

Service Quality Evaluation Model of Automated Teller Machines Using Statistical Inference and Performance Evaluation Matrix

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Automated teller machines (ATMs) provide customers with safe and efficient financial services round-the-clock, while simultaneously reducing operating costs. They have consequently become an integral aspect of financial service systems across the world. Clients' satisfaction with ATM service is an important concern for these firms. High-quality service provision necessitates analysis of factors underlying service failure. This paper uses a questionnaire survey to aggregate customer responses regarding their use of ATMs and their overall satisfaction toward this experience, and then employs a simple regression model to explore how individual service items affect their overall satisfaction. Lastly this paper presents an influence index which, combined with the satisfaction index, allows for the construction of a performance evaluation matrix. This paper also uses the mean of

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the two indices to create dynamic standards for ongoing quality management. Statistical inference is conducted to obtain interval estimations regarding both indices in order to counter the uncertainty of service quality evaluation caused by sampling error. Using this criterion, financial market operators can determine the standard of their service quality, as well as outline strategies for improvement.

Keywords: financial service industry, automated teller machine, performance evaluation matrix, statistical inference

JEL classification: C44

1 Introduction

Since the ban on the establishment of private banks and banking centers in Taiwan was lifted in 1990, financial institutions have proliferated. This has led to overbanking, which has made it increasingly difficult for financial institutions to maintain their profit margins. This fierce competition has led these firms to vie for the attention of their customers with an ever-wider array of financial services. In addition, today's customers are accustomed to the application of web-based and IT services in the majority of industries, which in turn increases their demand. This has led to mounting overheads through increasing software and hardware installation costs, which encourages financial market operators to accelerate orchestration of these services. The simultaneity and optimized convenience provided by this web-based platform (i.e., electronic banking) can reduce operating expenses and increase opportunities for market expansion.

Electronic banking comprises phone banking, mobile banking, internet banking, and ATM distribution services. According to statistics published by the Banking Bureau of Financial Supervisory Commission, in 2016 there were 27,240 ATMs nationwide, which were used approximately 845 million times a year, totaling TWD 10.36 trillion in transactions. In terms of the number of ATMs, frequency of transactions, and transactional amount, there was a growth of 38% from 2003. This suggests the highest per capita density of ATMs across Taiwan. The popularity of ATMs heralds an unprecedented era of convenience in physical financial services for Taiwanese people, and indicates that Taiwanese consumers rely on ATMs to

conduct their daily financial affairs. Furthermore, ATMs are installed to enable a bank's customers to independently perform transactions, such as cash withdrawals or deposits, fund transfers, or checking account information without the need for direct interaction with bank staff, thereby reducing the operating expenses incurred in a financial institution. According to a result released by the United States Department of Commerce, a transaction performed via an ATM costs USD 0.27, whereas an over-the-counter transaction amounts to USD 1.02. ATMs are therefore cost-effective. However, the principal driving force behind ATMs is the provision of 24-hr service. The brand identity and market exposure of a bank can be thus enhanced, which contributes toward to an increasing market share and business sustainability.

Faced with tough competition and a shrinking market, today's financial institutions need to employ diversified management strategies in order to achieve continuous growth and sustainability. According to Ahujaet and Khamba (2008), Cornuel (2007) and Voehl (2004), quality improvement has recently become a leading trend for organizational management and a key factor in a firm's success. Looking back at the past, in which the industry was focused on manufacturing, we can see that the concept and technology of product quality expanded from the manufacturing industry, making pricing to be the most useful weapon in competition. In contrast, service quality is becoming increasingly important in the service-oriented industry of today (Vargo and Lusch, 2004) and is regarded as the key factor to obtaining competitive advantage in servitized industries (Huang *et al.*, 2017; Lee *et al.*, 2000). In light of current conditions, it is imperative that financial institutions evaluate customer satisfaction with their ATM experience and determine which factors lead to inadequate service. This allows for the formulation of strategies to improve service quality and achieve long-term sustainable development.

There exists a wide array of quality evaluation tools. Among them, the performance evaluation matrix proposed by Lambert and Sharma (1990) provides a useful reference for performance improvement. It has been widely utilized to appraise service quality. Hung *et al.* (2003), Tao *et al.* (2009), Hsia *et al.* (2009), Chen (2009), Chen *et al.* (2010), and Lai (2011) have constructed performance evaluation matrices to explore which service items are deemed by customers as

important and currently unsatisfactory. This serves as a reliable reference for the improvement of service quality. Although the above studies helped firms discover inadequate service items via the performance evaluation matrix, they failed to present how individual service items affect customer satisfaction overall. This impedes efforts to increase service quality, especially within the context of limited resources. Moreover, these studies collected responses from customers about how they felt or how much they valued a firm's performance, which increased error in the appraisal of firm performance, and led to an elevated risk of unsuitable improvement strategies.

As mentioned previously, the present paper addressed this problem via questionnaire survey in which customers self-reported their satisfaction with each service item provided by ATMs, as well as their overall satisfaction experience. Obviously, this approach requires one less group of samples to be collected and increases the willingness of subjects to fill out the questionnaire and therefore the authenticity of the data they provide. One source of error is eliminated, which decreases the estimation error for service quality and thereby increased precision. In addition, we utilized the simple regression model employed by Yu *et al.* (2016) to explore the effect of satisfaction toward individual service item on overall satisfaction levels. These results were used to construct an influence index, which was combined with the satisfaction index to construct a performance evaluation matrix. Since the indices were obtained through the collection of customer voices, we made statistical inferences to obtain interval estimations for the indices, in order to reduce uncertainty associated with sampling error. The resulting performance evaluation matrix serves as valuable reference for financial market operators in the formulation of strategies to enhance service quality. The rest of this paper is organized as follows. The satisfaction index θ_h and influence index β_{1h} for individual service item are shown in Section 2. The interval estimations for θ_h and β_{1h} are derived in Section 3. In Section 4, the performance evaluation matrix is constructed to evaluate the service quality of ATMs. A numerical example application of the model is presented in Section 5. Our conclusions are presented in the last section.

2 Evaluation Index

Service quality has long been regarded as a critical factor of optimized sustainable management and competitive advantage (Lee *et al.*, 2000). Services do not share attributes with physical products; they are therefore defined and measured differently. Parasuraman *et al.* (1985) pointed out that customer service quality can be measured through customers' expectations for the service and their perceived impression (or satisfaction) of this service afterwards. Etzel *et al.* (2001) similarly proposed that service quality refers to how one's actual experience compares to one's expectations. In other words, service quality refers to the gap that exists between customer satisfaction and how much they value the service in terms of individual service items. A large number of researchers have used the five-dimensional SERVQUAL, presented by Parasuraman *et al.* (1988), to gauge the service quality of industries and institutions.

Conversely, Bolton and Lemon (1999), and Churchill and Surprenant (1982) declared service quality was a comprehensive attitude held by customers toward service providers. They stressed the basis of service quality lies in customer experience, not expectations. Bolton and Drew (1991) also advocated a more direct method of investigating customers' perceptions, known as "patron experience". Oliver (1981) asserted that customer satisfaction is an emotive response elicited in customers toward a product or service, which is formed in the process of its perception. Wang *et al.* (2015) professed that when patrons are given a questionnaire survey, they have an expectation of service, the actual experience of service, and a fixed impression of that experience afterward. In this regard, customer satisfaction level can be taken as an emotive response and feedback to a service experience. Fornell (1992) observed that service quality exerts a positive impact on customer satisfaction, while an increasing number of researchers have confirmed a high cross-correlation between customer satisfaction and service quality.

To sum up, customer satisfaction is defined as a kind of feedback that involves customers' prior expectations and actual experience when that service was rendered. Mazis *et al.* (1975) and Woodruff *et al.* (1983) unanimously recommended using customer satisfaction as a benchmark to measure firm performance and service quality. In view of this, this paper adopted customer satisfaction as the gauge for

ATM service quality. This not only spared us extra efforts to collect one more sample (guaranteeing customer willingness to fill in the questionnaire and the authenticity of the information supplied by them), but led to a decrease in the chance of error in evaluation. Ultimately the inferred value might be more accurate than before.

2.1 Satisfaction Index

As mentioned earlier, customer satisfaction and service quality are positively correlated; therefore, the former can be used as a gauge for the latter's performance. The mean of customer satisfaction can thus be utilized as a measurement benchmark, as it has been widely used to perform analyses in social science research. Hence, this paper utilized the sample mean to develop an index with which to appraise customer satisfaction with ATM service. Random variable X_h denotes the satisfaction level for question h , along with a k -point scale measuring customer satisfaction. Our method is described below:

$$X_{th} = \frac{X_h - 1}{k - 1}.$$

The expected value, $E(X_{th}) = \theta_h$, of random variable X_{th} was taken as the satisfaction index. Therefore, θ_h is expressed as follows:

$$\theta_h = \frac{\mu_h - 1}{k - 1}, \quad (1)$$

where $\mu_h = E(X_h) = \theta_h$. To prevent loss of generality, we assumed the number of randomly sampled individuals to be n , and their satisfaction toward *service item* h is $X_{h1}, \dots, X_{hj}, \dots, X_{hn}$. Clearly $X_{h1}, \dots, X_{hj}, \dots, X_{hn}$ were randomly selected for random variable X_h , when \bar{X}_h and s_h denote the sample mean and sample standard deviation, respectively. They are expressed below:

$$\bar{X}_h = \frac{1}{n} \times \sum_{j=1}^n X_{hj}, \quad (2)$$

$$s_h = \sqrt{\frac{1}{n-1} \times \sum_{j=1}^n (X_{hj} - \bar{X}_h)^2}. \quad (3)$$

Then, according to Eqs. (2) and (3), the estimate of satisfaction index θ_h can be obtained as follows:

$$\hat{\theta}_h = \frac{\bar{X}_h - 1}{k - 1}. \quad (4)$$

$\hat{\theta}_h$'s expectation value is θ_h , which suggests that $\hat{\theta}_h$ acts as the unbiased estimator for θ_h . Equation (4) shows that when $\bar{X}_h = k$, then $\hat{\theta}_h = 1$, denoting the highest level of satisfaction with item h . In comparison, if $\bar{X}_h = 1$, then $\hat{\theta}_h = 0$, indicating the lowest level of satisfaction with item h . Satisfaction index θ_h therefore ranges from 0 to 1; i.e., $0 \leq \theta_h \leq 1$.

2.2 Influence Index

Woodside *et al.* (1989) proffered that customer satisfaction is the overall attitude exhibited by customers following consumption. Muller (1991) posited that customer satisfaction exerts a significant impact on corporate image. Walters (1978) described corporate image as the overall impression and perception held by customers of a firm's activities and performance. Chitturi *et al.* (2008), and Ha and Janda (2008) ventured that customer satisfaction increases customers' willingness to purchase that product again and prompts these patrons to buy other products from the same company. All in all, overall satisfaction with a company's commodities or services not only exerts a direct influence over corporate image and customer loyalty, but has an indirect impact on customers' repurchase intentions, ultimately holding sway over a firm's sustainable development and competitive edge.

Therefore customer satisfaction plays a pivotal role in corporate development. It follows that improved customer satisfaction may increase a firm's service quality and operating performance, as well as their market share and competitive advantage. Because customers have different needs, a company must provide a diversified range of service items to satisfy their patrons. Customer satisfaction is a comprehensive rating by customers of the firm (service provider), and thus can be seen as "total satisfaction" (Chen *et al.*, 2015). In light of this, the questionnaire survey distributed by this paper was not only aimed at exploring customers' satisfaction with individual service items, but their total satisfaction as well. By so

doing, we may further scrutinize how an individual service item affects the rating of total satisfaction. To address this issue, Chen and Chen (2014) posited that a simple regression model is more appropriate when there is a high level of relevancy between independent variables. Yu *et al.* (2016) developed a simple regression model of X_h , the satisfaction with item h , and Y , overall satisfaction, all of which act as influence indices. This was designed to prevent mutual interference between items. This simple normal error regression model can be written as follows:

$$Y_j = \beta_{0h} + \beta_{1h} X_{hj} + \varepsilon_{hj}, \quad (5)$$

where $h=1,2,\dots,q$; Y_j is the dependent variable, and X_{hj} is the independent variable (and a known constant). β_{0h} acts as the intercept parameter, and β_{1h} as the slope parameter, whilst ε_{hj} acts as a random error, which complies with the normal distribution meaning zero with a variance σ_h^2 . Hence $\varepsilon_{hj} \sim N(0, \sigma_h^2)$. From Eq. (5), it is clear that a high value for β_{1h} means that investing resources in the service area covered by this item will greatly increase overall satisfaction (Y_j). For this reason, we employed β_{1h} as influence index. However, β_{1h} is an unknown parameter, so the estimate of influence index β_{1h} can be defined as follows:

$$\hat{\beta}_{1h} = \frac{\sum_{j=1}^n (X_{hj} - \bar{X}_h)(Y_j - \bar{Y})}{\sum_{j=1}^n (X_{hj} - \bar{X}_h)^2}. \quad (6)$$

Results from the work of Wang *et al.* (2015) and Chen *et al.* (2015) indicate that when customers are more satisfied with individual service items, their overall satisfaction is greater. This means that simple regression coefficient B_h must be positive. The estimated regression equation can be written as below:

$$\hat{Y}_{hj} = \hat{\beta}_{0h} + \hat{\beta}_{1h} X_{hj}, \quad (7)$$

where $\hat{\beta}_{0h} = \bar{Y} - \hat{\beta}_{1h} \bar{X}_h$, and $\hat{\beta}_{1h}$ complies with the normal distribution of β_{1h} and $\sigma_h^2 / \sum_{j=1}^n (X_{hj} - \bar{X}_h)^2$. This means

$$\mu(\hat{\beta}_{1h}) = \beta_{1h} \quad \text{and} \quad \sigma^2(\hat{\beta}_{1h}) = \frac{\sigma_h^2}{\sum_{j=1}^n (X_{hj} - \bar{X}_h)^2}. \quad (8)$$

By replacing the parameter σ_h^2 with MSE_h , the unbiased estimator $s^2(\hat{\beta}_{1h})$ of $\sigma^2(\hat{\beta}_{1h})$ can be expressed as follows:

$$s^2(\hat{\beta}_{1h}) = \frac{MSE_h}{\sum_{j=1}^n (X_{hj} - \bar{X}_h)^2}, \quad (9)$$

where $MSE_h = \frac{\sum_{j=1}^n (Y_j - \hat{Y}_{hj})^2}{n-2}$, $E(MSE_h) = \sigma_h^2$.

3 Interval Estimations

As mentioned previously, the indices, including satisfaction index θ_h and influence index β_{1h} , were obtained through collection of customer voices via questionnaire survey. Sampling error means there exists uncertainty regarding θ_h and β_{1h} . It is clear that θ_h and β_{1h} cannot fully and accurately represent customers' evaluation of ATM services. We therefore included the concept of a confidence interval, which is defined as a reasonable scope for the target value. We used the lower confidence limit of θ_h and the upper confidence limit of β_{1h} as a gauge of determining service quality.

To deduce the lower confidence limit for θ_h , we employed the following equation: $Z_h = \left[\frac{\sqrt{n}(k-1)(\hat{\theta}_h - \theta_h)}{s_h} \right]$. According to central limit theorem (CLT), as the number of samples n approaches infinity, the sampling distribution of the mean approaches a normal distribution. Clearly, when n moves toward infinity ($n \rightarrow \infty$), Z_h is distributed as the standardised normal distribution: $Z_h \sim N(0,1)$. Hence the proposed equation is modified as follows:

$$P(Z_h < a) \approx \int_{-\infty}^a N(0,1) dz = \Phi(a). \quad (10)$$

Equivalently,

$$1 - \alpha = P(Z_h \leq Z_\alpha) = P\left(\frac{\sqrt{n}(k-1)(\hat{\theta}_h - \theta_h)}{s_h} \leq Z_\alpha \right) = P(L\theta_h \leq \theta_h), \quad (11)$$

where Z_α is the α upper quartile of standardised normal distribution, α as the confidence level. Hence,

$$L\theta_h = \hat{\theta}_h - Z_\alpha \times \frac{s_h}{(k-1)\sqrt{n}}. \quad (12)$$

Similarly, to deduce the upper confidence limit for β_{1h} , we first proposed $T_h = \left[\frac{(\hat{\beta}_{1h} - \beta_{1h})}{s(\hat{\beta}_{1h})} \right]$, where T_h follows the t distribution with $n-2$ degrees of freedom. Then,

$$1 - \alpha = P(T_h \geq -t_{\alpha, n-2}) = P\left(\frac{\hat{\beta}_{1h} - \beta_{1h}}{s(\hat{\beta}_{1h})} \geq -t_{\alpha, n-2} \right) = P(\beta_{1h} \leq U\beta_{1h}), \quad (13)$$

where $t_{\alpha, n-2}$ is the upper α quartile of t -distribution complying with $n-2$. Hence, the upper confidence limit is given by $U\beta_{1h}$ ($100(1-\alpha)\%$ β_{1h}):

$$U\beta_{1h} = \hat{\beta}_{1h} + t_{\alpha, n-2} \times \sqrt{\frac{MSE_h}{\sum_{j=1}^n (X_{hj} - \bar{X}_h)^2}}. \quad (14)$$

4 Performance Evaluation Matrix

The performance evaluation matrix was developed by Lambert and Sharma (1990). Firm performance serves as the horizontal axis and the importance of customer expectations is represented on the vertical axis. This tool has been used globally by scholars to assess the performance of industrial institutions. In addition, it is a representation that is easily visualized, which makes it accessible to a range of users (Friendly, 2008). Graphics are widely used as an analytical instrument in performance management.

This paper utilized satisfaction index θ_h as the horizontal axis and the influence index β_{1h} as the vertical axis to establish the performance evaluation matrix shown in Figure 1. If customers are generally pleased with most of the service items, then the mean of the satisfaction index is set as a criterion for future improvement. Thus, when the satisfaction level of individual service items drops below the mean, it is an indication that action must be taken (Chen, 2009). Yu *et al.*

(2016) stressed that dynamic standards can be applied to the objective of continuous improvement in quality management. In short, this paper employed the means of satisfaction index and influence index, θ_0 and β_0 respectively, as the standards by which to gauge service quality, in hopes of making it easier for financial institutions to review and determine items that strongly affect overall satisfaction. θ_0 and β_0 are described as follows:

$$\theta_0 = \frac{1}{q} \times \sum_{h=1}^q \hat{\theta}_h, \quad (15)$$

$$\beta_0 = \frac{1}{q} \times \sum_{h=1}^q \hat{\beta}_{1h}. \quad (16)$$

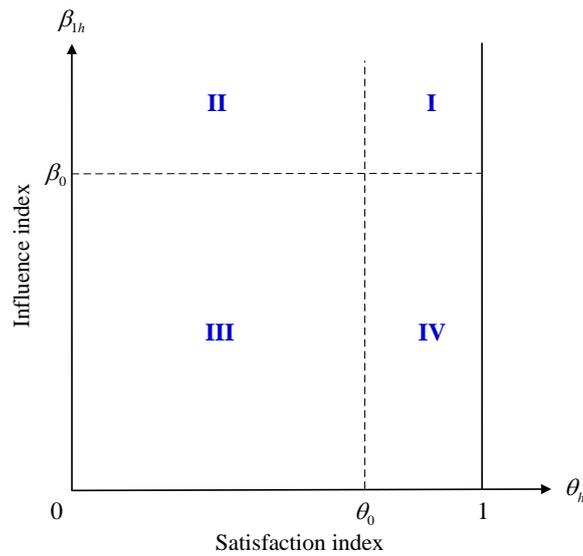


Figure 1. Performance Evaluation Matrix

The horizontal line β_0 and vertical line θ_0 divide the performance evaluation matrix into four quadrants (Figure 1). The four quadrants can be expressed by the following four sets:

$$\begin{aligned}
A_{\text{I}} &= \{(\beta_{1h}, \theta_h) \mid \theta_0 \leq \theta_h \leq 1, \beta_0 \leq \beta_{1h}\}, \\
A_{\text{II}} &= \{(\beta_{1h}, \theta_h) \mid 0 \leq \theta_h \leq \theta_0, \beta_0 \leq \beta_{1h}\}, \\
A_{\text{III}} &= \{(\beta_{1h}, \theta_h) \mid 0 \leq \theta_h \leq \theta_0, 0 \leq \beta_{1h} \leq \beta_0\}, \\
A_{\text{IV}} &= \{(\beta_{1h}, \theta_h) \mid \theta_0 \leq \theta_h \leq 1, 0 \leq \beta_{1h} \leq \beta_0\}.
\end{aligned}$$

As Yu *et al.* (2016) observed that the philosophy of quality management lies in continuous improvement, when the satisfaction index of each item drops below the average, then it might require improvement. To increase the reliability of θ_h and β_{1h} , we decided to use θ_h as a lower confidence limit and β_{1h} as an upper confidence limit. We use the satisfaction index θ_h of item h to define the coordinates $p_h = p_h(L\theta_h, U\beta_{1h})$ in the performance evaluation matrix. The location of p_h indicates the priority ranking of item h according to the following guidelines:

1. In the event that the lower confidence limit $L\theta_h$ falls below θ_0 ($L\theta_h \leq \theta_0$), then p_h falls within quadrant II or III. Hence this service item requires improvement.
2. If the upper confidence limit $U\beta_{1h}$ of influence index β_{1h} is higher than the mean β_0 (i.e., $U\beta_{1h} \geq \beta_0$), then p_h falls within quadrant II. This quadrant has a greater impact on total satisfaction than quadrant III; therefore, these items take priority.
3. When more than one service item falls within quadrant II, then it is advised to use upper confidence limit $U\beta_{1h}$ of influence index β_{1h} to determine a priority ranking. When financial institutions have limited resources, it is advised to focus on items within quadrant II with larger upper confidence limit $U\beta_{1h}$ of influence index β_{1h} .

This paper presents an evaluation process to determine the order of priority in terms of quality improvement for service items of ATMs. This model is suitable for ongoing quality management. The process is represented by the following steps:

- Step 1: We randomly selected a group of n customers for our questionnaire survey, and then used Eqs. (4) and (6) to obtain $\hat{\theta}_h$ and $\hat{\beta}_{1h}$ for each service item.

- Step 2: We obtained the lower confidence limit $L\theta_h$ of θ_h and the upper confidence limit $U\beta_{ih}$ of β_{ih} based upon Eqs. (12) and (14).
- Step 3: We utilized satisfaction index θ_h as the horizontal axis and the influence index β_{ih} as the vertical axis to establish a performance evaluation matrix aimed at exploring how customers feel about ATM service quality. We obtained the means of the abovementioned indices using Eqs. (15) and (16) to serve as the criteria for service quality and the benchmark for ongoing total quality management.
- Step 4: The location $p_h = p_h(L\theta_h, U\beta_{ih})$ in the performance evaluation matrix can be utilized to decide which items require improvement. Items that fall within quadrant II with a larger upper confidence limit $U\beta_{ih}$ of influence index β_{ih} take the highest priority.

5 A Numerical Example

In this section, we take a numerical example which illustrates the above concepts and the applicability of the proposed service quality evaluation model for ATMs. Thus, to gauge the service quality of ATMs at bank, this study assume that the questionnaire employs five-point scale and contains 10 items and one overall satisfaction. For each service item, the linguistic terms were divided into very dissatisfied, dissatisfied, slightly satisfied, satisfied, and very satisfied. The subjects of the questionnaire survey comprised all the customer users of the ATMs and 255 valid questionnaires were recovered. Furthermore, the reliability and validity of the questionnaire meet standard of further analysis. Table 1 presents \bar{X}_h , s_h and the estimator $\hat{\theta}_h$ and $\hat{\beta}_{ih}$ are presented for these 255 measurements of each service item. This enables the calculation of the 95% lower confidence limit $L\theta_h$ and upper confidence limit $U\beta_{ih}$. We then plotted the $(L\theta_h, U\beta_{ih})$ coordinates of each service item on the performance evaluation matrix, as shown in Figure 2.

Table 1. Summary of Satisfaction Survey for ATMs

| Service items | \bar{X}_h | s_h | $\hat{\theta}_h$ | $\hat{\beta}_{1h}$ | $L\theta_h$ | $U\beta_{1h}$ |
|---------------|-------------|-------|------------------|--------------------|-------------|---------------|
| Item 1 | 3.98 | 0.93 | 0.75 | 0.76 | 0.72 | 0.80 |
| Item 2 | 4.28 | 0.84 | 0.82 | 0.78 | 0.80 | 0.83 |
| Item 3 | 4.05 | 0.82 | 0.76 | 0.82 | 0.74 | 0.87 |
| Item 4 | 4.38 | 0.79 | 0.85 | 0.56 | 0.82 | 0.60 |
| Item 5 | 4.27 | 0.86 | 0.82 | 0.73 | 0.80 | 0.77 |
| Item 6 | 4.34 | 0.72 | 0.84 | 0.72 | 0.82 | 0.77 |
| Item 7 | 4.35 | 0.71 | 0.84 | 0.58 | 0.82 | 0.62 |
| Item 8 | 4.75 | 0.85 | 0.94 | 0.78 | 0.92 | 0.82 |
| Item 9 | 3.72 | 0.86 | 0.68 | 0.63 | 0.66 | 0.67 |
| Item 10 | 4.39 | 0.81 | 0.85 | 0.75 | 0.83 | 0.78 |

* α is 0.05; $\theta_0 = 0.81$; $\beta_0 = 0.71$.

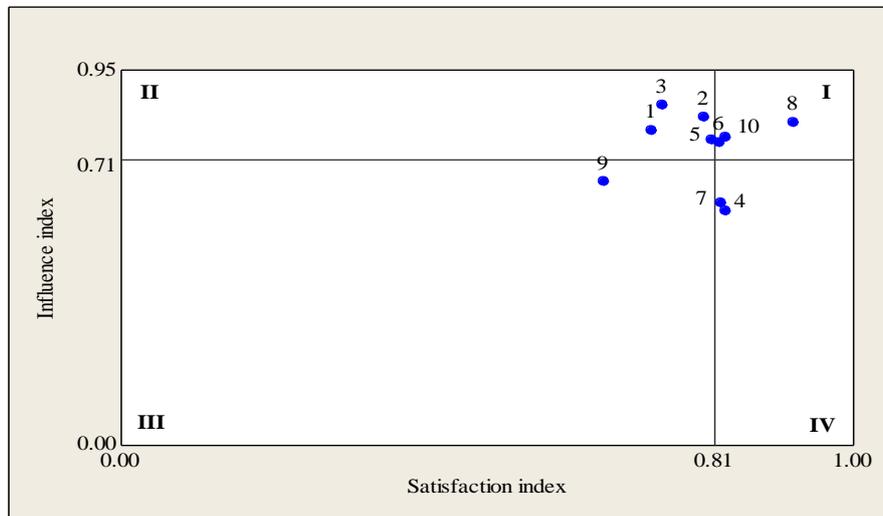


Figure 2. Performance Evaluation Matrix for ATMs

As shown in Fig. 2, items 6, 8, and 10 fell in Quadrant I, where $L\theta_h \geq \theta_0$ and $U\beta_{1h} \geq \beta_0$. Items 1, 2, 3, and 5 fell in Quadrant II, where $L\theta_h < \theta_0$ and $U\beta_{1h} \geq \beta_0$. Only item 9 fell in Quadrant III, where $L\theta_h < \theta_0$ and $U\beta_{1h} < \beta_0$. Items 4 and 7 fell in Quadrant IV, where $L\theta_h \geq \theta_0$ and $U\beta_{1h} < \beta_0$. According to

the criteria mentioned previously, items 1, 2, 3, 4, and 9 in Quadrants II and III must all be included in the improvements. The order in which they took priority was based on the 95% upper confidence limit $U\beta_{ih}$ of β_{ih} . Thus, the order in which they should be improved was item 3, 2, 1, 5, and 9. However, if resources are limited, then the items that fall in Quadrant II take priority because the influence of these individual items on overall satisfaction is greater than the mean 0.71, which will mean greater improvement effectiveness.

6 Conclusions

To enhance customer willingness to fill in the questionnaire and the authenticity of the information supplied by them, and to effectively measure customer experience with ATM usage, this paper performed a questionnaire survey to garner customers' responses toward ATM service quality and their total satisfaction level in this user experience. A simple regression model explored how individual service items affect total satisfaction. Influence index β_{ih} is combined with satisfaction index θ_h to establish a performance evaluation matrix designed to measure ATM service quality. However, sampling error causes uncertainty in the reliability of θ_h and β_{ih} . Therefore, this paper utilized the lower confidence limit θ_h and the upper confidence limit β_{ih} to replace point estimation. Ongoing total quality management is achieved by utilization of the means of θ_0 and β_0 as dynamic standards for priority ranking of items requiring improvement. This model serves as a practical reference for financial institutions seeking to increase and maintain high-quality ATM service for sustainable development.

References

- Ahuja, I. P. S. and J. S. Khamba, (2008), "Strategies and Success Factors for Overcoming Challenges in TPM Implementation in Indian Manufacturing Industry," *Journal of Quality in Maintenance Engineering*, 14, 123-147.
- Bolton, R. N. and J. H. Drew, (1991), "A Longitudinal Analysis of the Impact of Service Change on Customer Attitudes," *Journal of Marketing*, 55, 1-9.
- Bolton, R. N. and K. N. Lemon, (1999), "A Dynamic Model of Customers' Usage of

- Services: Usage as an Antecedent and Consequence of Satisfaction,” *Journal of Marketing Research*, 36, 171-186.
- Chen, H. C., K. S. Chen, T. L. Chang, and C. H. Hsu, (2010), “An Application of Six Sigma Methodology to Enhance Leisure Service Quality,” *Quality & Quantity*, 44, 1151-1164.
- Chen, K. S. and H. T. Chen, (2014), “Applying Importance-performance Analysis with Simple Regression Model and Priority Indices to Assess Hotels’ Service Performance,” *Journal of Testing and Evaluation*, 42, 455-466.
- Chen, K. S., K. J. Wang, and T. C. Chang, (2015), “A Novel Approach Based on Performance Influence for Evaluating Criteria of Service Quality,” *Journal of Testing and Evaluation*, 43, 191-200.
- Chen, S. H., (2009), “Establishment of a Performance-evaluation Model for Service Quality in the Banking Industry,” *The Service Industries Journal*, 29, 235-247.
- Chitturi, R., R. Raghunathan, and V. Mahajan, (2008), “Delight by Design: The Role of Hedonic versus Utilitarian Benefits,” *Journal of Marketing*, 72, 48-63.
- Churchill, G. A. and C. Surprenant, (1982), “An Investigation into the Determinants of Customer Satisfaction,” *Journal of Marketing Research*, 19, 491-504.
- Cornuel, E., (2007), “Challenges Facing Business Schools in the Future,” *The Journal of Management Development*, 26, 87-92.
- Etzel, M. J., B. J. Walker, and W. J. Stanton, (2001), *Marketing Management*, 12th edition, Boston, Massachusetts: McGraw Hill-Irwin.
- Fornell, C., (1992), “A National Customer Satisfaction Barometer: The Swedish Experience,” *Journal of Marketing*, 56, 6-21.
- Friendly, M., (2008), “A Brief History of Data Visualization,” *Handbook of Data Visualization*, 15-56.
- Ha, H. Y. and S. Janda, (2008), “An Empirical Test of a Proposed Customer Satisfaction Model in E-services,” *The Journal of Services Marketing*, 22, 399-408.
- Hsia, T. C., S. C. Chen, and K. S. Chen, (2009), “Enhancement of Service Quality in Internet Marketing through Application of the Six Sigma Process,” *Journal of Chinese Institute of Industrial Engineering*, 26, 11-21.
- Huang, P. L., B. C. Y. Lee, C. S. Wang, and C. T. Sun, (2017), “Relative Importance of the Factors under the ISO-10015 Quality Management Guidelines that

- Influence the Service Quality of Certification Bodies,” *Journal of Economics and Management*, 13, 105-137.
- Hung, Y. H., M. L. Huang, and K. S. Chen, (2003), “Service Quality Evaluation by Service Quality Performance Matrix,” *Total Quality Management & Business Excellence*, 14, 79-89.
- Lai, J. H. K., (2011), “Comparative Evaluation of Facility Management Services for Housing Estates,” *Habitat International*, 35, 391-397.
- Lambert, D. M. and A. Sharma, (1990), “A Customer-based Competitive Analysis for Logistics Decisions,” *International Journal of Physical Distribution and Logistics Management*, 20, 17-24.
- Lee, H., Y. Lee, and D. Yoo, (2000), “The Determinants of Perceived Service Quality and Its Relationship with Satisfaction,” *The Journal of Services Marketing*, 14, 217-231.
- Mazis, M. B., O. T. Antola, and R. E. Klippel, (1975), “A Comparison of Four Multi-attribute Models in the Prediction of Consumer Attitudes,” *Journal of Consumer Research*, 2, 38-52.
- Muller, W., (1991), “Gaining Competitive Advantage through Customer Satisfaction,” *European Management Journal*, 9, 201-211.
- Oliver, R. L., (1981), “Measurement and Evaluation of Satisfaction Process Inertial Settings,” *Journal of Retailing*, 57, 25-48.
- Parasuraman, A., V. A. Zeithaml, and L. L. Berry, (1985), “A Conceptual Model of Service Quality and Its Implications for Future Research,” *Journal of Marketing*, 49, 41-50.
- Parasuraman, A., V. A. Zeithaml, and L. L. Berry, (1988), “SERVQUAL : A Multi-item Scale for Measuring Consumer Perceptions of Service Quality,” *Journal of Retailing*, 64, 12-40.
- Tao, C. J., S. C. Chen, and L. Chang, (2009), “Apply 6-sigma Methodology in Measuring the Competition Quality of Satisfaction Performance—An Example of ISP Industry,” *Quality & Quantity*, 43, 677-694.
- Vargo, S. and R. L. Lush, (2004), “Evolving to a New Dominant Logic for Marketing,” *Journal of Marketing*, 68, 1-17.
- Voehl, F., (2004), “Six Sigma Community Improvement Projects,” *Annual Quality Congress Proceedings*, 58, 351-363.

- Walters, C. G., (1978), *Consumer Behavior: Theory and Practice*, 3rd edition, Homewood, Ill.: Richard D., Irwin, Inc.
- Wang, K. J., T. C. Chang, and K. S. Chen, (2015), "Determining Critical Service Quality from the View of Performance Influence," *Total Quality Management & Business Excellence*, 26, 368-384.
- Woodruff, R., E. R. Cadotte, and R. L. Jenkins, (1983), "Modeling Consumer Satisfaction Processes Using Experience-based Norms," *Journal of Marketing Research*, 20, 296-304.
- Woodside, A. G., L. L. Frey, and R. T. Daly, (1989), "Linking Service Quality, Customer Satisfaction, and Behavioral Intentions," *Journal of Health Care Marketing*, 9, 5-17.
- Yu, C. M., H. T. Chang, and K. S. Chen, (2016), "Developing a Performance Evaluation Matrix to Enhance the Learner Satisfaction of an E-learning System," *Total Quality Management & Business Excellence*, doi: 10.1080/14783363.2016.1233809 (forthcoming).