The Application of Six Sigma Improvement Process on Enhancement of Product Quality and Service Quality of Internet-Marketing

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Abstract

Internet marketing is believed to have many advantages over traditional marketing, such as limitless time and boundless distance, low cost and home delivery, and therefore has become another trend of marketing nowadays. It success is determined critically in two aspects: product quality and service quality. Product quality refers to the customer's acceptability of product's Research and Development (R&D) and manufacturing at the backstage while service quality means the customer's acceptability of product's marketing and maintenance at the proscenium.

Most research on customer's satisfaction on Internet-marketing generally limits itself within product quality and service quality and analyzes and improves customer's satisfaction through one single aspect. Such method is not able to find critical causal categories on customers' whole acceptability. Therefore, this study used Six Sigma MAIC (measure, analyze, improve and control) to ameliorate procedure and meanwhile considered product quality and service quality of Internet-marketing in order to establish a system to enhance customer's whole satisfaction. This study included three steps. First of all, focusing on the product quality at backstage, we conducted a customer acceptability survey (containing dimensions of importance and satisfaction), conducted product quality performance matrix to measure low importance, high satisfaction and high importance, low satisfaction of abnormal products, which determined the reducing or increasing R&D and manufacturing resources for such products. For abnormal products with high importance but low satisfaction,

Cause-and-Effect Diagram was used to analyze and identify the critical major causes of such products. Moreover, with focus on importance, satisfaction and process capability of critical major causes, a process-capability performance matrix was established. Then the worst critical main causal category would be the priority target as to enhance and improve R&D and manufacturing resources.

Secondly, emphasizing on the survey of the customer's acceptability at the proscenium, containing dimensions of importance and satisfaction, we conducted service quality performance matrix to measure low importance, high satisfaction and high importance, low satisfaction of abnormal service items, which decided on the reducing or increasing marketing and maintenance resources of such service items. For abnormal service, characteristics cause-and-effect diagram was conducted to analyze and identify specific service strategies. Then Quality Function Development would be used to determine critical service strategies for improvement.

Thirdly, after improvement, focusing on abnormal products, Machine Parameter, Optimum Tolerance, and conditions for best manufacturing were used as criteria to enhance process capability and ensure that each critical major cause are under control. Furthermore, for abnormal service, we ensured each critical service strategies under implementation. Finally, with emphasis on the department of R&D and manufacturing at the backstage and the department of marketing and maintenance at the proscenium, standard operating procedure and knowledge manage system were established in order to standardize operation and to maintain the control effect. Such Six Sigma Improvement Process provides practical method to manage the information of the importance and the satisfaction in the aspects of product quality and service quality step by step, and to holistically consider R&D, manufacturing, marketing and maintenance at the same time. Such application of Six Sigma Improvement Process on Internet-marketing is believed to reinforce customer's purchase inclination and enhance business performance.

Key words: Six-Sigma, Internet-marketing, Performance matrix, Process capability

1. Introduction

The rapid development of computer technology and the Internet has made Internet marketing, with features of limitless time and boundless distance, low cost and home delivery, popular among many customers. Nonetheless, customers tend to have more concerns on Internet marketing regarding the qualities of the product and the service than on traditional marketing. Therefore, in order to enhance the effects of the Internet marketing, we have to analyze it in two aspects: product quality and service quality.

Among the 4P (product, price, promotion and place) in Strategic Production Communication Campaigns marketing, product and price belong to the product quality while promotion and place belong to service quality. For products to be successfully accepted by customers depends on high qualities of product and service. Furthermore, product quality relies on the department of Research and Development (R&D) and manufacturing at the backstage, and product process capability, while service quality depends on the department of marketing and maintenance at the proscenium stage and the capability of selling (See Figure 1).

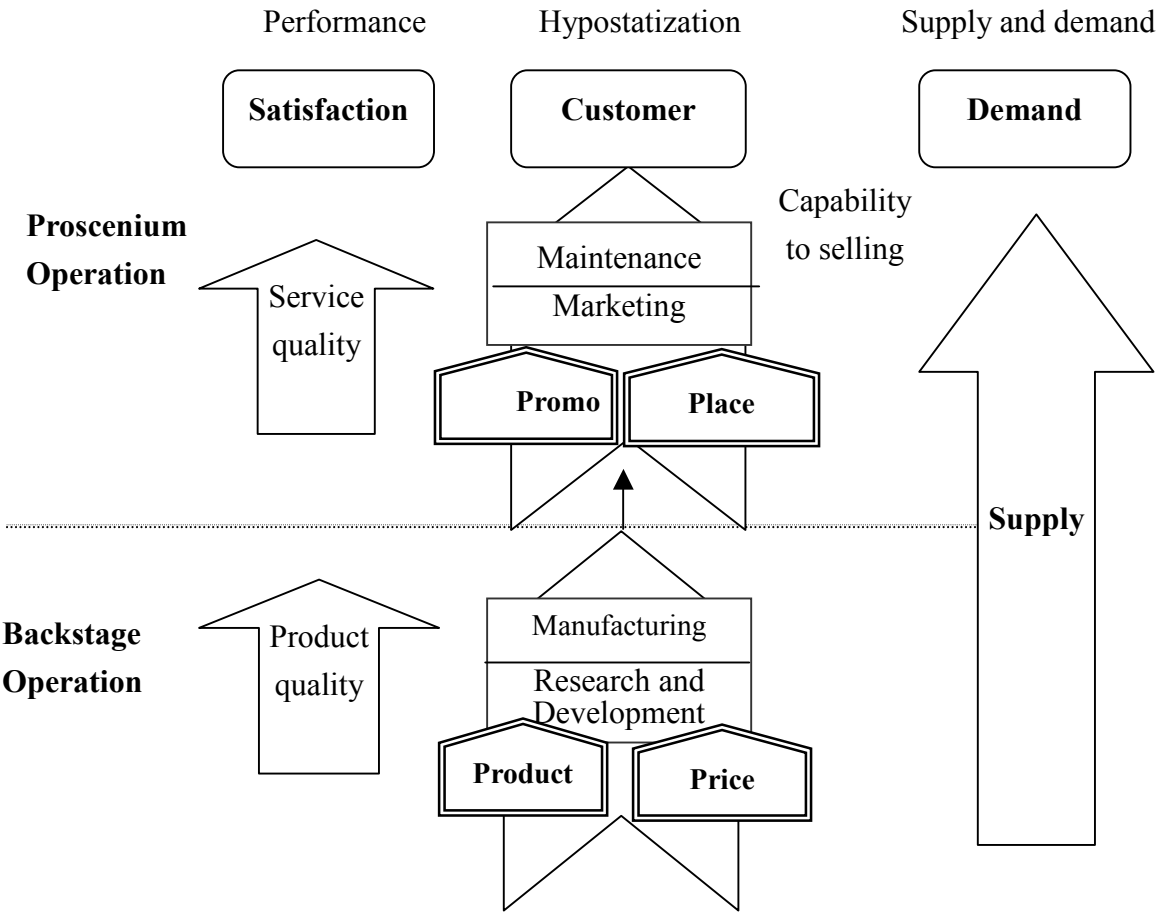

Figure 1 the 4P model and the relationship between product quality and service quality

In the studies of performance measurement, Pearn (1997), Chen (2002) and Chen et al. (2002) developed a performance measurement on product quality while Rosen et al. (2003), Huan et al. (2003) and Parasuraman et al. (1985, 1991) developed another on service quality. However, all of them only focused on one single aspect, the quality of either the product or the service, to measure customers' feedback on products. Besides, lacking the integration with proscenium and backstage operations, they cannot locate key elements that effect customers' acceptability as a whole. This study attempts to integrate the aspects of product and service qualities with Michael's (2002) theory of Measurement, Analysis, Improvement and Control (MAIC) to improve the product and service qualities and then to enhance the business performance.

For the first step of the MAIC, Measurement, a survey was conducted to investigate customers' acceptability, including the dimensions of importance and satisfaction, with the focus on product quality and service quality of Internet marketing. Based on the survey results, a performance matrix was established to sort out abnormal products and services. On the second step, Analysis, a characteristics cause-and-effect diagram was used to locate key factors on the abnormal product and then to decide on the enhancing or reducing R&D and manufacturing resources. The characteristics cause-and-effect diagram was also used to implement a holistic analysis on the abnormal service and then to generate specific service strategies.

On the next step, Improvement, focusing on the abnormal product, this study conducted a performance matrix of process capability according to importance, satisfaction and process capability of the critical main casual categories. Among these categories, the worst one was used to sort out the prior target for increasing R&D and manufacturing resources. After the improvement process, it would be examined whether its new process capability had reached the expected level. Meanwhile, the satisfaction of the critical main casual categories would be analyzed and examined again to confirm the effect of the improvement. As for the abnormal service, the study used Quality Function Development to locate the most important specific service strategy as a target to improve. After the improvement, a new satisfaction assessment on the abnormal service was implemented to confirm the complete improvement on all the abnormal services. On the last step, Control, the objective was to establish standard of procedure and knowledge management in order to standardize the procedure and control the effect after the above improvement on the qualities of the abnormal products and services. This study used Six Sigma to improve the

procedure and, through System Engineering Approach, provided an efficient system of Measurement, Analysis, Improvement and Control for customers' purchase on the Internet. The findings of the current study have shown that this system has the advantage to improve Internet marketing and to enhance the business performance.

2. Measuring customers' acceptability on products

Internet Marketing has become a trend. When customers purchase merchandise through the Internet, they usually think of the qualities of the product and the service at the same time. Therefore, in the following section, we will, based on the concepts of satisfaction and importance, discuss what constructs acceptable qualities of product and service. After that, we will investigate the products of an anonymous Internet-marketing company regarding their product quality and service quality. Then, based on the result of the investigation, a performance matrix about the qualities of product and service will be made in order to measure abnormal products and services.

In the beginning of the following section, we will divide the first step of MAIC, Measurement, into 1) definition on the importance and the satisfaction of the quality and 2) the method of measuring.

2.1 Definition on the importance and the satisfaction of the quality

When customers shop, they usually think about the satisfaction and the importance of the merchandise. In the aspect of the product quality, the merchandise is acceptable if the customer thinks that the satisfaction of the product is better than its importance. In the aspect of the service quality, the service is considered fine if the customer thinks that the satisfaction of the service is better than its importance. Therefore, when the customer thinks that the merchandise has acceptable product quality as well as fine service quality, the merchandise will be purchased. In this section, we will define the importance and the satisfaction of product quality and service quality.

In the aspect of product quality, the importance of merchandise is considered to be high when the customer uses the product very often and really needs it. The satisfaction of merchandise is considered to be high when the customer thinks that the product is highly reliable, has strong effect and is

convenient to use. In the aspect of service quality, we has designed 15 items, based on the products that customers purchased and based on the service they received, including pre-sell, in-sell, after-sell and whole service. These 15 items were used for customers to measure the importance and the satisfaction when they bought certain merchandise from the Internet-marketing company of this study and have been using the merchandise for a period of time. If customers think certain item of the service matches their perceived importance, they think the item as with importance. Similarly, if customers think the gap between certain item of the service and their perceived satisfaction as small, they consider the item to be acceptable and thus are with satisfaction. To gather data, we conducted a survey for customers who have purchased products from the company of this study and have used it for a period of time. Questionnaire in the survey is considered as a good instrument to measure the qualities of products and service of Internet marketing.

Adapting from Lambert and Sharma (1990) and Parasuraman et al. (1985, 1991), we conducted a questionnaire to investigate the four aspects of the Internet marketing: the importance of product quality, the satisfaction of product quality, the importance of the service quality and the satisfaction of service quality. The result would be presented as the following four indexes.

1. The importance index of product quality

$$\mathrm{I_{PI}} = \frac{\mu_{PI} - \min}{R} \tag{1}$$

2. The satisfaction index of product quality

$$\mathrm{I_{PS}} = \frac{\mu_{PS} - \min}{R} \tag{2}$$

3. The importance index of service quality

$$\mathrm{I_{SI}} = \frac{\mu_{SI} - \min}{R} \tag{3}$$

4. The satisfaction index of service quality

$$\mathrm{I_{SS}} = \frac{\mu_{SS} - \min}{R} \tag{4}$$

In the above four indexes, μ_{PI}, μ_{PS}, μ_{SI} and μ_{SS} respectively refer to the average of customers' product quality importance (*PI*), product quality satisfaction (*PS*), service quality importance (*SI*) and service quality satisfaction (*SS*) in the questionnaire.

Min refers the minimum value in the *k* scale table. It is usually set as 1 (min=1); $R = k - 1$ refers to range of *k* scale table.

To explain the above four indexes, we would use the importance index of product quality (I_{PI}) as an example. The value of the above four indexes is between 0 and 1.

When $I_{PI} = 0$ (i.e. $\mu_{PI} = 1$), it indicates that product quality is not important at all. The importance level is 0%.

When $I_{PI} = 0.5$ (i.e. $\mu_{PI} = (k + 1)/2$), it indicates that product quality is moderately important. The importance level is 50%.

When $I_{PI} = 1.0$ (i. e. $\mu_{PI} = k$), it indicates that product quality is highly important. The important level is 100%.

The values of the above four indexes are all between 0 and1. Taking the aspect of the product quality as an example, we will use the importance index and the satisfaction index to explain customers' evaluation on the product quality. In a 5-point interval-scale questionnaire (k=5, very important, important, neutral, not important, not at all important), if the mean of the quality importance index for a certain product is higher than 3 (neutral), it indicates that the importance index of that product is higher than 0.5. Meanwhile, if the mean of its quality satisfaction index is lower than 3, it reveals that its satisfaction index is lower than 0.5. The result of higher importance index than satisfaction index reflects customers' feedback on that product in that the satisfaction index of the product is expected to increase at least to be the same or above the importance index. On the contrary, the result of higher satisfaction index than importance index reflects customers' reaction as that the satisfaction index of the product should decrease to reduce the cost. This evaluation can also be applied to assess the aspect of service quality regarding the importance and satisfaction indexes.

To completely understand the evaluation of product quality and service quality, one good instrument is the performance evaluation matrix. Adapting from the Performance Evaluation Matrix provided by Huang et al. (2003) and Lambert and Sharma (1990), we have conducted the Performance Matrix for the current study.

In the Performance Evaluation Matrix of Huang et al. (2003) and Lambert and Sharma (1990), both the values of the satisfaction index and the importance index are between 0 and 1. Besides, the horizontal axis and the vertical axis of the matrix are divided into four scales [0.0, 0.33, 0.67, 1.0] and three ranks,

respectively the lower rank between 0.0 and 0.33, the middle rank between 0.33 and 0.67 and the higher rank between 0.67 and 1.0. The three ranks on both axes form nine cells. When the scores of the importance index and the satisfaction index plot within [0.0, 0.0] and [0.33, 0.33], it indicates that the product quality is neither with importance nor with satisfaction. When the scores plot within [0.67, 0.67] and [1.0, 1.0], it reveals that the product quality is with both more importance and more satisfaction. When the scores plot within [0.33, 0.33] and [0.67, 0.67], it shows that the product quality is neutral regarding the importance and the satisfaction. The above three cells contain similar level of the importance and the satisfaction; they are, therefore, called target cells.

A diagonal, which is the target line for quality importance and satisfaction, is drawn between [0.0, 0.0] and [1.0, 1.0] in the performance matrix. When the score of both the importance index and the satisfaction index plots on this line, it means the product quality is the most appropriate. When the score plots within the lower right of the target line, it indicates that the satisfaction is higher than the importance and further means that the resource can be reduced to properly decrease the quality. When the score plots within the upper-left of the target line, it reveals that the importance is higher than the satisfaction and further means that more resource should be increased in order to properly enhance the quality. Moreover, for more efficient controlling, two control lines have to set in the matrix: the Upper Control Line (UCL) between (0, a) and (1-a, 1) and Lower Control Line (LCL) between (a, 0) and (1, 1-a). How rigorous these lines are defined (i.e. the value of a) depends on the company policy, the enterprise standard, and competitors.

In the case of the anonymous Internet marketing company for the current study, the matrix has been divided into three equal performance zones, therefore the value of a must be set as 0.184. In this Performance Matrix, the line connecting (0.0, 0.184) and (0.816, 1.0) is the Upper Control Line while the other line connecting (0.184, 0.0) and (1.0, 0.816) is the Lower Control Line. The zone between the Upper and the Lower Control Lines is the target zone, labeled as A, in which the quality importance and the quality satisfaction are the same. The zone between the Lower Control Line and (1.0, 0.0) is called “resources over-loaded zone”, labeled as D, in which the quality satisfaction is higher than the importance while the zone between the Upper Control Line and (0.0, 1.0) is called “resources lacking zone”, labeled as I, in which the quality importance is higher than the quality satisfaction. (See Figure 2)

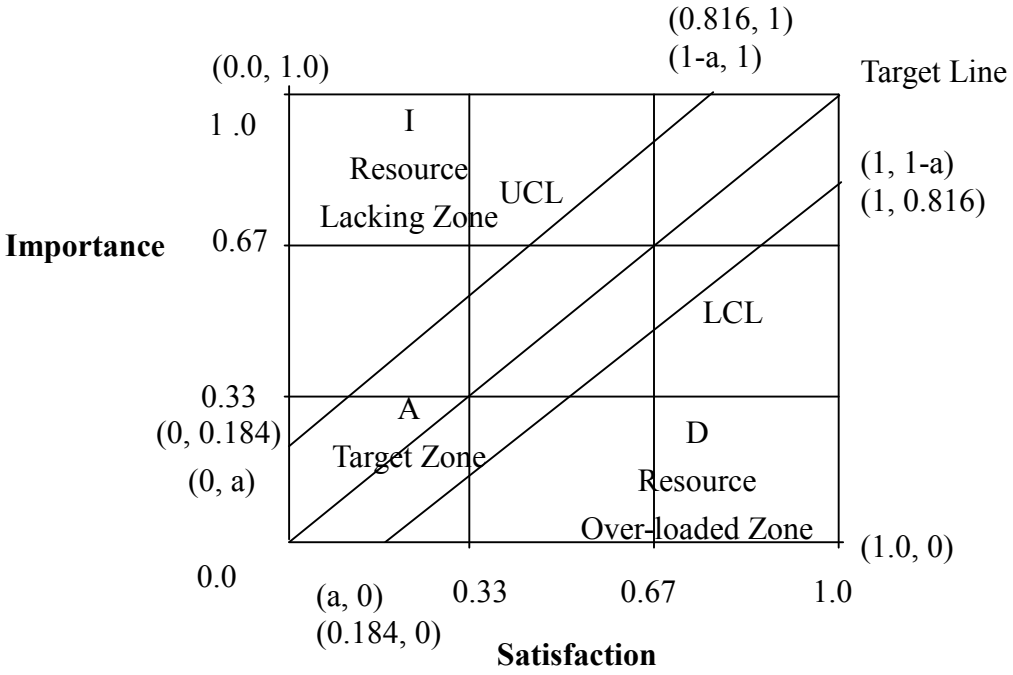

Figure 2 Three zones in Performance Matrix

2.2 The method of measuring

In the data base of the anonymous Internet marketing company for the current study, we have searched the various electronics and computer products that were sold last year and chose the first two items from the seven randomly-selected categories (14 items totally). A survey was conducted to investigate the marketed products regarding their product quality and service quality. Two sections, product quality and service quality, were designed in a questionnaire through different questions in 5-point interval scales for the survey. The questionnaire was established on the Internet and was implemented in two stages. Firstly, customers would check the product importance and the product satisfaction in the questionnaire for the products they bought. Secondly, customers would check the service importance and the service satisfaction from 15 service items for the products they bought. For this study, 50 questionnaires have been released for the 14 selected products (700 totally) and 302 responses were returned and among them were 286 effective responses; the response return rate is 41%.

The questionnaire used in this study was multiple item scales. In other words, many questions regarding the evaluation of the importance and the satisfaction were constructed. Moreover, we would have to exam the reliability

of this questionnaire. Reliability means that test scores should be consistent and stable, not being influenced by different time and contexts. As to evaluate the reliability of a one-shot test instrument, such as questionnaire, an inter item consistency or internal consistency reliability should be implemented. In other words, the reliability is evaluated by the consistency of all the items. Thus, the questionnaire should be pilot tested with reliability analysis before it is released. Furthermore, after all the questionnaires are collected, a further reliability analysis will be conducted for the collected data.

Cronbach's alpha coefficient is usually used to test internal reliability. Gay (1992) argued that an alpha coefficient of 0.80 and above is acceptable and an alpha coefficient of 0.90 and above means very high reliability. Researchers such as DeVellis (1991) and Nunnally (1978), however, considered an alpha coefficient of 0.70 and above to be the minimum reliability value. The data in this study were reliability-analyzed via SPSS and therefore had a result of 0.92. Moreover, the analysis on the previous four indexes had the following results: 0.89 for the quality importance, 0.89 for the quality satisfaction, 0.81 for the service importance and 0.82 for the service satisfaction, all of which have reached the internal reliability among items in this questionnaire.

Next, according to the survey result, a mean of product quality importance, product quality satisfaction, service quality importance, and service quality satisfaction has been calculated. Then, the values of the above four indexes on product quality importance, product quality satisfaction, service quality importance, and service quality satisfaction would be calculated with the mean based on the previous equation 1-4 (as shown in Table 1 and 2).

As in Figure 3, Product Quality Performance Matrix can be established based on the values of the product quality importance index (I_{PI}) and the product quality satisfaction index (I_{PS}) in Table 1. Similarly, as in Figure 4, Service Quality Performance Matrix can be established based on the value of the service quality importance index (I_{SI}) and service quality satisfaction index (I_{SS}) in Table 2. The performance matrixes in Figure 3 and Figure 4 can be used to measure the performance of different merchandises' product quality and of different service items' service quality.

In the product quality performance matrix in Figure 3, the plots of different merchandises' product quality and satisfaction indexes in performance show that 2 items among the 14 products are not located in the Target Zone (Zone A), which are abnormal products. The two items are Item 13 and Item 9 and they are

located in Resource Lacking Zone (Zone I). Figure 3 indicates that the product quality of most merchandizes in the anonymous Internet-marketing company is acceptable. Similarly, in the service quality performance matrix in Figure 4, the plots of different service items' importance and satisfaction indexes show that 3 out of 15 service items are not located in Target Zone (Zone A), which are abnormal service. The three items are Item 11 and Item 14 located in Resource Lacking Zone, and Item 6 located in Resource-overloaded Zone (Zone D).

Table 1 the product quality importance and satisfaction indexes of the 14 product items

Item	**Product item**	μ_{PI}	μ_{PS}	$I_{PI}(y_i)$	$I_{PS}(x_i)$
1	Kodak CX7430 4.0 Mega pixel digital Camera	4.01	4.18	0.75	0.80
2	CASIO EX257 4.0 Mega pixel digital Camera	3.92	3.78	0.73	0.70
3	Panasonic Min Cassette Recorder RQ-L31	3.17	3.55	0.54	0.64
4	Panasonic CD\MP 3player SL-CT520	3.19	3.71	0.55	0.68
5	Panasonic KX-FT901 Telephone/Facsimile	4.76	4.88	0.94	0.97
6	SANYO B93-F012-T Telephone/Facsimile	4.57	4.38	0.89	0.85
7	SONY DCR-PC108 Digital Video	3.89	3.37	0.72	0.59
8	SONY DCR-HC30 Digital Video	3.47	3.04	0.62	0.51
9	TECD TD2024VK DVD player	3.34	3.21	0.69	0.35
10	Panasonic DVDS30 DVD player	2.99	2.78	0.50	0.45
11	View sonic VA91 2LCD Monitor	3.24	3.77	0.56	0.69
12	CMV CT-720D LCD Monitor	3.34	3.52	0.59	0.63
13	Tyan Tiger MPX S2466-4M Motherboard	4.41	2.08	0.85	0.27
14	MSI K8 NSLI Motherboard	3.57	3.12	0.64	0.53

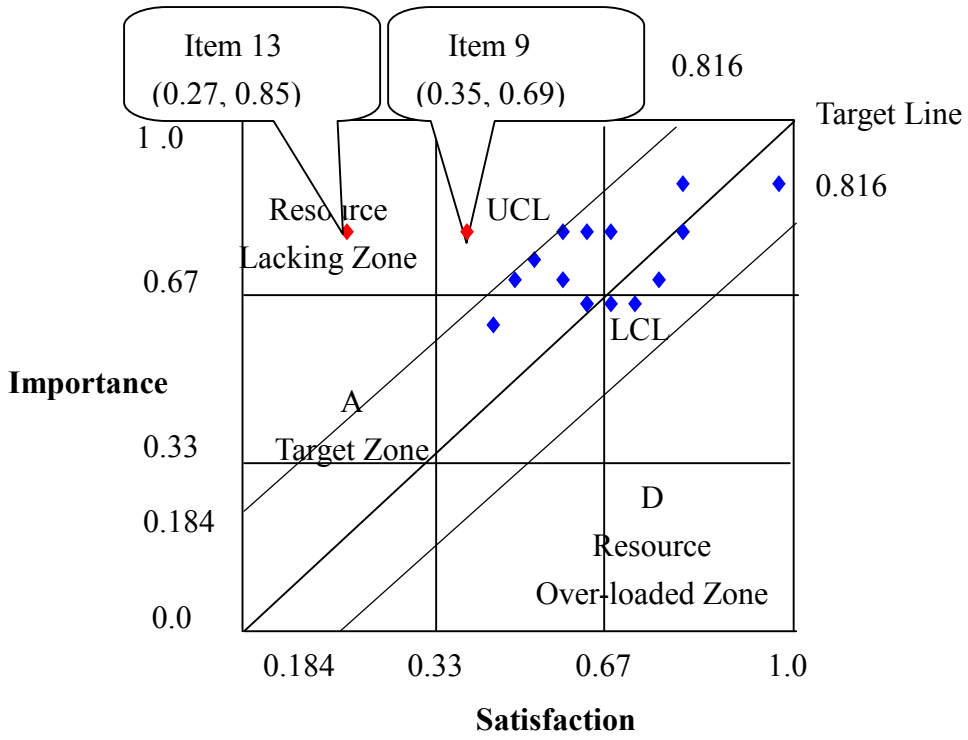

Figure 3 Product Quality Performance Matrixes

Table 2 Service quality importance and satisfaction of the 15 service items

Item	Service Items	μ_{SI}	μ_{SS}	$I_{SI}(y_i)$	$I_{SS}(x_i)$
1.before	The access to log into this company through the Internet	3.07	3.02	0.52	0.51
2.before	Whether the design of the website is user-friendly	3.14	3.10	0.54	0.50
3.before	The level of variety of the products on the Internet	3.18	3.14	0.55	0.54
4.before	The design of hyperlink	3.01	3.08	0.50	0.52
5.during	The easiness of choosing different products	3.20	3.09	0.55	0.52
6.during	Providing customized service	2.08	4.41	0.27	0.85
7.during	Security of electronic transaction	3.08	3.22	0.52	0.56
8.during	The cooperation of logistic circulation	3.24	3.12	0.56	0.53
9.after	Whether the delivering is on schedule and safe	3.17	3.02	0.54	0.51
10.after	The product delivery and customer confirmation	3.02	2.98	0.51	0.50
11.after	Warranty, service and repair of the product	3.91	1.78	0.73	0.20
12.after	Reasonableness of transaction cost on purchase and repair	3.11	3.28	0.52	0.57
13.whole	The acceptability of the product repairing time	3.08	3.03	0.52	0.51
14.whole	The whole quality and flow of the electronic commerce	4.11	2.32	0.78	0.33
15.whole	The whole performance of service by this company	2.90	2.97	0.48	0.49

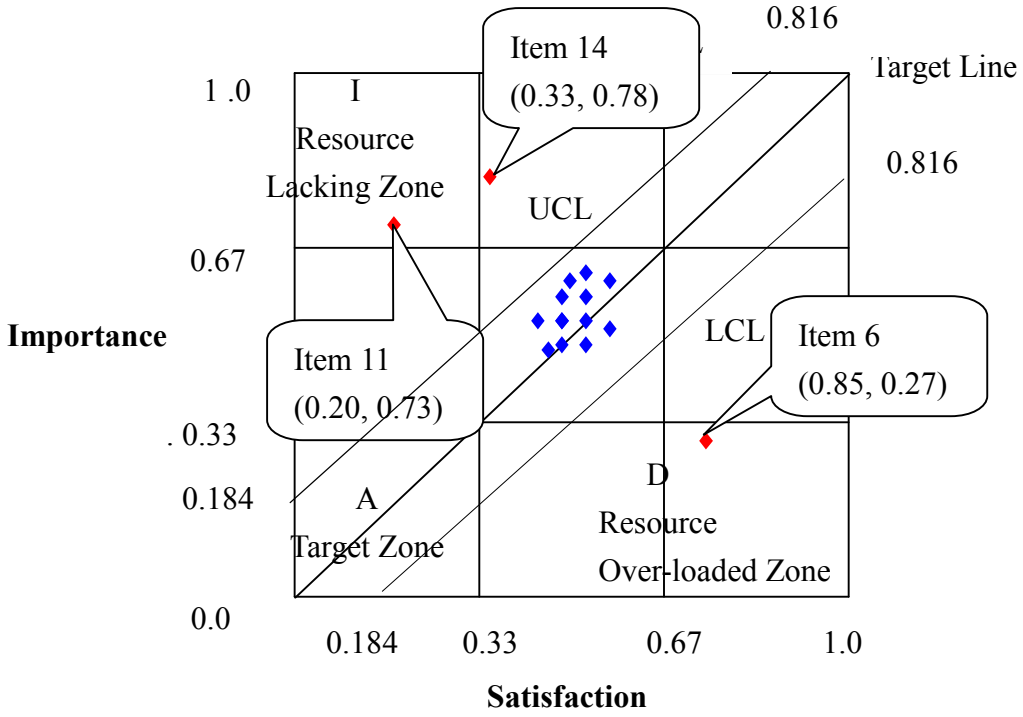

Figure 4 Service Quality Performance Matrixes

3. The analysis and improvement of abnormal products and abnormal service

Among the 14 products and the 15 service items in the above section, there are five of these products and service items measured and found located outside the Target Zone in the Quality Performance Matrix and labeled as abnormal products and abnormal service items. In this section, we will focus on these five abnormal products and abnormal service items and arrange the order of priority for improvement / examination. Next, an analysis / amelioration will be conducted on these five abnormal products and abnormal service items.

3.1 Arranging the order of priority for improvement / examination on abnormal products and abnormal service items.

The order of priority for improvement / examination on abnormal products and abnormal service items would depend on the plots of the importance and the satisfaction indexes in the performance matrix. The top priority would be to

improve those located in Resource Lacking Zone (Zone I) and then to examine those located in Resource Over-loaded Zone (Zone D). If there are two or above abnormal products or abnormal service items in Zone I or Zone D at the same time, the order of priority for improvement/examination would be arranged in the following way.

The farther the distance between the plots (x_i, y_i) of importance and satisfaction indexes in the matrix and the Target Line is, the more necessary it is to improve/examine, which is labeled as improvement/examination index (δ_i) to define the order of priority for improvement/examination on abnormal products and abnormal service items. The value of δ_i is between 1 and -1, i.e. [1, -1]. Positive value refers to the need for improvement while negative value presents the need for examination. Moreover, at the same performance matrix, the bigger the absolute value of δ_i is, the more priory they need to be improved/examined (as shown in the following equation).

$$\delta_i = y_i - x_i \tag{5}$$

y_i represents the importance index of the abnormal product or the abnormal service, i=1,…, n. x_i refers to the satisfaction index of the abnormal product or the abnormal service, i=1,…, n

In the following section, Item 13 of the products and Item 6 of the service will be used as an example. The importance and satisfaction indexes of Item 13 are plotted within Zone I in the matrix (f(x, y) = (0.27, 0.85), δ_{13} = 0.58). The value of δ_i is positive, indicating the need to be improved. Meanwhile, the service importance index and the satisfaction index of Item 6 are plotted within Zone D (f(x, y) = (0.85, 0.27), δ_6= -0.58). The value of δ_i is negative, referring to the need to be examined. Similarly, the δ_i value of product Item 9, service Item 11 and 14 can be calculated for improvement/examination, as shown in Table 3. In Table 3, Item 13, Tyan Tiger Mixes 2466-4M Motherboard, in product quality at the backstage is the top priority for improvement, and the secondary priority is Item 9, TECD TD2024VK DVD Player. Furthermore, in service quality at the proscenium, Item 11, warranty, service and repair of the product, is the top priority for improvement, and the secondary priority is Item 14, the whole quality and flow of the electronic commerce, while Item 6, providing customized service, is the top priority for examination.

For the priority of abnormal products based on the absolute value of δ_i, it is dealt based on the order of the single item as the unit. As for the abnormal service, there are two kinds of process: (1) to deal with it based on single service as the unit or (2) to deal with the abnormal service as a whole for amelioration/analysis.

Table 3. The order of priority for improvement/examination on abnormal products and abnormal service

Types of quality	**Abnormal quality items**	**Recommended counter-measure**	**δ_i for improvement /examination**	**The order of priority for Improvement/examination**
Product quality at the backstage	Item 13 TyanTigerMPXS2466-4M Motherboard	Need more resources to enhance customers' satisfaction on the production	+0.58	Top priority for improvement
	Item 9 TECD TD2024VK DVD player		+0.34	Secondary priority for improvement
Service quality at the proscenium	Item 11 Warranty, service and repair of the product	Need more resources to enhance customers' satisfaction on the production	+0.53	Top priority for improvement or to be dealt with as a whole
	Item 14 The whole quality and flow of the electronic commerce		+0.45	Secondary priority for improvement or to be dealt with as a whole
	Item 6 Providing customized service	Considering reducing resource to reduce cost	-0.58	Top priority for examination or to be dealt with as a whole

3.2 The analysis of abnormal products and abnormal service

After determining the order for improvement/examination, the second step of the MAIC is analysis on the above five abnormal products and abnormal service. The process is in two stages: (1) the analysis on the abnormal products; (2) the analysis on the abnormal service.

3.2.1 the analysis on the abnormal products

In analyzing the abnormal products, the first item to be discussed is Item 13, Tyan Tiger MPX S2466-4M motherboard and the second item is Item 9, TECD TD2024VK DVD Player. Customers think that these two products' quality

importance is higher than their satisfaction and therefore discussion is needed on enhancing the product quality satisfaction. Because the methods of analysis and amelioration in enhancing the product quality satisfaction are generally similar, the Tyan Tiger motherboard will be used as the example for explanation in the following section.

It is defined in the above that when the product is more reliable, more efficient and user-friendlier, it has higher satisfaction. In analyzing Tyan Tiger motherboard, we firstly invited the engineer of the motherboard manufacture and the customers and brainstormed with the focus on enhancing the reliability, the efficiency and the user-friendliness of the motherboard. Four major causes were found: reducing computer crashing, reducing electric power consuming, upgrading I/O speed, and ameliorating compatibility. Then, under the four major causes, minor causes were identified and arranged as in cause-and-effect diagram of Enhancing Motherboard Quality Satisfaction (Figure 5). Finally, with the focus on these four major causes, we would ask the designers of the motherboard manufacture to measure the quality importance and the quality satisfaction at the production line and find out the quality importance index and the quality satisfaction index before the amelioration (Table 4). With these four importance indexes and satisfaction indexes, performance matrix of the major causes before the amelioration was conducted as shown in Figure 6.

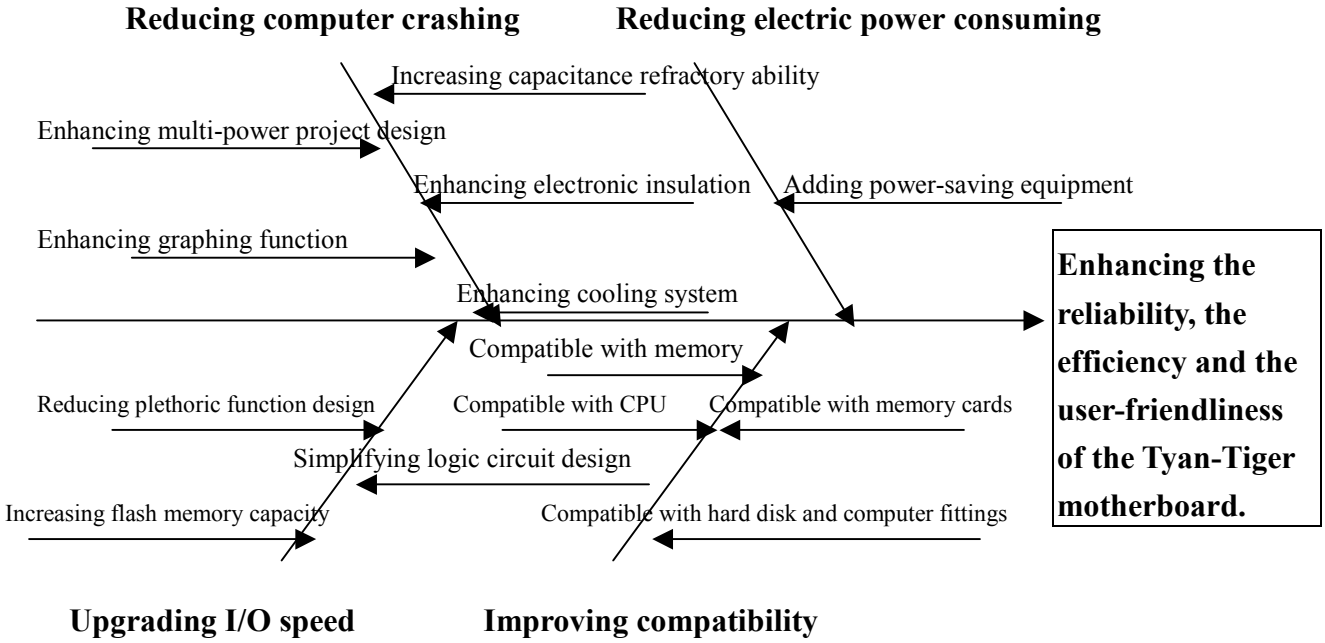

Figure 5 Cause-and-effect diagram of enhancing motherboard quality

Table 4. The quality importance index and the satisfaction index before ameliorating Tyan Tiger motherboard.

	Major causes	Importance Index(I_{PI})	Satisfaction Index(I_{PS})	Remarks
Tyan-Tiger motherboard	I/O speed	0.61	0.12	In Zone I, critical main causal category
	Computer crashing	0.76	0.31	In Zone I, critical main causal category
	Electric power consuming	0.30	0.35	In Zone A
	Compatibility	0.67	0.60	In Zone A

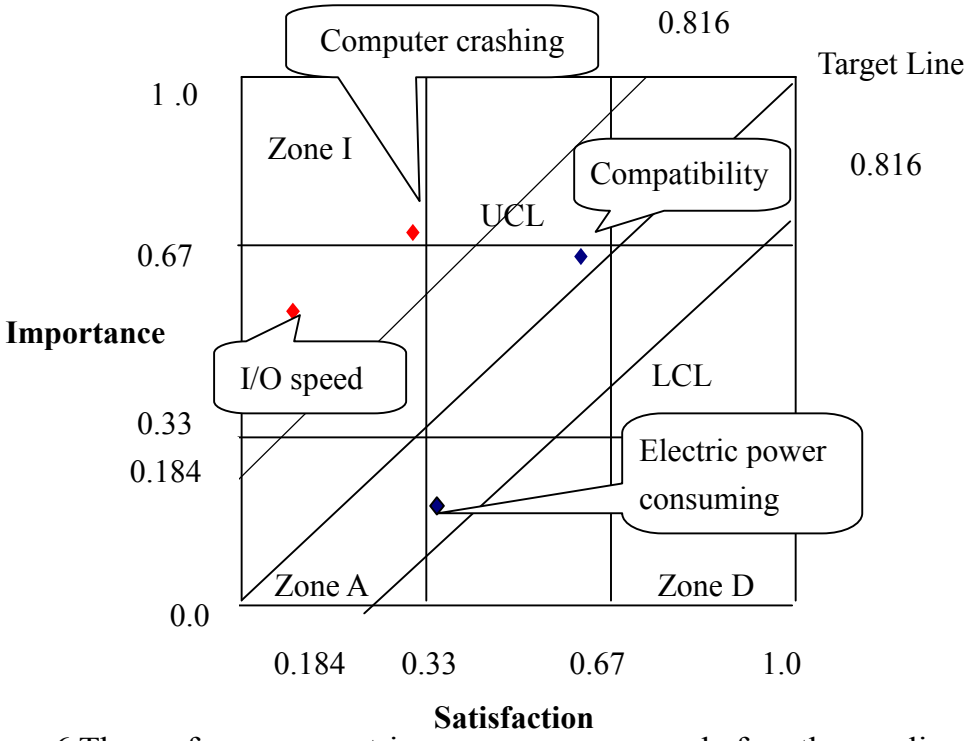

Figure 6 The performance matrix of the major causes before the ameliorating Tay Tiger motherboard.

As shown in Figure 6, two of the four major causes fall into Zone I and are called critical major causes: I/O speed and computer crashing. I/O speed means the amont of information per second that is processed by the motherboard (presented as s). The higher the value s, the more efficient the motherboard is. Computer crashing refers to the average period of time before the next computer crashing taking place (presented as d). The large(longer) the value d, the more reliable the motherboard is. The qualitity characteristics of the both two critical

causal categories is the-large-the-better type quality characteristics. Therefore, Kane's (1986) the-large-the-better type process capability index (C_{pi}) can be used to present the process capability index of the motherboard efficiency (I/O speed) or the motherboard reliability (computer crashing pre period of time), as shown in the Equation (6).

$$C_{pi} = \frac{\mu_i - LSL_i}{3\sigma_i} \quad (6)$$

In the above equation, $i \in S = \{s, d\}$, C_{ps} represents the efficiency index of the motherboard's I/O speed while C_{pd} represents the reliability of the motherboard; μ_i is the mean; LSL_s refers to the lower specification limit; σ_s refers to the standard deviation.

According to Equation (6), I/O speed and computer crashing pre period of time are both the-large-the-better type quality characteristics; therefore, the bigger the mean is or the smaller the standard deviation is, the farther it is from the lower specification limit and the bigger the process capability. Thus, it is necessary to consider the quality of the above two critical major causes in order to enhance the reliability, efficiency, and user-friendliness of the motherboard. In the following section, we would define P_i as the ratio of products meeting the criteria, as shown in Equation (7).

$$P_i = P(x_i > LSL_i) = \Phi(3C_{pi}) \quad (7)$$

In the above equation, x_i represents the value of quality characteristics of the item;LSL_i refers to the lower specification limit of quality characteristics of the item;$\Phi(3C_{pi})$ is the relation of process capability value transforming to yield, P_i represents the yield rate of quality characteristics of the item (i.e. The ratio of products meeting the criteria.)

The process capability indexes C_{pi} of the above two critical major causes has one-by-one relationship to yield P_i. In other words, the larger the two indexes C_{pi} are, the higher the p_i is. Therefore, C_{pi} can completely represent the required ratio of products meeting the criteria. For example, when index $C_{pi} = 1.0$, then it is guarantee that the ratio of products meeting the criteria is 99.865%.

Next step, on the product line, we examined the process capability index C_{pi} with the focus on the above two critical major causes: I/O speed and computer crashing and found out that the real process capability is only 0.33 and 0.51, which are equal to 2 and 3-sigma of product quality level (Table 5). In Table 5, it is shown that the reason of the customer's discontent in I/O speed and computer

crashing of the motherboard comes from the bad process capability. Therefore, to meet the customer's requirement, the process resource needs to be increased to enhance the process capability, emphasizing on the above two critical major causes.

Furthermore, according to the importance index and the satisfaction index in Table 5, corresponding to the process capability of the two major causes, a performance matrix of the process capability of the two major causes before amelioration was conducted as in Figure 7.

Table 5 Performance table of critical major causes of Tyan Tiger motherboard before amelioration.

Product quality	Critical major causes	Low specification limit (LCL)	Mean	Standard deviation	Process capability	Quality level	Importance index (I_{PI})	Satisfaction Index (I_{PS})
Tyan-Tiger motherboard	I/O speed	1,000M/ sec	1350	350	0.33	2-sigma	0.61	0.12
	Computer crashing	10,000 hrs/time	13800	2500	0.51	3-sigma	0.76	0.31

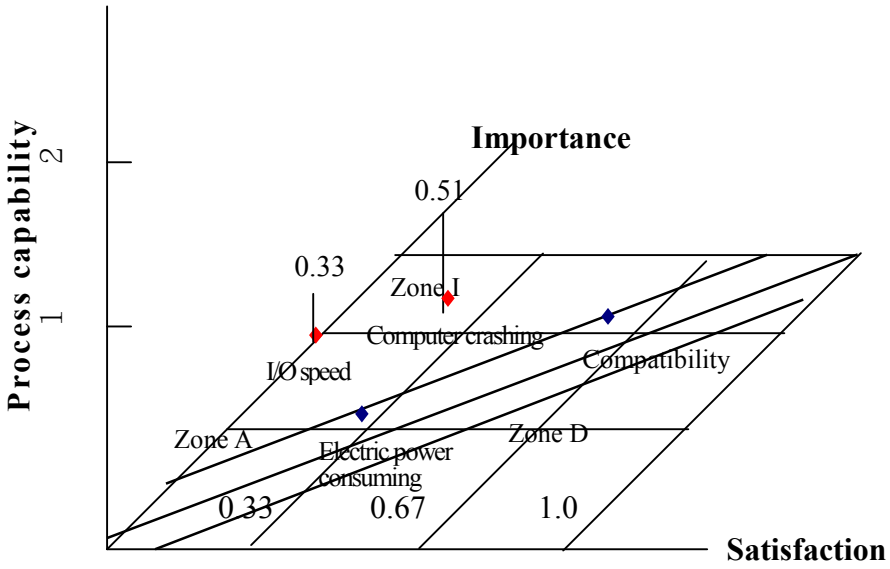

Figure 7. Performance matrix of the process capability of the two major causes before amelioration

3.2.2 Analysis on abnormal service

In Table 3, there are three abnormal service items: Item 11 Warranty, service and repair of the product, Item 14 The whole quality and flow of the electronic commerce, which needs more resources in order to enhance customers' satisfaction toward the service, and Item 6 Providing customized service, which can be considered to reduce resource to reduce cost. In the following section, we would analyze these three abnormal service items.

As mentioned above, there are two ways to deal with abnormal service: to conduct analysis/ amelioration (1) with a focus on each single service as a unit or (2) on the abnormal service as a whole. The decision on using the first or the second process depends on whether each abnormal service item can be measured or each abnormal service item is related to the whole service quality. In the current study, 15 items were designed to examine the whole service of the products bought by the customers; therefore, the three abnormal service items should be analyzed as a whole. Cause-and-effect diagram would be used for the analysis. The three items of abnormal service would be used as three major causes to enhance service quality. Under each category, we would identify the minor causes, which are the specific strategies to enhance the whole service quality. The minor causes are (1) conducting data mining on customer's purchasing products, (2) commissioners actively providing customers consultation, (3) commissioners actively providing customers advice for purchasing products, (4) 30-day warranty of full-refund with customer dissatisfaction, (5) home service for purchase and repair, (6) one-year warranty of prompt repair, (7) competitive prices of products and service, (8) customers choosing product-delivery time and place, (9) servers never shut down 24 hours a day year round, and (10) weekly updated web pages with updated products catalogues (Figure 8).

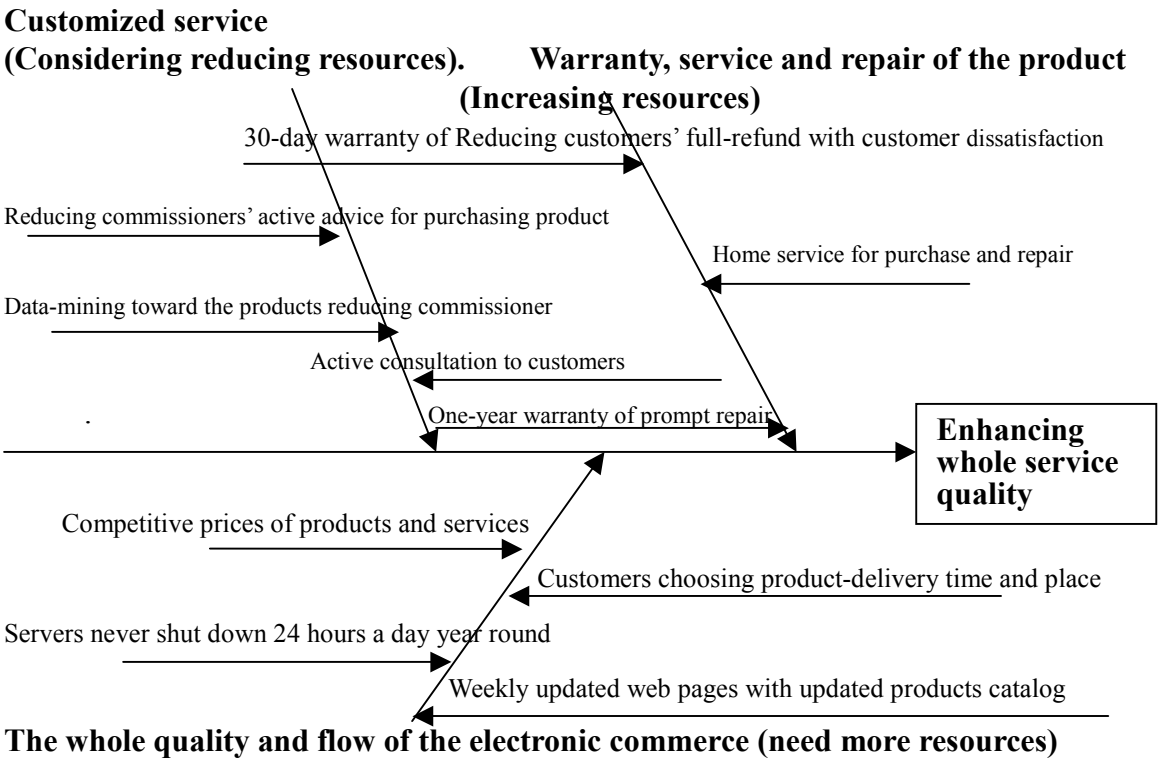

Figure 8 Cause-and-effect diagram of enhancing service quality characteristics

3.3 Amelioration of abnormal products and abnormal service

In the analysis of abnormal products and abnormal service, a characteristics cause-and-effect diagram was conducted to analyze each product in the section of abnormal products and then to identify critical major causes in order to enhance or reduce resources of R&D and manufacturing. On the other hand, abnormal service would be considered as a main causal category for enhancing service quality and used to conduct characteristics cause-and-effect diagram. Holistic analysis was used to identify specific service strategies. Next is the third step in MAIC: amelioration on abnormal products and abnormal service, which is divided into two stages: (1) focusing on abnormal product, and then (2) focusing on abnormal service.

3.3.1 Amelioration on abnormal products

In the analysis of abnormal products, we used characteristics cause-and-effect diagram to analyze Tyan Tiger motherboard and identified four major causes as well as minor causes. Among the above four major causes, we identified two critical ones: I/O speed and computer crashing, the process capabilities of which were 0.33 and 0.51 respectively and corresponding to

quality level 2 sigma and 3 sigma respectively. Then, engineers, in the product line of the motherboard, were required to conduct amelioration with the focus on three I/O minor causes: (1) add flash memory capacity, (2) reduce logic circuit, (3) decrease plethoric function design, etc. and, at the same time, on five computer crashing minor causes: (1) increase capacitance refractory ability, (2) enhance multi-power project design, (3) increase electronic insulation, (4) enhance graphing function, (5) enhance cooling system. The amelioration method is to decrease the lower specification limit (LSL) and standard deviation (δ_i) of the process of the two critical major causes. Therefore, we need to consider equipment parameters, tolerance, and use the best manufacture condition as criteria of enhancing process capability. After the period of process stability, data were collected to calculate I/O speed as 1.25, corresponding to quality level as 5 sigma, while the process capability of computer crashing is 1.96, corresponding to quality level as 7 sigma. Meanwhile, the above information would inform the designer of the motherboard, who would need to measure the quality satisfaction with the focus on the two critical major causes as in the above step. The quality satisfaction was calculated as 0.48 and 0.63 as shown in Table 7. In the following section, Figure 9 shows the correspondence between the importance index and the satisfaction index of the two critical major causes after amelioration and the process capability performance matrix of the critical major causes after ameliorating the process capability. According to Figure 9, the two critical major causes have been ameliorated to the ideal target zone, the amelioration procedure of which is shown in Figure 10.

Table 7. Performance matrix of critical major causes of Tyan Tiger motherboard after the amelioration

Product Quality	**Major causes**	**Lower Specification Limit**	**Average**	**Standard Deviation**	**Process Capability**	**Quality level**	**Importance Index(I_{PI})**	**Satisfaction Index(I_{PS})**
Tyan-Tiger motherboard	I/O speed	1,000M/ sec	1450	120	1.25	5 sigma	0.61	0.40
	Computer crashing	10,000 hrs	15800	985	1.96	7 sigma	0.76	0.63

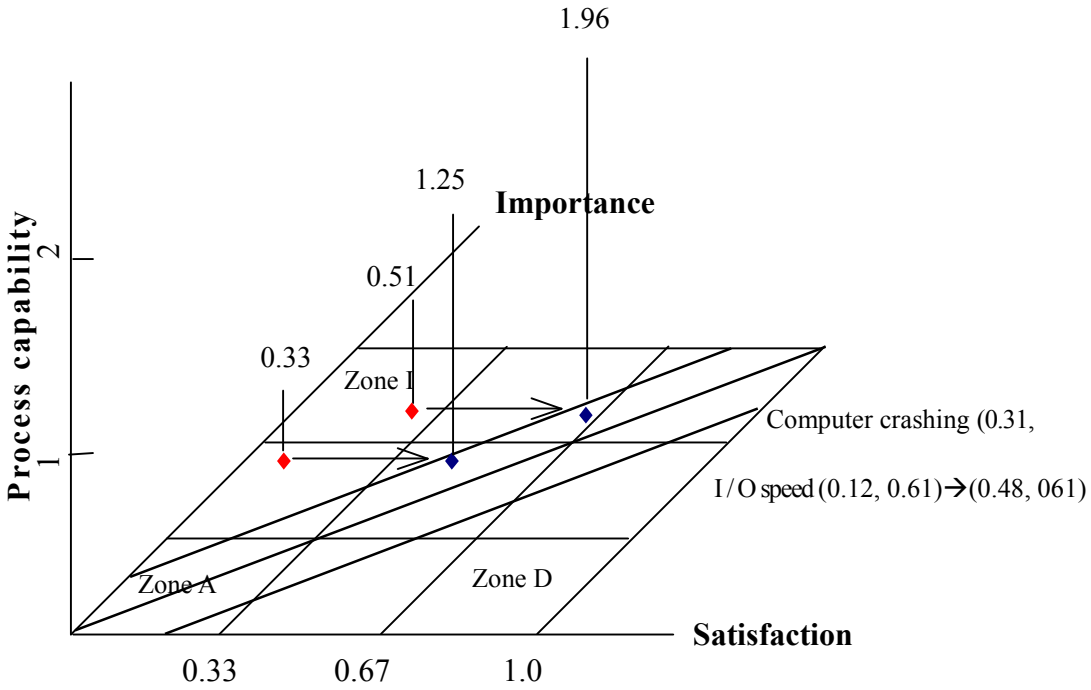

Figure 9. Performance matrix of process capability of critical major causes before and after amelioration

Current situation	Amelioration strategies	Corresponding strategies
Slow I/O speed	1. Increase flash memory capacity 2. Decrease logic circuit 3. Decrease plethoric function design	Increase resources in order to enhance customers' satisfaction on the product
High computer crashing	1. Increase capacitance refractory 2. Enhance multipower project design 3. Increase electronic insulation 4. Enhance graphing function 5. Enhance cooling system	

Feedback

Figure 10 Amelioration procedure of abnormal products at te backstage

3.3.2 Amelioration of abnormal service

In analysizing abnormal service, this study conducted holistic analysis through characteristics cause-and-effect diagram on the three abnormal service items and determined 10 specific service strategies (A to J) to enhance whole service quality. These 10 specific service strategies are interdependent with the whole service quality; therefore, this study would conduct Quality Funtion Development and use the relationship between the 10 specific service strategies and the three abnormal service items to determine several critical service strategies for amelioration among the 10 specific service strategies. The critical servce strategies are determined by the value of totoal weight (TW_i) in Quality Function Development. Furthermore, the value of total weight (TW_i) is measured by the sum of the values from the multiplying of each specific service strategies, corresponding to the value of weight w_i of each abnormal service item and improvement／examination index (δ_i) , as shown in Equation 8.

$$TW_i = \sum_{i=1}^{3} (\delta i \times w_i) \qquad (8)$$

In the above equation, w_i represents the value of weight w_i of each specific service strategies corresponding to the three abnormal service. δ_i represents improvement/examination index for abnormal service.

According to the values of total weight in the Quality Function Development, the specific service strategies corresponding to the bigger positive value are the critical ones that need more resources in order to enhance customers' satisfaction toward service while the specific service strategies corresponding to the bigger negative values are the critical ones that need to reduce resources in order to reduce cost.

The three abnormal service items corrsponding to the 10 specific service strategies were used to conduct Quality Function Development, through which three bigger positive values and two negative values were choisen among the values of total weight as the critical strategies to enhance whole service quality, as shown in Table 6. In Table 6, among critical service strategies for amelioration on abnormal service, three items need more resources in order to enhance customers' satisfaction: (Item 7) competitive prices of products and services, (Item 5) home service for pruchase and repair, and (Item 10) weekly updated web pages with updated proucts catelogues. Meanwhile, two items should be considered to reduce the resources in order to reduce cost: (Item 3) commissioners actively providing customers advice for purchasing products and

(Item 2) commissioners actively providing customers consultation.

Table 6 Critical strategies for enhancing whole service quality through Quality Function Development

Abnormal Service Items / Specific Service Strategies Weight w_i Very strong 4.0 Strong 3.0 Fair 2.0 Weak 1.0 Not relevant 0.0	**Improvement/Examination Index δ_i**	A conducting data mining on customer's purchasing products	B commissioners actively providing customers consultation	C commissioners actively providing customers advice for purchasing products	D 30-day warranty of full-refund with customer dissatisfaction	E home service for purchase and repair	F one-year warranty of prompt repair	G competitive prices of products and service	H customers choosing product-delivery time and place	I servers never shut down 24 hours a day year round	J weekly updated web pages with updated products catalogues
6. Providing customized service	-0.58	4	4	4	2	1	2	0	2	3	1
11. Warranty, service and repair of the product	0.53	2	1	1	4	4	4	4	3	3	3
14. The whole quality and flow of the electronic commerce	0.45	3	2	1	3	4	2	4	4	4	4
Total Weight (TW_i)		0.09	-0.9	-1.3	2.31	3.34	1.86	3.92	2.23	1.65	2.81
Critical Service Strategies			-2	-1		2		1			3

After knowing such critical service strategies of service quality, the Internet-marketing company was required to implement amelioration on the five critical strategies. Besides, the company would not only announce the amelioration on their website but also report to the customers who participated in the survey of the current study. After the amelioration, 268 customers of the effective questionnaire were asked to use the previous criteria to measure the satisfaction on the three service items: (Item 6) providing customized service, (Item 11) warranty, service and repair of the product, (Item 14) the whole quality and flow of the electronic commerce and calculated their service quality satisfaction index. The value of Item 6 decreased from 0.85 to 0.38, the value of

Item 11 increased from 0.20 to 0.44 while the value of Item 14 increased from 0.33 to 0.69. The importance index and the satisfaction index of the above three abnormal service items after amelioration was used to conduct the performance matrix of abnormal service quality after amelioration, as shown in Figure 11. Figure 11 presents that the three abnormal service items were ameliorated and have reached the ideal target zones, the amelioration procedure is presented in Figure 12.

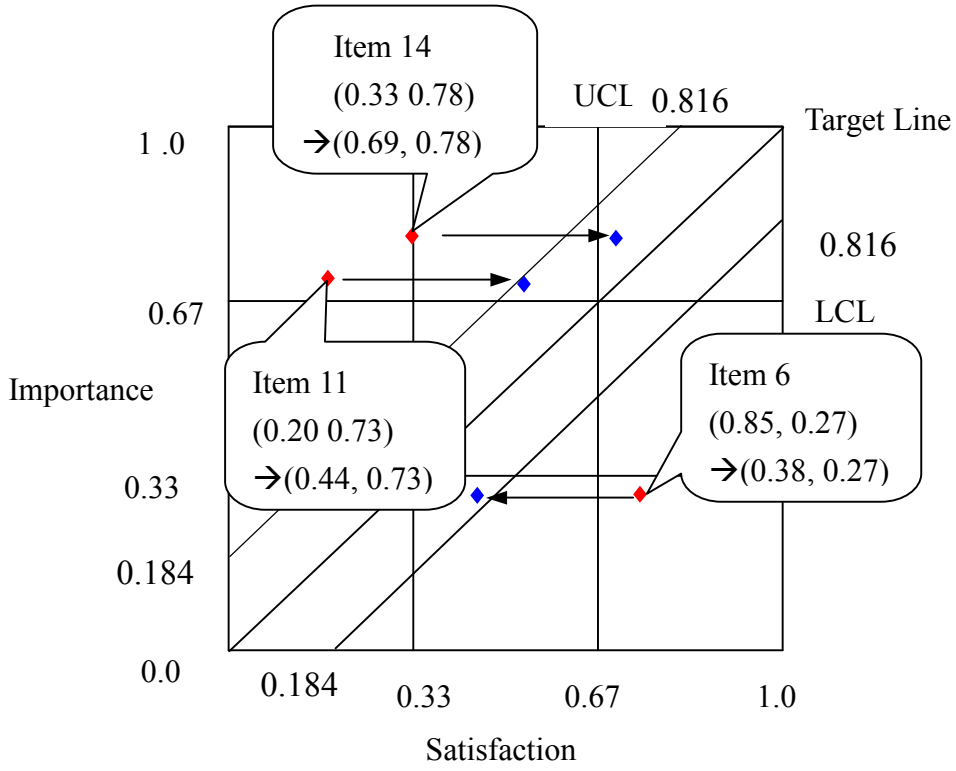

Figure 11. Performance matrix of abnormal service quality after amelioration

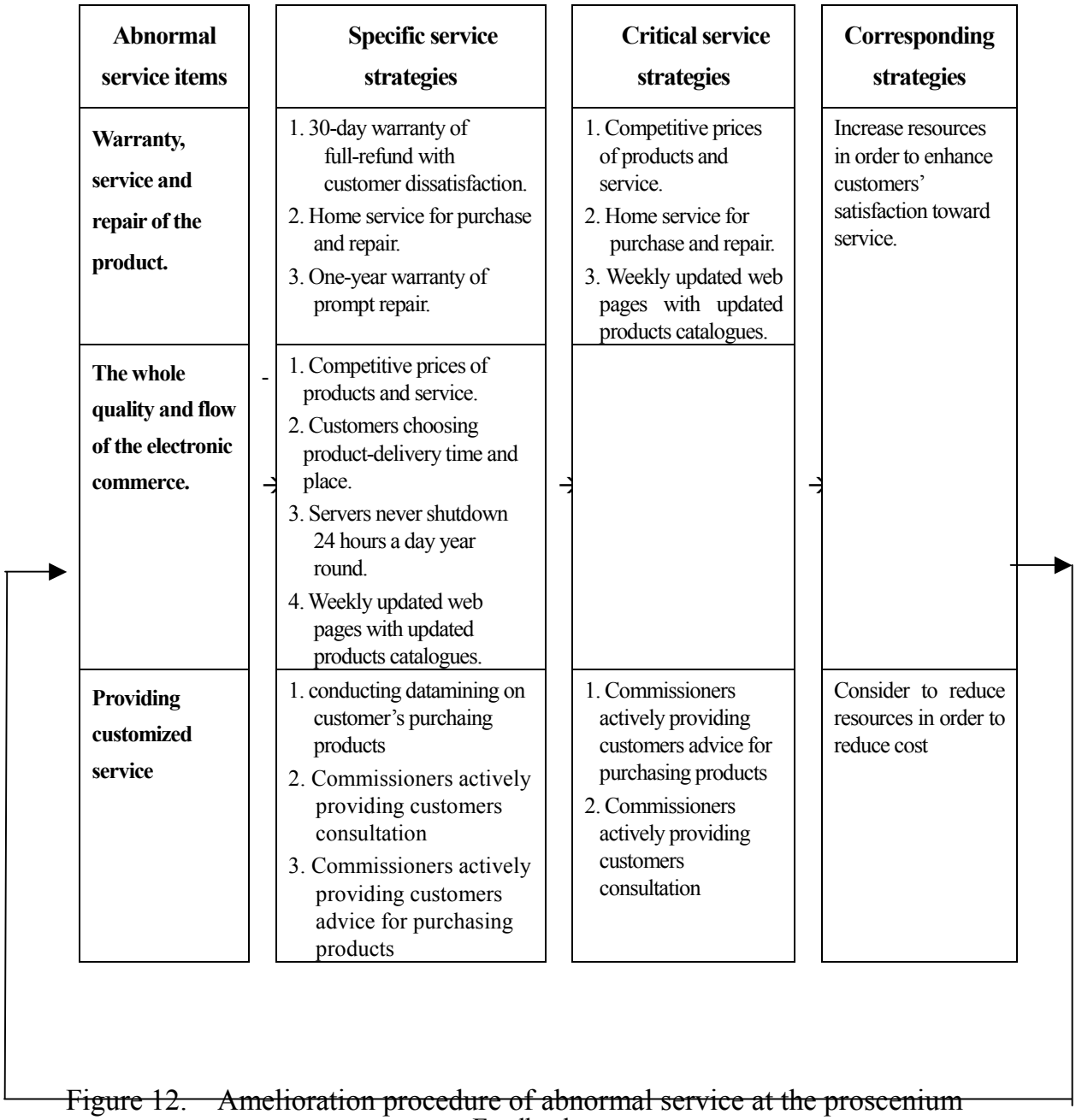

Figure 12. Amelioration procedure of abnormal service at the proscenium

4. The control of product quality and service quality

After the corroboration of effective amelioration on product quality and service quality, we would step into the fourth stage of MAIC, control, which is to

control the abnormal products and the abnormal service within the ideal zones. The control is discussed in narrow and broad perspectives.

4.1 Narrow perspective of control

The narrow perspective of control focuses on the action toward control. In other words, it is to corroborate the enhancement of process capability of the abnormal products' critical major causes, the control of satisfaction corresponding to importance within the target zones, and the implementation of critical service strategies toward abnormal service, each item of which is confirmed to be accepted by customers. After the control is implemented completely, standard operation procedure and knowledge management system would be established, focusing on the departments of R&D and manufacturing and the departments of marketing and maintenance at the proscenium in order to ensure the effect of long-term control.

4.2 Broad perspective of control

The broad perspective of control focuses on appropriate control of each step of MAIC of six-sigma in order to enhance the performance of Internet-marketing product quality and service quality. At the first step, measurement, the questionnaire should be completely designed with definition of product quality and service quality importance index and satisfaction index and questionnaire should be circulated and analyzed in order to determine abnormal products and abnormal service. At the second step, analysis, focusing on various abnormal products and abnormal service, we should arrange the priority of improvement/examination, then identify critical major causes through characteristics cause-and-effect diagram, and finally determine specific service strategies toward abnormal service. At the third step, improvement, we firstly conduct critical main-cause-categories process-capability performance matrix before and after improvement in order to ensure the effect of improvement. Then, critical service strategies are determined as improvement objectives through Quality Function Development focusing on abnormal service. At the fourth step, control, after corroborating abnormal service is controlled within the ideal zones; we establish standard operation procedure and standardize knowledge management in order to ensure the effect of control. Such broad perspective of control through these interdependent steps will maintain the performance of the Internet-marketing product quality and service quality. The procedure of these steps is presented as Figure 13.

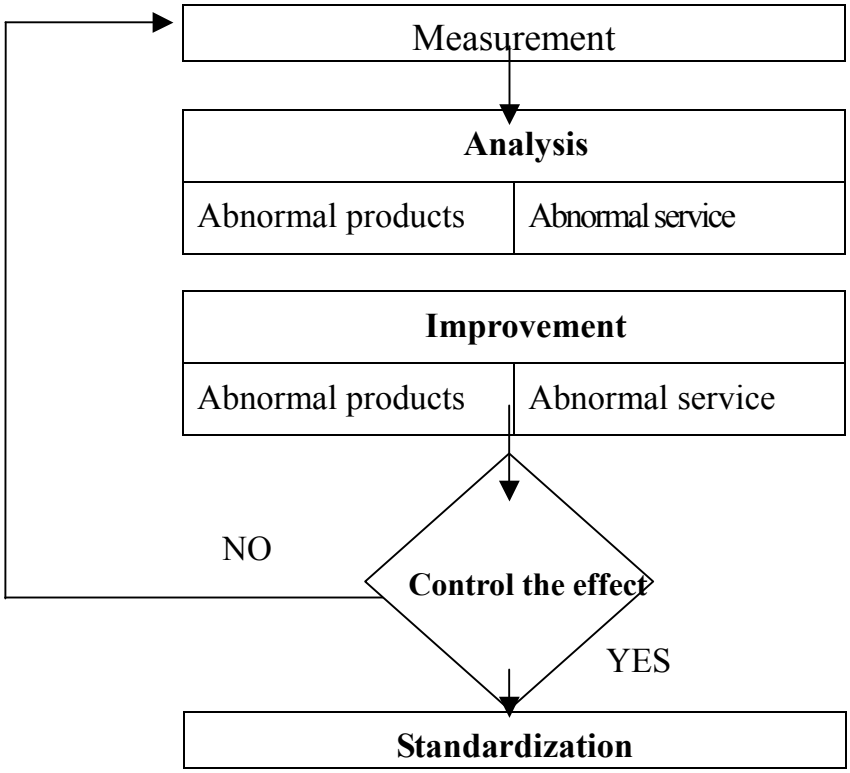

Figure 13 Procedure of broad perspective of control on product quality and service quality

5. Conclusion

Internet marketing has been gradually become a trend of marketing. Its success is critically determined in the aspects of product quality and service quality. Product quality refers to the customer's acceptability of product's R&D and manufacturing at the backstage while service quality means the customer's acceptability of product's marketing and maintenance at the proscenium. Most research on customer's satisfaction on Internet-marketing generally analyzes and improves customer's satisfaction through one single aspect. This study used Michael's (2002) Six Sigma MAIC (measure, analyze, improve and control) to ameliorate procedure and meanwhile considered product quality and service quality of Internet-marketing in order to establish a system to enhance customer's whole satisfaction.

Many countries have joined WTO and many companies have developed logistic management to systematically arrange logistics and the flow of information in order to finally satisfy supply chain management. Therefore, there has been marked increase on the percentage of purchase order through Internet-marketing. In such case, a quality Internet-marketing system will

reinforce the company's national competitiveness. This study provided the procedure of measurement, analysis, improvement and control to arrange the information in the aspects of product quality and service quality step-by-step and argued a practical method of holistically considering R&D, manufacturing, marketing and maintenance in order to enhance product quality and service quality of Internet-marketing. This study is believed to contribute in reinforcing customers' purchase inclination and enhancing business performance.

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