www.irmbrjournal.com June 2017
International Review of Management and Business Research Vol. 6 Issue.2

Study on the Performance Measurement of Taiwan Railway Service Quality through Grey Relational Analysis

CHING-KUEI KAO
Department of Logistics Management
Beijing Institute of Technology, Zhuhai
519088, No.6, Jinfeng Road, Tangjiawan, Zhuhai City, Guangdong Province, China
Email: ckkao_zhbit@163.com

LI XU
Department of Logistics Management
Beijing Institute of Technology, Zhuhai
519088, No.6, Jinfeng Road, Tangjiawan, Zhuhai City, Guangdong Province, China
Email: 276612909@qq.com

Abstract

Taiwan's railway is one of the major modes of transportation for the Taiwanese people. At present, the operating income of the railway is challenged by the competition of high-speed rails used for travelling in medium and long distances, the mass transit system for travelling in short distances, and other means of land transportation. Therefore, Taiwan railway should seek development to obtain the favor of the customers. Further, another way for the survival of the railway is by maintaining a good long-term relationship with the customers and by enhancing the customer's loyalty. This study begins by understanding the situation of the value flow in the enterprise using balanced scorecard, establish the performance measurement of passengers' satisfaction and loyalty, and understand the loyalty of the Taiwan railway passengers using the grey relational analysis and the Importance-Performance Analysis. Results showed that most of the railway passengers are commuters and students. Hence, Taiwan railway management needs to pay attention to the train's punctuality and ticket prices to improve passenger satisfaction. Higher satisfaction will improve the passengers' loyalty and willingness to continuously consume, which can improve real profits.

Key Words: *Balanced Scorecard, Grey Relational Analysis, Importance-Performance Analysis, Satisfaction, Loyalty, Service Quality.*

Introduction

Nowadays, enterprises should establish and maintain good interaction with customers even in an environment with increasing competition, declining profit, and continuous innovation of products and technology. Enhancing the customers' loyalty is a good way to establish a good long-term relationship with customers. With the support of loyal customers, enterprises can achieve continuous development and sustainable management. The railway is the artery for Taiwan's in-land transportation, shouldering the weight and responsibility in transporting passengers and cargo for over a hundred years. The transport function of the railway is located at the "Intercity Railway Transport Service." About 73% of the railway ticket revenues is for short-distance travel, whereas over 76% is for medium- and long-distance travel. However, Taiwan's high-speed rail began to operate in 2007, becoming the railway's largest competitor for

medium- and long-distance travel. Other than the high-speed rail, the railway also faces a competition with land transport and mass transit system for short-distance travel. Therefore, seeking the most favorable development in the highly competitive transportation market is currently an important issue for Taiwan's railway system.

For enterprises, customers have become the most important strategic resources, and their survival depends on their good long-term relationship with the customers (Armstrong and Kotler, 2000). The most important way of establishing a good long-term relationship with customers is by enhancing customer loyalty. Customer loyalty refers to a sense of belongingness or the identification of persons, products, or services that will directly affect customer behavior (Jones and Sasser, 1995). Customer loyalty is also reflected in the frequency of customer visits (Bowen and Shoemaker, 1998). According to Reichheld and Sasser (1990), an increase of 5% in customer retention rates will raise the average value of each customer to the enterprise by 25% to 100%. This finding indicates that loyal customers can bring about more profits and lower maintenance costs. Customers' loyalty is influenced by their satisfaction, and these two concepts are positively correlated. The higher the customers' satisfaction, the higher their loyalty is. Likewise, the lower the customers' satisfaction, the lower their loyalty is (Day, 1977; Kasper, 1988; Lin et al., 2007; Yeh and Wu, 2014). Customers' satisfaction is an overall measure of how much value they put in a purchased product or service (Woodruff et al., 1983; Fornell, 1992). Satisfied customers will begin to develop a high degree of loyalty that will increase their willingness to repurchase, thus affecting the operational performance of enterprises and further allowing enterprises to obtain higher revenue (Reichheld and Sasser, 1990).

Customers' satisfaction comes with the content and quality of the enterprises' service. The customers' satisfaction is higher when the quality of service is better and meets the customers' expectations (Hennig-Thurau et al., 2002; Huang, 2012). The SERVQUAL scale can be used to measure the gap between the customers' expectations and cognitive service for enterprise (Parasuraman et al., 1988). In this study, the balanced scorecard (BSC) was used to transform corporate vision and strategies into measurable and implementable action (Kaplan and Norton, 1992). In conjunction with the corporate vision and departmental objectives, the evaluation of the enterprises' operational performance does not merely come from the data of financial reports. Besides focusing on the "financial dimension," it also emphasizes non-financial indicators, such as "customer dimension," "internal business process dimension," and "learning and growth dimension," and connects these four dimensions with causal relationship to establish a set of systematic tools of measuring satisfaction and loyalty (Butler et al., 1997; Chow et al., 1997; Clinton and Hsu, 1997; Basu et al., 2009; Yuksel and Dagdeviren, 2010). Therefore, this study used BSC to link measurable indicators with different dimensions within and outside the Taiwan Railway Company through causal relationships and to explore the effect of the four dimensions (customer dimension, internal business process dimension and learning, and growth dimension) on passengers' satisfaction and loyalty.

This study was based on BSC, and the questionnaire consisted of surveys on the following: (1) Taiwan railway passengers' attention; (2) passengers' satisfaction; and (3) passengers' loyalty. In the "attention survey" section, grey relational analysis (GRA) was used to extract important key factors of passengers' concerns when taking the Taiwan railway. The GRA is a common method used to identify important factors that influence the trends of enterprises and organizations' development to master the main features of things (Deng, 1989; Deng, 1997). It has been widely used in various studies. Shie et al. (2015) used the GRA to extract the key factors in order to propose the suggestions for female buyers of used car on Internet. Chiu et al. (2015) applied the GRA to look for key factors for entry into American market in order to provide the service in conformity to local demand. Kao et al. (2017) made use of the GRA to determine key factors for performance measurement of Taiwan High Speed Rail service quality. The GRA is very advantageous due to its simple and clear calculation process without the need for large data (Huang et al., 2006). This study further used Importance-Performance Analysis (IPA) to understand passengers' attention to the quality attributes of Taiwan railway. The Taiwan railway's performance level is essential in the evaluation of its quality attributes and can also be used as a basis for future business development or in

improving customers' status (Sampson and Showalter, 1999). Finally, the IPA builds a railway passengers' satisfaction and loyalty matrix that can help the Taiwan railway management to better understand their customers' demands and expectations.

Literature Review

This section is divided into three parts: the first part introduces the quality of service and the BSC; the second part introduces the customers' satisfaction and loyalty; and the third part introduces the GRA.

Quality of Service and Balanced Scorecard

Service refers to various activities and the benefits or satisfactory contents associated with sale of products that will increase the utility or value of the product (Lovelock; 1979). It is an invisible economic activity with abstract and elusive idea (Crosby; 1979). Therefore, it is very difficult to directly judge products as either good or bad since there are subjective differences in the way or process of providing services to consumers. Hence, the perceptions on the quality of service may vary (Sasser et al., 1978). Parasuraman et al. (1985) argued that, for consumers, the quality of service is more difficult to evaluate than physical products' quality. Thus, the quality of service is the gap between perceived quality of service before and after receiving the service and expectations of customers before and during the service.

According to the conceptual model of the quality of service presented by Parasuraman et al. (1985, 1988), the service quality quantified by the SERVQUAL scale includes five dimensions, namely, tangibility, credibility, reactivity, reliability, and empathy, which are used to measure the gap between the customers' expectations for business and cognitive services. In addition, the conceptual model of service quality was developed by Haywood-Farmer (1988), which divided the attributes of the service into three dimensions, namely, professional judgement, physical facilities, processes and procedures, and People's behavior and conviviality. Dabholkar et al. (1996) also proposed the model of service quality with the five dimensions (physical aspects, reliability, personal interaction, problem solving, and policy).

We, therefore, can make clear from the above discussion that the service cannot be measured and controlled like the quality of physical product because of the characteristics of the service (intangibility, heterogeneity, perishability, and inseparability). Thus, there is no fixed criteria for measuring the quality of service. Even if the view of each researcher is not the same, the study of the performance evaluation indicators of the service quality frequently makes mention of an attitude of the service provider (Sasser et al., 1978; Rohrbaugh, 1981; Parasuraaaman, et al., 1985) and the willingness of the service provider (Armistead, 1985; Juran, 1986; Parasuraaaman, et al, 1985). In the process of providing service, thus, the service provider is playing a quite important role to affect the perceptions of service quality for customers.

The BSC theory takes the company's vision and strategy as a starting point, combining with financial and non-financial measures of performance measurement system. The performance evaluation indicators are divided into four dimensions: (1) financial dimension, (2) customer dimension, (3) internal process dimension, and (4) learning and growth dimension. The BSC, besides including financial indicator, also contains the operational indicators such as the customer's satisfaction indicator that drives the results of financial performance and the internal business process indicator, which includes the innovation and improvement of organizational staff. That is, the service quality is based on the service ability of service staff and service procedure of service provider. Therefore, the BSC can drive administrators to consider all important operational indicators simultaneously from a macroscopic perspective and to perceive whether the improvement in one aspect would affect the other (Kaplan and Norton; 1992).

Customers' Satisfaction and Loyalty

Customers' satisfaction is defined as the evaluation of purchase or opportunity (Howard and Sheth, 1969). Therefore, customers' satisfaction is an immediate emotional response to the specific use of products. For the measurement scale of customer satisfaction, the Likert scale was adopted by many scholars to evaluate the satisfaction degree of testers because its measurement scale is easier to be understood and accepted by testers compared to the other measurement scales (Likert, 1932). Therefore, the Likert scale was used in this present study to measure customers' satisfaction.

Customers' loyalty can be referred to the strength of the relationship between customers' personal attitude and patronage behavior (Dick and Basu, 1994). The stronger the relationship of the two, the higher probability that customers will patronize again and the higher customers' loyalty will become. The degree of customers' loyalty can be measured by customers' willingness to repurchase and satisfaction with the price (Fornell, 1992). The common indicators of customers' loyalty are as follows: (1) the intention of customers to repurchase measures customers' satisfaction and repurchase intention and is linked with the results of forming a strong indicator for analyzing customer repurchasing behavior; (2) the intention to recommend products to others measures the intentions of customers for good public reputation, public recommendation, and customers' introduction; (3) the intention of price tolerance measured by the available price; (4) cross purchase measures the intention to buy other products from the company (Jones and Sasser, 1995). High customer satisfaction will increase customers' loyalty and as well as the frequency and amount of the customers' repurchase of a particular service or product. Therefore, customers' loyalty can bring substantial profits or revenue for enterprises.

Grey relational analysis

The grey system theory is proposed by Deng (1982). It is used to describe the characteristic of information in the realistic environment with the concept of the grey. The grey refers to the parts between the black and white. In the indeterminate event (the grey event), the degree of grey can be expressed as the integrity of information. That is to say, the white is used to describe the characteristic of information as to the system with intact information. When the system with completely unknown information, the black is used to describe the characteristic of information. When the information is insufficient, and incomplete, the system is expressed by the grey. Thus, the method of the grey system theory is widely used in many studies, and can be used to effectively process the uncertainty of the events, multivariate input, discrete data, and incomplete data (Wen et al., 2003).

Grey relational analysis is the important concept of the grey system theory. Grey relational stands for the uncertain relational between the events, and can be used to analysis the degree of relational in the discrete sequence data, the mail and minor factors can be extracted by the degree of relational. Grey relational analysis applied to few data and multivariate analysis, and make up for the needs of a large number of data of the regression method and the disadvantage of the constraint on function relationship (Jiang et al., 1998).

Questionnaire Design and Research Method

The following part will introduce the questionnaire designed by the BSC as well as the GRA and IPA analysis used.

Questionnaire Design

This study was conducted through field visits, with the passengers of the Taiwan railway as respondents. The content structure of the questionnaire is divided into four parts: (1) investigation of Taiwan railway passengers' attention; (2) investigation of Taiwan railway passengers' satisfaction; (3) investigation of Taiwan railway passengers' loyalty; (4) basic characteristics of the passengers (Figure 1).

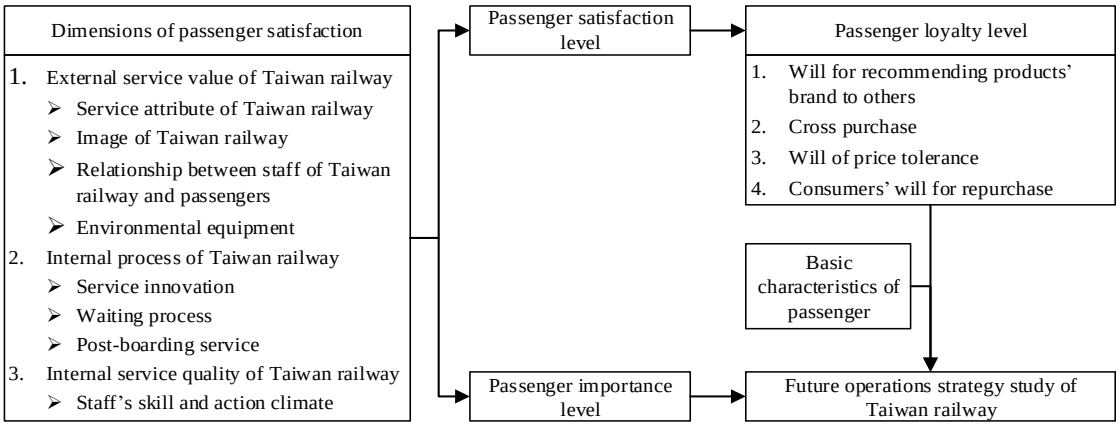

Figure 1. Structure of the questionnaire

Table 1. Questionnaire of importance and satisfaction measurement indicators

Research dimension		Questionnaire of measurement indicators
External service value of Taiwan railway	Service attribute of Taiwan railway (function, quality, price, time)	Q. 1 Situation of train's punctuality
		Q. 2 Reasonable price
		Q. 3 Convenience of external public transportation
		Q. 4 Safety of the train
	Image of Taiwan railway	Q. 5 Reputation of Taiwan railway
		Q. 6 Credit of Taiwan railway
	Relationship between staff of Taiwan railway and passengers (communication, attitude)	Q. 7 Staff's concern level for passengers
		Q. 8 Staff's patience for passengers
		Q. 9 Staff's explanation for inquiry
		Q. 10 Staff's service attitude
	Environmental equipment	Q. 11 Clean environment, beautification and afforestation
		Q. 12 Cleanliness of carriage and toilet
		Q. 13 Cleanliness of toilets in the station
		Q. 14 Ratio of new train
		Q. 15 Driving equipment (such as grade crossing, electricity and track etc.)
Internal process of Taiwan railway	Service innovation	Q. 16 Management quality of selling ministries in the station
		Q. 17 Meals selling service and quality in carriage
		Q. 18 Telephone voice booking
		Q. 19 Measures of post office for collecting tickets after telephone voice or online booking
		Q. 20 Online booking
		Q. 21 Service of automatic ticket machine
	Waiting process	Q. 22 Guidance index or moving-line arrangement
		Q. 23 Waiting time of window service
		Q. 24 Service facilities and design of passengers' waiting space
		Q. 25 Content and clarity of broadcasting system
	Post-boarding service	Q. 26 Activities' advocation of Taiwan railway
		Q. 27 Treatment for customers' complaints
Internal service quality of Taiwan railway	Staff's skill and action climate	Q. 28 Staff's professional skill
		Q. 29 Staff's awareness of service quality
		Q. 30 Staff's emotional expression

The investigation of attention and satisfaction includes the following: the external service value of Taiwan railway (customer dimension), the internal process of Taiwan railway (internal process dimension), and the internal service quality of Taiwan railway (learning and growth dimension). Further, each measurement dimension is linked to each other in accordance with the causal relationships. The measurement indicators are listed in Table 1 below.

1. External service value of Taiwan railway: If Taiwan railway wants to achieve superior financial performance, it must create and provide expected products and services to passengers. The questionnaire consists of four parts, namely, (1) service attribute of Taiwan railway, which includes the function, quality, price, and time of products or service provided for passengers; (2) image of Taiwan railway, which includes the intangible factors that attract visitors such as image and goodwill; (3) the relationship between staff and passengers characterized by the passengers' feeling for staff service when taking Taiwan railway; and (4) the environmental equipment or factors of the Taiwan railway to attract tourists.

2. Internal process of Taiwan railway: The internal process of Taiwan railway should consider how to meet the passengers' expectations of products and services. The questionnaire consists of three parts: (1) service innovation, which includes the study of the potential needs of passengers and then creating products or services to meet these needs; (2) waiting process, which includes providing superior boarding services for passengers in an efficient and timely manner; (3) post-boarding service, which includes continuous offering of services to passengers that will increase the value of services.

3. Internal service quality of Taiwan railway: The service quality of internal staff provides an infrastructure on external value and internal process of Taiwan railway. The questionnaire was designed to determine the staff's skill and action climate. The first-line staff is most familiar with the internal processes and passengers' needs. The service quality of the railway is measured through the transformation and stimulation of staff's skills and motivation and their authorization, coordination, and initiative to pursue the organizational goal.

Customers' loyalty refers to the strength of the relationship between customers' personal attitudes and patronage behavior. The stronger the relationship between the two, the higher the probability that the customers will patronize. Likewise, the weaker the relationship, the lower the probability that the customer will patronize. Therefore, the measurement of customers' loyalty in this study includes the following: (1) passengers' patronage, (2) public praise, (3) cross-patronage, and (4) price tolerance. The detailed measurement indicators are listed in Table 2.

Table 2. Questionnaire of loyalty measurement indicators

Measurement indicators	Questionnaire of measurement indicators
Will for recommending products' brand to others	Q. 31 Would you like to recommend Taiwan railway to your friends and family?
Cross purchase	Q. 32 Would you like to buy meals in the station or inside the carriage?
Will of price tolerance	Q. 33 Would you like to be tolerant of the price of Taiwan railway higher than other passenger transport?
Consumers' will for repurchase	Q. 34 Would you like to patronize Taiwan railway again?

Research Method

The questionnaire titled "Investigation of Passengers' Attention of Taiwan Railway" was analyzed by using GRA to extract key and important factors that passengers pay attention to when taking the Taiwan railway.

First, the comparison sequence and reference sequence are determined according to the reclaimed questionnaire. Then, the grey relational coefficient (r) of the investigation of passengers' attention was calculated, and the grey relational degree was obtained. Afterward, the obtained grey relational degree was ranked in descending order, and the grey relational sequence can be obtained as a key and important factor for passengers' attention to take Taiwan railway. The detailed steps are as follows:

Step 1. The paper applies the Likert five-point scale as assessment criteria with comparison sequence as $x_i=\{x_i(1), x_i(2),..., x_i(k)\}$, wherein, $x_i(k)$ is the answer score of respondent; i for question k in the questionnaire; and reference sequence is $x_0=\{x_0(1), x_0(2),..., x_0(k)\}$. If the respondent's answer is 5 points, indicating that he or she pay most attention to the influence level described in this question, then $x_0(1)=x_0(2)=...=x_0(k)=5$. The difference sequence value is defined as the absolute difference between comparison sequence and reference sequence expressed as $\Delta_{0i}(k)=\left|x_0(k)-x_i(k)\right|$.

Step 2. The grey relational coefficient is shown in Equation (1). The function of distinguished coefficient (ζ) is to compare the comparison sequence and reference sequence. It is generally recommended to take 0.5 as the value of the distinguished coefficient (Deng, 1989). When the grey relational coefficient approaches 1, it shows a higher degree of correlation between the reference sequence and comparison sequence. On the other hand, when the grey relational coefficient approaches 0, it shows lower degree of correlation between the reference sequence and comparison sequence.

Step 3. The grey relation degree is the average of the grey relational coefficient, as shown in Equation (2), which represents the degree of relation between the comparison sequence and reference sequence (Deng, 1997). When the grey relational degree is larger, it shows greater attention.

Step 4. The values of correlation degree between the two are arranged in order, and the formed relationship is the grey relational sequence, which can be used as the basis of analysis and decision.

$$r\left(x_0(k), x_i(k)\right)=\frac{\Delta\min+\zeta\Delta\max}{\Delta_{0i}(k)+\zeta\Delta\max} \quad (1)$$

$$r\left(x_0, x_i\right)=\frac{1}{n}\sum_{k=1}^{n} r\left(x_0(k), x_i(k)\right) \quad (2)$$

The GRA of the "Investigation of Passengers' Attention of Taiwan Railway" and grey relational degree will be used in the IPA analysis to provide information of the relationship between passengers' attention on the quality attributes of the Taiwan railway and the passengers' satisfaction. The steps of IPA analysis are explained as follows:

Step 1. It takes the degree of satisfaction as the horizontal axis; the "grey relational degree" as degree of attention listed in the vertical axis; and the grey relational degree and the degree of satisfaction in "investigation on passengers' attention of Taiwan railway" and "investigation on passengers' satisfaction of Taiwan railway" as coordinates that are marked in the coordinates of two-dimensional space.

Step 2. It takes the average value of each question's grey relational degree and satisfaction degree as a point of separation and divides the space into four quadrants.

The first quadrant (I) indicates that both attention degree and satisfaction degree are high. The attribute

falling in this quadrant should continue to keep up the good work. The second quadrant (II) shows that attention degree is low but satisfaction is good, and the attribute of this quadrant is possible overkill, which probably belongs to excessive attention area. The third quadrant (III) indicates that both are bad, and the attribute of this quadrant means low priority. Finally, the fourth quadrant (IV) shows high attention but poor satisfaction, and the attribute in this quadrant is that the focus of service supply should be the concentrate area.

Results Analysis

The following contents include the following: (1) the analysis on the Investigation of Passengers' Attention of Taiwan Railway, (2) the results of the IPA analysis, and (3) the grouping of Taiwan railway consumers.

Analysis on Passengers' Attention of Taiwan Railway

This study is based on the analysis of the "Investigation of Passengers' Attention of Taiwan Railway" with the grey relational analysis as research method to extract key and important factors that passengers pay attention to when taking Taiwan railway. According to Equation (2), the calculated results of grey relational degree of each question in the "Investigation of Passengers' Attention of Taiwan Railway" are shown in Table 3. Then the grey relational degree in Table 3 is converted into a figure (as shown in Figure 2). Each point on the figure represents a question, and if its position is closer to the right side, it means that the grey relational degree is larger and the importance of the question is higher. The basis of the compactness and gap can be divided into 11 groups. According to Daniel, "There are three to six key factors that affect the success of an enterprise, and if the enterprise lacks these key factors, then it is easy to fail" (Daniel, 1961). Therefore, this study followed this guideline. We stopped the extraction after selecting 3 to 6 factors and took it as a way to filter key factors.

Table 3. Grey relational degree and grey relational sequence of Taiwan Railway passenger importance survey questionnaire asked each of the items

Number	Grey relational degree (GRE)	Grey relational sequence	Number	Grey relational degree (GRE)	Grey relational sequence
Q.1	0.8308	1	Q.28	0.7297	16
Q.3	0.7779	2	Q.26	0.7285	17
Q.2	0.7683	3	Q.30	0.7229	18
Q.17	0.7647	4	Q.27	0.7226	19
Q.4	0.7637	5	Q.25	0.7142	20
Q.5	0.7617	6	Q.15	0.709	21
Q.7	0.7567	7	Q.10	0.7068	22
Q.9	0.7553	8	Q.12	0.7067	23
Q.11	0.7535	9	Q.13	0.7015	24
Q.29	0.7448	10	Q.22	0.699	25
Q.6	0.7447	11	Q.20	0.6968	26
Q.24	0.7442	12	Q.14	0.6964	27
Q.8	0.7355	13	Q.21	0.6644	28
Q.23	0.7333	14	Q.16	0.6633	29
Q.18	0.7327	15	Q.19	0.6492	30

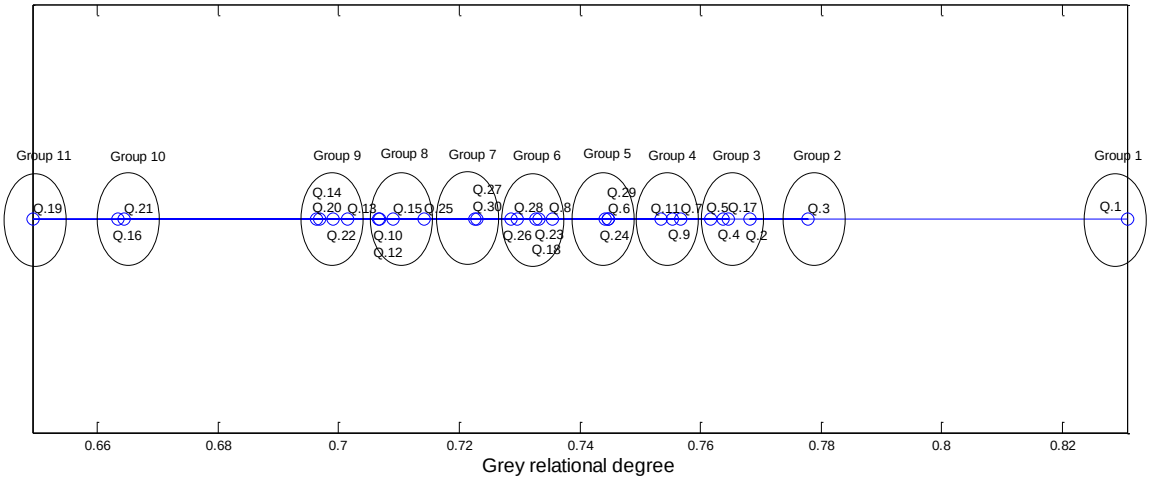

Figure 2. Graph of grey relational degrees for selecting important key factor

According to Daniel's principle, six important factors are selected in the section of the "Investigation of Passengers' Attention of Taiwan Railway," namely, "Q.1 situation of train's punctuality" in the first group (GRE=0.8308), which is one item; "Q.3 convenience of external public transportation" in the second group (GRE=0.7779), which is another item; "Q.2 reasonable price" (GRE=0.7683), "Q.17 meals' selling service and quality in carriage" (GRE=0.7779), "Q.4 safety of the train" (GRE = 0.7637), and "Q.5 reputation of Taiwan railway" (GRE = 0.7617) in the third group.

Results of IPA Analysis

Based on the information collected from the "Investigation on Passengers' Attention of Taiwan Railway" and the "Investigation of Passengers' Satisfaction of Taiwan Railway," the IPA analysis draws an "Attention Degree–Performance Level Graph" to analyze passengers' satisfaction of the service quality of Taiwan's railway. The horizontal axis of "Attention Degree–Performance Level Graph" is the degree of satisfaction, whereas the vertical axis is the degree of attention, which is expressed by the GRE value in Table 3. The results are shown in Figure 3. Taking satisfaction degree in Figure 3 and GRE value in Table 3 and the average of the two as the origin, the graph is divided into four quadrants as follows:

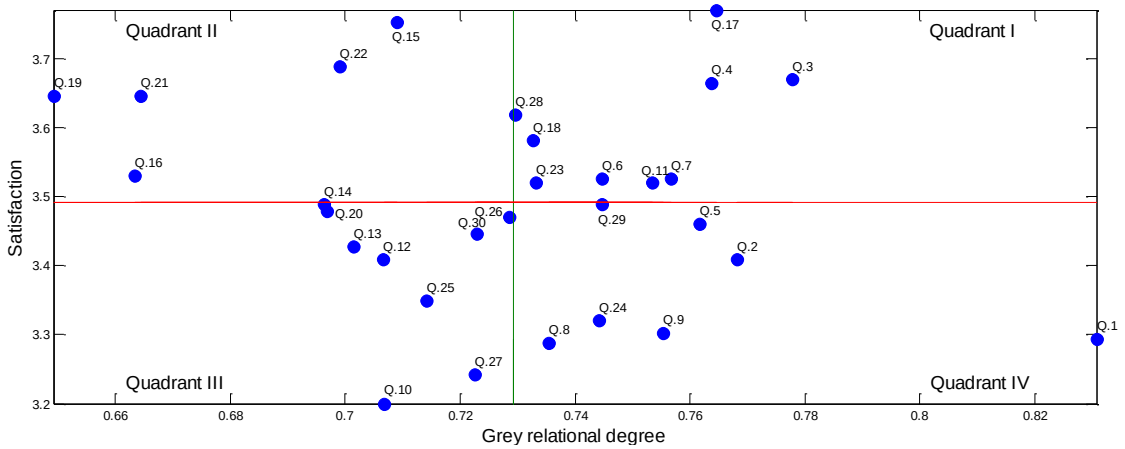

Figure 3: Scatter plot of importance-performance analysis

(1) The first quadrant represents the competitive advantages of Taiwan railway's service, indicating that service quality-related strategies (determined in the first quadrant) are correct and fit the passengers' expectations. Hence, it should continue to maintain these advantages, including service attribute of the Taiwan railway (Q.3, Q.4), image of Taiwan railway (Q.6), relationship between staff and passengers (Q.7), environmental equipment (Q.11), service innovation (Q.17, Q. 18), waiting process (Q.23), and staff's skill and action climate (Q.28). In described competitive advantages of Taiwan railway' service, according to the results of the GRA, the key items valued by passengers are the "convenience of external public transportation" (Q.3) and the "safety of the train" (Q.4). As the stations of Taiwan railway are mostly located at the center of the city, the external public transportation vehicles are very convenient. The Taiwan railway operates in the same station as the MRT in Taipei and Kaohsiung, making it more convenient for passengers to transfer. As for security issues, common passengers think that it is safer to take Taiwan railway compared to self-driving because the train is running on dedicated tracks.

(2) The second quadrant represents excessive supply of resources, including environmental equipment (Q.15) and service innovation (Q.16, Q.19, Q.21, Q.22). At present, the Taiwan railway has paid attention on the application of safety devices in railways to ensure passengers' safety and to avoid train delay and passengers' complaint. However, for passengers, these devices are not directly used in riding. Therefore, though passengers have high satisfaction with "driving equipment (i.e., grade crossing, electricity, and track, etc.)" (Q.15), their attention degree is not high. In addition, Taiwan railway has set selling ministries in some main stations, especially in Taipei station, and it has been like a department store. This is the additional value that Taiwan railway creates in order to enhance the service for passengers. However, for passengers, taking Taiwan railway is mainly for receiving transport services. Therefore, though "management quality of selling ministries in the station" (Q.16) obtained passengers' satisfaction, it is not their first priority. Passengers want to get tickets and get on the train when taking Taiwan railway, so they are highly satisfied with the "measures of post office for collecting tickets after telephone voice or online booking" (Q.19), "service of automatic ticket machine" (Q.21), and "guidance index or moving-line arrangement" (Q.22). However, attention degree is not high.

(3) The third quadrant concludes that Taiwan high-speed rail does not have competitive advantages. It is listed as the focus of secondary improvement. The main items mostly fail to meet the different demands of customers, including the relationship between the staff of Taiwan railway and the passengers (Q.10), environmental equipment (Q.12, Q.13, Q.14), service innovation (Q.20), waiting process (Q.25), post-boarding service (Q.26, Q.27), as well as staff's skill and action climate (Q.30, Q.20, Q30). For Q.10, Q.25, Q.26, Q.27, and Q.30, they are the staff's service attitude, treatment for customers' complaints, and improvement of staff's emotional expression. Hence, Taiwan railway should adopt customer-oriented service attitude, constantly take care of customers' demands, reduce negative emotions of passengers, and increase their willingness to ride again. In terms of Q.12 and Q.13, toilet cleaning in Taiwan railway station has been long criticized by passengers. The Taiwan railway should actively improve the situation and provide the passengers a comfortable environment. As for Q.14, Taiwan railway also actively replaced old trains with new ones, such as the purchase of Puyuma Express, which shortened travel time and improved passengers' will of taking the railway. The problem of "online booking" (Q.20) is often reported by news media, especially in continuous holidays. Passengers often fail to buy a ticket online, so Taiwan railway needs to establish a system to avoid the problem and release tickets to passengers who really need them.

(4) In the fourth quadrant, the Taiwan railway does not get the favor of passengers on service items, such as service attribute (Q.1, Q.2), image (Q.5), relationship between staff and passengers (Q.8, Q.9), waiting process (Q.24), staff's skill and action climate (Q.29), etc. The "staff's awareness of service quality" (Q.29) is the recognition, desire, and determination of the staff to improve service

quality of the Taiwan railway. Good service quality and high customers' satisfaction are achieved by the staff through the service process. Thus, the management of the staff's awareness of service quality will profoundly affect service attitude and customers' evaluation on service quality. The Taiwan railway is frequently taken by the general public and is especially crowded during holidays. If the staff has a good sense of service quality, they can plan for the train scheduling and design of waiting space on "service facilities and design of passengers' waiting space" (Q.24) to ease the crowd and so that the delay caused by the crowd can be reduced as much as possible in "situation of train's punctuality" (Q.1). The train's delay has been a major item complained by passengers since it wastes the passengers' time and reduces the income of the railway because passengers tend to refund the tickets. This will lead to the passengers reflecting on the increase of the tickets' price and eventually will lead to the decrease of passengers. Therefore, if the "situation of train's punctuality" (Q.1) is good, the Taiwan railway will not see a decrease of passengers due to "reasonable price" (Q.2). Concurrently, if the staff of Taiwan railway could be careful and patient for passengers' inquiries and explanations, passengers will have a relatively high satisfaction degree on the items of "staff's patience for passengers" (Q.8) and "staff's explanation for inquiry" (Q.9). Hence, the passengers' comprehensive evaluation on Taiwan railway is finally reflected in passengers' satisfaction for "reputation of Taiwan railway" (Q.5).

Among the four quadrants, the items in the fourth quadrant are of low satisfaction and high loyalty. Satisfaction is a comprehensive assessment of various aspects of Taiwan railway services. Loyalty refers to whether passengers will continue to take the services provided by Taiwan railway. Since consumers' expectations for products or services offered by enterprises are endless, the pursuit of high satisfaction may not be profitable for enterprises and it is critical for enterprises to make consumers to patronize the product or service. High loyalty shows that competitiveness of the enterprise is relatively strong and consumers are willing to continue using the products or services. Therefore, the phenomenon of low satisfaction and high loyalty means that the passengers' loyalty towards the Taiwan railway is a behavior rather than an attitude. The passengers are mostly helpless loyalists rather than satisfactory loyalists. As a result, once other competitors have grown up, market of the enterprise will decline and the competitiveness will decrease its satisfaction. Taiwan railway is an exclusive industry, and the consumers choose the services of Taiwan railway because of the most basic motivation are convenience, security, and other factors. Taiwan railway stations run throughout Taiwan, which is mostly used by the working group and students. The high-speed rail stations, which are the main competitors of Taiwan railway, are mostly located in the suburb. Hence, it is not competitive enough for commuters to transfer because of services and the loyalty of the consumers.

According to the results of the GRA, the items valued by passengers in the fourth quadrant are "train's punctuality" (Q.1), "reasonable price" (Q.2), and "reputation of Taiwan railway" (Q.5). The "train's punctuality" (Q.1) received the most complaints from passenger, and it is the major topic of Taiwan railway that should be firstly solved. As for the item of "reasonable price" (Q.2). Taiwan railway increases the tickets' price to cover the cost of oil and electricity, which has increased in the recent years, and it causes passengers' constant rebound. The Taiwan railway is a public transport and should not only consider making profit. Its primary purpose should be to serve the general population and take social responsibility. Therefore, Taiwan railway can establish a fair procedure to provide information and give consumers opportunities to express their ideas and reduce public rumors and unfair awareness that may improve passengers' satisfaction and avoid the loss of passengers. Higher satisfaction will improve passengers' loyalty, making the passengers willing to continuously consume and enhancing improvement of real profits for Taiwan railway.

Taiwan Railway Consumers' Grouping

Jones and Sasser (1995) pointed out that "full satisfaction" can ensure the customers' loyalty and that customers' satisfaction must be over 4 points to ensure customers' loyalty for a long time. Therefore, this study takes the consumers' satisfaction as the horizontal axis, consumers' loyalty as the vertical axis, and

the respondents' satisfaction and loyalty (4, 4) as the origin. These are divided into four groups according to the degree of consumers' satisfaction and loyalty with meaning explained as follows:

(1) The first quadrant refers to the group of loyal customers. In this group, the average degree of consumers' satisfaction is 4.3807, and the average loyalty degree is 4.4286; both of which are high. As a result, consumers in this group are very satisfied with the services provided by the Taiwan railway and are willing to take Taiwan railway again.

(2) The second quadrant refers to the group of increasing complaints. In this group, the average degree of consumers' satisfaction is 3.5100, and the average loyalty degree is 4.2132. Their satisfaction degree for Taiwan railway is low, but the loyalty degree for Taiwan railway is high. Therefore, though consumers in this group are willing to take Taiwan railway again, their complaints and dissatisfaction for Taiwan railway also increased. If Taiwan railway will not improve its related services, it lead consumers to choose other vehicles or other mode of transportation.

(3) The third quadrant refers to the group of customers' loss. The average degree of consumers' satisfaction in this group is 3.3120, whereas the average loyalty degree is 3.1544; both of which are low. As a result, consumers in this group are not satisfied with the services provided by Taiwan railway and are reluctant to take Taiwan railway again.

(4) The fourth quadrant refers to the group of potential threat. The average degree of consumers' satisfaction in this group is 4.2235, whereas the average loyalty degree is 3.3500. Their satisfaction degree for Taiwan railway is high but their loyalty degree is low. Therefore, though consumers in this group are satisfied with the services provided by Taiwan railway, they will turn to other competitors if they are provided with better transportation and services.

Among the four groups, the group of increasing complaints in the second quadrant is the potential customer of Taiwan railway. As long as the Taiwan railway improves its services and the consumers' satisfaction, it can achieve consumers' loyalty to Taiwan railway. According to the analysis of the questionnaire, the items with consumers' low satisfaction in the group of increasing complaints are "Q.1 train's punctuality," "Q.10 staff's service attitude," and "Q.27 treatment for customers' complaints." Obviously, consumers in the group of increasing complaints are not satisfied with staff's treatment of train delays. Therefore, the staff of Taiwan railway should be more considerate of passengers in cases of train delays. They should do their best to provide passengers with considerate and thoughtful service with heart and soul, then they will make passengers understand their work. It will further reduce passengers' complaints, improve passenger satisfaction, and avoid the loss of passengers. Higher satisfaction will lead to passengers' loyalty and make them continue to consume. This will thus promote profit for Taiwan railway.

Conclusion

At present, the operating income of the Taiwan railway is challenged by the competition of high-speed rails used for travelling in medium and long distances, the mass transit system for travelling short distance, and other means of land transportation. Therefore, the Taiwan railway should seek the most favorable development to be favored by the customers. The way for it to survive is by maintaining a good long-term relationship with the customers and by enhancing customer's loyalty. Therefore, this study will start from understanding the situation of value flowing in the enterprise by using BSC, establish a set of effective measurement system of passengers' satisfaction and loyalty, and use GRA and IPA analysis to understand the loyal behavior of Taiwan railway passengers. The results show that railway passengers are mostly commuters and students. Thus, it needs to pay attention to punctuality of the train and ticket price. Therefore, if Taiwan Railway Company can improve train's punctuality and rationalize ticket's price, it

will be able to improve passengers' satisfaction. Higher satisfaction will improve passengers' loyalty, make passengers be willing to consume continually, and enhance improvement of real profits for Taiwan railway.

References

Armistead, C. G. (1985). *Design of Service Operations, in Operations Management in Service Industries and the Public Sector*. Christopher Voss, ed. John Wiley & Sons, Inc., New York.

Armstrong, G., and Kolter, P. (2000). *Marketing: An Introduction*. Prentice-Hall, New York.

Basu, R., Little, C., and Millard, C. (2009). Case study: A fresh approach of the balanced scorecard in the Heathrow terminal 5 project. *Measuring Business Excellence*, 13(4), 22-33.

Bowen, J.T., and Shoemaker, S. (1998). Loyalty: a strategic commitment. *Cornell Hotel and Restaurant Administration Quarterly*, 39, 12-27.

Butler, A., Letza, S. R., and Neale, B. (1997). Linking the balanced scorecard to strategy. *Long Range Planning*, 30(2), 53-79.

Chiu, H. F., Lee, T. R. (Jiun-Shen), and Kao, C. K. (2015). The key factors of selecting electronics manufacturing service suppliers - An example of company U in Taiwan. *Management and Production Engineering Review*, 6(4), 4-14.

Chow, C. W., Haddad, K. M., and Williamson, J. E. (1997). Applying the balanced scorecard to small companies. *Management Accounting*, 79(2), 21-277.

Clinton, D. B., and Hsu, K. C. (1997). JIT and the balanced scorecard: Linking manufacturing control to management control. *Management Accounting*, 79(3), 18-24.

Crosby, P. B. (1979). *Quality Is Free*. McGraw-Hill, New York.

Daniel, D. R. (1961). Management information crisis. *Harvard Business Review*, 39, 111-116.

Dabholkar, P. A., Thorpe, D. I., and Rentz, J. O. (1996). A measure of service quality for retail stores: scale development and validation. *Journal of the Academy of Marketing Science*, 24(1), 3-16.

Day, R. L. (1977). Extending the concept of consumer satisfaction. *Consumer Research*, 4(1), 149-154.

Deng, J. L. (1982). *Grey System Theory*, Huazhong University of Science and Technology Press, Wuhan.

Deng, J. L. (1989). Introduction to grey system theory. *Journal of Grey System*, 1(1), 1-24.

Deng, J. L. (1997). A novel GM(1,1) model for non-equigap series. *The Journal of Grey System*, 9(2), 111-116.

Dick, A. S., and Basu, K. (1994). Customer loyalty: Toward an integrated conceptual framework. *Journal of The Academy of Marketing Science*, 22(2), 99-113.

Fornell, C. (1992). A national customer satisfaction barometer: The Swedish experience. *Journal of Marketing*, 56(1), 403-412.

Haywood-Farmer, J. (1988). A conceptual model of service quality. *International Journal of Operations and Production Management*, 8(6), 19-29.

Hennig-Thurau, T., Gwinner, K. P., and Gremler, D. D. (2002). Understanding relationship marketing outcomes: An integration of relational benefits and relationship quality. *Journal of Service Research*, 4(3), 230-247.

Howard, J. A., and Sheth, J. N. (1969). *The Theory of Buyer Behavior*. John Willey & Sons, New York.

Huang, K. C., Huang, L. F., Lin, H. Y., Lin, S. C., and Kuo, J. C. (2006). Fight evaluation of NBA teams-application of grey relational analysis. *Journal of Information and Optimization Sciences*, 27(2), 481-498.

Huang, M. H. (2012). Investigating the moderating effect of brand equity on customer dissatisfaction with service failure and satisfaction with service recovery. *Journal of Management*, 29(4), 355-371.

Jiang, J. S., Wu, P. L., Chiang, H. T., Chang, T. C., Chan, F. T., Chang, H. T., and Wen, K. L. (1998). *Grey Theory Introduction*. Gao Li, New Taipei City.

Jones, T. O., and Sasser, W. E. (1995). Why satisfied customer defect. *Harvard Business Review*, 73(6), 88-99.

Juran, J. M. (1986). A Universal Approach to Managing for Quality. *Quality Progress*, 19(8), 19-24.

Kao, C. K., Kung, B. R., and Hsieh, W. I. (2017). Application of grey relational analysis to determine key factors for performance measurement of Taiwan high speed rail service quality. *Asian Journal of Business and Management*, 5(1), 1-11.

Kaplan, R. S., and Norton, D. P. (1992). The balanced scorecard: Measures that drive performance. *Harvard Business Review*, 70(1), 71-79.

Kasper, H. (1988). On problem perception, dissatisfaction and brand loyalty. *Journal of Economic Psychology*, 9(5), 387-397.

Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology*, 140, 1-55.

Lin, Y. C., Lin, H. C., and Lee, Y. C. (2007). The study of the relationship among experiential marketing, customer satisfaction and customer loyalty. *Journal of Customer Satisfaction*, 3(2), 57-94.

Lovelock, J. E. (1979). *Gaia: A New Look at Life on Earth*. Oxford University Pass, Oxford.

Parasuraman, A., Zeithaml, V. A., and Berry, L. L. (1985). A conceptual model of service quality and its implications for future research. *Journal of Marketing*, 49(4), 41-50.

Parasuraman, A., Zeithaml, V. A., and Berry, L. L. (1988). SERVQUAL: A Multiple item scale for measuring consumer perceptions of service quality. *Journal of Marketing*, 64(1), 12-40.

Reichheld, F. F., and Sasser, W. E. (1990). Zero defections: Quality comes to services. *Harvard Business Review*, 68(5), 105-111.

Rohrbaugh, J. (1981). Operationalizing the competing values approach: Measuring performance in the Employment Service. *Public Productivity Review*, 5, 141-159.

Sampson, S. E., and Showalter, M. J. (1999). The performance-importance response function: Observations and implications. *The Service Industries Journal*, 19(3), 1-25.

Sasser, W. E., Olsen, R. P., and Wyckoff, D. D. (1978). *Management of Service Operation: Text and Cases*, Allyn and Bacon Inc.

Shie, M. H., Lee, T. R. (Jiun-Shen), and Kao, C. K. (2015). To apply binary logit model and GRA to give advice for female consumers of used car on Internet. *International Journal of Performance Measurement*, 5(1), 33-60.

Wen, K. L., Huang, Y. F., Zhang, W. Z., Zhang, T. Z., Yu, M. R., and Lai, J. R. (2003). *Grey Relation Analysis model and application*. Gao Li, New Taipei City.

Westbrook, R. A., and Oliver, R. L. (1981). Developing better measures of consumer satisfaction: Some preliminary results. *Advances in Consumer Research*, 9, 94-99.

Woodruff, R. B., Cadotte, E. R., and Jenkins, R. L (1983). Modeling consumer satisfaction processes using experience-based norms. *Journal of Marketing Research*, 20(3), 296-304.

Yeh, T. M., and Wu, H. Y. (2014). The relationships among visitor experiential marketing, service quality, customer satisfaction and loyalty of tourism factories. *Journal for SME Development*, 31, 101-132.

Yuksel, I., and Dagdeviren, M. (2010). Using the fuzzy analytic network process (ANP) for balanced scorecard (BSC): A case study for a manufacturing firm. *Expert Systems with Applications*, 37(2), 1270–1278.