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The Study of an Integrated Rating System for Supplier Quality Performance in the Semiconductor Industry

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Abstract: This study provides an integrated model of Supplier Quality Performance Assessment (SQPA) activity for the semiconductor industry through introducing the ISO 9001 management framework, Importance-Performance Analysis (IPA) Supplier Quality Performance Assessment and Taguchi's Signal-to-Noise Ratio (S/N) techniques. This integrated model provides a SQPA methodology to create value for all members under mutual cooperation and trust in the supply chain. This method helps organizations build a complete SQPA framework, linking organizational objectives and SQPA activities to optimize rating techniques to promote supplier quality improvement. The techniques used in SQPA activities are easily understood. A case involving a design house is illustrated to show our model.

Key words: Supplier quality performance assessment, supplier rating system, importance-performance analysis, signal-to-noise ratio

INTRODUCTION

From the last two decades, supplier selection and performance assessment has played an important role in supply chain management. Numerous academic researchers have paid much attention to this topic. Weber and Current (1993) researched the methods and tools for supplier selection. De Boer *et al.* (2001) performed similar research. Verma and Pullman (1998) investigated whether selection criteria are consistent with their perceived importance in the eyes of purchasers. Ansari and Modarres (1988) researched weighting the evaluative criteria and setting the relative importance based on specific supply the presence of trade-offs in the similar suppliers and claimed that analysis of trade-offs among quality, price and deliver reliability is particularly important in JIT environments. Lamming *et al.* (1996) discussed the benefits and problems of vendor assessment systems. Thompson (1991) recommended the Thurstone Case V scaling technique as an extremely useful tool for scaling the importance weights associated with evaluative criteria and the probable performance of suppliers. Ho and Carter (1988) consider the supplier's capacity as the one of key factors in production planning. Ellram (1990) focused on the supplier's capability in future manufacturing. Choi and Hartley (1996) studied the capabilities of continuous supplier improvement. Ragatz *et al.* (1997) discussed the importance of co-design with a supplier. Monczka *et al.* (1994) and Burt and Soukup (1985) claimed that suppliers can also be involved in product design at an early stage and will generate more cost effective design choices, develop alternative conceptual solution, select the best components and technologies and assist in design assessment. Giunipero and Brewer (1993) developed criteria to assess supplier performance. Ellram (1996) used the total costs analysis method to evaluate suppliers. Albino *et al.* (1998) used the Fuzzy Logic method to evaluate suppliers. Petroni and Braglia (2000) proposed using the statistical method to make precise weight assessments of supplier performance. De Boer *et al.* (2001) showed that the AHP method usually uses models in these research works.

Kannan and Tan (2002) verified that a supplier's willingness and ability to share information has a significant impact on performance. All these studies include wide discussions of dimensions and rating techniques of SQPA in previous researches. However, there are several problems that have not been considered and discussed as follows: (1) There was no systematic management framework for SQPA activities discussed, (2)

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SQPA activity was not linked to the importance of the organization's objectives and operations, (3) Rating techniques were not treated well for the case of variation in supplier performance from different personnel perceptions. This study therefore provides an integrated SQPA activity model for the semiconductor industry through introducing the ISO 9001 management framework, introducing Importance-Performance Analysis (IPA) and Taguchi's Signal-to-Noise Ratio (S/N) techniques to optimize a rating system for supplier quality performance.

POPULAR MODELS REVIEW

Practical models: Chen and Yang (2002) described the most popular vender quality performance rating system model for vender performance (Y) as constructed using the sum of three core factor scores quality (Q), cost (C) and delivery (D), multiplied by subjective weights developed by the corporate synergy development center in Taiwan.

$$Y = w_q Q + w_c C + w_d D \quad (1)$$

Clearly, the first model seemed to be simple to use, but lots of important information was ignored when rating a supplier's performance.

Cost-based models: Monczka and Trecha (1988) asserted that a cost-based supplier performance evaluation system reflects the actual cost of doing business with suppliers. They developed two indices, Supplier Performance Index (SPI) and Service Factor Rating (SFR) to evaluate supplier performance. The SPI recognizes costs attributed to non-performance (NPC) by suppliers for delivery, material quality and so on. These costs are identified and collected and the Supplier Performance Index (SPI) is defined as the total cost of the supplier's performance to Extended Purchase Price (EPP) for each supplier for each major item.

$$SPI = \frac{EPP + NPC}{EPP} \quad (2)$$

Service factors should be established such as the ability to solve problems, availability of technical data, ongoing progress reporting and supplier response to corrective action, etc. The seven scaled method (the higher the rating, the better the performance) is used to evaluate the performance points for each supplier by the buying firm-personnel in the purchasing, quality control, manufacturing and product engineering departments. For a given supplier, his average ratings on all factors are easy to obtain. This figure is then divided by the total number of points possible, to obtain the supplier's SFR.

Chen and Yang (2004) provided an operational method to evaluate supplier quality performance, which considers the Total Involved Quality Cost (TIQC) and the matrix of inter-relation of quality events and departments. The Supplier Performance Index (SPI) is defined as the percentage of supplier's total involved quality cost to Purchase Price (PP), TIQC is just the measure of cost of use in Deming's definition. The vendor that gets the lowest percentage value is the best.

$$SPI = \frac{TIQC}{PP} \times 100\% \quad (3)$$

Generally, the cost-based model has several advantages, such as reflecting the actual total cost of doing business, utilizing quantitative evaluation criteria, integrating different items into a unique comparison base and facilitating supplier evaluation and selection decision making criteria. Wasserman and Lindland (1996) asserted that the most important advantage of quality cost is to translate quality problems or events into the language of top management, who are more concerned with financial performance, facilitating managers paying attention to quality events and their improvements. The same cost-based model changes a manager's focus from the lowest purchase price to the lowest use cost. Conversely, the cost-based model has some drawbacks that need a further research and improvement. First, estimating hidden costs is very difficult, even with multiplier or market research methods we still get rough costs that are useful only for references. Second, the cost-based model is hard to use with first time supplier qualification and selection. Third, service quality attributes are not considered in the cost-based model and, if available, not translatable into SLR costs. Fourth, cost-based supplier evaluation methods do not provide useful information for continuous improvement to suppliers.

Weighted point models: Thompson (1991) described that the weighted point method is by far the most commonly used technique. Its basic structure is formulated using the following method:

$$A_j = \sum_{i=1}^{n} a_i b_{ij} \quad (4)$$

Where:

- A_j = Summated score representing the overall performance anticipated from vendor j
- a_i = Importance weight attached to evaluative criterion.
- b_{ij} = Performance rating on evaluative criterion i for vendor j
- n = No. of evaluative criteria

In this model the vendor with the highest score is represented as the best performance. In practice, the above weighted point model has been widely used with the advantages of easy calculation, understanding and communication. However, there are two key problems in this model. First, the importance weight is still subjective and hard to define fairly and consistently. Kamal *et al.* (2001) and Pi and Low (2006) introduced the Analytical Hierarchy Process into the supplier performance rating system to define the importance weight more reasonably. Second, uncertainty is not considered. Thompson (1990) developed the Vander Profile Analysis (VPA) to overcome this problem. VPA uses the Monte Carlo simulation for modeling the uncertainty associated with predicting the performance range and assumed the actual vendor performance falls into a predicted range. Decision makers should only estimate reasonable high and low levels of performance for vendors in each evaluative criterion and simulate randomly a thousand times. The performance distribution of summated scores for each vendor should then be sketched based on a triangular distribution to determine the performance index. If the analysis shows less than 20% probability that the vendor's predicted performance will drop below a reasonable cutoff value, 0.7, of the performance index based on historical data, we can actually do business with the vendor. The VPA model is shown below:

$$A_{jk} = \sum_{i=1}^{n} a_i b_{ijk} \tag{5}$$

Where:

A_{jk} = Summated score for vendor j on iteration k of the simulation
a_i = Importance weight attached to evaluative criterion i
b_{ijk} = Randomly generated performance rating on evaluative criterion i for vendor j during iteration k
n = No. of evaluative criteria

$$PI = \frac{A_{jk}}{\sum_{i=1}^{n} a_i \times \text{Max}\left(b_{ijk}\right)} \tag{6}$$

Although, the VPA model introduces the uncertainty concept into the vendor rating system, it seems to be subjective when decision makers determine the predicted range for each evaluative criterion and ratio under the cutoff value. The estimated vendor's future performance is difficult to assure. In this aspect, process-based models (such as TQM, ISO 9001 and TS 16949 etc.) will obtain more accurate assurance about the vendor's future performance than the VPA model.

Taguchi loss functions model: In the past, if a product measurement falls within the specification limit, the product will be accepted. Otherwise, the product will be rejected. Genichi *et al.* (1989) assert that loss is always incurred when a products functional quality characteristic deviates (denoted by y) from its target value (denoted by m), regardless of how small that deviation is. Quality loss caused by deviation equals zero when y = m. Pi and Low (2005) used the Taguchi loss functions to develop a new supplier evaluation and selection model. Similarly, the Taguchi loss function model converts supplier performance from different attributes (quality, on-time delivery, price and service) into the same base-quality losses and chooses the supplier with the lowest total quality loss. This model has three types of loss functions that may be used, shown as follows:

The total loss of the ith supplier is:

$$C_i = \sum_{j=1}^{4} L\left(y_j\right)$$

Where:

j = Assessment attributes

The weighted Taguchi loss (L_T) for all the attribute performances can then be calculated as follows:

$$L_T = \left(\sum_{i=1}^{n} W_i C_i\right) \tag{7}$$

Where:

W_i = Weight assigned to characteristic i
C_i = Taguchi loss characteristic i

The supplier with the minimum loss will be the best selection.

The Taguchi loss function model provides an excellent comparison base to evaluate and select suppliers and successfully translates SFR into the loss. At the same time, this model provides useful information on the supplier's performance deviating from the expected value for the extent of improvement in the future. However, the Taguchi loss function model still has some deficiencies in practice. First, when the supplier's performance does not fall into the expected tolerance, the loss A when the performance characteristic is out of tolerance and used to derive the coefficient k is very difficult to estimate. Second, after translating the performance into the loss, the value becomes less sensitive than the original data and is easily affected by the weight. Third, this model only uses the mean performance to determine the loss and does not consider the impact of variance. Fourth, attributes are not applicable in Taguchi loss functions.

Capability-based models: The aim of process capability indices is to provide numerical measures of whether manufacturing ability meets the product specification or not. The production department can trace and improve poor process to meet customer needs. Process capability indices have been widely used in process assessments and purchasing decisions in the automotive and high technology industries. Pearn *et al.* (2004) introduced the C_{pm} index and a procedure to measure the process performance based on the average loss in supplier selection. Chan *et al.* (1988) and Boyles (1991) proposed two different estimators of C_{pm}, respectively, defined as follows:

$$\hat{C}_{pm}(CCS) = \frac{d}{3\sqrt{s^2 + [n/(n-1)](\bar{x}-T)^2}} \text{ and } \hat{C}_{pm}(B) = \frac{d}{3\sqrt{s_n + (\bar{x}-T)^2}} \quad (8)$$

Where:
d = [(USL-LSL)/2] is the half width of the specification interval
s^2 = Sample variance with (n - 1) degrees of freedom
s_n^2 = Sample variance with n degrees of freedom

As in the index of $C_{pm}(B)$, Let $\hat{\gamma}(B) = s_n^2 + (\bar{x}-T)^2$, very clearly searching the largest C_{pm} is equivalent to looking for the smallest $\hat{\gamma}(B)$.

Chen and Chen (2006) apply the process incapability index C_{pp} to develop an evaluation model that assesses the quality performance of suppliers. The incapability index C_{pp} due to Greenwich and Jahr-Schaffrath (1995) is defined as follows:

$$C_{pp} = \left(\frac{\mu - T}{D}\right)^2 + \left(\frac{\sigma}{D}\right)^2 \quad (9)$$

Where, T represents the target value and D = USL=LSL/6.

As we know, C_{pp} is unknown and should be estimated by $\hat{C}_{pp}$. In order to build up the suppliers' performance comparison, the statistic F_{max}, used to test whether all suppliers' capabilities are equal or not should be made first. If not, then a pair-wise comparison should be done by calculating the indices CL_{ij} and CU_{ij} to judge. Capability-based models have considered the influences of mean and variance in quality characteristics at the same time, which is preferable to the statistician's viewpoint. The greatest advantage of capability-based models is to objectively provide great insights into the process situation of suppliers that may enter a long-term partnership with a company. However, some deficiencies inhabit these models. First, these models ignore those performances that have qualitative characteristics in supplier selection and assessment. Second, process capabilities do not follow the additive principle for different quality characteristics. Third, capability-based models have high complexity when the number of suppliers and quality characteristics increases.

PROPOSED MODEL

Supplier management framework: The ISO 9001 quality management system is widely accepted by various kinds of organizations in the world. Franka and Slavko (2006) approved that the ISO 9001 is an important tool for managing a company. Zeng *et al.* (2007) explored the barriers to ISO 9000 series implementation in China. If the barriers could be eliminated, the benefits of ISO 9000 implementation will appear. As to the supplier assessment, Walker (1997) identified the ISO 9001 requirements to assess supplier capability. Yen *et al.* (2007) provided a framework for management by objectives and customer satisfaction based on ISO 9001: 2000 quality management systems. This paper developed a framework for SQPA quality improvement and objective management derived from ISO 9001: 2000 quality management systems and compliance with process-oriented P-D-C-A management methodology. Organizations should set up definite quality objectives to create all members' values from cooperation and management in the supply chain. Secondly, according to objectives, organization should make plans about authority and responsibility for operations, processes control and standards, communication and quality improvement in SQPA activity. Thirdly, organizations should carry out communicating the purpose and value of SQPA with suppliers to ensure that activities will be conducted under the conditions of mutual cooperation and trust. Organization should provide all required resources, according to the plans, produces and outsourcing control. Fourthly, organizations should aim at purchasing and production feedback from suppliers to verify the achievement of each objective. If the expected degree of objective achievement is not obtained, the manager should identify the causes and work out an improvement scheme to enhance quality attributes. Rectification and prevention methods can be used through adjusting original quality objective, supplier's control plans, communication and training, etc. After adjustment and improvement, the organization should re-measure the supplier's performance, to ensure that the improvement actions are proper and effective. Fifthly, the organization should provide the supplier's performance information to top management for review and verify the appropriateness and effectiveness of the definition of quality objectives, quality plan and outsourcing control methods.

Rating system of supplier quality performance: In recent researches, the dimensions of the supplier rating system always focused on price, quality, delivery and flexibility or service (Pi and Low, 2005; Chen and Yang, 2004; Chin and Yeung, 2006). More detailed supplier selection and assessment criteria were developed in Kannan and Tan's research (2003). The SQPA dimensions are different among industries, but they still have common characteristics, such as quality, delivery, price and flexibility, etc. This study stands on the design house point of view to modify and develop SQPA quality attributes based on the JEDEC Publication No. 146 (2003) methods, which are widely used for SQPA in the semiconductor industry. We use five dimensions and detailed items for SQPA as shown in Table 1.

According to the SQPA quality attributes described above, we developed a questionnaire with two questions for each quality attribute. To determine the valuable quality attributes and understand the supplier's performance, a questionnaire was employed using a five-point Likert scale. The questionnaire classified five responses-Unacceptable Poor common Good and Excellence-from scales 1 to 5 for supplier's performance from quality attributes. To determine the importance of each quality attribute to the organization, the questionnaire classified five responses-Very Low Common High and Very High-from scales 1 to 5 for importance to organization from quality attributes. The rating system is divided into two categories that is importance to achieve organization's quality objectives and operations and performance of supplier. Five scales method is used and shown in the Table 2.

The assessment of supplier's quality performance should be conducted by related personnel from different departments in the organization, such as purchasing, quality assurance, manufacturing, product engineering and marketing.

Modified IPA model: IPA was introduced by Martilla and James (1977) as a method for developing effective marketing programs. Through such simple data processing, organizations can directly examine different types of quality attributes and form strategies and plans, based on each of the four quadrants in the IPA map. Several famous scholars provided numerous modified IPA models after the first IPA issue by Martilla and James (1977), for example the researches by Eskildsen and Kristensen (2006) integrated the Taguchi loss function, Kano's model and regression analysis to enhance the IPA model. Tonge and Moore (2007) used the importance-satisfaction model and gap analysis to evaluate the quality of visitors' experience, as well as making effective management in protecting the natural environment. Deng (2007) provided a revised IPA that integrated partial correlation analysis and natural logarithmic transformation for measuring the importance of attributes. This study provides a modified IPA and makes extended use of IPA in assessing a supplier's quality performance. The benefit of introducing Taguchi's S/N ratio into IPA is that the S/N ratio considers the mean and variance simultaneously from the different perceptions of assessors. Moreover, the benefit of introducing IPA into SQPA, the buyer will get lots of information to take purchasing action and the supplier will understand precise directions for continuous improvement.

Taguchi introduced the concept of Signal-to-Noise (S/N) Ratio, which is widely used in telecommunication engineering and quality engineering. The signal is always the useful system output that is expected, while the noise is any non-useful result. The purpose of robust design is to maximize the signal and minimize the noise. In other words, optimize the product or process design. Genichi *et al.* (1989) thought that excellent quality has two key elements. The first is the mean quality characteristic equal to the target. The second is small in variance. The S/N Ratios consider the mean and variance of the quality

Table 1: Five dimensions and detailed items for SQPA

Dimension	Detailed items
1. Quality	a. Defects
	b. Disruptions
	c. Returned material
	d. Failure analysis
	e. Reliability
2. Delivery	a. On-time
	b. Support
	c. Flexibility
	d. Inventory
3. Technology	a. New technology
	b. Manufacturing technology
	c. Information technology
	d. Continuous support
4.Value	a. Cost
	b. Cooperation
	c. Environmental
5. Service	a. Marketing support
	b. Product/Process change
	c. Communication

Table 2: Scales of importance and performance

Importance	Scale	Performance	Scale
Very high	5	Excellence	5
High	4	Good	4
Common	3	Common	3
Low	2	Poor	2
Very low	1	Unacceptable	1

characteristics into the quality decision at the same time when evaluating the quality performance.

Peace (1993) described the S/N ratio as taking into consideration both the mean and variance in the quality evaluation. The analysis results are integrated from a two-dimension into a mere one-dimensional approach. Thus, S/N ratios have a favourable additively characteristic for quality evaluation and prediction (Genichi, 1987, 1991). Fowlkes and Creveling (1995) concluded that some excellent characteristics of Taguchi's S/N ratios are revealed when used to evaluate quality performance. Genichi *et al.* (2005) described a direct relationship with the economy as one the benefits of using S/N ratios, because they are derived from the loss function and the loss is proportional to the variance. In other words, when organization perceptions regarding a supplier's quality performance reflect a large variance, dissatisfaction occurs and causes economic losses.

SQPA typically employs questionnaires that use Likert-type scales. The importance and performance of quality attributes adopt an ordered classification such as ranked data. According to Genichi (1991) S/N ratio, this paper employs a five-point Likert scale to illustrate how the S/N ratio can be used to analyse SQPA activity through the IPA model. Suppose that the importance and performance of quality attributes can be classified using the five-point Likert scale. The grade number represents the extent of the importance and performance of quality attributes. We set the best grade 5 as the target m, then calculate the discrepancy in the grade values and target m. The distance from the best grade can thus be explained by the extent of the performance gap. The ith distance d_i of grade value g_i which deviates from the best grade value m is shown in Eq. 1:

$$d_i = |g_i - m| \tag{10}$$

According to the transformation of Eq. 1, the performance gap belongs to the smaller-the-better type of quality characteristic and its S/N ratio is shown below.

$$\eta = -10\log_{10}\left(\frac{1}{n}\sum_{i=1}^{s} d_i^2 \times y_i\right) \tag{11}$$

Where, $n = \sum_{i=1}^{s} y_i$ represents a valid sample size, s represents the scales.

We set the best grade regarding the importance of organization's perceptions on quality attributes in SQPA as the target m. Each grade value can be transformed into the distance from the best grade using Eq. 1. Thus, the distance can be explained by the extent of unimportance.

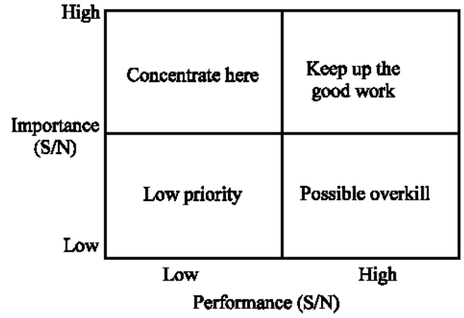

Fig. 1: The modified importance-performance map

The unimportance of the smaller-the-better type S/N ratio can be calculated using Eq. 2. Similarly, in the data transformation from performance, the greater the S/N ratio, the greater the importance of the quality attributes. The S/N ratio is advantageous when evaluating the importance and performance of quality attributes in SQPA; the greater the S/N ratio, the greater the importance and the better the performance. The IPA model, revised using the Taguchi S/N ratio method, should be used to indicate which quality attribute must be improved or degraded. Through introducing Taguchi's S/N ratio method, we could change the IPA map scale to the S/N ratio scale and re-build the IPA map. The modified IPA map interpretation is provided in the four quadrants (Fig. 1), as shown below:

- **Concentrate here:** Organization believes that quality attributes are very important but indicate low performance with the supplier's performance.
- **Keep up the good work:** Organization believes that quality attributes are very important and indicate high performance with the supplier's performance.
- **Low priority:** Supplier's performance in terms of quality attributes is low, but the organization does not perceive them to be very important.
- **Possible overkill:** The supplier is judged to be excellent in terms of quality attributes, but the organization give only slight importance to them.

From the IPA map, we can determine which quality attributes need to be kept and improved in supplier's performance. Thus, this information can be used to select, assess and manage suppliers.

CASE DESCRIPTION

In this study, we identified three semiconductor suppliers in Taiwan for the purpose of SQPA. We reviewed quality system documents such as the quality and delivery procedure records from 2005 to 2006. This

Table 3: Results of SQPA and actions for quality improvement

Quality attribute	Performance S/N	Importance S/N	Strategy	Meet objective	Suppliers actions
Defects	-4.47	3.98	C	No	Introduces six sigma way to reduce defects
Disruption	-5.19	0.97	C	No	Build up an RFIC line for production
Returned material	-5.56	-1.76	C	No	Introduce six sigma way to reduce material return
Failure analysis	-3.80	-3.62	L	No	
Reliability	-3.80	-1.14	C	No	Conduct DOE
On-time	3.01	3.01	L	Yes	
Support	-2.04	-3.62	P	Yes	
Flexibility	-3.80	-5.05	L	No	
Inventory	-3.01	-7.08	K	Yes	
New technology	-4.31	-3.98	L	No	
Manufacturing technology	-3.62	3.98	C	Yes	Introduce advanced process in 2007
Information technology	-3.80	-5.44	L	No	
Continuous support	3.01	-6.90	P	Yes	
Cost	-7.16	-6.99	C	No	Reducing failure cost
Cooperation	3.98	-1.14	K	Yes	
Environmental	-2.30	-2.79	P	Yes	
Marketing support	-4.77	-6.53	L	Yes	
Product/Process change	-0.79	-0.41	K	Yes	
Communication	2.00	-5.05	P	Yes	

C: Concentrate here; K: Keep up the good work; P: Possible over kill; L: Low priority

study took RFIC design houses as an example to explain the SQPA integrated method. The RFIC design house is an expert in broad band integrated circuit design, a product manufactured by various specialized suppliers. Therefore, the design house depends strongly upon suppliers. Supplier performance can directly affect a RFIC design house. The case description includes one design house and three assembly houses as the example. The RFIC design house set its objectives for each SQPA quality attribute and developed quality control plans. The design house communicates these quality attributes with the assembly houses to seek their understanding and agreement. After comparing three assembly houses in advance, the quality control plans show that the manufacturing steps are consistent under the same products. Only the partial quality control methods and parameters for machine settings are different. Historical records were collected and provided to the purchasing, quality assurance, production control, product engineering and marketing as reference for SQPA. The supplier's quality performance assessment was conducted by related personnel from different departments in the organization, such as purchasing, quality assurance, manufacturing, product engineering and marketing. The assessment results are summarized in Table 3 and Fig. 2 for only one supplier.

According to Fig. 2, the SQPA quality attributes are clearly divided into four categories. The quality attributes that need to be improved under the concentrate here quadrant are defects, disruption, return material, reliability, manufacturing technology and cost. The quality attributes in the keep up the good work quadrant are inventory, cooperation and product/process change, which can be developed as market segmentation factors. The low priority quadrant indicates quality attributes should be viewed as potential competitive factors in the future, including failure analysis, on-time delivery, flexibility, technology, etc. The quadrant on the right bottom defined as 'possible overkill' includes delivery support, technology support, environmental management and communication.

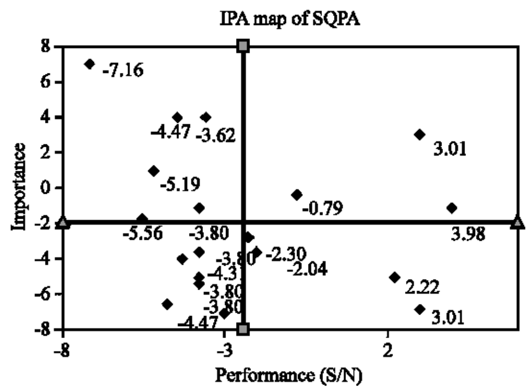

Fig. 2: IPA map of SQPA

In Table 3, we should know whether the supplier's quality performance was met to the organization's objectives or not? A 'yes' represents meets the target objective values or just locates in the acceptable tolerance. A no indicates the supplier performance falls outside the acceptable zone or is far away from the organization's objectives. Through the IPA model we can effectively define the quality attributes that need to be improved, such as defects, disruption, return material, reliability, manufacturing technology and cost. In traditional objective management, failure analysis, flexibility, new technology and information technology will be discussed and improved. The supplier should invest resources to support these corrective and

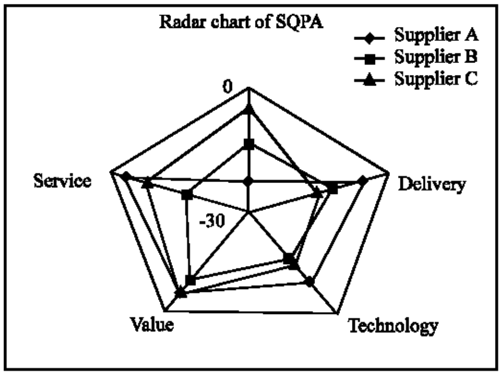

Fig. 3: Suppliers' comparison of SQPA

preventive actions. Figure 3 demonstrates the performance comparison for each SQPA dimension by radar chart. We can clearly understand which supplier's competitive advantages and weak points will be. For example, the relative strength of quality attribute for supplier C is quality and weak points are delivery and technology. For the purpose of supplier selection, supplier C would be better than others on the relative comparison conditions.

CONCLUSIONS

Supplier performance directly influences an organization's business performance. This study through the integrated rating system of SQPA combines the ISO 9001: QMS, IPA model framework and Taguchi's S/N ration method. Using the case description from the design house, we can get some conclusions as follows: (1) The SQPA activity should link with organization's objectives and operations, (2) The organization should develop a systematic SQPA method and inform the results to suppliers for continuous quality improvement, (3) IPA model could get results more correctly and easily from SQPA activities and get better focus on the main and important quality attributes for supplier's continuous quality improvement and (4) Taguchi's S/N ratio considers the mean and variance of SQPA simultaneously and gets more precise results under the influences of different assessors. Today, most organizations face complete global competition. They should integrate their own supply chain and collaborate with suppliers to enhance their abilities. Building a strong logistical system should rely on supplier selection and performance assessment first, because you can select strong suppliers or improve existing suppliers through these activities. When the activity has a linkage with the organization's objectives it will create a good opportunity to review and adjust the suppliers' quality management direction to reach organization's objectives. Through implementing the integrated SQPA method, an organization and its suppliers will build a channel and opportunity to improve their quality and enhance their competitive advantages.

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