future will be bright.

(5) Invisible income

Besides the financial income of Six Sigma Project, companies will have a lot of invisible income (Zhang Lijun, 2004, p.59). Through implementation of Six Sigma Project, companies change previous Bureaucratic work style, form Six Sigma

company culture, and employees' value and employees' satisfaction increase. These will increasingly enhance companies' cohesiveness and the employees' personal qualification also will be improved.

CHAPTER 4
SHIPPING COMPANIES' PROCESS FLOW MANAGEMENT

Process is most noticed in Six Sigma Management. Eliminating the unnecessary process can optimize the efficiency of the whole system, save the circle time of process, and gain the real value of the process.

4.1 Steps of Process Improvement

Companies need to manage many processes including sale, purchase, R&D, production, service, human resource, finance and so on. How to improve these processes and make them more efficient is a question for discussion. Process improvement generally has five steps (He Wan, 2005, p.46):

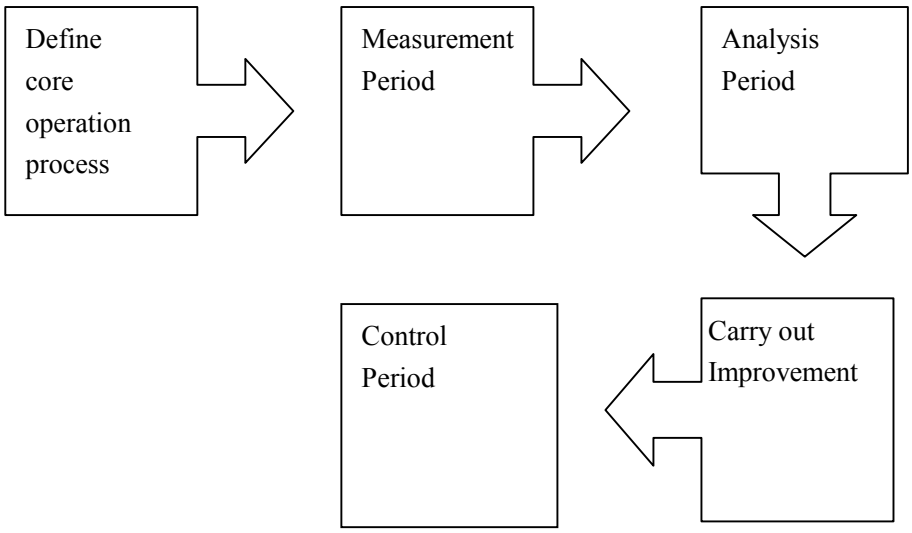

Figure 4.1: Steps for process improvement

(1)Define

Companies should define their core business processes and standardize them. Companies with extensive management mainly depend on leaders' ability and experience. But world famous companies have already defined their main business processes, such as GE, though Jack Welch have retired,his company still operate very smoothly, because GE has made a very effective definition for his main business processes and made them become a very standard document (Yang Yuejin, 2006, p.77).

(2)Measure

Through widely collecting the data and facts of the process performance, companies can understand the processes' requirement characteristics, and then change them into the standard of process quality characteristics. According to the standard, companies can evaluate the performance of the core processes and find out their disparity with Six Sigma standard (Michael L. George, 2003, p.90). In addition, we can elementarily use the to fishbone picture to find the influential factors for current processes and collect and settle the relevant data.

(3)Analyze

After knowing the process operation situation and getting the measurement results, companies should seriously analyze them and find out the fundamental reasons for the problems, through which they can define the improvement orientation (Shen Yan, 2005, p.40). For example, if companies find some problems in the document processes flow when analyzing, they will firstly focus on document process improvement.

(4)Improve

The objective of improvement is to provide more benefits for both the companies and customers (Zhou Yongfa, 2005, p.41). The result of improvement must make the efficiency and benefit of activities and processes improve a lot.

(5)Control

Control is to continuously supervise the process, find and evaluate deviation at any time, correct the mistakes in time, eliminate the accidetal defects, and make the processes stay at working order (Lin Fei, 2003, p.69). The assignment of quality control is to keep stated quality level.

4.2 The Tool of Six Sigma Process Management

Cause and Effect analysis tool is the basic method for solving problems in Six Sigma management. It has two basic tools: Cause and effect diagram and Cause and effect Matrix (Wen Huaifang and Zhang Chi, 2004, p.367).

4.2.1 Cause and Effect Diagram

4.2.1.1 The Steps to Draw a Cause and Effect Diagram

Cause and effect diagram is to identify, investigate and graphic the possible reasons for the particular problem. The steps to draw this diagram are like this:

(1) Let the team concentrate on the problem' content.

(2) Draw a whole picture about all the knowledge of the problem.

(3) Make a team member' common understanding of the cause.

(4) Provide support for the problem' solution.

(5) Don't concentrate on the omen but on the cause.

4.2.1.2 The Structure of the Cause and Effect Diagram

Cause and effect diagram is also called fishbone picture. The problem to be analyzed is on the end of the right arrow point, and the possible reasons' main classification are as the branches of the arrow point. And then draw all the possible reasons on every branch.

Generally a Cause and effect diagram is like the chart:

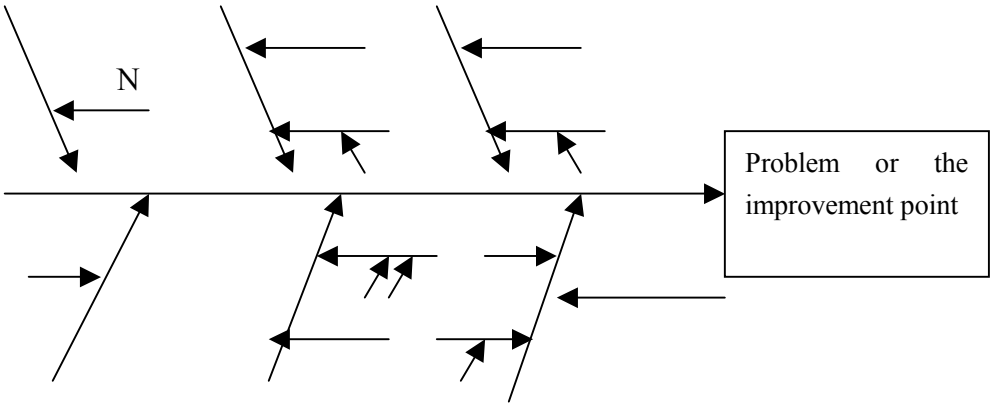

Figure 4.2 Cause and effect diagram

Source: Malin. (2004). *Six Sigma Management*(p.304) . Beijing: China Renmin University Press

4.2.1.3 The Advantages and Disadvantages of Cause and Effect Diagram

This diagram has many advantages: it can combine all the relevant factors and reasons to comprehensively analyze the problem, provide the basic content for the method of brain storming, and absorb all people' intelligence to solve the problem.

Of course, it inevitably has some disadvantages, such as it maybe make the problem very complicated, and people should have the impatience to draw this diagram. In addition, most companies applying Six Sigma Management can't make a sequence of the causes when using fishbone picture. I suggest that companies can put the most possible and serous causes nearer to the right end of the arrow point, which can clearly make a sequence of the causes.

4.2.2 Cause and Effect Matrix

Cause and Effect Matrix is a graph to display the relationship between input and output. This graph is also called X-Y Matrix.

Table 4.1: Cause and Effect Matrix

	Y1	Y2	Y3	……	Yn	Rank of influential rate of X' to Y'
Ranks	10	9	8	7	8	Total evaluation
X1						
X2						
X's						
….						
….						
….						
Xn						

Source: Wen Huaifang and Zhang Chi.(2004). *The Sigma Sigma Management For Servicing*(p.456). Guangzhou: Guangdong Economic Press

The steps to make a Cause and Effect Matrix:

(1)List the main output variables y's

(2)Make a sequence of the output variables according to the customer requirement.

(3)List the main input variables x's.

(4)Make the relationship between x's and y's.

(5)Calculate the X's influential degree to Y's and then make a sequence.

4.3 Case Study of Shortening the Cycle Time for Sending Ship's Appliance and Equipments to be Repaired

Ship's appliance and equipment need to be maintained and repaired at regular intervals, so the Maintenance Department must spend a lot of money to store enough substitute appliance and equipment to keep the ship normal operation. If we could shorten the cycle of sending the appliance and equipment to be repaired, we would improve the appliance and equipment' turnover rate, reduce the cost, and advance the appliance and equipment' utilization rate.

DMAIC Phrases of this project

(1)Define

The work content of this phrase is on the following:

1) Confirm the internal and external customers and their requirement which will influence the cycle of sending the appliance and equipment to be repaired.

2) Draw the current flow chart of sending the appliance and equipment to be repaired.

3) Select the team member of this project and make the members reach agreement for this project.

4) Estimate the cost and the expected benefit of improvement.

We can draw a square picture to show the main work of this phase. Also in the square picture we can add the types of customers, customer requirement, and the other projects using for reference.

Problem description: The cycle of sending the appliance and equipment to be repaired is too long, which increases the procurement expenses and needs to be improved . **Defect definition**: The cycle is over 30 days, which is too long. **Objective**: The cycle is reduced to 22 days and the maximum time is 25 days. **Data source**: IT management system and note of the maintenance manufacturer	**Core business Y affected:** XXX ability XXX ability **Expected Benefit:** 1. Replace the bad appliance and equipment; Improve Customer Satisfaction; Reduce storage cost 2. Increase the turnover rate by X%
Project Schedule **Measure**: Control technology chart DD/MM/YY **Analyze:** Fishbone Picture DD/MM/YY **Improve**: List the plan of improvement DD/MM/YY **Control**: Implement control instrument DD/MM/YY	**Project Leader**: XXX **Team Member**: - XXX - XXX - XXX - XXX **Sponsor:** XXX XXX

Figure 4.3: The case' project square picture

Project square picture can clearly describe the project' objective and problems in the process control. It is a very good graph tool in definition phrase.

Flow chart is also a key part in definition phrase. Through drawing flow chart, we can clearly know the whole process of sending the appliance and equipment to maintenance manufacturer and find out the relevant influential factors. This project

involves the processes showing in the following picture:

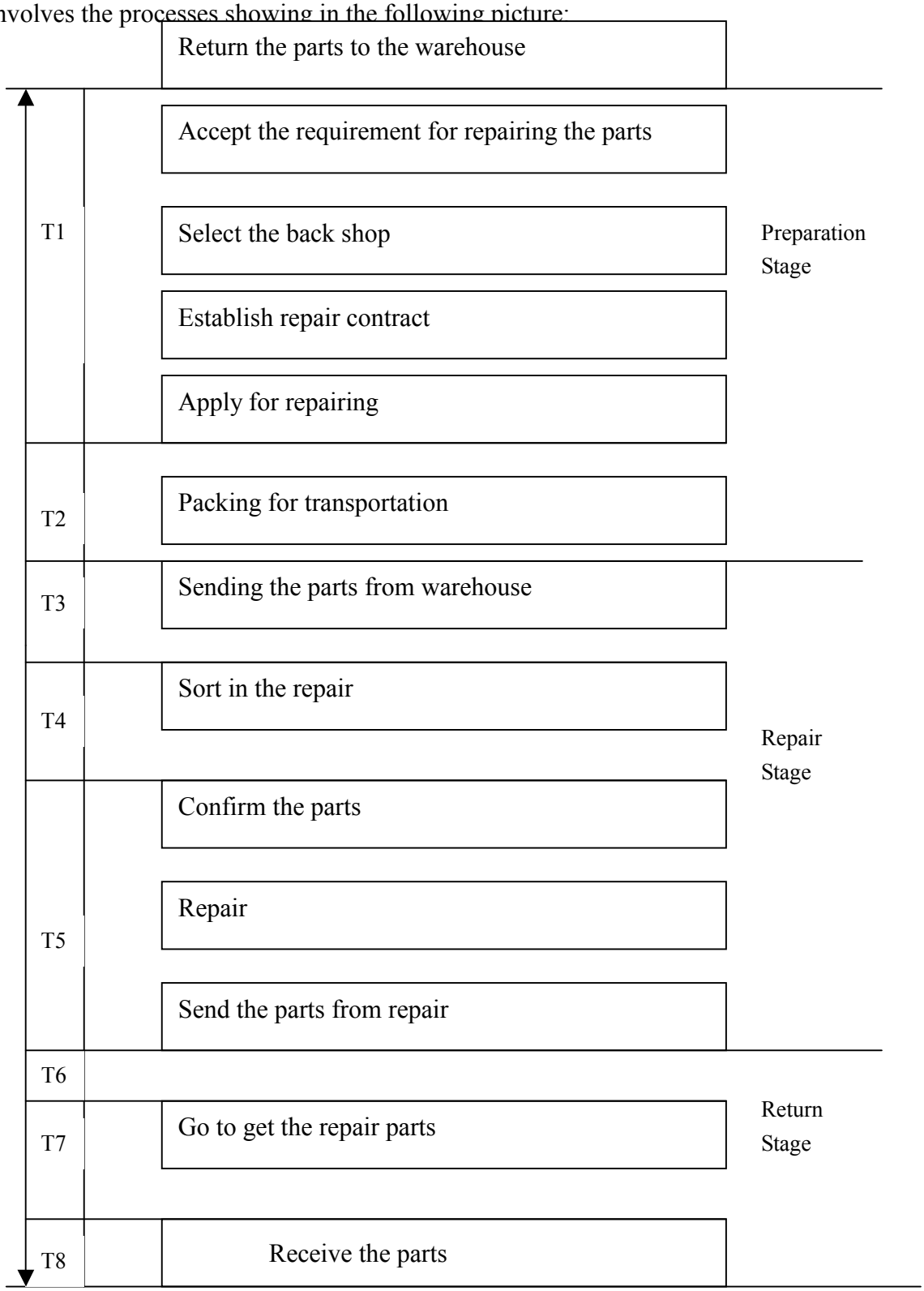

Figure 4.4 : The flow chart for sending ship parts to be repaired

According to the above flow chart, we can see that the influential factors for the cycle is t1, t2, ….., t8. Defining the responsibilities of the involving departments set good foundation for the phases of measurement and analysis.

(2) Measure

This phrase needs to collect the data of the total time of the cycle (Y), and analyze the data collected in order to insure the reliability of the data. Then according to the data, we analyze the current and potential ability of sending the appliance and equipment to be repaired and draw the relevant control technique picture. Finally we draw a fishbone picture to find out all the factors influencing the cycle time.

The process data type of this project is persistent data, so we use the measurement system analytical tool is Gage R&R of Minitab. The calculating result is on the following:

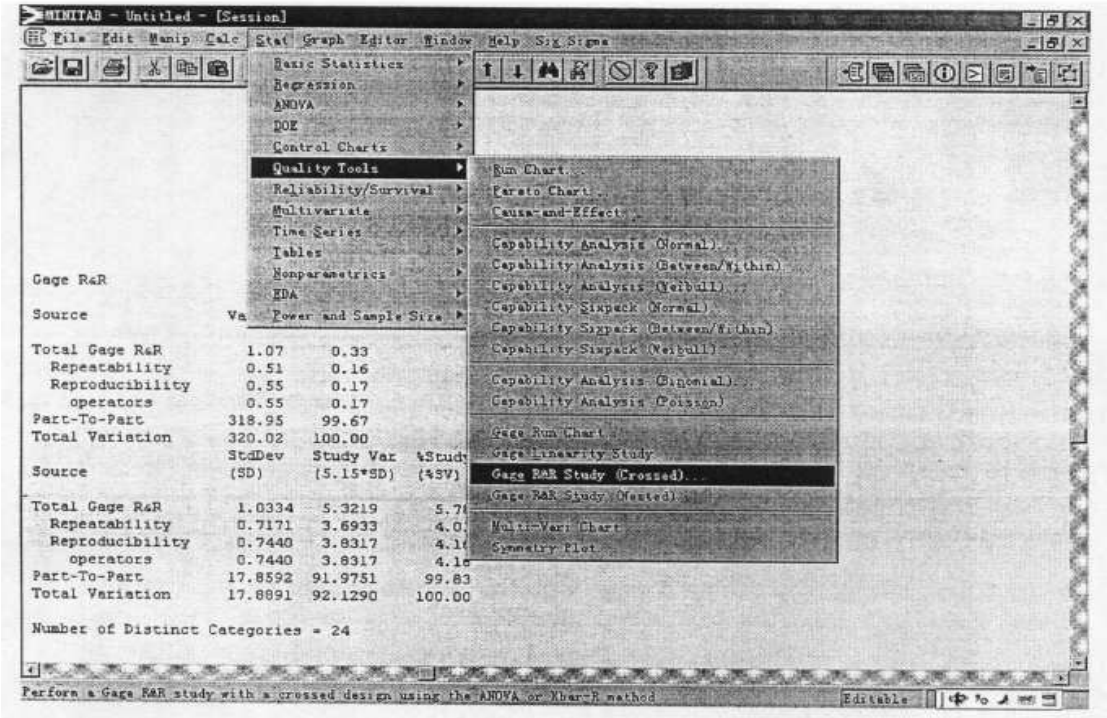

Figure 4.5: The calculating result of Gage R&R of Minitab for the case

According to the calculating result, we know that Total Gage R&R =5.3219% <10%, therefore the reliability of data is very high. And then based on current data, we can analyze the whole process' long-term capability and short-term capability. Because we have proved the whole cycle is Normal Distribution, we can use Process Capability in Minitab to estimate process' long-term capability and short-term capability. The estimating result is on the following:

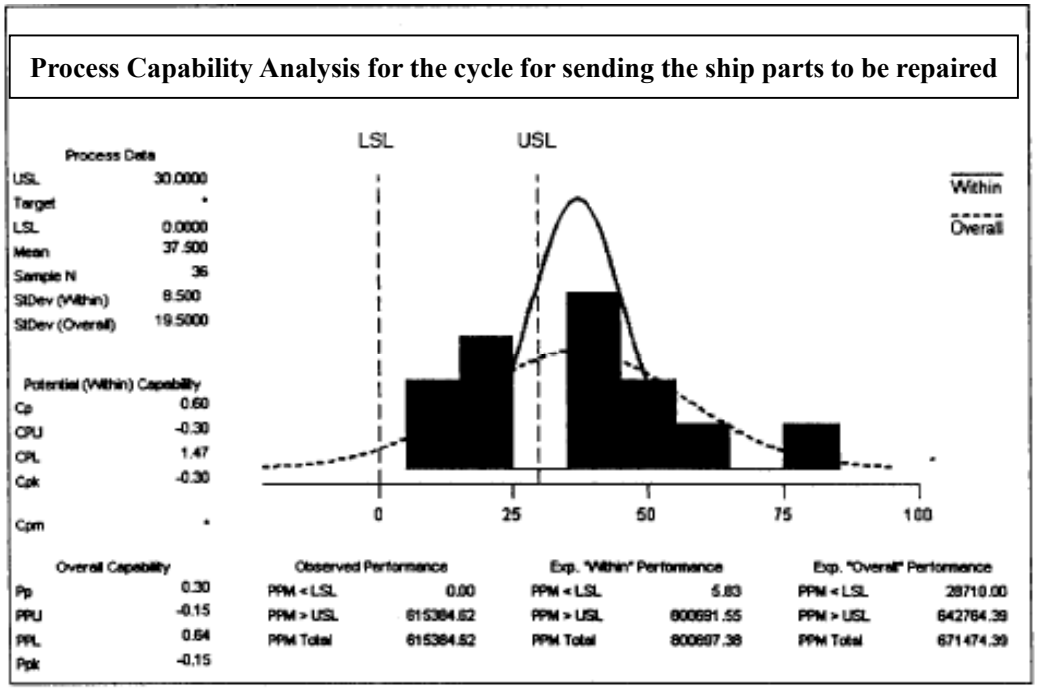

Figure 4.6: Process Capability Analysis for the cycle for sending the ship parts to be repaired

According to the computing result, we know that most of the data collected is between upper limit and lower limit, so we use the method of "choosing the points" to compute the whole process' long-term capability and short-term capability.

1) Compute long-term capability: According to the description statistics method, we

know that Mean of cycle is 37.5 and the deviation is 19.5. Therefore:

$$Z_{USL} = \frac{USL - X}{\sigma} = \frac{30 - 37.5}{19.5} = -0.3846 \qquad p(d) = 0.64973$$

$$Z_{USL} = \frac{\overline{X} - LSL}{\sigma} = \frac{37.5 - 0}{19.5} = 1.923 \qquad p(d) = 0.02724$$

$$p(d)total = 0.64973 + 0.02724 = 0.67697 \qquad Z_{LT} = -0.459$$

The result indicates that the long-term capability is minus and the result hasn't reached half of the required level.

2) Compute long-term capability: Rank the data based on the time, we can find seven better points which can be as the expression of short-term process. The computing method is similar to the long-term capability. The result is:

$Z_{ST} = 0.95$， $Z_{SHIFT} = Z_{ST} - Z_{LT} = 0.95 - (-0.459) = 1.409$

According to the above computation result, we know that there is 1.409 Six Sigma improvement and there is certain difference between Long-term capability and short-term capability. We should improve the process to make them reach agreement. We can also draw the following technology control picture:

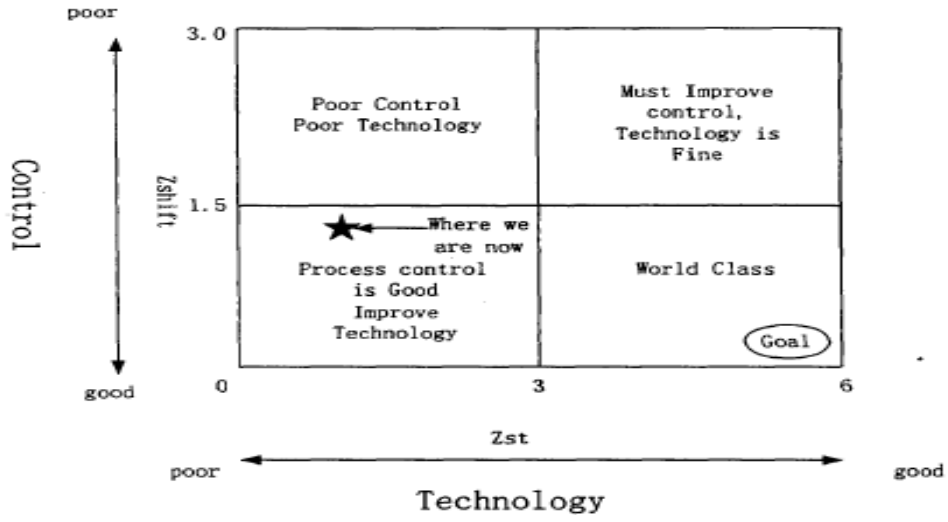

Figure 4.7: Technology control picture

The technology control picture shows that the situation of current process is on C, which means that control ability is good but technology ability should be improved. And it also indicates the improvement orientation and potential.

At last, we have to analyze all the factors influencing the cycle of sending the appliance and equipment to be repaired. The fishbone picture of this project is on the following. From this picture, we can find the factors t1, t2, t3, f1, f2, which will set solid foundation for analysis stage.

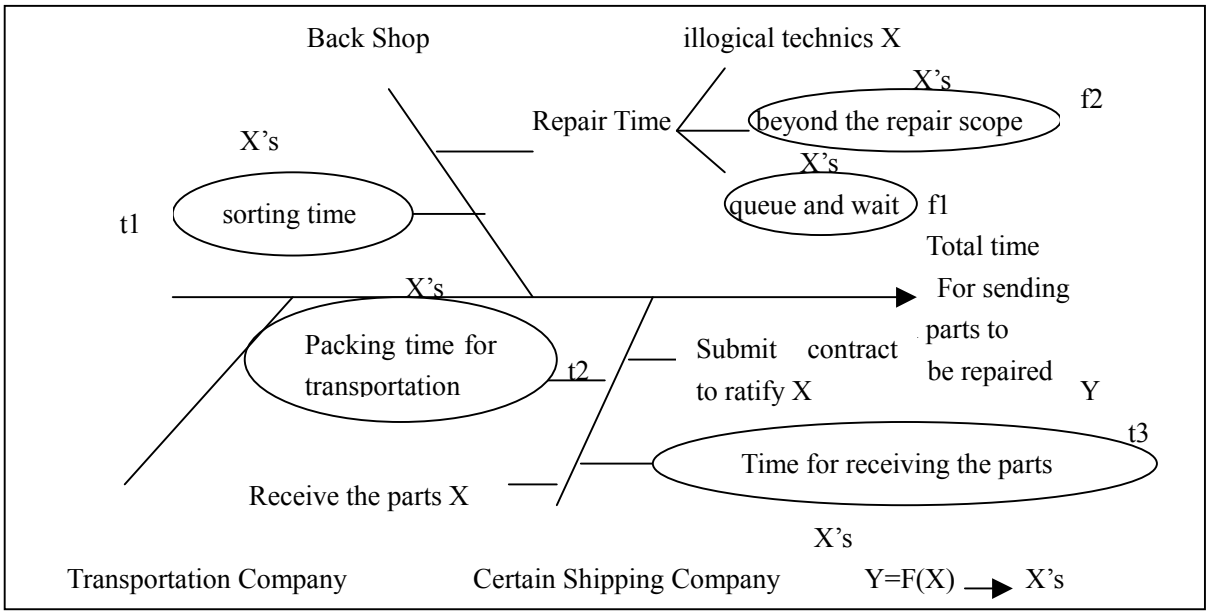

Figure 4.8: Fishbone picture for the cycle of sending the appliance and equipment to be repaired.

(3) Analysis Stage

This stage mainly uses some statistical methods to find out the key causes influencing the whole cycle and set functional relation between the cycle and the influential factors. That is to say, confirm Y=F(X) to find out effective improvement

orientation for shortening the cycle. From the measurement stage, we know that the influential factors include t1, t2, t3, f1, f2, and then we use Best Subsets to select important influential factors. The computation result is on the following:

Table 4.2: Computaion result of Best Subset for this case

Best Subsets Regression: T versus t1, t2, t3, f1, f2

Response is T					t	t	t	f	f
Vars	R-Sq	R-Sq(adj)	C-p	S	1	2	3	1	2
1	92.7	92.4	33.3	5.3423			X		
1	71.8	70.6	191.3	10.493	X				
2	95.1	94.6	17.3	4.4803			X	X	
2	93.2	92.6	31.3	5.2549	X			X	
3	96.1	95.5	11.8	4.0966		X	X	X	
3	96.0	95.4	12.4	4.1378	X		X	X	
4	97.2	96.6	5.4	3.5569	X	X	X	X	
4	96.3	95.6	12.0	4.0632	X		X	X	X
5	97.4	96.7	6.0	3.5201	X	X	X	X	X

The result shows that t1, t2, t3, f1, f2 are all the important factors and the five factors' correlation is 96.7% with the cycle. That is to say, these five factors contribute 96.7% of the change of the cycle.

Since we have found out the main factors influencing the cycle, we can use the function between cycle and key factors to find out the of improvement order. Now we can use regression analysis to set a function between cycle and key factors.

Because f2 is Category variable, we can use GLM (General Linear Model) to do regression analysis.

Table 4.3: Using GLM to do regression analysis for this case

General Linear Model: T versus f2

Factor	Type	Levels	Values
f2	random	2	1 2

Analysis of Variance for T, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
t1	1	6711.4	121.1	121.1	9.77	0.005
t2	1	24.4	98.9	98.9	7.98	0.010
t3	1	545.5	342.9	342.9	27.67	0.000
f1	1	1806.9	880.9	880.9	71.09	0.000
f2	1	17.9	17.9	17.9	1.44	0.244
Error	20	247.8	247.8	12.4		
Total	25	9353.8				

Term	Coef	SE Coef	T	P
Constant	11.647	2.458	4.74	0.000
t1	0.7677	0.2456	3.13	0.005
t2	1.1765	0.4165	2.82	0.010
t3	1.8471	0.3511	5.26	0.000
f1	1.0930	0.1296	8.43	0.000

f2>0.05 (we choose significance =0.5 in this case) means that the factor f2 has significance with the cycle, so we should delete f2. The left variables are persistent data, so we can do multivariate linear regression analysis.

Table 4.4: Multivariate linear regression analysis of this case

Regression Analysis: T versus t1, t2, t3, f1

The regression equation is

T = 15.5 + 0.652 t1 + 1.26 t2 + 1.79 t3 + 1.39 f1

Predictor	Coef	SE Coef	T	P
Constant	15.457	2.272	4.60	0.000
t1	0.6517	0.2243	2.86	0.009
t2	1.2572	0.4177	2.96	0.007
t3	1.7894	0.3502	5.08	0.000
f1	1.39372	0.09989	11.95	0.000

S = 3.557 R-Sq = 97.2% R-Sq(adj) = 96.6%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	4	9088.2	2272.0	179.59	0.000
Residual Error	21	265.7	12.7		
Total	25	9353.8			

Source	DF	Seq SS
t1	1	6711.4
t2	1	24.4
t3	1	545.5
f1	1	1806.9

According to regression analysis, we know that all of the p are smaller than 0.05, which means that regression equation has prominent significance and t1, t2, t3, f1 has more influence on the cycle. Each of them has the following contribution:
t1=72%, t2=3%, t3=6%, f1=19%

Therefore in order to shorten the cycle, we should firstly improve t1 (sorting time), secondly improve f2 (waiting time), finally improve t3(time for carrying to transport). This is also the project improvement orientation in improvement stage.

(4) Improve

This stage is to make clear the relationship among the influential factors and define the improvement objective of the key factors. Through test and imitation, we can make improvement strategy and design new process to achieve the objective. And evaluate the implementation result in time in order to insure that the plan reach a good result.

This project we use brain storming method to define the improvement strategy of the four key factors. Specific strategy is on the following:

Key Reasons	Source of defects	Improvement strategy and measurement
Waiting time(f1) is too long.	Arrangement Order	Regulate time deadline and some restraint
Sorting time (t1)	Management defects between maintenance company' headquarter and subsidiary	Sign a new agreement. Send the appliance and equipment to subsidiary directly.
Packaging and sending time (t2) Carrying to transport time (t3)	No clear standard and process. Information is not input into computer in time. It is uncontrollable.	Make operator supervision process . Based on process regulation, we input the information into computer and supervise it in time.

Figure 4.9: Improvement Strategy Picture of this case

Based on improvement strategy, we design new process flow picture through simple

design and delicate design. In this project, f1 and f2 are determined by maintenance company, so they can't controlled by shipping company, which can use some regulation to restrain maintenance company' behavior. But t2 and t3 are determined by shipping company, we begin with the two factors to design new process. The new process is on the following:

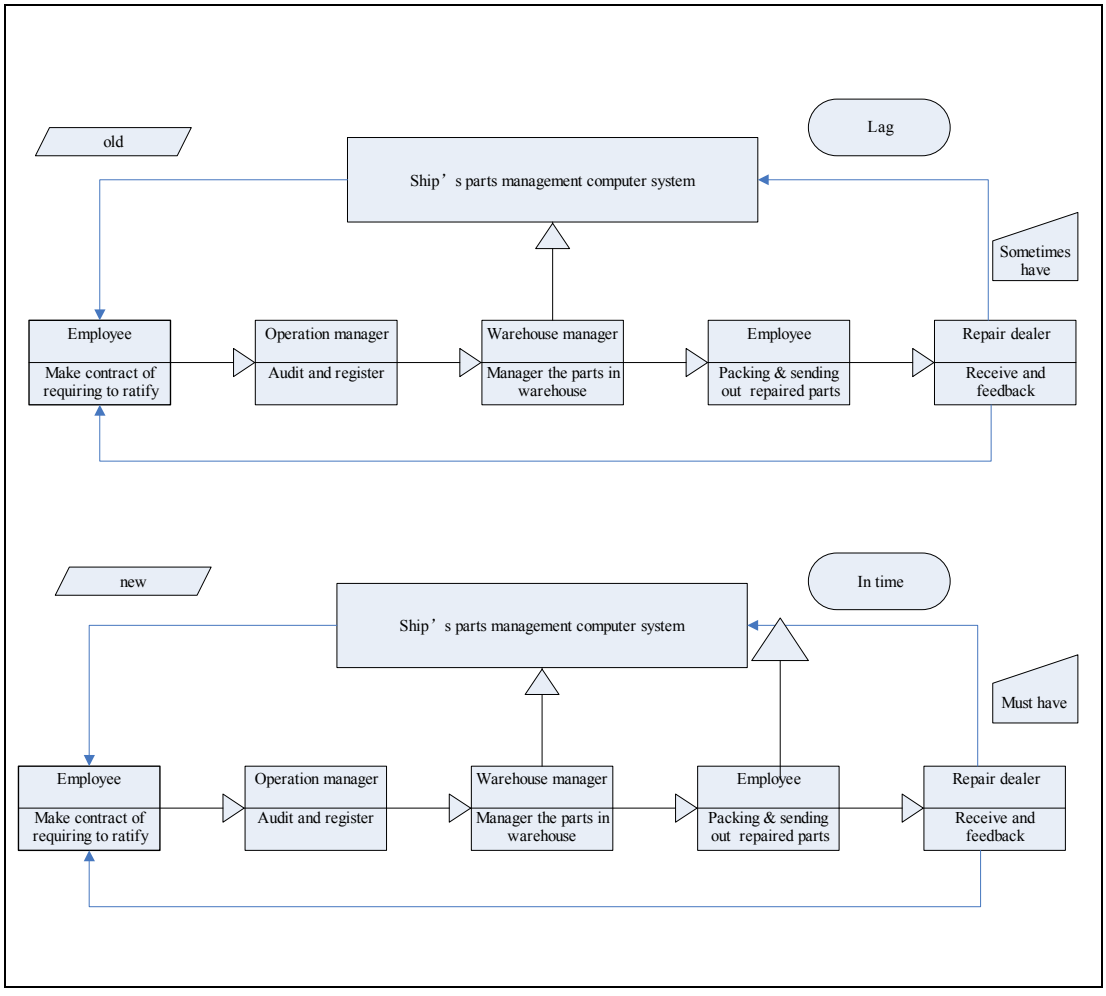

Figure 4.10: Process improvement of sending the parts to be repaired

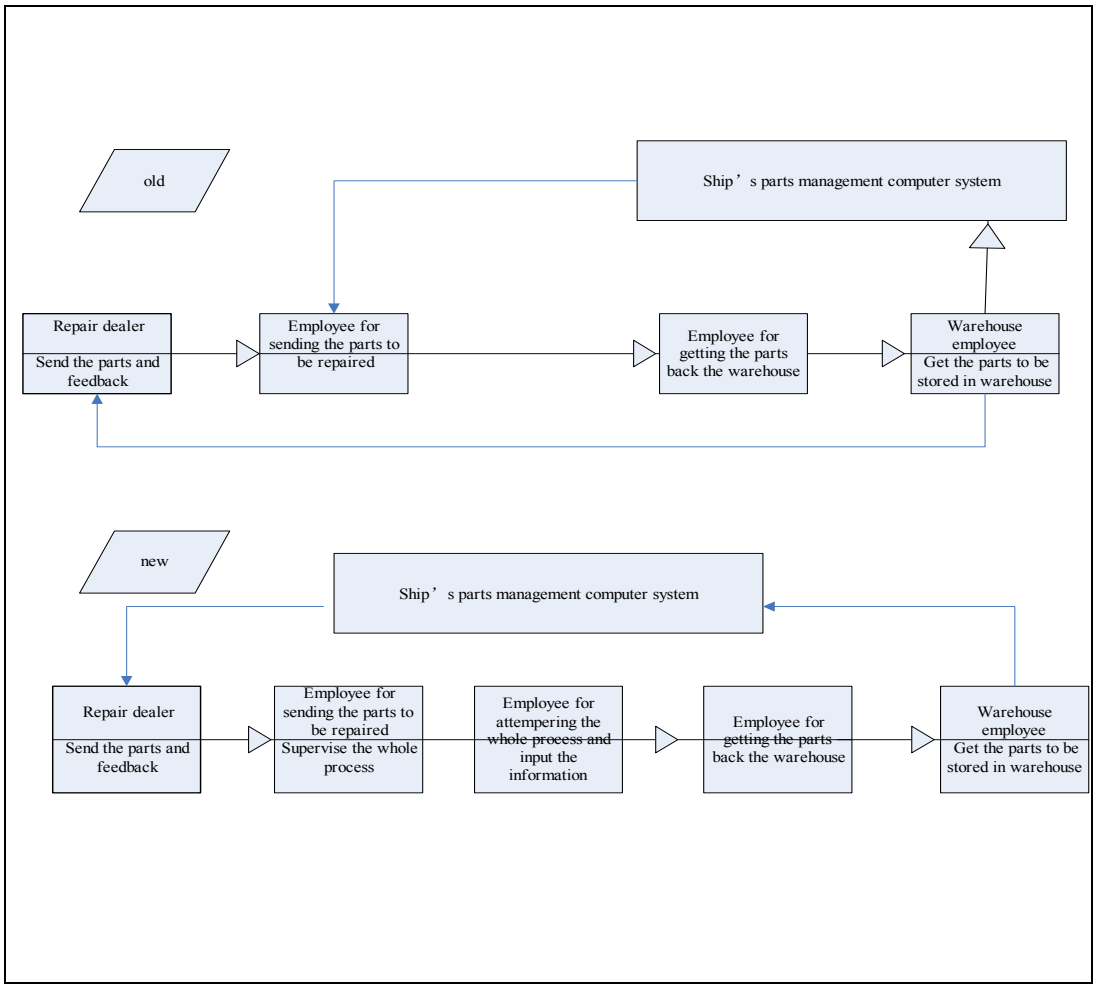

Figure 4.11: Process improvement of getting the parts back to the warehouse

Through collecting data of relevant new improvement plan, we can do some comparison between improvement data and previous data.

Table 4.5: Comparison between improvement data and previous data

	Previous process	Improvement process
Mean	37.5	22
StDev(within)	8.5	0.8
StDev(overall)	19.5	1.6

According to the analysis result, we know that the effect of new process is very clear, not only the average cycle time is reduced from 37.5 to 22, but also the standard deviation change from 19.5 to 1.6. Therefore, we can say that this improvement plan is feasible and effective.

(5) Control

Control stage is the final phase of Six Sigma project improvement. Through the data collected, we use some methods, such as SPC, to supervise the improvement result and implement control plan to guarantee the improvement result. In this project we use I-MR control picture to control the implementation effect. If the control point is beyond the cordon, we should check the cause and improve it in time in order to make the control point within the cordon.

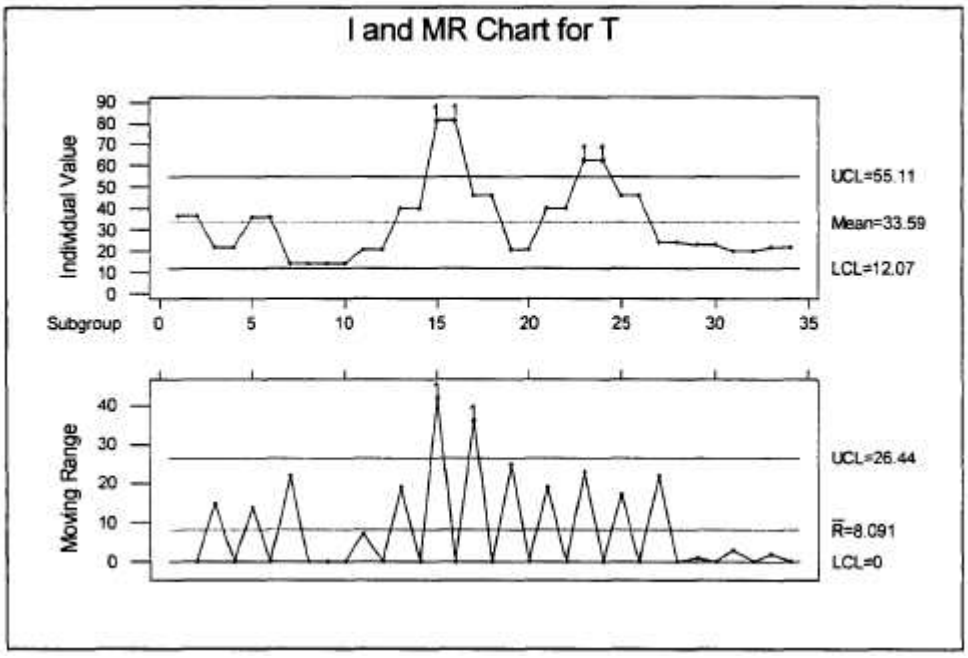

Figure 4.12: I-MR control picture of this case

In the picture, 1 stands for the control point, which is beyond the cordon. In the picture I, there are four points beyond the cordon and in picture MR there are two

points beyond the cordon. In order to insure the improvement effect, I suggest that shipping companies should check the process and operation to improve the links, which is liable to make mistakes, and make training plan to make the employees operate the standard process and find & solve the problems in practice.

CHAPTER 5
IMPLEMENTATION OF SIX SIGMA MANAGEMENT IN SHIPPING COMPANIES

5.1 Implementation Steps of Six Sigma Management in Shipping Companies

I suggest that Chinese shipping companies implement Six Sigma Management by five stages:

(1) Introduce the idea and concept of Six Sigma Management

The objective of introducing the idea and concept is to make the top managers and employees accept Six Sigma Management and admit its availability. When introducing Six Sigma management to top managers, I think we can propagandize the following ideas and concept: Six Sigma management has successfully be applied in a lot of companies of service industry and it is the tendency for Six Sigma Management used in shipping industry; To become a world famous shipping company, we must use a world-class quality management method-Six Sigma Management; Six Sigma Management is a very supernatural management method which not only obtains high quality but also reduces the cost; Though continual reducing bad cost to find out the breakthrough, Six Sigma Management can make company rapidly develop; Six Sigma Management is a scientific management tool pursuing the quality concept of " zero defect" and a mass quality improvement movement; Only win the leaders' support and administratively implement, we can successfully plan as a whole to conquer the companies' difficulties.

(2) Establish Six Sigma Management organization system

In order to gain administrative support, companies should specially establish relevant Six Sigma institutions for implementing Six Sigma Management. For example, certain shipping company established two departments for carrying out Six Sigma Management, One is Six Sigma implementing Council, whose main responsibilities are proposing Six Sigma idea and concept and administratively pushing implementation of Six Sigma project. The other department is full time Six Sigma working department, whose members are Black Belt and Master Black Belt and the consultants of training and research institution outside the company. Six Sigma working department is responsible for project selection, training, supervision, evaluating the result and researching the difficulties in Six Sigma projects.

(3) Project Training

Companies invest large quantity of money to train Green Belt and Black Belt in order to provide managing talents and skilled workers. I suggest that at the beginning of implementing Six Sigma Management in shipping companies, we can select some excellent employees for Green Belt training from every department and then among the Green Belts we select some of them to be trained as Black Belts. The training of Green Belt and Black Belt must have concrete improvement projects and they could gain the relevant qualification only the projects achieve better result. And I think the qualification of Green Belt and Black Belt should be linked with companies' personnel appointing and removing mechanism.

(4) Project implementation

In the stage of project implementation, companies should carry out the scheme of project improvement and evaluate the effect of project implementation. I suggest that when putting the project into effect, shipping companies should supervise the

implementation process and evaluate the effect in time. For the project of good effect, companies should write it into operation management handbook and popularize it into the relevant departments. If there are problems appearing in the popularizing process, we should carry out more improvement and finally make the company form a closed loop quality persistent improvement system.

(5) Perfect data and information management system.

Six Sigma Management is impelled by data and information, so Motorola also call it applied with ERP "Digital Six Sigma". All the technology and method in every stage of Six Sigma Management needs to input facts and data. And the veracity and authenticity directly influence the result of output. And the result of output influences the results of project design and improvement. Because companies use Six Sigma Management to achieve persistent improvement, advance the process ability and quality level, and boost up their market competitiveness, it is impossible for them to compile some data, but it is not easy to gather and collect exact data. Thus, we must rely on and perfect the system of data collection and information management. Therefore, insuring the data veracity and authenticity is very important for Six Sigma application.

5.2 Avoid Several Errors

(1) Imitate by rote

We can't consider Six Sigma as a management fashion and blindly chase dandyism. If we can solve the problems with very easy methods, we don't need to use methods with very high difficulty .Every shipping company should base on his own situation to set a suitable quality standard and level. For example, in China, there are a lot of small scale shipping companies. They generally have 2-10 ships which mainly sail in

short sea. Because the ships don't sail in ocean shipping, the ships' technology and equipment don't need to have international quality standard. In a short-term these shipping companies don't need to apply Six Sigma Management. Of course, some big scale shipping companies such as COSCO, CHINA SHIPPING, should learn and apply Six Sigma Management as quickly as possible in order to strengthen their ability and shorten their disparity with the top shipping giants.

(2) Lack Six Sigma professional training and consultation

Some people think that Six Sigma is just statistical method used in companies. Though statistics method is very important, we need to achieve the practical projects with many other methods and tools. Six Sigma consultants should systematically use statistical method, modern management theory, industry engineering technology and computer technology to help Black Belt and Green Belt to solve companies' problems. Rote of SPC/DOE/ANOVA is very ridiculous, which may also cause statistical method misapplication.

(3) Lack scientific and rational project application plan

Some leaders think that sending several people to join in Six Sigma training class is just achieving the Six Sigma training assignment. Without participation in practical Six Sigma project application, any certificate of Black Belt and Green Belt is just a waste paper. I know that once in a Chinese shipping company, at the beginning of Six Sigma application, headquarter of the group call in some employees, who come from his subsidiary companies, to learn Six Sigma knowledge together. And finally all of the selected employees passed the test of this training and gained professional certificates. But these people didn't bring Six Sigma knowledge to subsidiary companies. This training is not a training, which didn't have any influence on Six Sigma Management in subsidiary companies.

(4) Without establishing Six Sigma quality culture of persistent improvement

Six Sigma is a persistent improvement activities which has beginning but without end point. Some companies ignore establishing quality culture of persistent improvement, just regard Six Sigma as a movement. Advance it only for a while, then come back to previous state.

CHAPTER 6
CONCLUSION

This dissertation studies the shipping companies' characteristic and the situation of Chinese shipping companies, and suggests a set of Six Sigma Management methods, including project choice, process management, organization structure, managing and statistical technique and instrument. This dissertation has mainly obtained the following achievement, which provides important referential value for shipping companies.

1. It analyzes the process characteristic of shipping companies and suggests a general framework for shipping companies' Six Sigma Management, which will be a cut-in point for shipping companies' Six Sigma Management.

2. It proposes to use project management method to manage Six Sigma project. It includes how to select Six Sigma project, manage the project risk, project application and project evaluation, all of which set a solid foundation for Six Sigma Management system.

3. It founds Six Sigma organization structure to confirm suitable shipping company Six Sigma project team and designs six sigma team inspire system, which supply organization support and drive for Six Sigma management implementation.

4. It establishes a set of process management method and use a case to show the validity of Six Sigma Management.

5. This dissertation uses graph tools and analysis tools. Graph tools mainly involve square picture and process flow graph. Analysis tools mainly contain FMEA and regression analysis. It also uses some computer software, such as excel and Minitab to help shipping companies do the analysis.

6. According to the experience of other industries and companies, we suggest some aspects to avoid the possible mistakes.

This dissertation only does some elementary research on Six Sigma Management applied in shipping company. Though there is some achievement, there are a lot of contents worth researching. We suggest that we research the following contents, which may provide some reference for people in this field.

(1) How to make knowledge engineer integrate with Six Sigma Management? How the decision-making support system combine with Six Sigma Management?

(2) New process analysis method: How to make use of ASME and Petri net to analyze business process? How to combine ASME and Petri net with flow chart?

(3) Effective statistics method: How to make use of statistical method to dig useful knowledge from data? How to select statistics method to analyze data?

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