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Incorporating disservice analysis to enhance perceived service quality

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Abstract

Purpose – To ensure the service quality, it is very important and necessary for a company to systematically identify and prioritize the critical failure modes that result in disservice of quality, and take the required remedial actions before the service is delivered to customers. The purpose of this paper is to propose an approach to enhance perceived service quality by incorporating disservice analysis with failure modes and effects analysis (FMEA).

Design/methodology/approach – The approach, first, identifies the potential failure modes that might have explicit effects on the service quality. Subsequently, the risk priority number (RPN) is computed to identify the risk priority for each potential failure mode. Furthermore, a disservice index that represents the extent of composite adverse effect of service failures on quality perceptions is computed to recognize the disservice priority for each quality dimension. Based on which, vital quality dimensions are determined as those quality dimensions that have higher disservice indices. The critical failure modes are, then, confirmed as those failure modes that have higher RPNs in the vital quality dimensions. Finally, the effects and root-causes of the critical failure modes are determined by thoroughly exploiting the service infrastructure, service design, and service encounter for the company to take effective remedial actions to enhance perceived service quality. A practical case regarding a hypermarket service was used to demonstrate the proposed approach. Managerial implications and suggestions are provided to the case company, the hypermarket industry, and other service industries. Possibilities for future research are also addressed.

Findings – The vital quality dimensions are determined as responsiveness and reliability for the hypermarket case. Six critical failure modes are confirmed, by the order of criticality, as "unstable supply of goods/merchandise," "no goods/merchandise on designated shelf of the sales floor," "slowness of cashier speed," "tardiness of warranty/repair goods/merchandise," "nonconforming quality of goods/merchandise," and "unable to find first-line server in the sales floor." These critical failure modes should be eliminated or reduced in top priority to enhance perceived service quality. Note that the determination of vital quality dimensions and the confirmation of critical failure modes depend on the applicable company resources.

Originality/value – The proposed approach improves both the academic and the practical developments of service quality in five aspects: explicitly identifying potential mistakes or failures of the service system that might result in disservice of quality. Arousing notices and focuses on those failure modes that have higher risk priorities by performing FMEA. Identifying how seriously the service failures adversely affect each of the quality dimensions and determining what the vital quality dimensions are by carrying out disservice analysis. Confirming the critical failure modes as those failure modes that have higher risk priorities in the vital quality dimensions with higher disservice indices. Knowing what actions need to be taken in advance to enhance perceived service quality by identifying the root-causes that result in those critical failure modes.

Keywords Customer service management, Quality, Service failures, Failure modes and effects analysis

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1. Introduction

Service quality is defined as the measure of how well the service level delivered matches the customer expectations (Grönroos, 1982; Lewis and Booms, 1983). Delivering a quality service means conforming to customers' expectations on a consistent basis. Perceived service quality can be evaluated as the degree and direction of discrepancy between consumers' perceptions and their expectations about the particular service provided by the service company. Following this line of thinking, Parasuraman *et al.* (1988) developed a SERVQUAL model based on the disconfirmation paradigm that measures service quality as the discrepancy between customer's expectations for a service offering and customer's perceptions of the service received. The SERVQUAL involves 22 quality items, spreading among five service quality dimensions: reliability, responsiveness, assurance, empathy, and tangibles. Following this advent, the SERVQUAL model has been widely used in measuring the service quality for a specific service industry or a particular service company (Berry *et al.*, 1994; Berry and Parasuraman, 1997; Harrison-Walker, 2002; Riemenschneider and Thompson, 2004; Taylor, 2004; Peiró *et al.*, 2005; Pakdil and Aydin, 2007; Lin, 2010).

Nevertheless, due to the fact that people tend to give consistently high-expectation ratings while their perception scores rarely exceed their expectations (Babakus and Boller, 1992), Cronin and Taylor (1992) developed a SERVPERF model, which was a performance-only measure of service quality. They proposed that service quality should be measured by considering only consumer perceptions rather than perceptions minus expectations. This assertion was also suggested and empirically studied by other authors (Carman, 1990; McDougall and Levesque, 1994; Buttle, 1996; Brady and Cronin, 2001; Brady *et al.*, 2002; Kang and Bradley, 2002; Landrum *et al.*, 2007; Roses *et al.*, 2009).

Regardless of which conceptual model is used, the systematic use of tools for measuring quality is obviously focused on comparing the service quality score over time, in order to obtain a dynamic view of customer perceptions (Martínez and Martínez, 2009). That is, it is vital for a service company to establish a quality system that can identify mediate and root-causes of unfavorable quality and take effective remedial actions to ensure the customer's perceived quality. Mediate causes signify service failures that result in the disservice of quality and thus producing poor perceived quality; while root-causes signify those causes that result in the occurrence of the service failures. Therefore, an approach that integrates causal-effect model is essential to enhancing perceived service quality.

Homology to service quality, a service failure occurs when customer expectations are not met (Mueller *et al.*, 2003; Weber and Sparks, 2004). Service failures may cause negative responses of customers, such as negative word-of-mouth, hatred of sellers or reluctance to repeat purchase, all of which may potentially harm business profitability or reputation (Kalamas *et al.*, 2008; Kuo *et al.*, 2009). Studies also showed that overall evaluations of the firm, including overall satisfaction, repurchase intent, and word-of-mouth, will be significantly lower after a service failure occurs (Choi and Mattila, 2008; Lin, 2009). That is, service failures may result in disservice of quality system and consequently affect the perceptions of quality requirements. That was why Halstead *et al.* (1996) emphasized that nothing is better than performing a service to satisfy customers the first time, while nothing is worse than failing to detect a problem or obtain information from an unsatisfied customer. Thus, a systematic approach that could identify and prioritize the critical service failure modes as well as prevent them from occurring is very important and necessary.

In addition, though it is evident that service failures result in disservice of quality, it is rare to systematically demonstrate how and to what extent the perceived quality is affected by the service failures, which explicitly signify the mistakes or inadequacies of the service system and lead the service company to take required remedial actions. That is, when customers are not satisfied with the service, their perceptions on quality are definitely poor. And this happens because of the occurrence of some explicit failures in the service system. In other words, the explicit service failures would have adverse effects on the perceptions of service quality. The explicit service failures are, in turn, resulted from some root-causes due to inadequacies of service design or management deficiencies of the service organization.

In this regard, failure modes and effects analysis (FMEA) is a systemized group of activities that intend to recognize and evaluate the potential failures of a product or process, identify actions that could eliminate or reduce the likelihood of the potential failure occurrence, and document the entire process (Johnson, 2002; Pillay and Wang, 2003). The goal of FMEA is to predict how and where systems, that are designed to detect errors and alert staff, might fail. If the potential effects of the errors are intolerable, then action is taken to eliminate the possibility of errors or minimize their consequences (Cohen *et al.*, 1994). FMEA is both an important method of preventive quality assurance (Wirth *et al.*, 1996) and a proactive technique for error detection and reduction (Chiozza and Ponzetti, 2009).

Therefore, this paper proposes an approach to enhance perceived service quality by incorporating disservice analysis with FMEA. The approach, first, identifies the potential failure modes that might have explicit effects on service quality. Subsequently, the risk priority number (RPN) is computed to identify the risk priority for each potential failure mode. Furthermore, a disservice index that represents the extent of composite adverse effect of service failures on the quality perceptions is computed to recognize the disservice priority for each quality dimension. Based on which, vital quality dimensions are determined as those quality dimensions that have higher disservice indices. The critical failure modes are, then, confirmed as those failure modes that have higher RPNs in the vital quality dimensions. Finally, the effects and root-causes of the critical failure modes are exploited for the service company to take effective remedial actions or preventive actions to enhance perceived service quality. A practical case regarding a hypermarket service is used to demonstrate the proposed approach.

2. Service quality

Service quality is defined as the measure of how well the service level delivered matches the customer expectations (Grönroos, 1982; Lewis and Booms, 1983). Grönroos first developed a model that involved two service quality dimensions to measure the service quality – technical and functional quality (Grönroos, 1982, 1984). The most famous and prevailing model in this area is believed to be the gap model proposed by Parasuraman *et al.* (1985).

To generate objective measures of service quality, Parasuraman *et al.* (1988) further developed a SERVQUAL instrument, which involves 22 quality items, by conducting a total of 12 focus group interviews with those consumers of four different services – retail banking, credit card, security brokerage, and product repair and maintenance. Parasuraman *et al.* (1988) also concluded that the 22 quality items spread among five dimensions via a factor structure analysis. Perceived service quality can be evaluated as the degree and direction of discrepancy between the consumers'

perceptions and expectations about the particular firm for each of the quality items or quality dimensions. The five dimensions were defined as follows:

(1) *Reliability*. The degree to which a promised service is performed dependably and accurately.

(2) *Responsiveness*. The degree to which service providers are willing to help customers and provide prompt service.

(3) *Assurance*. The extent to which service providers are knowledgeable, courteous, and able to inspire trust and confidence.

(4) *Empathy*. The degree to which the customers are offered caring and individualized attention.

(5) *Tangibles*. The degree to which physical facilities, equipment, and appearance of personnel are adequate.

Although SERVQUAL was the model most widely used and disseminated by academics, it brought some criticism and debates since it was reported. Skepticism has arisen mainly about service quality measure and conceptualization. The latter has challenged the dimensionality of the service quality construct for different industries, such as airline service, information technology, and shipping industry (Buttle, 1996; Mels *et al.*, 1997; Cook and Thompson, 2000; Harrison-Walker, 2002; Kang and Bradley, 2002; Finn, 2004; Pakdil and Aydin, 2007; Chen *et al.*, 2009); while the former has challenged the way to measure the perceived service quality being based on disconfirmation paradigm (gap between perception and expectation) rather than attitudinal paradigm (perception-only) (Carman, 1990; Babakus and Boller, 1992; Cronin and Taylor, 1992; McDougall and Levesque, 1994; Buttle, 1996; Brady and Cronin, 2001; Brady *et al.*, 2002; Kang and Bradley, 2002; Landrum *et al.*, 2007; Roses *et al.*, 2009). Cronin and Taylor (1992) also developed a SERVPERF model, which was a performance-only measure of service quality, and stressed that it could obtain psychometrically superior assessment of service quality than the SERVQUAL.

Despite the arguments on the dimensionality of construct for different industries, Kang and Bradley (2002), Finn (2004), Pakdil and Aydin (2007) and Chen *et al.* (2009) recognize that the original 22 quality items of SERVQUAL is good for evaluating service quality. In addition, the five dimensions of SERVQUAL with modified/adapted number of quality items to specific contexts has been used as an effective tool to measure service quality across a broad range of service categories, such as supermarkets, travel agencies, information service, and hotel industries (Bigné *et al.*, 2003; Akbaba, 2006; Landrum *et al.*, 2007; Roses *et al.*, 2009). This responded to the improvement made by the authors of SERVQUAL themselves in 1991 and 1994. Parasuraman *et al.* (1991, 1994) affirmed that SERVQUAL provided the basic structure to support service quality and this structure may receive some adjustments to fit specific needs.

Moreover, in spite of the criticisms about SERVQUAL, it is still a marketing breakthrough for service quality measurement (Kettinger and Lee, 1999) and is also considered as a reliable tool for measuring service quality (Lin, 2010). Since the demonstrated example in this research is regarding a hypermarket service, thereby, the five dimensions with 22 items of SERVQUAL are used to identify how the perceptions (SERVPERF) of quality are adversely affected by the critical service failures.

But note that the limitations and adaptation of SERVQUAL to specific application of service industry should also be kept in mind.

3. Service failures

Service failures may result in disservice of quality system and consequently affect the perceptions of quality requirements. That is, it is the customer's perception that determines whether a service failure has occurred, even if the companies with the best strategic plans and the tightest quality control procedures provide service according to the blueprint established by the service provider (Goldstein *et al.*, 2002; Weber and Sparks, 2004). Just as Murphy's law states "If anything can go wrong, it will." Even if zero-defect is the desired objective for most of the firms, it is unlikely that service organizations will achieve this goal. Thus, a systematic approach that could identify and prioritize the critical service failure modes as well as prevent them from occurring during the service design stage is very important and necessary.

Service failure, according to Keaveney (1995), can be divided into two broad categories: core-service failures and service-encounter failures. Core-service failures are incidents that result from mistakes or technical problems with the service itself. Service-encounter failures might occur in the personal interactions between customers and employees of the service firms. Kelley *et al.* (1993) focused on retail industry and classified three main groups of service failures: service delivery system failures, buyer needs and requests, and unprompted and unsolicited seller actions. Kuo *et al.* (2009) further adopted these three groups for service failure analysis of online auction and showed that "unprompted and unsolicited seller action" had the highest level of severity; "buyer needs and requests" was ranked second; and "admitted buyer error was considered the least severe. The results also showed that service failures could cause negative responses of customers, such as negative word-of-mouth, hatred of sellers or reluctance to repeat purchase, unless appropriate recovery strategies and/or preventive actions were taken.

4. Failure modes and effects analysis

FMEA is a systemized group of activities that intend to recognize and evaluate the potential failure of a product or process, identify actions that could eliminate or reduce the likelihood of the potential failure occurrence, and document the entire process (Johnson, 2002; Pillay and Wang, 2003; Chin *et al.*, 2009). FMEA is widely used in the manufacturing sectors, such as automotive, aerospace, chemical, and electronics industries, to identify, prioritize, and eliminate known potential failures, problems, and errors from the systems under design, before the product is released (Sankar and Prabhu, 2001; Nakajima *et al.*, 2002; Price and Taylor, 2002; Scipioni *et al.*, 2002; Xu *et al.*, 2002; Rhee and Ishii, 2003; Guimarães and Lapa, 2004a, b; Teoh and Case, 2004a, b; Almannai *et al.*, 2008; Su and Chou, 2008). Literatures regarding the FMEA in the service industries are rare, with few on medical surgery or health-related industries (Radermacher *et al.*, 2004; Duwe *et al.*, 2005; Scipioni *et al.*, 2005; Tellefsen, 2005; Chiozza and Ponzetti, 2009).

The basic procedures of FMEA involve four steps:

(1) Review the process and list the potential failure modes of the process or the system.

(2) Assign a severity rating, an occurrence rating, and a detection rating for each of the potential failure modes.

(3) Calculate RPN for each potential failure mode: the RPN is calculated as the product of the severity rating, occurrence rating, and detection rating.

(4) Identify the critical failure modes and their corresponding root-causes for prioritizing the remedial actions. Take action to eliminate or reduce the occurrence of critical failure modes.

5. Proposed approach to enhance perceived service quality

This paper proposes an approach to enhance perceived service quality by performing two phases of analysis, FMEA and disservice analysis, as shown in Figure 1. Details of the proposed approach are described, step by step, below:

(1) In the first step, the model identifies the potential service failure modes that might have effects on each of the service quality dimensions. This is accomplished, first, by reviewing the service process and listing the potential failure modes. To identify how each service failure might result in the disservice of quality, the potential failure modes are re-organized according to their adverse effects on each of the five quality dimensions in SERVQUAL. Through this work, the service design team can explicitly signify the mistakes or failures of the service system, which might potentially lower customer's perceptions of the quality.

Note this research connotes potential failure modes to quality dimensions rather than quality items because the quality items in the same dimension of SERVQUAL are internally consistent and highly correlated. The convergent validity of each dimension in SERVQUAL being significant has been acknowledged by Parasuraman *et al.* (1988, 1991, 1994), Kettinger and Lee (1999), Bigné *et al.* (2003), Akbaba (2006), Landrum *et al.* (2007) and Roses *et al.* (2009). That is, if a service failure mode has adverse effect on a particular quality item, it might have the same effect on other quality items in the same dimension. To identify the composite adverse effects of service failures on disservice of quality, therefore, the paper connotes the potential failure modes to the quality dimensions.

(2) In the second step, the FMEA method is performed by computing the RPN for each of the potential failure modes. The RPN value is computed by multiplying the severity rating (S), occurrence rating (O), and detection rating (D) of the corresponding failure mode, as shown in equation (1). The higher the RPN, the more risky is the potential failure mode:

$$\mathrm{RPN} = S \times O \times D \tag{1}$$

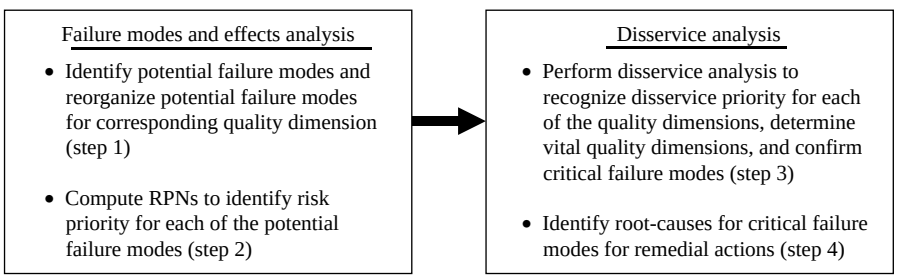

Figure 1.
Phases and steps of proposed approach

In this stage, the severity rating is assessed based on the seriousness and to what extent a service failure affects the perception of the corresponding quality dimension. If the failure effect is more serious, the severity rating is higher. The occurrence rating is assigned by determining the possibility and to what extent a possible cause to the corresponding failure mode might occur. The higher the probability of a cause to the corresponding failure mode, the higher is the occurrence rating. The detection rating represents the extent of the ability of the current control of the service system in preventing the effect of the corresponding failure mode from occurring. The higher the ability of the controls to prevent failure mode from occurring, the lower will be the detection rating. It can be observed that the value-direction of the detection rating is different from those of the other two, because when the current control has higher ability to prevent the effect, the risk of the failure mode would be lower.

(3) In the third step, a disservice index that represents the extent of composite adverse effect of service failures on each of the quality dimensions is computed to recognize the disservice priority for each quality dimension. Based on which, vital quality dimensions are determined as those quality dimensions that have higher disservice indices. The critical failure modes are, then, confirmed as those failure modes that have higher RPNs in the vital quality dimensions. This will provide the service company in not only identifying what and where the service system might fail, but also knowing the extent of how those failures affect the disservice of quality.

(4) The final step is to identify the root-causes that result in those critical failure modes. The remedial actions to eliminate or reduce these root-causes can be taken to prevent the occurrence of the corresponding failure modes before the service is delivered to the customers. Since the explicit service failures are mediate causes that result in the disservice of quality dimensions and they are relating to customer perceptions of quality. And service failures are generally caused by implicit insufficiencies or inappropriateness of service infrastructure, service design, and service encounter. Thus, the possible root-causes are determined by thoroughly exploiting the service infrastructure, service design, and service encounter of the specific company.

6. Practical case and discussions

To demonstrate the proposed approach, a practical case regarding the hypermarket service was adopted. The selected company is a chain hypermarket store that has four branch stores in Taiwan (addressed as Y-store thereafter). In the case, the FMEA is first performed to prioritize the more risky failure modes, followed by the disservice analysis to identify the composite adverse effect of service failures on each of the service quality dimensions, determine the vital quality dimensions, and confirm the critical failure modes for the Y-store. Lastly, the effects and the root-causes for the critical failure modes are exploited.

6.1 FMEA for hypermarkets service

Step 1. Identify and re-organize potential failure modes. To systematically identify potential failure modes, the service system of hypermarket industry is decomposed into four sub-systems: service facility, prior-service, in-service, and post-service.

Each sub-system involves several processes or activities. Among these, service facility involves sales floor facility, sales floor security, and sales floor surroundings. Prior-service involves incoming goods/merchandise activity as well as warehousing and inventory activity. In-service involves customer choose/purchase flow and cashier flow. Post-service involves post-sale activity and warranty. The potential failure modes for each process/activity are then explored and listed according to the service blueprint of hypermarket industry. A total of 23 potential failure modes, as shown in Table I, are structurally listed for further analysis.

The above failure modes also explicitly illustrate the potential mistakes of a hypermarket service that might result in lower perceptions of quality requirement. As described in previous section, the quality items in the same dimension are internally consistent and highly correlated. To identify the composite adverse effects of service failures on disservice of quality, the potential failure modes are re-organized to connote their composite adverse effects on each of the five quality dimensions. The results are shown in Table II.

Step 2. Compute RPNs to identify risky failure modes. To compute the RPN for identifying the risk priority of each potential failure mode, the required data of severity, occurrence, and detection ratings were collected by a questionnaire survey assisted by the Y-store. After obtaining the approval from the Y-store, 100 questionnaires were sent to its employees including executive managers, middle/floor managers, and first-line servers. The respondents were asked to rate the degree of severity, the probability of occurrence, and the degree of detection ability of each failure mode. In the questionnaire,

Sub-system	Process/activity	Potential failure mode
Service facility	Sales floor facility	Insufficient parking space
		Air-conditioning malfunction
		Escalator malfunction
		Shopping cart malfunction/damage/impair
	Sales floor security	Emergency, fire, and security alarm failure
	Sales floor surroundings	Inappropriate streamline arrangement of sales floor
Prior-service	Incoming goods/merchandise activity	Unstable supply of goods/merchandise
		Tardiness of incoming goods/merchandise
		Incoming inspection failure of goods/merchandise
	Warehousing and inventory activity	Forecasting error of goods/merchandise
		Inconsistency between actual and book inventories
		Wrong location of warehousing goods/merchandise
In-service	Customer choose/purchase flow	No goods/merchandise on designated shelf of the sales floor
		Nonconforming quality of goods/merchandise
		Unable to find first-line server in the sales floor
		Bad service attitude of first-line server
		Wrong price tag/price tag missing
	Cashier flow	Slowness of cashier speed
		Bad attitude of cashier server
		Wrong cashier amount of money
Post-service	Post-sale activity	Inappropriate complaints/liability adjustments
		Inappropriate returned/refund policy
	Warranty	Warranty/repair failure in timeliness, items, charge

Table I.
Potential failure modes for hypermarket case

Table II.
Potential failures that results in disservice of quality for hypermarket case

Potential failure modes	Disservice of quality dimension	Effects on customer perceptions of the hypermarket service (quality items in SERVQUAL)
Unstable supply of goods/merchandise Tardiness of incoming goods/merchandise Inconsistency between actual and book inventories Wrong goods/merchandise on designated shelf of the sales floor No goods/merchandise on designated shelf of the sales floor Wrong price tag/price tag missing Incoming inspection failure of goods/merchandise Nonconforming quality of goods/merchandise Wrong cashier amount of money	Disservice of Reliability →	1. When this hypermarket store promises to do something by a certain time, it does so 2. When you have problems, this hypermarket store is sympathetic and reassuring 3. This hypermarket store is dependable 4. This hypermarket store provides its service at the time it promises to do so 5. This hypermarket store keeps its records accurately
Unable to find first-line server in the sales floor Slowness of cashier speed Tardiness of warranty/repair goods/merchandise	Disservice of Responsiveness →	6. This hypermarket store tells its customers exactly when services will be performed 7. You receive prompt service from this hypermarket store's employees 8. Employees of this hypermarket store are always willing to help customers 9. Employees of this hypermarket store respond to customer requests promptly
Emergency, fire, and security alarm failure Bad attitude of the first-line server Bad attitude of the cashier server Inappropriate warranty policy	Disservice of Assurance →	10. You can trust employees of this hypermarket store 11. You can feel safe in your transactions with this hypermarket store's employees 12. Employees of this hypermarket store are polite 13. Employees get adequate support from the hypermarket store to do their jobs well

(continued)

Potential failure modes	Disservice of quality dimension	Effects on customer perceptions of the hypermarket service (quality items in SERVQUAL)
Forecasting error of goods/merchandise Inappropriate complaints/liability adjustments	Disservice of → Empathy	14. This hypermarket store gives you individual attention 15. Employees of this hypermarket store give you personal attention 16. Employees of this hypermarket store know what your needs are 17. This hypermarket store has your best interests at heart 18. This hypermarket store has operating hours convenient to all their customers
Insufficient parking space Air-conditioning malfunction Escalator malfunction Shopping cart malfunction/damage/impair Inappropriate process/aisle arrangement of sales floor	Disservice of → Tangibles	19. The hypermarket store has up-to-date equipment 20. The physical facilities at this hypermarket store are visually appealing 21. The employees at this hypermarket store are well-dressed and appear neat 22. The appearance of the physical facilities of this hypermarket store is in keeping with the type of service provided

Table II.

a rating from one to five was used for each failure mode, i.e. for the severity rating, one represents the least severe if the corresponding failure mode occurs and five indicates the most severe; for the occurrence rating, one means the lowest possibility for the corresponding failure mode to occur and five signifies the highest possibility; for the detection rating, one represents that the store has the highest degree of control ability to prevent the corresponding failure mode from occurring and five indicates the lowest degree of control ability.

The values of the severity, occurrence, and detection ratings for each failure mode are listed on the fourth, fifth, and sixth columns, respectively, in Table III, by computing the arithmetic average of the surveyed data. And, by using equation (1), the RPN for each failure mode can be computed and listed on the right-most column of Table III. The higher the RPN, the more risky is the service failure mode.

To identify the more risky failure modes, the third quartile (Q3) is used as the threshold. This means that those potential failure modes with the RPN values in the top 25 percent are the more risky failure modes. Since there are 23 failures modes in total, the Q3, in the ascending order, is the 18th ranked value, 23.28. Those RPN values higher than Q3, by priority order from the highest, are "unstable supply of goods/merchandise", "air-conditioning malfunction," "no goods/merchandise on designated shelf of the sales floor," "slowness of cashier speed," "tardiness of warranty/repair goods/merchandise," and "nonconforming quality of goods/merchandise." In addition, the RPN of 23.27 for the failure mode of "unable to find first-line server in the sales floor" is also close to Q3. Thus, these seven failure modes represent the more risky ones in the Y-store.

6.2 Disservice analysis

Step 3. Perform disservice analysis to confirm critical failure modes. To perform the disservice analysis for each of the service quality dimensions, the Bayesian probability calculation was adopted. For each service quality dimension, the disservice index represents the composite adverse effect of the corresponding potential failure modes on a particular quality dimension, which can be computed as equation (2):

$$R_i = \sum_{j=1}^{n_i} P(F_{ij} \cap Q_i) \quad i = 1, 2, \ldots, 5 \tag{2}$$

where:

- R_i = the disservice index of the ith service quality dimension.
- F_{ij} = the jth potential failure mode in the ith service quality dimension.
- Q_i = the ith service quality dimension.
- n_i = total number of failure modes in the ith service quality dimension.
- $P(F_{ij} \cap Q_i)$ = probability of the disservice effect of the jth potential failure mode on the ith service quality dimension.
- $\sum_{j=1}^{n_i} P(F_{ij} \cap Q_i)$ = probability of the composite adverse effect of the corresponding potential failure modes on the ith service quality dimension.

Table III. Results of FMEA for the case

Service quality factorial structure	Service quality dimension	Potential failure modes	Severity rating (1-5)	Occurrence rating (1-5)	Detection rating (1-5)	RPN
Intrinsic service quality	Reliability	Unstable supply of goods/merchandise	3.54	3.00	2.57	*27.29* [a]
		Tardiness of incoming goods/merchandise	2.83	2.76	2.89	*22.57*
		Inconsistency between actual and book inventories	2.32	2.18	2.84	*14.36*
		Wrong goods/merchandise on designated shelf of the sales floor	2.51	2.13	2.99	*15.99*
		No goods/merchandise on designated shelf of the sales floor	3.07	2.64	2.94	*23.83* [a]
		Wrong price tag/price tag missing	2.68	2.50	2.78	*18.63*
		Incoming inspection failure of goods/merchandise	2.35	2.35	3.01	*16.62*
		Nonconforming quality of goods/merchandise	3.29	2.67	2.65	*23.28* [a]
		Wrong cashier amount of money	2.80	2.35	2.85	*18.75*
	Responsiveness	Unable to find first-line server in the sales floor	2.81	2.76	3.00	*23.27* [a]
		Slowness of cashier speed	2.94	2.74	2.94	*23.68* [a]
		Tardiness of warranty/repair goods/merchandise	2.89	2.65	3.05	*23.36* [a]
	Assurance	Emergency, fire, and security alarm failure	2.85	1.91	3.01	*16.38*
		Bad attitude of first-line server in the sales floor	2.84	2.45	3.10	*21.57*
		Bad attitude of cashier server	2.96	2.51	2.87	*21.32*
		Inappropriate warranty policy	3.05	2.47	2.91	*21.92*
	Empathy	Forecasting error of goods/merchandise	2.48	2.19	2.93	*15.91*
		Inappropriate complaints/liability adjustments	3.46	2.15	2.74	*20.38*
Extrinsic service quality	Tangibles	Insufficient parking space	2.93	2.42	3.01	*21.34*
		Air-conditioning malfunction	3.10	2.65	3.09	*25.38* [a]
		Escalator malfunction	2.58	2.00	2.77	*14.29*
		Shopping cart malfunction/damage/impair	2.40	2.01	3.03	*14.62*
		Inappropriate process/aisle arrangement of sales floor	3.09	2.48	2.79	*21.38*

Note: [a]The more risky failure modes

And:

$$P(F_{ij} \cap Q_i) = P(F_{ij}) \cdot P(Q_i|F_{ij}) \quad (3)$$

where:

$P(F_{ij})$ = probability of occurrence of the jth potential failure mode.

$>$ = occurrence rating of the jth potential failure mode/5 (5 is the highest value in the rating scale).

$P(Q_i|F_{ij})$ = probability of the disservice effect of the ith service quality dimension, given that the jth potential failure mode has occurred.

By adopting equations (2) and (3), the disservice index that represents the composite adverse effect on each service quality dimension can be computed. The results are shown in Table IV. As shown in the right-most column of Table IV, the disservice priority for the service quality dimensions from highest to lowest are responsiveness, reliability, tangibles, assurance, and empathy. Based on which, the vital quality dimensions can be determined as responsiveness and reliability. This reveals that the current service system of the Y-store should have critical failures that result in more adverse perceptions on the quality dimensions of responsiveness and reliability. That is, the critical failure modes can be confirmed as those failure modes that have higher RPNs in the quality dimensions of responsiveness and reliability. From Table IV, it shows that the quality dimension of responsiveness is affected by three potential failure modes: "unable to find first-line server in the sales floor," "slowness of cashier speed," and "tardiness of warranty/repair goods/merchandise," and they all are identified as the critical failure modes. It also reveals that the quality dimension of reliability is affected by nine potential failure modes, among which "unstable supply of goods/merchandise," "no goods/merchandise on designated shelf of the sales floor," and "nonconforming quality of goods/merchandise" are identified as the critical failure modes. In summary, six critical failure modes are confirmed, by the order of criticality, as "unstable supply of goods/merchandise," "no goods/merchandise on designated shelf of the sales floor," "slowness of cashier speed," "tardiness of warranty/repair goods/merchandise," "nonconforming quality of goods/merchandise," and "unable to find first-line server in the sales floor."

Step 4. Identify root-causes for critical failure modes. Further analysis regarding the effects and root-causes for each of the six critical failure modes was exploited. In this paper, the service failures, explicitly relating to customer perceptions of quality, are caused by the implicit insufficiencies or inappropriateness of service infrastructure, service design, and service encounter; and the service failures would eventually lower the perceptions of service quality. Therefore, the root-causes for this hypermarket case were determined by thoroughly exploiting the service infrastructure, service design, and service encounter of the Y-store. The results are shown in Table V.

Note that each root-cause could cause multiple critical failure modes. For instances, failure to match supply and demand is the root-causes of critical failure modes "unstable supply of goods/merchandise," "no goods/merchandise on designated shelf of the sales floor," and "unable to find first-line server in the sales floor"; poor supplier evaluation and selection is the root-causes of critical failure modes "unstable supply of goods/merchandise" and "nonconforming quality of goods/merchandise"; lack of empowerment is the root-causes of critical failure modes "tardiness of warranty/repair goods/

Table IV. Results of disservice analysis for the case

Service quality dimension	Potential failure modes	RPN (A)	RPN sum for each quality dimension (B)	$P(Q_i \mid F_{ij})$ ($C = A/B$)	Occurrence rating (D)	$P(F_{ij})$ ($E = D/5$)	$P(F_{ij} \cap Q_i)$ ($F = E \times C$)	Disservice index for each quality dimension $R_i = \sum_{j=1}^{n_i} P(F_{ij} \cap Q_i)$
Reliability	Unstable supply of goods/merchandise	*27.29* [a]	181.32	0.1505	3	0.6	0.0903	*0.5122* [b]
	Tardiness of incoming goods/merchandise	*22.57*		0.1245	2.76	0.552	0.0687	
	Inconsistency between actual and book inventories	*14.36*		0.0792	2.18	0.436	0.0345	
	Wrong goods/merchandise on designated shelf of the sales floor	*15.99*		0.0882	2.13	0.426	0.0376	
	No goods/merchandise on designated shelf of the sales floor	*23.83* [a]		0.1314	2.64	0.528	0.0694	
	Wrong price tag/price tag missing	*18.63*		0.1027	2.5	0.5	0.0514	
	Incoming inspection failure of goods/merchandise	*16.62*		0.0917	2.35	0.47	0.0431	
	Nonconforming quality of goods/merchandise	*23.28* [a]		0.1284	2.67	0.534	0.0686	
	Wrong cashier amount of money	*18.75*		0.1034	2.35	0.47	0.0486	
Responsiveness	Unable to find first-line server in the sales floor	*23.27* [a]	70.31	0.3310	2.76	0.552	0.1827	*0.5434* [b]
	Slowness of cashier speed	*23.68* [a]		0.3368	2.74	0.548	0.1846	
	Tardiness of warranty/repair goods/merchandise	*23.36* [a]		0.3322	2.65	0.53	0.1761	

(continued)

Table IV.

Service quality dimension	Potential failure modes	RPN (A)	RPN sum for each quality dimension (B)	$P(Q_i \mid F_{ij})$ ($C = A/B$)	Occurrence rating (D)	$P(F_{ij})$ ($E = D/5$)	$P(F_{ij} \cap Q_i)$ ($F = E \times C$)	Disservice index for each quality dimension $R_i = \sum_{j=1}^{n_i} P(F_{ij} \cap Q_i)$
Assurance	Emergency, fire, and security alarm failure	*16.38*	81.19	0.2017	1.91	0.382	0.0771	*0.4725* [b]
	Bad attitude of first-line server in the sales floor	*21.57*		0.2657	2.45	0.49	0.1302	
	Bad attitude of cashier server	*21.32*		0.2626	2.51	0.502	0.1318	
	Inappropriate warranty policy	*21.92*		0.2700	2.47	0.494	0.1334	
Empathy	Forecasting error of goods/merchandise	*15.91*	36.29	0.4384	2.19	0.438	0.1920	*0.4335* [b]
	Inappropriate complaints/liability adjustments	*20.38*		0.5616	2.15	0.43	0.2415	
Tangibles	Insufficient parking space	*21.34*	97.01	0.2200	2.42	0.484	0.1065	*0.4740* [b]
	Air-conditioning malfunction	*25.38*		0.2616	2.65	0.53	0.1387	
	Escalator malfunction	*14.29*		0.1473	2	0.4	0.0589	
	Shopping cart malfunction/damage/impair	*14.62*		0.1507	2.01	0.402	0.0606	
	Inappropriate process/aisle arrangement of sales floor	*21.38*		0.2204	2.48	0.496	0.1093	

Notes: [a]Represent the confirmed priority order of critical failure modes; [b]represent the disservice priority order of the corresponding quality dimension

Table V. Effects and root-causes for critical failure modes

Priority order	Critical failure mode	Effects on the hypermarket service system	Possible root-causes
1	Unstable supply of goods/merchandise	Shortage of goods/merchandise Lost sales Decreasing customer loyalty Customer complaints Complicating job allocation and replenishment activity Adverse goodwill of store	Poor supplier evaluation and selection Inappropriate supplier relationship management Insufficient inventory of suppliers Inadequate marketing research Lack of upward communication Insufficient customer relationship focus Failure to match supply and demand
2	No goods/merchandise on designated shelf of the sales floor	Lost sales Customers cannot find the goods Customer complaints	Insufficient replenishment of goods/merchandise in sales shelf POS system failure Goods/merchandise in wrong shelf Unclear or wrong tag of goods/merchandise Failure to match supply and demand Inadequate horizontal communication Over promising in advertising
3	Slowness of cashier speed	Increasing customer waiting time Customer impatient Customer complaints Customers run away	Mistakes in cashier system Bar-code system failure Deficiencies in human resource policies such as recruitment, training Poor employee-job fit Failure to plan number of cashiers that reflect peaks and valleys of demand Wrong price tag or price tag missing

(continued)

Priority order	Critical failure mode	Effects on the hypermarket service system	Possible root-causes
4	Tardiness of warranty/repair goods/merchandise	Increasing customer costs Adverse goodwill of store Lost customers	Ineffective communication with customers Poor design of warranty process Poor management of maintenance/repair contractors Lack of empowerment Over promising
5	Nonconforming quality of goods/merchandise	Affect food safety Against regulations/be fined Facing lawsuit Adverse goodwill of store Increasing discard/scrap costs	Poor supplier evaluation and selection Inspection failure for incoming goods/merchandise Poor warehousing/storage conditions/activities Ineffective examination/checkout on goods/merchandise
6	Unable to find first-line server in the sales floor	Lost sales Customer complaints	Poor employee-job fit Failure to match supply and demand Lack of empowerment Dawdled employees

Table V.

merchandise" and "unable to find first-line server in the sales floor"; over promising is the root-causes of critical failure modes "no goods/merchandise on designated shelf of the sales floor" and "tardiness of warranty/repair; and goods/merchandise" poor employee-job fit is the root-causes of critical failure modes "slowness of cashier speed" and "unable to find first-line server in the sales floor."

The required remedial actions to eliminate or reduce these root-causes need to be taken to enhance perceived service quality. The remedial actions fall into two categories. Preventive actions are taken to avoid a failure situation; whereas compensatory actions minimize losses in the event of a failure. In addition, the results reveal that the most adverse effects harmed by the critical failure modes are lost sales, customer complaints, customer run away, and adverse goodwill of store. This corresponds to the findings of Choi and Mattila (2008), Kalamas *et al.* (2008), Kuo *et al.* (2009) and Lin (2009).

7. Managerial implications and suggestions

7.1 Implications and suggestions to the case company and the hypermarket industry

Results of FMEA show there are seven failure modes that have higher risks of negatively affecting the perceptions of service quality. They are "unstable supply of goods/merchandise," "air-conditioning malfunction," "no goods/merchandise on designated shelf of the sales floor," "slowness of cashier speed," "tardiness of warranty/repair goods/merchandise," "nonconforming quality of goods/merchandise," and "unable to find first-line server in the sales floor." Thus, these seven failure modes represent the more risky ones in the Y-store and should receive higher notices and more focuses.

Note that the results depend heavily on the occurrence rating and the detection rating for each of the potential failure modes. Thus, if other hypermarket stores that have different service design and service delivery processes, they would have different occurrence rating for various failure modes. In this situation, the RPNs for the potential failure modes would be different from the demonstrated example and thus the resulting risky failure modes could also be different. In the same logic, if different companies that have different levels of ability to control the service system in preventing the effect of the corresponding failure mode from occurring, they would have different detection ratings for various failure modes. In this situation, the RPNs for the potential failure modes and the resulting risky failure modes may also be different from the demonstrated example.

Furthermore, disservice analysis shows that the quality dimensions of responsiveness and reliability are determined as vital quality dimensions since both dimensions have the higher composite adverse effects from service failures. It means there must be critical failure modes, in the service system of Y-store, that have more negative impacts on the perceptions of quality dimensions of responsiveness and reliability. Thus, to effectively enhance perceived service quality based on limited resources, the company should eliminate or alleviate the adverse effects of the critical failure modes. To do this, moreover, six critical failure modes are confirmed, by the order of criticality, as "unstable supply of goods/merchandise," "no goods/merchandise on designated shelf of the sales floor," "slowness of cashier speed," "tardiness of warranty/repair goods/merchandise," "nonconforming quality of goods/merchandise," and "unable to find first-line server in the sales floor." Therefore, these critical failure modes should be eliminated or reduced in top priority to enhance perceived service quality.

It should be emphasized that the determination of vital quality dimensions and the confirmation of critical failure modes depend on the applicable company resources. That is, if more resources are allowed for a company to simultaneously improve more quality dimensions, more vital quality dimensions can be determined and more critical failure modes can be confirmed for enhancing perceived service quality. Note that "Air-conditioning malfunction" is not confirmed as a critical failure mode in the example case since its failure effect relates to quality dimension of "tangibles" which the disservice index is not higher compared to the dimensions of responsiveness and reliability. But if the example company or other hypermarket companies facing the same situation is/are willing to allocate resources on more quality dimensions, the "tangibles" might be determined as vital quality dimension and thus the "Air-conditioning malfunction" could also be confirmed as a critical failure mode.

Moreover, the root-causes for the hypermarket case are determined by thoroughly exploiting the service infrastructure, service design, and service encounter of the Y-store. As discussed in Step 4 of Section 6.2, each root-cause could cause multiple critical failure modes. And since the existence of the explicit service failures are eventually lowering the perceptions of service quality, the required remedial actions to eliminate or reduce these root-causes need to be taken to enhance perceived service quality. The remedial actions fall into two categories. Preventive actions are taken to avoid a failure situation; whereas compensatory actions minimize losses in the event of a failure.

A company can prioritize the remedial actions based on the number of critical failure mode that are resulted by each root-cause if only limited resources are allowed. That is, the more the number of critical failure modes by a single root-cause, the higher the priority that the root-cause is to be eliminated. For example, in the hypermarket case, the root-cause "failure to match supply and demand" results in three critical failure modes "unstable supply of goods/merchandise," "no goods/merchandise on designated shelf of the sales floor," and "unable to find first-line server in the sales floor"; while "poor supplier evaluation and selection" results in two critical failure modes "unstable supply of goods/merchandise," and "nonconforming quality of goods/merchandise." Since the root-cause "failure to match supply and demand" results more failure modes, it gets higher priority to be eliminated. Thus, a company can weigh its applicable resources to determine the breadth and the scope of remedial actions.

Finally, the results also reveal that the most adverse effects harmed by the critical failure modes are lost sales, customer complaints, customer run away, and adverse goodwill of store. Thus, the service recovery strategy and actions in response to the critical failure modes should also be planned in advance and receive the maximum attention to restore the service immediately if they do occur.

7.2 Implications and suggestions to other service industries

This study uses five quality dimensions with 22 quality items of SERVQUAL to identify how the perceptions of each quality dimension are adversely affected by service failures and determine the vital quality dimensions. Other service industries, such as airline, distribution, banking services, or other retail services can also apply the proposed approach to perform the FMEA and disservice analysis to enhance perceived service quality. Note that, though SERVQUAL is considered a marketing breakthrough for service quality measurement (Kettinger and Lee, 1999) and a reliable tool for measuring service quality (Lin, 2010), the number of quality dimension

and the number of quality items used for different service industry depend on the validities of construct/dimensions and contents. Thus, the limitations and adaptation of SERVQUAL to specific application of service industry should be kept in mind. That is, various service industries may adopt different number of quality dimensions with different number of quality items, such as Kang and Bradley (2002) used three dimensions with 22 items for information technology service quality; Landrum *et al.* (2007) used five dimensions with 24 items for information service quality; Pakdil and Aydin (2007) used three dimensions with 22 items for airline service quality; Chen *et al.* (2009) used three dimensions with 22 items for shipping industry; Roses *et al.* (2009) used five dimensions with 24 items for information service quality; and Lin (2010) used four dimensions with 22 items for supermarkets' service quality.

8. Conclusion and future research

Service failure is almost inevitable owing to the multi-dimensional nature of the service encounter that involves service facility, service environment, service logistics, and service flow as well as the interaction between first-line servers and customers. Thus, it is very important for the service company to identify, in advance, how and to what extent the service quality is affected by critical failure modes, and take the required remedial actions.

This paper proposed an approach that incorporates disservice analysis with FMEA to enhance perceived service quality. A hypermarket service was used to demonstrate the approach. The proposed approach improves both the academic and the practical developments of service quality in five aspects:

(1) Explicitly identifying potential mistakes or failures of the service system that might result in disservice of quality.

(2) Arousing notices and focuses on those failure modes that have higher risk priorities by performing FMEA.

(3) Identifying how seriously the service failures adversely affect each of the quality dimensions and determining what the vital quality dimensions are by carrying out disservice analysis.

(4) Confirming the critical failure modes as those failure modes that have higher risk priorities in the vital quality dimensions with higher disservice indices.

(5) Knowing what actions need to be taken in advance to enhance perceived service quality by identifying the root-causes that result in those critical failure modes.

Owing to the fact that the quality dimensions and the quality items may be different for various service industries, future research in this area can first test the construct validity, involving convergent validity of quality items and the discriminant validity of quality dimensions; and then apply the proposed approach to enhance perceived service quality. In addition, future research can also be devoted to quantitatively evaluate the severity of the service failure by considering the cost-of-quality. This would allow the service design team to quantify the effects of service failure according to the magnitude of quality loss. Subsequently, the FMEA can be performed by consolidating the quantitative quality loss of the severity and the qualitative rating of the occurrence and detection.

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