Assessing Product Satisfaction Performance using 6-Sigma Methodology and S/N Ratio Approach – the case of PDA

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With the advent of the Internet, personal digital assistants (PDAs), which were originally meant for management of personal information, are now equipped with the features of network connection and wireless communication. No longer restricted by time and space, PDAs can access information anytime and anywhere, thus resembling a palm-top computer. Nevertheless, the upsurge of Information Appliances (IAs) has bred over-optimism on the development of PDAs. In terms of importance, PDAs are inferior to mobile phones; while in terms of functions, they are less versatile than notebook PCs. Such perspective, however, has neglected the uniqueness of PDAs. In view of the sluggish sale of PDAs, this study aims to explore how production satisfaction, brand name, and service convenience affect the desire to purchase PDAs, which can serve as useful references for planning IA promotion strategies. By utilizing the DMAIC methodology of 6-sigma, a comprehensive assessment and improvement model is constructed. This model enables enterprises to quickly and effectively measure, analyze, improve and control their service quality, which would in turn promote the overall satisfaction of customers, thus creating high value-added quality competitiveness and enhancing the profitability of enterprises.

1. INTRODUCTION

The post-PC era, which emphasizes compact and easy-to-use products, has led to intense research and development of Information Appliances (IAs). IA not only integrate the 4C (Computer, Communication, Consumer and Contents) concept with the Internet, but also offer convenience of portability. Among IAs, personal digital assistants (PDAs) are considered to have the greatest potential. With the advent of the Internet, PDAs, which were originally meant for management of personal information, are now equipped with the features of network connection and wireless communication. No longer restricted by time and space, PDAs can access information anytime and anywhere, thus resembling a palm-top computer. Nevertheless, the upsurge of Information Appliances (IAs) has bred over-optimism on the development of PDAs. In terms of importance, PDAs are inferior to mobile phones; while in terms of functions, they are less versatile than notebook PCs. Such perspective, however, has neglected the uniqueness of PDAs. In view of the sluggish sale of PDAs, this study aims to explore how production satisfaction, brand name, and service convenience affect the desire to purchase PDAs, which can serve as useful references for planning IA promotion strategies.

Previous research on new product focuses mainly on the innovation proliferation while studies on customers' evaluation of product attributes have been scarce. To make up for such deficiency, this work employs the DMAIC methodology described in 6-Sigma deviation of Michael (2002) to promote the overall customer satisfaction using the example of PDA. First, with reference to Dabholker et al. (1966) and Parasuraman et al. (1985, 1991), a questionnaire is designed under five quality feature items of PDA: Function, Specification, System, Service Convenience and Brand Name, containing a total of 30 questions. This questionnaire is then employed to measure satisfaction and importance of the product and to construct the performance matrix and overall satisfaction control chart as tools for analysis. The results thus obtained can reveal the key items for review and improvement. Further analysis on the items identified will be made using the cause-effect diagram, and corrective actions for improvement will be devised. Finally, another questionnaire with focus on the key items for review and improvement will be designed. Survey results from the questionnaire will be employed to construct the overall satisfaction control chart for monitoring the execution and effectiveness of the relevant corrective actions.

This comprehensive assessment and improvement model developed in this study enables enterprises to quickly and effectively measure, analyze, improve and control their service quality, which would in turn promote the overall satisfaction of customers, thus creating high value-added quality competitiveness and enhancing the profitability of

enterprises.

2. SERVICE QUALITY ASSESSMENT MODEL

From the perspective of Dabholker et al. (1966) and Parasuraman et al. (1985, 1991), service quality is meant to fulfill the gap between a customer's expectation and perception of a product, while overall customer satisfaction is the total satisfaction derived from all products consumed. Hence, in terms of overall satisfaction, a customer's expectation for quality can be defined as the importance ratio between different products while a customer's perception for quality can be defined as the satisfaction ratio between different products. Taking the example of PDA, this study designs the questionnaire using the colloquial service quality items developed from the customer requirement point of view. Then with reference to the works of Hung et al. (2003), Lin et al. (2005) and Chen et al. (2005, 2006), an index for assessing the degree of importance expected before use and the degree of satisfaction perceived after use of a product is developed. This value of this index will reveal the performance of a product in terms of importance and satisfaction, as expressed by the following equations, respectively.

$$P_I = \frac{\mu_I - \min}{R} \quad (1) \qquad P_S = \frac{\mu_S - \min}{R} \quad (2)$$

where the subscripts I and S denote the degree of importance and satisfaction, respectively; and hence, P_I and P_S represent the importance index and satisfaction index, and μ_S and μ_I stand for average degree of satisfaction and average degree of importance, respectively. $min = 1$ denotes the minimum value of k scale table, while $R = k - 1$ represents the full range of k scale table. A low index value indicates low satisfaction or importance of a product's service quality. Obviously, these two index values are both set between (0, 1). For example, for a scale of 5 ($k = 5$), a degree of importance (satisfaction) equal 1 means the product is of the lowest importance (satisfaction), a degree of importance (satisfaction) equal 3 means the product is of medium importance (satisfaction), a degree of importance (satisfaction) equal 5 means the product is of the highest importance (satisfaction). Therefore, when full range $R = k - 1 = 4$ and the average importance (satisfaction) exceeds the medium level of 3, its index value will be greater than 0.5 (half), indicating a positive overall average importance (satisfaction). On the other hand, when the average importance (satisfaction) is below the medium level of 3, its index value will be less than 0.5 (half), revealing a negative overall average importance (satisfaction). Hence, the index value is indicative of whether the customer's assessment of a product is positive or negative in terms of its importance or satisfaction. Nevertheless, the value of P_I and P_S cannot reflect the variation *(What do you mean?)* of the questionnaire. To overcome this, the S/N ratio proposed by Taguchi (1989) is adopted to modify the index value, which is then compared with P_I and P_S to shed light on the variation between the index values. This would facilitate the interpretation of the responses obtained by the questionnaire and help identify the most appropriate corrective actions. The S/N ratio for degree of importance and satisfaction are express respectively as follows:

$$SN_I = \frac{P_I}{s_{PI}} \quad (3) \qquad N_S = \frac{P_S}{s_{PS}} \quad (4)$$

Then the Performance Evaluation Matrix proposed by Hung et al. (2003), Lin et al. (2005) and Chen et al. (2005, 2006) is modified as the assessment tool. As seen in Fig. 1, the performance evaluation matrix can reveal both the degree of importance and satisfaction of every quality service item, expressed along the vertical and horizontal axis, respectively. Because the value of SN_I and SN_S are both within [0, 30], we can use four scales: [0, 10, 20, 30] to define three different levels; with 0 to 10 denoting the lowest importance or satisfaction; 10 to 20, the medium importance or satisfaction, and 20 to 30, the highest importance or satisfaction. In other words, when the performance index (SN_I, SN_S) = [0, 0], the service quality item is the least important and most unsatisfactory; while the service quality item with performance index (SN_I, SN_S) = [30, 30] is the most important and most satisfactory. The target line (T) runs diagonally across the matrix with coordinates of $SN_I = SN_S$, indicating products of equal importance and satisfaction. Above the target line, the service quality items have more importance than satisfaction. Take for example, the coordinates of [SN_I, SN_S] = [20,10] where $SN_I > SN_S$ imply that improvement has to be made and resource investment should be increased to enhance satisfaction. Hence, the area below T is also called the "block for improving satisfaction". Below the target line, the service quality items have more satisfaction than importance. Take for example, the coordinates of [SN_I, SN_S] = [10, 20] where $SN_I < SN_S$ imply that review has to be made and resource investment should be decreased to reduce cost. While achieving high customer satisfaction is an important goal of business management, it must be pursued in consideration of the cost incurred. Efforts should be made to identify the key service quality items to be improved and the proper quality performance level. Hence, the area above T is also called the "block for reviewing resource investment".

Moreover, we can also use the statistical method to calculate the degree of importance and satisfaction of points Q_1, Q_2 and Q_3 for drawing the box-and-whisker plot of the questionnaire items. The location of the box-and-whisker plot can serve to indicate the overall satisfaction level. If it is located above the target line, it means that the level of satisfaction is higher than that of importance and resource investment should be reduced. On the other hand, if it is located below the target line, as seen in the example shown in Fig. 1, the level of satisfaction is lower than that of

importance and resource investment should be increased to promote satisfaction.
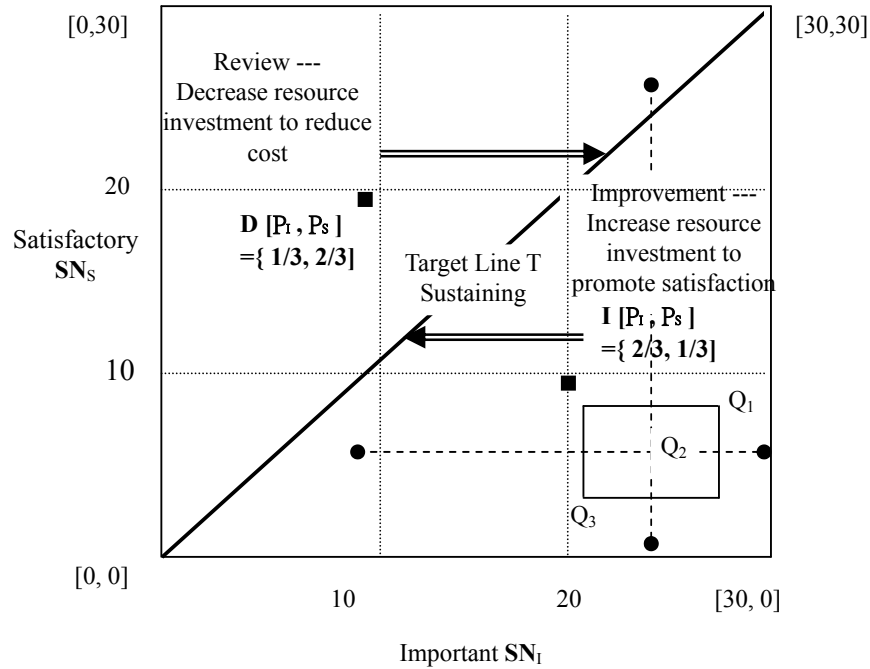

Figure 1: Performance Evaluation Matrix

However, the above coordinates cannot accurately and objectively determine which are the items that need to be improved or reviewed. To overcome such drawback, we employ the difference in degree of importance and satisfaction to denote the overall degree of satisfaction, as expressed by the following equation:

$$SN_{I-S} = SN_I - SN_S \qquad\qquad (5)$$

where SN_I represents the importance performance index, SN_S represents the satisfaction performance index, and SN_{I-S} represents the overall satisfactory performance index.   Their values all range between -1 and +1. Take for example coordinates $[SN_I , SN_S] = [24, 12]$, calculating with the above equation yields $SN_{I-S} = 12$. A positive SN_{I-S} implies the need to improve satisfaction through increase in resource investment.   On the other hand, take for instance coordinates $[SN_I, SN_S] = [13, 25]$, the equation gives $SN_{I-S} = -12$.   A negative SN_{I-S} indicates the need to review if resource investment should be decreased to reduce cost.

3. THE DEFINITION AND MEASUREMENT OF PDA'S QUALITY SATISFACTION

In accordance to the above mentioned evaluation model, this article will investigate the importance and satisfaction of the 5 quality compositions, and these 5 quality compositions are: "function", "specification", "system", "brand name" and "service convenience". Then we deploying these 5 quality compositions into 30 question features and use them as the question items of the questionnaire and focus on the Taiwan area survey the customer in the information industry market. In total, we released 100 copies of questionnaire after retrieval and arrangement, deducting the general public that did not purchase the PDA commodity and ineffective 37 copies that incomplete and with same answer for all questions, we totally collected 63 copies effective questionnaire. The effective retrieval rate is 63%.

In the following, we will carry out the confidence analysis on the questionnaire. Since we applying the "multiple item scale" in the questionnaire, therefore we will pay more attention on the internal confidence level. The so called internal confidence level means the degree that one scale measures a single concept, at the meantime; it will represent the internal consistence degree of the question item in the scale. The most used internal confidence level is Cronbach's alpha coefficient. In according to the viewpoint of Gary (1992). After the analyzing of statistic software the average Cronbach's α value   of the importance of the 5 quality compositions of PDA is over 0.7487, that is, for the question item of this questionnaire to the person for answering the importance of that question there is over 74.87% confidence level that his answer is consistent. And as for the satisfactory degree of this PDA questionnaire, except the "function", the Cronbach's α value of the other compositions are all over 0.7134, this is explaining that for the satisfaction of this questionnaire the answer consistency of the result of the responders are over 71.34% confidence level. In summary of the above analysis, as to the importance and satisfaction of this questionnaire the confidence level is acceptable.

Furthermore, the average score of importance of "function", "specification", " system", "brand name" and "service convenience" are 4.26, 4.27, 4.36, 3.98 and 4.05, respectively. Therefore, we know that the importance of the above mentioned 5 quality items is within the range of 3.98 to 4.36, that is, they are felt important in average. For the respect of satisfaction, the average score for "function", "specification", "system", "brand name" and "service convenience" are 3.21, 3.12, 3.14, 3.03 and 3.08, respectively. Therefore, we know that the satisfaction of the above mentioned 5 quality items is within the range of 3.98 to 4.36, that is, the satisfactory level somewhat lower than expectation. But for the confidence level (95%), every quality item's importance and satisfaction are all greater than 0.95, that means the measured result can represent the whole set. In the final we summarize the above statistics as shown in Table 1:

Table 1. The performance statistics of Importance and Satisfaction of Quality compositions

Measurement composition Quality composition	Importance			Satisfaction		
	Average μ_I	Index value P_I	Confidence Level (95%)	Average μ_S	Index value P_I	Confidence Level (95%)
Function	4.26	0.815	0.64	3.21	0.5525	0.82
Specification	4.27	0.8175	0.91	3.12	0.53	0.88
System	4.36	0.84	0.54	3.14	0.535	0.61
Brand	3.98	0.745	1.06	3.03	0.5075	1.23
Service Convenience	4.05	0.7625	0.79	3.08	0.52	0.85

In the following, by using the above 5 quality items to composite performance matrix model, as shown in figure 2. From the above figure 2 we can find that the importance of the 5 quality items are all higher than satisfaction, that means for the every quality item of current PDA can not meet customer's requirement in general, thus we must increase the resource investment to search the real quality features needed by the customer to promote the customer satisfaction:
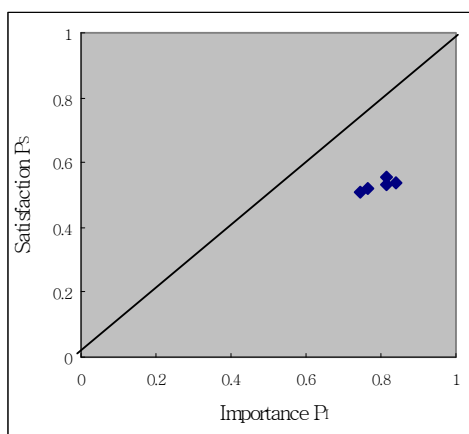

Figure 2. The performance matrix of quality compositions

4. THE ANALYSIS AND IMPROVEMENT OF PRODUCT AND SERVICE QUALITY FEATURES OF PDA

On the analysis respect of importance and satisfaction of product and service quality of PDA, at first we make statistics on every quality question to calculate the importance value P_I and satisfaction value P_S, then in accordance with the above formula to get the importance performance value SN_I, satisfactory performance value SN_{I-S}, and at last calculate the quartile Q1, Q2, Q3 and standard deviation value of the P_I and SN_I value of importance and the P_S and SN_S value of satisfaction, as well as their 3 coordinates, by using these coordinates to draw out the box-and-whisker plot   and fill the data into table 2.

In the respect of satisfactory evaluation, we can refer to the importance performance value P_I and satisfactory performance value P_S to plot the quality evaluation matrix and use it as the reference for evaluating every service quality. And we can with the reference of the 3 coordinates of the quartile values of importance and satisfaction Q1, Q2 and Q3 to draw out the box-and-whisker plot; and use the minimum and maximum coordinates to plot the whisker of the box, and use it to measure the variation degree of importance and satisfaction. Use the block that the box-and-whisker plot been located to judge the bas and good of overall satisfactory level. If the coordinates and box-and-whisker plot located in the upper left block of the target line, it means satisfactory level is higher than the importance therefore need to consider to decrease the investment of resource to lower the cost; if the coordinates and

box-and-whisker plot located in the lower right block of target line, it means satisfactory level is lower than the importance therefore need improvement to increase the resource investment to promote the satisfactory level, as shown in figure 3.

Table 2. Quality satisfactory and importance performance table

Compositions	Measured question	P_I	P_S	S_{PI}	S_{PS}	SN_I	SN_S	SN_{I-S}
Function	**1. Easy to control**	**0.8492**	**0.5623**	**0.0313**	**0.0385**	**27.105**	**14.5936**	**12.5114**
	2. Stock News	0.7500	0.4960	0.0968	0.0534	7.75	9.286872	-1.53687
	3. Entertainment	**0.7976**	**0.5595**	**0.0421**	**0.0639**	**18.9682**	**8.75038**	**10.2178**
	4. Image processing	0.8214	0.8426	0.0472	0.0589	17.39017	14.30955	3.080622
	5. Touch panel	0.8572	0.7895	0.0357	0.0680	24.0002	11.61502	12.3852
Specification	6. Portability	0.8532	0.7859	0.0497	0.0439	17.17885	17.89927	-0.72042
	7. ID Design	0.7857	0.8956	0.0400	0.0579	19.62617	15.47026	4.155902
	8. Battery life	0.7976	0.7895	0.0441	0.0587	18.10035	13.45163	4.648719
	9. Data processing	0.8254	0.5175	0.0557	0.0474	14.81453	10.92519	3.889344
	10. Shelf life	0.8373	0.8956	0.0366	0.0521	22.87059	17.17969	5.6909
	11. Screen size	0.7976	0.7256	0.0461	0.0306	17.30846	23.74292	-6.43446
	12. Expandability	0.8254	0.6893	0.0376	0.0513	21.96942	13.44522	8.524198
System	13. System stability	0.8730	0.8126	0.0360	0.0461	24.22761	17.63255	6.595055
	14 OS compatibility	0.8611	0.7956	0.0318	0.0400	27.07007	19.87283	7.197244
	15. Document processing	**0.8404**	**0.5357**	**0.0308**	**0.0481**	**27.2407**	**11.1379**	**16.1028**
	16. Operation Interface	0.7857	0.5318	0.0400	0.0393	19.62617	13.53105	6.095121
Brand Name	17. Reputation	0.7302	0.7895	0.0429	0.0333	17.00129	23.74427	-6.74298
	18. Price	0.7143	0.8954	0.0521	0.0595	13.70145	15.05891	-1.35746
	19. Quality	0.8333	0.7852	0.0464	0.0412	17.97083	19.04963	-1.0788
	20. S/W gift	0.6627	0.8564	0.0669	0.0569	9.912901	15.05953	-5.14663
	21. Brand name	**0.6389**	**0.7596**	**0.0621**	**0.0374**	**10.29621**	**20.3219**	**-10.026**
	22. Market Share	**0.5236**	**0.7570**	**0.0621**	**0.0300**	**8.438088**	**25.2718**	**-16.834**
	23. Vendor information	0.7341	0.8965	0.0381	0.0448	19.29347	20.02418	-0.73071
	24. Down rate	**0.8651**	**0.7812**	**0.0400**	**0.0675**	**21.64281**	**11.56916**	**10.0736**
	25. Time to repair	**0.8810**	**0.5623**	**0.0421**	**0.0668**	**20.94972**	**8.423179**	**12.5265**
Service	26. Service convenience	0.7659	0.7896	0.0622	0.0582	12.3044	13.57105	-1.26665
	27. Brand name reputation	0.6826	0.7985	0.0629	0.0472	10.84859	16.90483	-6.05624
	28. Payment flexibility	0.6151	0.8564	0.1105	0.0694	5.564523	12.33785	-6.77332
	29. Passion of serviceman	**0.8611**	**0.7956**	**0.0379**	**0.0671**	**22.74527**	**11.84981**	**10.8955**
	30. Professional Knowledge	**0.8929**	**0.7913**	**0.0357**	**0.0705**	**24.9998**	**11.22332**	**13.7765**
1st quartile Q_1		13.9797	11.6737			13.97972	11.67372	-1.49202
2nd quartile Q_2		18.0305	15.2417			18.03053	15.24178	2.788745
3rd quartile Q_3		22.5513	17.8325			22.55131	17.83259	9.68628
Standard Deviation								8.085816

From figure 3, the box-and-whisker plot located in improvement zone means most of the quality feature are with importance lower than satisfaction, that is, most of the quality feature can not meet customer expected satisfactory level. Due to the evaluation matrix is established by the quality performance value P_I and P_S, and P_I and P_S value is the performance values that established by the average and target value which only considering the shift and not considering the deviation, thus causes the coordinates of every quality feature are too cumulative and can not accurately find out the quality items that need to be reviewed and improved. Therefore, this article will applying the SN ratio concept of Taguchi (1989) to add the parameter of standard deviation to set up the evaluation index value of SN_I and SN_S and use these indices value to set up the performance matrix, and using the 3 coordinates of the quartile values Q1, Q2, Q3 of importance SN_I and satisfactory value SN_S to draw the box of box-and-whisker plot,; and then using the minimum and maximum coordinate as the whisker of the box and use it to measure the variation degree deviation of importance and satisfaction and judging the bad or good of the overall satisfactory level by the block that box-and-whisker plot locates, as shown in figure 4.

From figure 4, we can see the box-and-whisker plot locates in improvement zone it means that most of the quality feature with the importance lower than it's expecting satisfactory level, that is, most of the quality feature can not meet

customer's expected satisfaction. Since the evaluation matrix of ion SN_I and SN_S do not easy to define the upper and lower control limit, and thus hard to find out the quality items that need be improved and reviewed. Therefore, this thesis will adopt the concept of s control chart to define the control chart of overall satisfaction. At first, using the above formula and the relative distance between coordinate on the quality performance evaluation matrix to the target line, to transfer the 2 dimensional coordinate of performance value SN_I and SN_S of the performance matrix into one dimensional coordinate of quality satisfactory performance value SN_{I-S}. In the following, we adopting the above formula to set up the central line, upper and lower control limit. We define the central line T value is 0 (zero) and the upper and lower control limits are plus and minus one standard deviation value. Due tot eh standard deviation value is 6.56815 so that the upper control limit UCL will be 6.56815 and the lower control limit LCL is -6.56815. In the end, draw the overall satisfactory performance value SN_{I-S} of every quality item on the overall satisfactory performance control chart, as shown in figure 5.
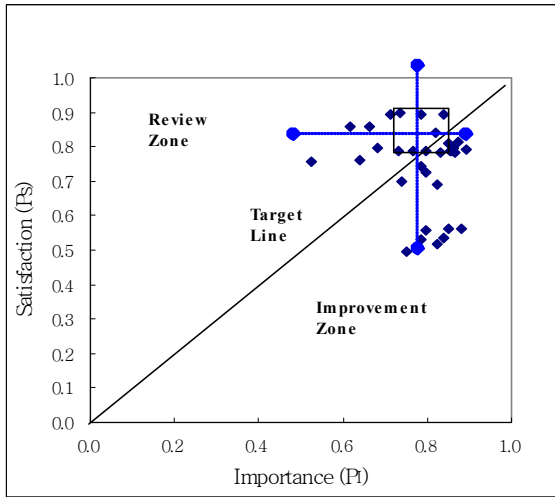

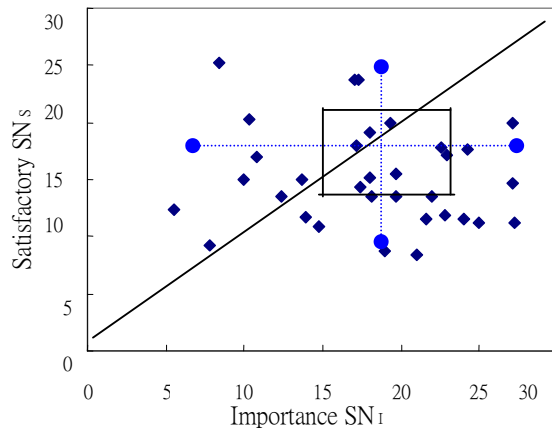| Figure 3. The evaluation matrix of quality performance P_I and P_S before improvement | Figure 4. The evaluation matrix of quality performance SN_I and SN_S before improvement |

From the figure 5, we can see in the performance control chart of SN_{I-S}, the area above the upper limit is the improvement zone and there are 9 items locate in this area they are: 1st item - easy to control, 3rd item - video entertainment, 5th item - touch panel, 12th item - expandable function, 15th item - document processing, 24th item – down rate, 25th item – time to repair, 29th item – service passion and 30th item – professional knowledge; it means those quality feature have importance higher than satisfaction, that is, these quality feature can not meet the expected satisfactory level of customer. Therefore, we need to increase the resource investment to promote the satisfactory level. The area below the lower control limit is the review zone, there are 2 items locate in this area, and they are: 21st item – brand name and 22nd item – market share; it means these quality feature with importance lower than its satisfaction, that is, over customer's expectation, and we need to review and take consideration to decrease the resource to lower the cost.
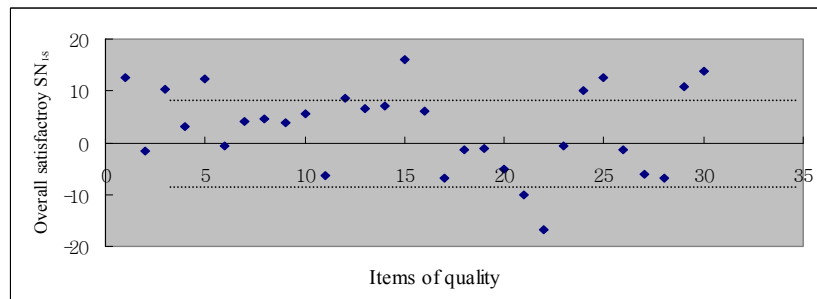

Figure 5. The overall satisfactory performance control chart before improvement

Improvement： **Increase resource investment to promote the satisfaction.**	**Review：** Review the resource investment, consider reducing the resource investment to lower the
1st–easy to control, 3rd–video entertainment, 5th–touch panel, 12th– expandable function, 15th–document processing, 24th– malfunction rate, 25th– repair speed, 29th– passion altitude, 30th–professional knowled	21st – Brand name 22nd – Market sharing

Cause | **Product, Personnel, Facility, Process - 4P Analysis**

1. The design do not consider the difference in personality and customer layer.
2. The technology and cost of video entertainment can not be commercialized
3. Screen too small and poor touch control quality
4. Can not grasp exactly the customer requirement
5. Not compatible with Microsoft Office.
6. High malfunction rate of battery's power supply system
7. Lack of repair station
8. Insufficient training on service altitude
9. System design too complex to meet public requirement

Cause | **Product, Personnel, Facility, Process - 4P Analysis**

1. Customer does not respect the brand name, so that need to consider reducing the promotion advertisement cost.
2. Due to the PDA do not meet public need and cause the shrinkage of market and so on disrespect the market sharing. Therefore need to consider reducing the investment on market sharing and instead by enhancing the value-added of PDA to expand the market growth.

Situation

1. Design the PDA to take the differentiation in
2. pernality and customer layer into consideration.
3. Enhance PDA's video entertainment technique.
4. Enhance the touch panel technique and quality
5. Design questionnaire for enhancing the market survey to understand the real customer need
6. Establish the co-platform with OFFICE.
7. Enhance the quality of battery power supply system.
8. Add repair station.
9. Enhance the training on service altitude.
10. Consider the customer need on quality feature and simplify the design.

Situation

1. Due to customer do not respect the brand name so that we need consider of reducing the promotion advertisement cost and bundled with other related product for promotion.
2. Enhance the value-added of product to the customer to expand the market growth rate.
3. Enhance the market survey to design a PDA that meet customer's need.

Counter Plan

1. Set up control mechanism and evaluating the design budget as well as the investment benefit.
2. Control the progress schedule of task and personnel and periodically review and revise accordingly.

Counter Plan

1. Review the confidence level of the market survey questionnaire and make analysis on the practice process.
2. Set up promotion advertisement control mechanism, strictly control the investment benefit of promotion advertisement.
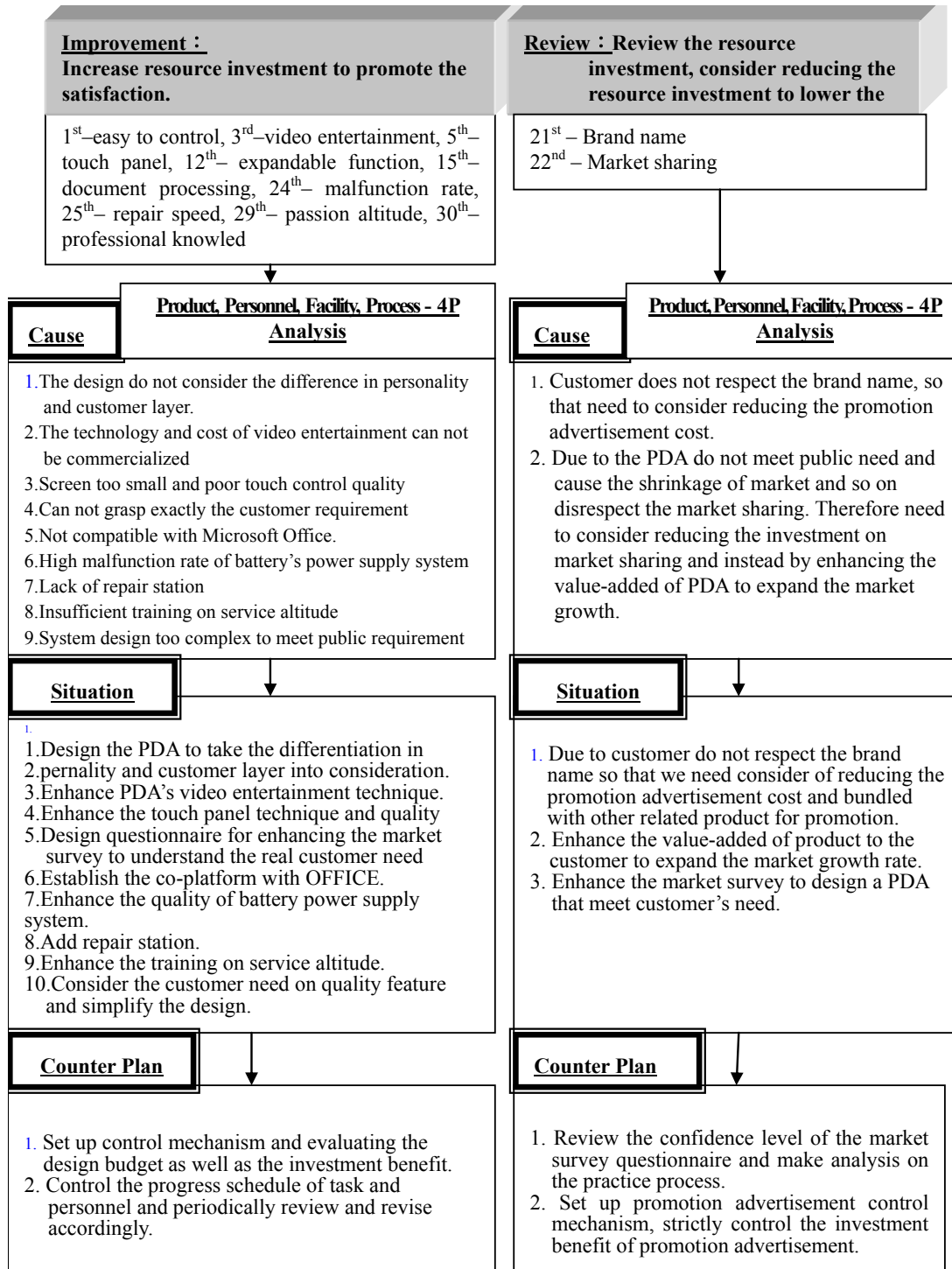
Figure 6. Cause-effect relation diagram

For the respect of improvement, this article using the action relationship diagram shown in figure 6. At first, focus on the 9 items that need to be improved and considering to increase the resource investment to promote the satisfaction. They are: 1st item - easy to control, 3rd item - video entertainment, 5th item - touch panel, 12th item - expandable function, 15th item - document processing, 24th item – down rate, 25th item – time to repair, 29th item – service passion and 30th item – professional knowledge, then proceeding the 4P analysis on process, man and facility to get 9 critical cause they are: the design not considering the variation of personality and customer layer, the technology and cost of video entertainment can not reach the scale of merchandise, screen too small and the quality of touch control is bad, can not grasp exactly the customer requirement, not compatible with Microsoft OFFICE, the down rate of battery's power supply system is too high, repair station not enough, insufficient training for the service altitude, system design is too complex to meet mass public's need. By following the above analysis, we find out the related and respective corrective

actions for these 9 items, they are: when design the PDA to take customize and customer layer variation into consideration, enhance the video entertainment technique of PDA, enhance the touch control technique and quality, design the survey questionnaire to find out the actual need of customer, establish the relation with Microsoft to set up the co-platform with OFFICE, enhance the quality of battery power supply system, increase the repair station, enhance the training of service altitude and considering the importance of customer's need to the quality features, simplify the product design. In the end, for the action limitation we propose 2 counter plan, they are: set up the cost control mechanism should considering the design budget and investment benefit and set up the schedule control for the above mentioned task and related personnel and in reference with competitor's product for   review, revise in periodically.

Besides, according to the above analysis there are 2 items that need to be reviewed for considering decreasing the resource investment to lower the cost, they are: 21st item – brand name and 22nd item – market sharing. After discussion and analysis we concluded there are 2 main factors: 1. customer is not emphasize the brand name, therefore we must consider decreasing the advertisement cost. 2. due to PDA can not meet public's requirement and thus cause the market shrinking and so on the market sharing is not respected, so that we need to lower the investment for market sharing and enhance the value-added of product to the customer to expand the   growth of market share. We find out 3 corrective actions in accordingly: 1. due tot eh customer is not respecting the brand name so we need to consider to decrease the promoting advertisement cost and promoting the product bundled with the other relevant products. 2. Increase the product value-added to the customer to expand the market growth rate. 3. Enhance the market survey to design the PDA product that really meet customer's requirement. In the end, we propose 2 counter action plans: 1. Review and approve the confidence level of the market survey questionnaire and analyzing the practice process. 2. Set up control mechanism for advertisement promotion; strictly control the investment benefit of advertisement.

5. THE CONTROL AND EVALUATION STEPS OF CRITICAL SERVICE QUALITY ITEM

For the respect of control, at first focus on specific customer layer carry out the planned critical corrective action, counter plan and execution steps, then focus on the deviated question item re-design the questionnaire and in accordance with the coordinate position of importance and satisfaction on the performance matrix (SN_I, SN_S) calculate the overall satisfactory performance value SN_{I-S} of every service quality item and set up the overall satisfactory performance control chart, accordingly. Use the control chart as a toll for controlling the service quality. When the value of SN_{I-S} is positive it will locate in I zone and with the larger the SN_{I-S} value, the importance is higher than the satisfaction, therefore need to invest more resource to promote the satisfaction; in vice versa, when the value of SN_{I-S} is negative it will locate in D zone and with the larger the SN_{I-S} value, the importance is far lower than the satisfaction, therefore need to review resource investment to reduce the resource to avoid the waste of resource. Besides, when the coordinate of importance and satisfaction of the critical service quality item is very close, its SN_{I-S} value will approximate to 0 (zero), thus there is a high probability that the coordinate will locate in the "appropriate control zone". And follow up the above formula we can calculate the SN_{I-S} value of every service quality item and set up a control chart with control limit been set between -20 to +20. By using this overall satisfactory performance control chart, the managers can measure and detect if the above deviated service quality item is out of the control limits. If they are not within the control limit, then we need to submit the related corrective action strategy and counter plan. For the real example of this thesis, currently, the deviated product quality function all within the control limit, as shown in figure 8. It means we have achieved the expecting improvement target therefore need to standardization the process to set up the quality plan and standard operation procedure of after improvement, and expand the education and training for related process personnel.
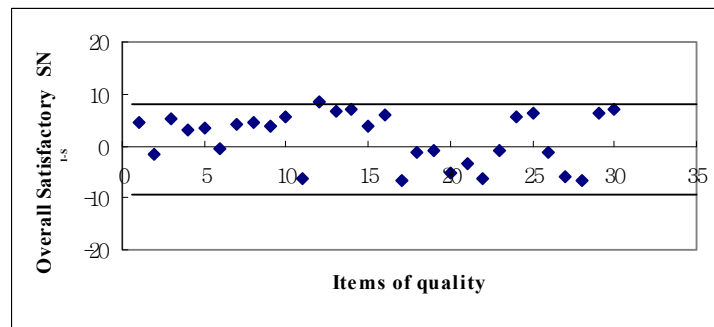

Figure 7. Overall performance control chart after improvement

6. CONCLUSION

By using the DMAIC evaluation methodology of 6-sigma provided by this thesis the industrial enterprise can focus on the related industry's product quality and service quality, under the consideration of time and cost, to proceed an

effective and quick evaluation. Then use the customer overall satisfactory performance value to find out the service item that need to be improved and for cost review then under the reasonable cost condition to effectively promote the overall customer satisfactory level to create high value-added quality competition and win-win situation of consumer and supplier. For the example case of this thesis, from the process of evaluation analysis we found 2 quality items that need to be reviewed, they are: brand model and market share. After discussion, we get 2 root causes they are: the customer pay less emphasis on the brand model hence we need to consider reducing the promoting advertisement expense and due to the current PDA can not meet the mass public's requirement and cause the market shrinking and so on cause the disregard of the product market sharing. And then, focus on the cause to find out the relevant actions they are: consider to reduce the brand name promotion advertisement expense and promote the product by combining with the other related products and enhance the market survey to design the PDA product that meet the customer requirement to promote the value-added that the product brought to the customer to enlarge the market growth rate and quality. Besides, there are 9 service items that need improvement they are: easy to control, video entertainment, touch panel, expansion of function, document processing, down time rate, time to repair, service passion, and professional knowledge, respectively. Then we found out 9 relevant corrective actions　for improvement, they are: while designing the PDA consider the customized and differentiation of customer level, enhance the video entertainment technique of PDA, enhance the function and quality of the touch panel, design a questionnaire to enhance the market survey to understand the real need of customers, build up the co-platform　with Microsoft Office, increase the quality of the battery's power supply system, increase the repair station quantity, enhance the training of service altitude and considering the importance of customer requirement to the quality features and simplify the product design, respectively.

The study of this thesis found that due tot eh main function of personal digital assistant (PDA) can not meet the customer's basic main need; therefore, the overall satisfactory level is lower than its importance. Moreover, currently the customer facing the evolution of product variety for information utilized information appliance (IA), hence there are many products will become a quality feature of an integrated product, but these evolution process are all based on the need of human nature. And these needs can be categorized into 2 groups: first is need for transportation which require light weight, thin, short, small and the second is for leisure need which requires mainly for IRAH (Innovation, Recreation, Aesthetic and Humanity). Therefore, if PDA wants to be a main stream product it must grasp the portability features of light, thin, short and small and effectively integrated with the other highly required products by the customer and to become one of its quality function. But how to do the integration and evaluating the customer's expected PDA is one of the important future research directions.

6. ACKNOWLEDGEMENTS

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