The Service Quality Analysis of Public Transportation System using PZB Model- Dynamic Bus Information System

Abstract—To enhance transport efficiency and service quality, a lot of countries are actively promoting Intelligent Transportation System (ITS) on public transportation today. The transport efficiency and service quality that people concern mostly are less waiting time and the reliability of the system. Dynamic bus information system is one kind of more efficiency transportation service of intelligent transportation system. Therefore the valuation of dynamic bus information system on public transportation becomes an important issue. This study builds a theoretical framework to create a survey and perform a practical investigation among users of the dynamic bus information system of Taiwan. It is an interesting finding that the dissatisfied problem tends to be a not familiar phenomenon for user.

Keywords: dynamic bus information systems, service quality, satisfaction, PZB model, Importance-Performance Analysis (IPA)

I. INTRODUCTION

Intelligent transportation system has been promoted over recent years advanced countries in the world. There are a lot of studies and reports in this area focus on the benefits of intelligent transportation systems rather than service quality. Therefore, people concern mostly is less waiting time and reliability of the system. This paper aims to explore the transport efficiency and service quality of dynamic bus information systems by examining service quality and users satisfaction.

In Taiwan, intelligent transportation system is more increasingly popular and the dynamic bus information system is to provide passengers with real time information about coming runs on their arrival to bus stations and thus offer obvious service promotion. Therefore, the valuation of bus dynamic information system becomes an important issue.

The service of dynamic bus information system is one kind of more convenience and efficiency transportation service. This service can affect people to travel by bus and affect the bus company’s willingness to deploy and improve the system.

Our survey is conducted to gauge levels of satisfaction of bus passengers within the five months of the system completion and initial assessment tests. The purpose is to understand the perceptions of users and the findings can serve as reference to improve intelligent transportation system in the future.

II. LITERATURE REVIEW

In recent years, the dynamic bus information system is introduced to Taiwan from overseas. This new technology is new and its benefits steadily increase. We conduct literature reviews to establish a directional foundation to create our survey and perform a practical investigation among users of the dynamic bus information system of Taiwan. The purpose of our research describe as (1) reviewing about dynamic bus information system, customer satisfaction and service quality and (2) including PZB model to measure the levels of users satisfaction.

A. Dynamic Bus Information System

The dynamic bus information system consists of the following software and hardware components in Taiwan: (1) a monitoring center, (2) bus stops, locations and buses, and (3) information management and inquiry platforms. The system provides all types of information required by different users.

Monitoring center: it is responsible for providing all types of integrated information, offer high-quality instructions, monitor and manage the system. Information is received, sent, and calculated to respond to inquiries from bus operators, government bodies, and users.

Bus stops, locations and buses (in-vehicle facilities): this component includes the bus stops, vehicles, provides
information regarding bus locations, expected arrival times, and transfer information. The basic data inside the buses are the names of the stops (displayed on LED screens) and broadcasting the stop names. The broadcasting system consists of wireless communications modules and GPRS modules.

Information management and inquiry platforms: passenger can log on an internet site for inquiries of relevant information, as well as accessing information via PDA and mobile phones. The restrictions are the speed of network transmissions that may slow information displays.

The facilities, provided by monitoring centers and information management platforms, for users allow easy access to real-time bus information from anywhere they can log on. LED displays at bus stops and inside buses show the arrival time at the next stop, the name of which is clearly displayed and broadcasted inside the bus, as well as information regarding transfers. The biggest benefit of this dynamic information system is easy access the required information.

B. Customer Satisfaction

Cardozo (1965) [13] indicated that customer satisfaction greatly enhances repeat purchase intentions of the same and other products. Woodside et al. [4] suggested that customer satisfaction is the greatest influence on consumer behaviors. It is safe to assume that user satisfaction affects their willingness to use mass transportation systems.

Definitions satisfaction as below:

- Satisfaction is the psychological status of consumer feelings and being pleased with the results of their purchase [8].
- It is the level of realized benefits by customers, and the degree of consistency between expectations and actual results [5].
- Customer satisfaction is the assessment of the gap between original expectations and perceived performances of services or products by customers [10].
- Customer satisfaction is the feeling of happiness or disappointment by individuals. The intensity of such feelings stem from the perceived product quality and expectations of individuals [11].

To sum up the definitions by different scholars on customer satisfaction, we define it as the gap between the actual services or products purchased and the original expectations of customers. The greater the gap, the lower the level of satisfaction is. The reverse is true.

Customer satisfaction is measured by the levels of satisfaction and customers expectations and perceptions. Such measurements aim to deepen relationships with customer by encouraging them to share their thoughts and perceptions. Efforts should be made to satisfy customers, as based on the feedback, in order to retain customers [6].

Jung (1994) [15] indicated that there are five methods to measure the levels of satisfaction. They are simple satisfaction scale, mixed scale, exceptional scale, attitude scale and affect scale.

C. Service Quality

Most services cannot be counted, measured, inventoried, tested, or verified in advance of sales to assure quality [17]. Basically, service quality is a conscious and intangible feeling. Service quality cannot be determined from appearances, as most products are. Service quality can be divided into process quality and outcome quality [16]. Lewis [12] indicates that service quality is measured according to the level of services rendered meeting with expectations of customers. Process quality refers to the level of services, as determined by customers during the service process. It is a subjective view of customers. On the other hand, outcome quality is the measurement of customers regarding service results. To sum up, service quality is determined by subjective assessors. Parasuraman et al. [13] indicate that to customers, service quality is more difficult to determine than product quality. They also believe that perceived service quality is the difference between original expectations and actual service performances.

The PZB Model is a conceptual model to evaluate service quality. They conducted interviews with the management and clients in banking, securities, credit card, and product maintenance industries. These interviews found that there are variances and gaps between the perceptions of management and the services delivered to customers. The PZB Model highlights the following five gaps as Fig 1.
GAP1 to GAP4 are the gaps in services rendered. GAP 5 is the difference between expectations and actual services. There is a functional relationship between these five gaps. Parasuraman et al. [1] suggested that the service quality (SQ) perceived by customers depends on the scale and direction of the gap between expectations (E) and performance (P). Namely, SQ=P-E.

Many experts and scholars propose different classifications for service constructs. The most representative and frequently used are the 10 service quality constructs, as proposed by Parasuraman et al. [1] in the PZB Model. They are as follows:

- **Reliability**: it refers to the consistency of service performances. Services are delivered well at the agreed time and the committed services are implemented.
- **Responsiveness**: it refers to the willingness of employees to provide services, and the timeliness of the services.
- **Competence**: it refers to the knowledge and skills required to render services.
- **Assess**: it refers to the level of easiness/difficulty to access services.
- **Courtesy**: it refers to good manners, respect, and friendliness of service staff to customers.
- **Communication**: relevant information is conveyed to customers in easy-to-understand language. This allows customers to understand service contents, prices, and feel assured that their problems can be resolved.
- **Credibility**: this allows customers to believe that the organization is sincere. The factors that influence customers’ trust in companies include names, reputations, and personalities of service staff.
- **Security**: it prevents dangers or other concerns to customers during the services delivery and processes.
- **Understanding the Customer**: this means efforts made to understand customers’ needs, special requests, and to identify frequent customers.
- **Tangibles**: it refers to the physical facilities and tools to provide services, and appearances of service staff.

Parasuraman et al. [2] proposed measurements to evaluate service quality by reducing the original 10 service quality constructs into 5 constructs. These 5 constructs and 22 items are used as the measurement variables for service quality (SERVQUAL SCALE), and allow a clearer definition and measurement of service quality. The 5 constructs are as follows:

- **Tangibles**: tangible equipment required to render services, and the presentations of service staff.
- **Reliability**: the actual implementation, in a timely manner, of the committed services.
- **Responsiveness**: the willingness of service personnel to offer speedy services.
- **Assurance**: professional knowledge, good manners, and trustworthiness of service staff.
- **Empathy**: the provision of convenient and considerate services to customers, catering to their specific needs.

We use the five constructs of SERVQUAL SCALE as the framework for the questionnaire to measure the levels of users satisfaction with intelligent bus stops, and evaluate their emphasis on different service quality attributes.

**III. RESEARCH METHODOLOGY**

Subjects are from the metropolis of Taiwan with convenience sampling. Investigate into the passengers of the Orange Line of the MRT, the roundabout 168 lines, and city roads where LED stops are located. Surveyors conduct site surveys, and provide timely assistance to respondents when they fill in questionnaires in order to avoid differences in the interpretations of the questionnaire contents.

**A. Survey Timeframe**

The questionnaire survey is conducted during weekends and weekdays in August, 2009. The survey covers the first bus and last bus of each stop along Orange Line of the MRT, the roundabout 168 lines, and city roads where LED stops are located.

**B. Questionnaire Design**

This paper designs its questionnaire by referring to the five “SERVQUAL SCALE” constructs [3]. The measurement is based on the Likert scale. The contents cover the basic data of the respondents and their levels of satisfaction.

**IV. RESULTS**

**A. Basic Data Analysis**

A total of 1,215 questionnaires are recovered and use SPSS for Windows 12.0 to analysis. After the elimination of 5 incomplete and invalid questionnaires, there is the total of 1,209 valid recovered questionnaires, accounting for 99.5% of all recovered questionnaires. The 1,209 effective samples is a reasonable size for analysis because of the SERVQUAL measurement usually requires over 200 samples.

**B. Reliability and Validity**

**1) Validity Analysis**

a) **Content Validity**: Content validity of this paper refers to the service quality concepts, as proposed by the PZB model, in the development of its questionnaire. This measurement is validated by many scholars and carries good content validity.

b) **Construct Validity**: The first step is to perform a factor analysis. The main purpose is to derive construct validity. Varimax is applied to
an orthogonal rotation. Table I shows KMO and Bartlett’s Test results.

**TABLE I. KMO AND BARTLETT’S TEST**

<table>
<thead>
<tr>
<th>Kaiser-Meyer-Olkin Measure of Sampling Adequacy</th>
<th>0.936</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bartlett’s Test of Sphericity</td>
<td></td>
</tr>
<tr>
<td>Approx. Chi-Square</td>
<td>12350</td>
</tr>
<tr>
<td>df</td>
<td>210</td>
</tr>
<tr>
<td>Sig.</td>
<td>0.000</td>
</tr>
</tbody>
</table>

The greater the KMO (close to 1), the more common factors are among the variables, and the more suitable it is to perform a factor analysis. Kaiser (1974) [7] indicated that the threshold for a factor analysis should be at least 0.6. The KMO value of this paper is 0.936, indicating the existence of common factors among variables and suitability for factor analysis. There are common factors in the correlation matrices that represent the population. Therefore, it is appropriate to conduct a factor analysis.

**TABLE II. FACTOR MATRIXES**

<table>
<thead>
<tr>
<th>Factor</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.000</td>
<td>.388</td>
<td>-.441</td>
<td>.231</td>
<td>.464</td>
</tr>
<tr>
<td>2</td>
<td>.388</td>
<td>1.000</td>
<td>-.267</td>
<td>.124</td>
<td>.422</td>
</tr>
<tr>
<td>3</td>
<td>-.441</td>
<td>-.267</td>
<td>1.000</td>
<td>-.147</td>
<td>-.363</td>
</tr>
<tr>
<td>4</td>
<td>.231</td>
<td>.124</td>
<td>-.147</td>
<td>1.000</td>
<td>.169</td>
</tr>
<tr>
<td>5</td>
<td>.464</td>
<td>.422</td>
<td>-.363</td>
<td>.169</td>
<td>1.000</td>
</tr>
</tbody>
</table>


Table II shows the coefficient matrices of the five factors. Since all the correlation coefficients are below 0.6, these factors are mutually independent.

2) Reliability Analysis

Reliability refers to the levels of consistency and stability of measured results. Wortzel (1979) [14] suggests that a Cronbach’s α between 0.70 and 0.98 denotes high reliability. Any value below 0.35 should be discarded. Among the assessed items in this paper, four items report high reliability (0.771–0.873). The Cronbach’s α of each of the five factors all reach 0.70, a high reliability value. Therefore, the assessed items have reasonable contributions to the individual constructs. It is, therefore, possible to perform a construct analysis directly on these 21 items. With the exception of the 10th questionnaire in the matrix of tangible factors, all the other coefficients are above 0.4, indicating a high degree of consistency.

C. Descriptive statistical analysis on satisfaction with overall service quality

Table III shows that the average scores of the five service quality factors for satisfaction with overall service quality. The average for the factor of Empathy, Assurance, Reliability, Responsiveness and Tangibles are between 3 to 4. The frequency distributions of these five factors are 82.02% for Empathy, 81.11% for Assurance, 81.24% for Reliability, 84.26% for Responsiveness, and 84.09% for Tangibles.

In terms of the satisfaction with overall service quality, users are reasonable satisfied with the service quality of intelligent stops. This means there is room for improvement.

**TABLE III. OVERALL SERVICE QUALITY.**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Frequency</th>
<th>Percentage</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empathy</td>
<td>Low</td>
<td>65</td>
<td>0.99%</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>2806</td>
<td>97.91%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>2871</td>
<td>100.00%</td>
</tr>
<tr>
<td>Assurance</td>
<td>Low</td>
<td>47</td>
<td>1.24%</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>1790</td>
<td>23.36%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>2237</td>
<td>100.00%</td>
</tr>
<tr>
<td>Reliability</td>
<td>Low</td>
<td>15</td>
<td>0.62%</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>2002</td>
<td>39.59%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>2017</td>
<td>100.00%</td>
</tr>
<tr>
<td>Responsiveness</td>
<td>Low</td>
<td>143</td>
<td>5.91%</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>1003</td>
<td>42.31%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1146</td>
<td>100.00%</td>
</tr>
<tr>
<td>Tangibles</td>
<td>Low</td>
<td>47</td>
<td>0.73%</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>293</td>
<td>45.88%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>340</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

D. Importance-Performance Analysis (IPA) for service quality

Importance-Performance Analysis (IPA) was formulated by Martilla and James (1977) [9] and this simple technique had been a popular tool for understanding customer satisfaction and prioritizing service quality improvements. It was not only an analysis methodology but implicitly a theory of behavior. A typical IPA which mean of customer ratings of the importance and performance across several attributes are plotted against each other and the resulting importance-performance space is divided into four quadrants.

Service quality dimensions of importance mean as X-axis, performance mean as Y-axis, while the overall importance and performance of the average as a quadrant divided baseline shows as Figure 2. Items in quadrant A indicate high importance and high performance that dynamic bus information system has strengths and should continue being maintained. This category is labeled as “Keep Up the Good Work.” Quadrant B shows low importance and high performance, which suggests insignificant strengths and a possibility that the resources invested may better be diverted elsewhere. In quadrant C, performance is high but importance is low. In contrast, the category of low importance and low performance items makes the third quadrant labeled as “Low Priority”. While the systems with such a rating of the attributes do not pose a threat they may be candidates for discontinuation. In quadrant D, importance is high but performance is low. This quadrant is labeled as “Concentrate Here”, indicating the dynamic bus information system require urgent corrective action and thus should be given top priority.
V. CONCLUSIONS AND SUGGESTIONS

The overall satisfaction with services provided by intelligent stops is reasonable to high satisfaction. This shows that they are not yet completely accepted by bus passengers. It is suggested that efforts should be made continuously to promote these stops and familiarize users to them. Meanwhile, transportation information should be easy-to-understand and commercials should be reduced in order to maximize benefits to the public and enhance the levels of satisfaction with overall services. These findings suggest several important managerial and practical implications as following:

A. Empathy

The average score of empathy as a service factor exceeds 3.5, indicating a high level of satisfaction. Some passengers think that the font sizes are too small and information provided is too little. There are omissions in certain stops in terms of bus arrival information.

B. Assurance

The average score of assurance as a service factor exceeds 3.4, indicating a high level of satisfaction. Most passengers suggest greater accuracy in arrival time information, a reduction of omissions in bus arrival information, and a shorter wait for buses.

C. Reliability

The average score of reliability as a service factor exceeds 3.4, indicating a high level of satisfaction. Some passengers suggest greater accuracy in arrival time information and a shorter wait for buses. Options are recommended in order to enhance the utilities of intelligent bus stops.

D. Responsiveness

The average score of responsiveness as a service factor exceeds 3.5, indicating a high level of satisfaction. However, users do not provide any feedback regarding the display in Chinese and English, or recommendations for overall bus service improvement at intelligent stops. This means that users need to become further familiarized with the system to accurately provide ratings in this regard.

E. Tangibles

The average score of tangibles as a service factor exceeds 3.3, indicating a high level of satisfaction. Some passengers indicate that the bus stops are not well located. Some signs are too high at the MRT exits. In addition, the location of bus stop on the road is bad for people to see and reach the information.

REFERENCES