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APPLICATION OF QUALITY FUNCTION DEPLOYMENT AND SERVQUAL FOR DESIGN SERVICE INNOVATION

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ABSTRACT

With increasing market competition, it is not sufficient for organizations to rely solely on continuous improvement in order to maintain and develop their competitive edge. There is a need to begin a strategic move towards innovation. This paper proposes a comprehensive approach to design a service innovation by combining QFD and SERVQUAL. The proposed method aims to help organization enhance customer satisfaction by guiding improvement efforts in strengthening their weak attributes, and to expedite the development of innovative service through the identification of attractive attributes and embedding them in to future service. The model shows its usability and feasibility through a service innovation of cafeteria cases in a company.
***Keywords**: Quality Function Deployment, SERVQUAL, Service innovation.*

1. INTRODUCTION

In the world of globalization era, the world economy has changed rapidly. This is particularly in the service industry that must develop and change all the time to keep pace with the changing stream of technology with continuous expansion at present. As a result, every organization accelerates the creation of new services or called Innovation. The widely used technique in the creation of today's innovation is the method of Quality Function Deployment.

QFD: Quality Function Deployment is transformation of customer requirements into products or services. This method was mainly applied in the manufacturing industry by being used in the design and development of new products. Subsequently, it has been applied to the service industry increasingly such as Central Library (Bayraktaroglu and. Ozgen, 2007), Hotel (Ikiz and Masoudi, 2008) (Paryani, Masoudi and Cudney, 2010), Hospital (Gremyr and Raharjo, 2013), etc. However, due to the complicated and difficult design process of QFD, therefore its use is generally mentioned in terms of benefits to be obtained whereas the potential loss is omitted. Moreover, it has been often applied to the manufacturing industry which causes limited functions, lack of applying other tools to be mixed systematically. As a result, QFD is not as effective as expected.

Therefore, if the user can apply the technique of QFD to the design of service and creating of system to help in decision-making by taking SERVQUAL for measuring the quality level from the perspective of customer directly and considering the risk in the design of new service providing process in terms of funds and time, the results of applying QFD and SERVQUAL will make QFD more efficient and appropriate for service industry in consequence.

2. THEORETICAL BACKGROUND

2.1. Design and Development Service

The Components of service comprise of (1) Core product, (2) Supplementary service, and (3) Delivery processes. But in the competitive service, customers will not feel the difference of core product of the service. Thereby creating a competitive advantage depends on the make a difference to the service product, by focusing on developing supplementary service to meet the needs and expectations of customers.

Core products often share a range of similar supplementary service elements. There are two types: (1) facilitating supplementary services, required for either needed for service delivery or help in the use of the core product, and (2) enhancing supplementary services, which add extra value for customer. There are potentially dozens of different supplementary service, but almost all of them can be classified into one of the eight clusters shown in Figure 1, which are identified as either facilitating or enhancing. The eight clusters are displayed as petals surrounding the center of a flower – called the flower of service.

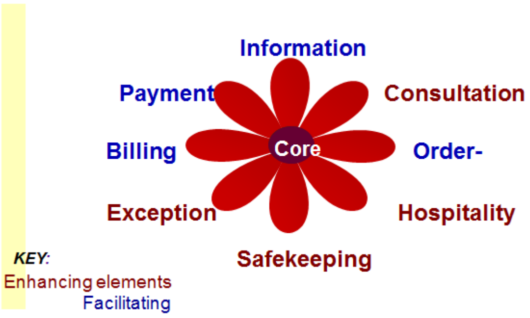


Figure 1. The flower of service
(Lovelock 2012)

facilitating supplementary services:
• Information – To obtain full value from any good or service, Customers need relevant information.
• Order-Taking – Once customers are ready to buy, a key supplementary element comes into play accepting applications, orders, and reservations.
• Billing – Billing is common to almost all services (unless the service is provided free of charge)
• Payment – In most case, a bill requires the customer to take action on payment

enhancing supplementary services:
• Consultation – To enhancing supplementary service, led by consultation. In contrast to information, which suggests a simple response to customer question, consultation involves a dialog to probe customer requirement and then develop a tailored solution.
• Hospitality – Related services should, ideally, reflect pleasure at meeting new customers and greeting old ones when they return.
• Safekeeping – When customers are visiting a service site, they often want assistance with their personal possessions.
• Exceptions – Exceptions involve supplementary services that fall outside the routine of normal service delivery.

Process of designing and developing new products / services or process of creating innovation can be described and shown in Figure 2. The process starts from finding the customer needs to be then transformed into the technical requirements. This step needs the QFD technique to help convert customer needs into technical requirements. Then, this will be taken to create the product concept with the selection of best ideas to be brought in creating the design in detail, building and testing the model. It does not matter what the types of innovations are, the processes are similar. However, there may be difference in starting operations actually. The example is the service industry that does not need creation of the model

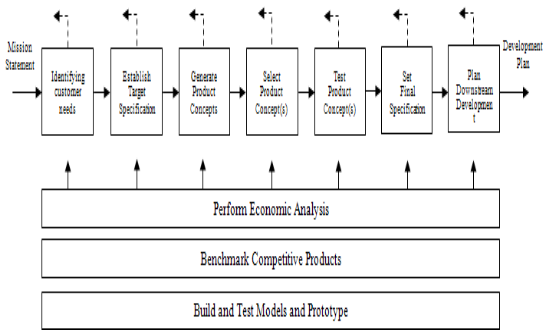


Figure 2. Concept development process
(Ulrich and Eppinger 2000)

2.2. SERVQUAL

SERVQUAL is used as a diagnostic technique for uncovering broad areas of an organization’s service quality strengths and weakness. The model by Parasuman et al. (1988) consists of the following five dimensions:
(1) Tangible – physical facilities, equipment, and the appearance of personnel.
(2) Reliability – ability to perform the promised service accurately and dependably.
(3) Responsiveness – willingness to help customers and to provide prompt service.
(4) Assurance – knowledge and courtesy of employees and their ability to convey trust and confidence.
(5) Empathy – caring and individualized attention to customers.

The SERVQUAL model employed a pair of identical 22-attribute scales, with one scale assessing the perceived performance of a service and the other assessing customers' prior expectations of the level of service to be received. By calculating the gap score between the 22 attributes, researchers could measure the SQ for each of the five SQ dimensions. This gap was expressed as "Service Quality (SQ) = Perception (P) – Expectation (E)". For each respondent, the SQ for each dimension was calculated as follows:

$$SQ_j = \frac{\sum_{i=1}^{n_j}\left(P_{ij} - E_{ij}\right)}{n_j} \qquad (1)$$

where SQ_j is the SQ of the jth dimension, E_{ij} is the expectation for the ith attribute in the jth dimension, P_{ij} is perception for the ith attribute in the jth dimension, and n_j is the number of attributes in the jth dimension. An average score for each dimension was then calculated across all respondents. A global SQ score was also calculated by taking the arithmetic mean score for the five dimensions. Positive scores represented better-than-expected service, whereas negative ones represented poor service. A score of zero implied satisfactory quality.

The ratio scale is superior because it compares measurements between different rating scales. By introducing the ratio scale into SQ measurement, the perceived SQ indicates the degree to which customers are satisfied with a service delivered, regardless of the type scale. Therefore, the most reliable way to measure the degree of customer satisfaction through the difference between expectations and perceptions is to use a ratio scale between the two. This can be stated as "Service Quality (SQ) = Perception (P) / Expectation (E)". The SQ for each dimension is calculated for each respondent by using the geometric mean, which is an appropriate measure of central tendency (i.e. ratio scale). The dimensional SQ is as follows:

$$SQ_j = \left[\prod_{i=1}^{n\,j}\left(\frac{P_{ij}}{E_{ij}}\right)\right]^{1/n_j} \qquad (2)$$

where the variables are defined as in equation (1). A global SQ score can also be calculated by taking the geometric mean score for the five dimensions in SERVQUAL. Scores that are > 1 (100 percent) represent better-than-expected service (P>E), whereas scores <1 show poorer than expected quality (P<E), A score of one implies that the quality is neutral (P=E).

Kim, Lee and Yun (2004) identified the ratio-based SERVQUAL scale efficiently assesses services delivered, and does so dynamically – depending on customer expectations. The results generated by using a ratio-based scale and the comparison with the results from the gap-based model. It can be seen intuitively that customers' satisfaction is not equal, even though the SQ estimated by the gap-based model is the same between the two organizations. However, SQ as measured by a ratio-based model is estimated in accordance with customer satisfaction. Consequently, the ratio based scale is a more customer-oriented SQ measurement than the gap-based scale.

2.3. QFD

QFD was first developed in late 1960s and then implemented at the Kobe shipyards of Mitsubishi Heavy Industries in Japan in 1972(Akao, 2003).

The basic matrix of QFD is the "house of quality", so named since the triangular matrix which forms its top structure – the roof – makes the diagram resemble a house. The quality matrix in QFD translates the voice of the customer into the engineering, design, process and production stages.

As Figure 3 shows, the left room of an HOQ lists the customer need or requirements called the "Whats". "Whats" are phrases that customers use to describe their need. The needs are translated into corresponding "Hows" as shown in the upper room below the roof. The function of the "Hows" is to translate the "Whats" in to terms that are measurable. After the "Whats" and the "Hows" have been identified, the next step is to specify their relationship in the body or correlation matrix shows the extent to which each "Hows" affects each "Whats"

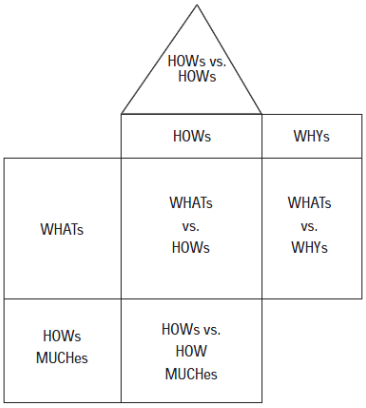


Figure 3. The house of quality (Prasad 1998)

Other rooms of a basic HOQ include the roof which maps out the interdependencies between pair of "Hows". The priorities assigned to the customer needs and the competitive assessments are recorded in the two rooms on the right side of the house.

The QFD process helps us to focus in on what the customer wants a very early stage, and to apply a team working approach to carry his through all of the steps from this stage to delivery to the customer of the final product or service. This can be seen to have many benefits throughout our operation. These we include:

• Less time in development - due to better up-front planning
• Fewer and earlier change - due to better and earlier identification of problems.
• Fewer start-up problems and lower start-up costs.
• Fewer field problem - due to a better understanding of the customer requirements and the conditions of service.
• Satisfied customers - due to the better customer focus.

2.4. RISK

Risks may be classified in a variety of risk frameworks as follows:

• Operational Risk– Risks related to the organization's systems, processes, technology, and people.
• Schedule of project implementation Risk - Inability to perform the operations by the scheduled time under the budget that has already been allocated. This point is associated with the people, investment funds, time and materials used in the project.
• Cost Risk- Lack of budget to work as assigned within the specified time which may result from the erroneous cost estimates of various activities, wrong pricing and incorrect decisions.
• Technical Risk - The operating system cannot function to meet the requirements or the buyers' needs or cannot produce by requirements or specifications as demanded by the buyers.

Such four aspects of risks stem from the implementation of project under constraints on time, costs and operations which are equally important and interrelated. The problem of any one aspect may pose a risk to the project until it may finally affect the failure of the project.

Risk analysis can be applied to all types of projects. However, it will work well and very beneficial if such project requires innovation and new technology, high investment funds and fast operations to completion. The technique of risk analysis is divided into 2 types namely:

(1) Qualitative Risk Analysis: It operates by interviewing the project team, brainstorming of all parties involved and using past experience to help in the analysis to identify risk. This is the consideration of various components of the process. After that, risk assessment will be done as to the high, moderate or low levels that such risk is likely to occur. At the same time, it is possible to identify the impact on the project. Moreover, it is wise to be prepared to respond to the risk identified in each aspect, especially the risk in high level that must be urgently handled. The subsequent step is the evaluation of risk management to determine the extent of ability to manage the risks.

(2) Quantitative Risk Analysis: Procedure of operation consists of identifying all risks and in-depth analysis in quantitative terms, resulting in the ability to identify the impact on the project in quantitative terms. The consideration is based on the evaluation basis of project achievement including three respects namely Cost, Time and Performance.

Benefits of risk management analysis

• Be able to strengthen the understanding of the project and be able to plan the resources to approximate the reality more in terms of the cost estimates and duration of

implementation.
• Help in the evaluation and decisions before project implementation.
• Help in accepting risks more and be able to find ways to prevent the future impact on the project.

3. RESEARCH METHOD

Research methodology in this study is divided into three phases as shown in figure 4. The first phase is the search to find customer needs by determining the agency for improvement of the corporate case study, collection of data, problems and analysis to find the needs of customers. The second phase is the technical modelling of QFD by studying related theories and researches until the Conceptual Framework is obtained and taken to design the technique of QFD for the design of service in cafeteria. The third final phase is the examination of QFD Technical Model.

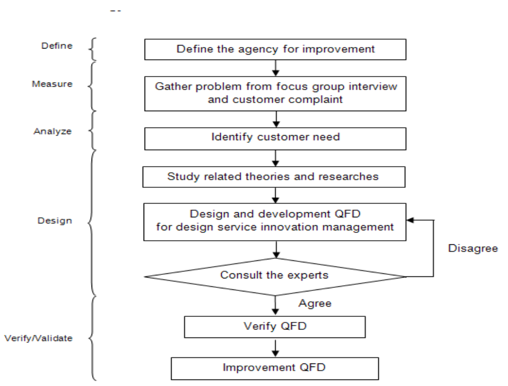


Figure 4. Research methodology

4. RESULT AND DISCUSSION

In linking SERVQUAL and Kano's model to QFD(Tan and Pawitra, 2001), it is found that on the part of customer needs, there is application of QFD, SERVQUAL and Kano's Model as input. As a result, on the part of data collection, it is necessary to collect information additionally from the current use for another two parts namely SERVQUAL and Kano Model despite the fact that QFD at present collects just the level of Importance only. As a result, the designed questionnaires look redundant. Therefore, the information obtained may be inaccurate due to the respondents' lack of interest in doing. Besides, the agency must waste more time and money to collect questionnaires. The proposals obtained are then taken into consideration. It is found that the level of Importance is used for knowing what the customers focus on. Level of Importance is thus a requisite part. Kano Model is used for classifying the quality issues that cause satisfaction or dissatisfaction. However, the Kano Model does not indicate the level of satisfaction with the service at present. This differs from SERVQUAL that is used to measure the difference between the actually received service and service of expectation or indicate the level of satisfaction with the present service. Therefore, Kano Model is excluded. Despite the usefulness of Kano Model in enhancing the efficiency of QFD, however the outcome of consideration reveals that the benefits to be obtained are not worth the risk. Kano model is dispensable because just the use of Importance and SERVQUAL can help sufficiently to know what the customers want. Furthermore, there is the addition of risk analysis in terms of the time and costs to waste in the design and development of new products / services to help in decision-making. As a result, there is the Application of QFD and SERVQUAL as shown in Figure 5. The process of Quality Function Deployment with 6 total Steps is shown in Figure 6. Each phase comprises sub-steps as shown in Figure 7..

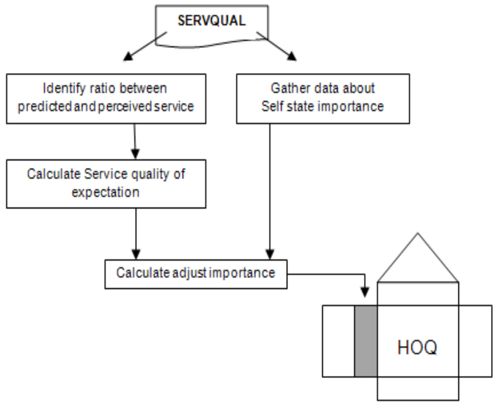


Figure 5. Framework for the application of SERVQUAL into QFD

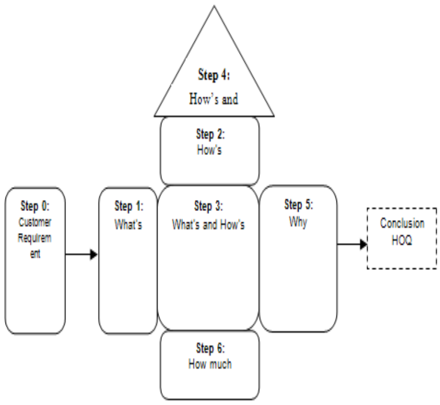


Figure 6. Steps to Create the House of Quality

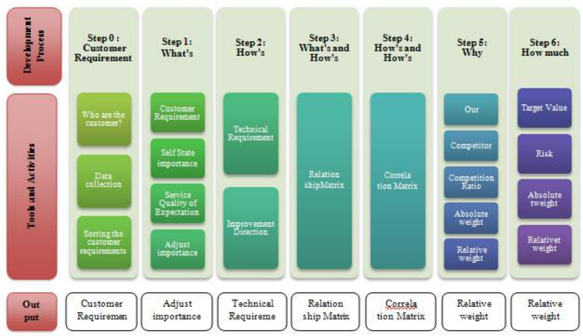


Figure 7. Sub-steps to Create the House of Quality

Step 0: Customer Requirement

1) who are the customer?

A service innovation team of five person from cross function is formed. The first step of QFD is to identify the "customer" or "influencers. The "voice of the customer" includes inputs from sources such as manufacturing, purchasing, field service, suppliers, etc. They represent a company's internal customers. Figure 8 lists four sources of market research data to develop customer requirements.

The major sources of market research data are:

- Voice of the customers
- Product data
- Warranty or field data
- Competitive analysis data

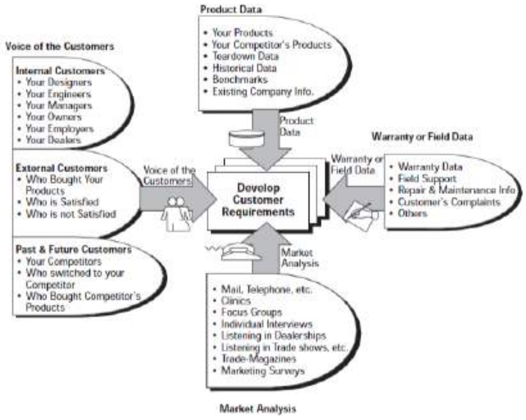


Figure 8 Sources of data to develop customer requirements (Prasad 1998)

2) Data collection

There are many possible sources for data relating to customer requirements. These include:

- Interviews - face to face or focus group
- Survey – questionnaire mail and letter
- Specially commissioned market research
- Customer Complaints
- Feed back
- Sale Records

3) Sorting the customer requirements

For a product or system of more than trivial complexity, the customer requirements collected during the initial phase may amount to several hundred separate "wants" and "needs". To make these comparable and to keep the matrix a manageable size, they must be grouped into related topics, and combined to give requirement at the same level of detail.

Step 1: What's

1.1) Customer Requirement: Determination of customer needs is obtained from data collection by different ways. These customer needs are divided into five groups of SERVQUAL namely Tangible, Reliability, Responsiveness, Assurance and Empathy.

1.2) Self State importance: Calculation of the importance level of customer needs. The data is derived from the above data collection. Calculation to find the Self State Importance of each requirement can be done as follows:

$$\text{Self State Importance}_j = \frac{\sum x_{ij}}{n_i} \quad (3)$$

where i is the respondent No. i.
j is the requirement issue No. j.

x_{ij} is the scoring of self state importance, person No. i about requirement No. j.
n_j is the number of respondents to the requirement issue No. j.
1.3) Service Quality Expectation: Calculation on the ratio of the service quality expectation compared with the actually received service. The information will be obtained from the data collection above. It is possible to calculate to find Service Quality of Expectation (SQE) of each requirement as follows:
Service Quality of Expectation (SQE) = Expectation(E) ÷ Perception (P)
As for the analysis of Service Quality Expectation (SQE), calculation to find the average value can be done from Geometric Mean as follows:

$$SQ_j = \left[\prod_{i=1}^{n\,j} \left(\frac{E_{ij}}{P_{ij}} \right) \right]^{1/n_j} \qquad (4)$$

where the variables are defined as in equation (3).
1.4) Adjust importance:
Adjust importance$_j$ =
SQE_j * Self State importance$_j$ (5)

Step 2: How's
2.1) Technical Requirement: Put the technical requirements that will meet customer needs in each item. This can be divided into eight main parts for service (The Flower of Service) namely Information, Payment, Billing, Order-Taking, Consultation, Exception, Safekeeping and Hospitality.
2.2) Improvement Direction: Put the manner of direction for developing the targets of technical requirements by using the following symbols.

↑ = Objective is to maximize
○ = Objective is to hit target
↓ = Objective is to minimize

Step 3: What's and How's
The third step is to relate customer requirements with technical requirement. where

or 1 = Weak relationship
or 3 = Moderate relationship
or 9 = Strong relationship

Step 4: How's and How's
This is the roof of the House of Quality which represents the relationship between technical requirements of different types (Correlation Matrix) to know how they play a part in supporting or confuting each other so as to help solve the problems in the design. It is possible to indicate the correlation between technical requirements by using the symbols as follows:

△ ++ = Strong Positive Correlation
○ + = Positive Correlation
⊙ Blank = Without Correlation
- = Negative Correlation
-- = Strong Negative Correlation

Step 5: Why
This part is on the right-hand side of the House of Quality. It is used for strategic planning because it contains information about the survey of customers' opinions between the product / service of competitors and ours, assessment of selling points. It is composed of the following sub-steps.
5.1) Our: Analysis of ourselves by assessing the level of customer satisfaction with our customer needs at present. The 1 - 5 scale is used as basis for evaluation. The level 5 of scale means that the customers are satisfied with the company that can meet customer needs in highest level.
5.2) Competitor: Analysis of competitor by evaluating the level of customer satisfaction with customers' needs of competitor. The 1-5 scale is used as basis for assessment likewise.
5.3) Competition Ratio:

$$\text{Competition Ratio} = \frac{Competitor}{Our} \qquad (6)$$

5.4) Absolute Requirement weight:
Absolute Requirement weight =

$$\text{Adjust importance} * \frac{Competitor}{Our} \qquad (7)$$

5.5) Relative Requirement weight: Relative Requirement weight =

$$\frac{\text{Absolute Requirement weight}}{\sum \text{Absolute Requirement weight}} * 100 \qquad (8)$$

Step 6: How much
This section is at the bottom of the House of Quality. It is used in assessing the target value, including the risk to achieve the value as targeted. It includes the following sub-steps.

6.1) Target Value: Determination of the target value of technical requirements as to how the target is characterized. The target value must be measurable and often expressed in numerical terms.

6.2) Risk: Determination of the risk that will occur in the development of technical requirements to meet the specified target in numerical terms for use in analysis and selection to take the technical requirements for use. In this place, two points of view will be taken into consideration namely

- Time
- Cost

6.3) Absolute Technical weight:

Absolute Technical weight =

$$\Sigma(\text{Interrelationship}*\text{Absolute Requirement weight}) \quad (9)$$

6.4) Relative Technical weight:

Relative Technical weight =

$$\frac{\text{Absolute Requirement weight}}{\sum \text{Absolute Requirement weight}} *100 \quad (10)$$

The next section presents a case study to illustrate the applied approach. This case study involved the evaluation of cafeteria. The survey employed a SERVQUAL questionnaire. A sample of customer 200 people in cafeteria was selected in July 2012.

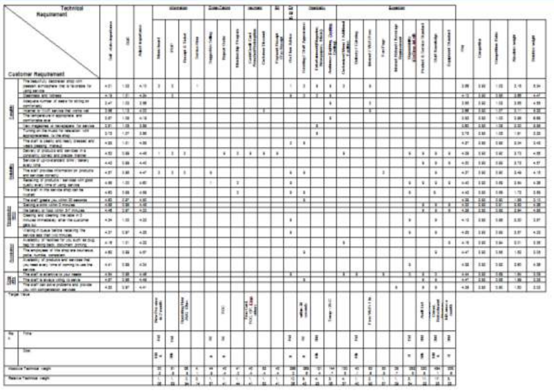
After completing administration of the SERVQUAL questionnaire, the self stated importance score, expected service score, and perceived service score, were identified. Can be calculate Service Quality of Expectation as Table 1.

Table 1. Case study result of cafeteria

Customer Requirement		self stated importance	Expected	Perceived	SQE
Tangible	The beautifully decorated shop with pleasant atmosphere that is favorable for using service	4.01	3.94	3.86	1.02
	Internet or Wi-Fi service that works well	3.56	4.14	3.66	1.13
Reliability	The staff provides information on products and services correctly	4.57	4.28	4.37	0.98
	Receiving of products / services with good quality every time of using service	4.58	4.4	4.40	1.0
Responsiveness	Waiting in queue before receiving the service less than two minutes	4.37	4.12	4.25	0.97
Assurance	The employees of this shop are courteous, polite, humble, consistent	4.62	4.43	4.47	0.99
Empathy	The staff is attentive to your needs	4.54	4.35	4.44	0.98

Table 2 presents the HOQ with SERVQUAL elements incorporated. Take the example of "The beautifully decorated shop with pleasant atmosphere that is favorable for using service" In the traditional HOQ, its Self stated importance is 4.01, while it becomes 4.10 (4.01x1.02) after incorporation of the SERVQUAL analysis. This customer need has now assumed greater priority for improvement.

Table 2. Case study example of house of quality with applied approach



As a consequence of adjusting the importance scores of the "Whats", adjusting the importance scores of the "Hows" are affected also. For example, as shown in Figure 7, the following strategies are affected by the customer need of "The staff is always willing to serve"

• Column 23 – Staff Knowledge (17.28), Time 30 days and cost 5,000 bath 10,000 bath for improvement process

• Column 21 – Product & Service Standard (11.22), Time 30 days and cost 5,000 bath for improvement process

Service innovation at a cafeteria case study is composed of

1. Innovation - Equipment Standard
2. Incremental - Payment Receipt / Tax Receipt, On Floor Advice , Greeting / Staff Appearance, Entertainment(Magazine, Newspapers, Music), Dependability (On Time-In Full), Staff Knowledge
3.Improvement – Menu board, POP, Receipt & Ticket, Service Hour, Suggestive Selling, Repeat Order, Membership Program, Cash/Credit Card/Voucher/Redemption, Customer Discount, Ambience (Lighting, Seating, Cooling), Customized Menu / Additional Facilities, Delivery / Catering, Fan Page, Internet Refund / Beverage Replacement, Product & Service Standard, Internet / Wi-Fi Free

5. CONCLUSION

The applied approach creates value out of the data that cannot be attained through the use of either method alone. To begin with, SERVQUAL's customer satisfaction data are enriched with risk evaluation that provides more thorough analysis by the marketing and product innovation departments. Also, there can be better targeting of resources to, first and foremost, the attractive attributes. Customer indifference to weak attributes is determined also. The result is a better prioritization plan for improving product/service attribute performance.
In its present form, the integrated approach requires much manual work both for data input and output. It should be possible to develop a computer program that will calculate the SERVQUAL scores and have them in a format ready for input into a HOQ.

6. REFERENCES

(a) Akao, Y. and Mazur, G. H., QFD: Past, Present, and Future, International Journal of Quality&Reliability Management, 20(2003): 20-35.
(b) Bayraktaroglu, G. and Özgen, Ö., Integrating the Kano model AHP and planning matrix QFD application in library services. Library Management, 29(2008): 327–351.
(c) Carman, J.M., Consumer perceptions of service quality: an assessment of the SERVQUAL dimensions, Journal of Retailing, 66(1990): 33-55.
(d) Cook, C. and Thompson, B., Reliability and validity of SERVQUAL scores used to evaluate perceptions of library service quality, Journal of Academic Librarianship, 26(2000): 248-58.
(e) Gremyr, I. and Raharjo, H., Quality function deployment in healthcare: a literature review and case study. International Journal of Health Care Quality Assurance, 26(2013): 135–146
(f) Headley, D.E. and Miller, S.J., Measuring service quality and its relationship to future consumer behavior, Journal of Health Care Marketing, 13(1993): 32-41.
(g) Hussain, M. Tsironis, L. and Ajmal, M. M., A QFD strategy for improving customer satisfaction: case study of telecom companies of Pakistan, Asian Journal on Quality, 12(2011): 282-295.
(h) Ikiz, A.K., K. and Masoudi, A., A QFD and SERVQUAL Approach to Hotel Service. Işetme Fakültesi Dergisi, 17(2008): 17–31.
(i) Kim, Y. Lee, S. and Yun, D., Integrating current and competitive service quality level analyses for service-quality improvement programs, Managing Service Quality, 14(2004): 288-296.
(j) Kumar, A. Antony, J. and Dhakar, T. S., Integrating Quality function deployment and benchmarking to achieve greater profitability, Benchmarking An International, 13(2006): 290-310.
(k) Ladhari, R., A review of twenty years of SERVQUAL research, International Journal of Quality and Service Sciences, 1(2009): 172-198.
(l) Lovelock, C. and Wirtz, J., (2012),Service Marketing people, technology, strategy Seventh Edition, Pearson Prentice Hall, United States of America.
(m) Mels, G., Boshoff, C. and Nel, D., The dimensions of service quality: the original European perspective revisited, Service Industries Journal, 17(1997): 173-189.
(n) Parasuraman et al., A Conceptual Model of service Quality and Its Implications for Future research, Journal of marketing, 49(1985): 41-50.
(o) Parasuraman et al., SERVQUAL: A multiple-item scale for measuring consumer perceptions of service quality, Journal of marketing, 49(1985): 41-50.
(p) Parasuraman et al., Refinement and reassessment of the SERVQUAL Scale, Journal of Retailing, 67(1991): 420-450.
(q) Paryani, K. Masoudi, A. and Cudney, E. A., QFD Application in the Hospitality Industry: A Hotel Case Study. The Quality Management Journal, 17(2010): 7–28.
(r) Prasad, B., Synthesis of market research data through a combined effort of QFD, value engineering, and value graph techniques. Qualitative Market

ISSN : 1978-774X

Research: An International Journal, 1(1998): 156–172.
(s) Sanguan Changchut. Documentation of teaching Risk Management. Faculty of Management Phibulsongkram Rajabhat University, 2004.
(t) Tan, K. C. and Pawitra, T. A. Integrating SERVQUAL and Kano's model in to QFD for service excellence development, Managing Service Quality, 11(2001): 418-430.
(u) Ulrich, K. T. and Eppinger, S. D., (2000),Product design and development, Irwin McGraw-Hill, New York.

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