Application of Grey Relational Analysis to Determine Key Factors for Performance Measurement of Taiwan High Speed Rail Service Quality

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ABSTRACT— *In this paper, the balanced scorecard (BSC) is used to establish an effective performance measurement of Taiwan High Speed Rail (HSR) service quality, and then the grey relational analysis is used to determine key factors for performance measurement of Taiwan HSR service quality and the importance-performance analysis (IPA) is used to analyze HSR passenger service quality in a satisfactory condition. The results show that HSR passenger exhibit a performance and willingness to spend more money in exchange for saving time; thus, it is good to pay attention to punctuality, safety, and comfort. In addition, if the policy of HSR can provide preferential fares to passengers, it will be able to increase passenger satisfaction and loyalty. This way, passengers are willing to continue spending, bringing substance to enhance the profitability of HSR.*

**Keywords— **Taiwan High Speed Rail, balanced scorecard, grey relational analysis, importance-performance analysis, service quality

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1. INTRODUCTION

In an increasingly fierce and competitive market, companies often have to deal with falling profits. Not only should companies provide leading products, technologies, and innovation, but they should also establish and maintain good customer interactions. In other words, customer service is important. Thus, establishing customer loyalty is the key for company to create positive, long-term customer relations (Armstrong and Kotler, 2000). With the support of loyal corporate customers, a business can achieve sustainable development in business.

Commencing operations and service in 2007, Taiwan HSR is Taiwan's only HSR connecting Taiwan's north and south acting as an important traffic artery. The system has a total of 345 km and can travel up to maximum operating speed of 300 km/hour. The Taiwan HSR can zip from Taipei to Kaohsiung (Zuoying station) in just 90 minutes, while driving a vehicle takes four to five hours. Thus, HSR dramatically reduces the travel time between Taiwan's two biggest cities. However, the HSR construction costs were expensive, and resulted in insufficient funds that led to the company seeking outside financing. This action led to huge interest and debt burdens, and coupled with initial low traffic volume resulted in insufficient earnings. Thus, these problems caused the Taiwan HSR to experience heavy burdens and pressures financially. In light of heavy debts and low earnings from low traffic volume, the Taiwan HSR company sought out ways to deal with these issues by enhancing its value, obtaining customer favor, and seeking out the most favorable path of development. As a result, Taiwan High Speed Rail is now a sustainable company where the average value per customer to the company has increased by 25 % to 100%. This is due to the presence of loyal customers that have contributed in profits and development of the company (Reichheld and Sasser, 1990). Loyalty has affected customer satisfaction, and the relationship between the two is one of a positive correlation in which the higher the level of customer satisfaction, the higher the level of loyalty and vice versa (Day, 1977; Kasper, 1988; Lin et al., 2007; Yeh and Wu, 2014). Customer satisfaction occurs after the customer purchases the product or uses the service as a whole measured value for the use of the reaction obtained from using the product which leads an attitude towards the product (Woodruff et al., 1983; Fornell, 1992). Satisfied customers will measure higher levels of loyalty, higher levels of

customer loyalty and an increase in their willingness to purchase the product again, thereby affecting the enterprise's operating performance by increasing the enterprise's ability to obtain higher revenues (Reichheld and Sasser, 1990).

Customer satisfaction originates from delivering quality content and service. When customers experience higher quality service, the greater the perception of quality by customers that can be more in line with what customers have in mind in terms of desired quality, which ultimately leads to high levels of customer satisfaction (Hennig-Thurau et al., 2002; Huang, 2012). From the point of view service quality, the use of the SERVQUAL scale used to measure the gap between customer expectations and business services between the cognitive (Parasuraman et al., 1988). In this study, in order to be able to turn corporate vision strategy and implementation of measurable actions, called the Balanced Scorecard (BSC) (Kaplan and Norton, 1992), combined with corporate vision and sectoral objectives are, in accordance with its causal relationship to measure the dimensions of each series, there needs to be an establishment of a systematic satisfaction and loyalty measurement system tools. BSC for business performance assessment is not just only the information from the financial statements, in addition to the "Financial aspects" measure of focus, but also emphasized "customer aspects", "internal aspects", and "learning aspects" (Butler et al., 1997; Chow et al., 1997; Clinton and Hsu, 1997; Basu et al., 2009; Yuksel and Dagdeviren, 2010; Zizlavsky, 2014). Thus, the BSC is used in this paper, a causal relationship to Taiwan HSR link within the enterprise, measurable indicators of different dimensions, thereby exploring these facets (customer aspects, internal aspects, and learning aspects) on passenger satisfaction and loyalty.

This study was based on the BSC to construct the questionnaire, the questionnaire comprises (1) an emphasis on HSR passenger survey, (2) HSR passenger satisfaction surveys, and (3) HSR passenger loyalty survey. Then, the study based on the grey relational analysis (GRA) was analyzed, whereby the extracted key important factor to take HSR passengers seriously. GRA, a common method to identify important factors affecting the business or organization trends, is used to equip the main characteristics of things, has been widely used in various studies (Deng, 1989; Deng, 1997), and the calculation process simple and clear and does depend on large amounts of data, etc. (Huang et al., 1996). Next, the importance-performance analysis (IPA) was used to learn guests for high-speed performance attributes great importance to the degree of HSR to the performance standards of customers, to provide the status of HSR for themselves the quality of performance attributes to make an evaluation, but also for future business development or improvement of the status of the customer reference (Sampson and Showalter, 1999). Finally, the construction of HSR passengers according to their satisfaction and loyalty of satisfied loyal matrix, with its HSR to help better understand the needs of their customers' expectations.

2. LITERATURE INVESTIGATION

This section is divided into three parts. The first part describes the quality of service, the second part is to introduce the Balanced Scorecard, and the third part describes customer satisfaction and loyalty.

2.1 Quality of Service

Service refers to a variety of activities for sales or general related activities, for the interests of the content or satisfaction, attached to the product in order to increase the value or utility of the product (Lovelock, 1979). It is an invisible economic activity, an abstract and elusive concept (Crosby, 1979), as it is difficult to determine if the service is "good" or "bad". Moreover, since consumers view services with subjective attitudes, formulating a uniform method of determining quality is difficult (Sasser et al., 1978). Therefore, Parasuraman et al. (1985), for consumers, service quality is more difficult to evaluate than the product quality; therefore, since proposed service quality as perceived as a quality gap between pre-service and post-received services, which constitutes a more realistic comparison of how customer service expectations beforehand and after service.

Based on Parasuraman et al. (1985) and Parasuraman et al. (1988), a conceptual model of service quality is proposed and can be quantified as the SERVQUAL scale. The SERVQUAL scale includes "tangibles quality", "reliability quality", "responsiveness quality", "assurance quality", and "empathy quality" five dimensions used to measure the gap between customer expectations and recognition of the enterprise's services. The SERVQUAL scale is the good indicator to measure the service quality (Fisk et al., 1993) and is referred to as the standard (Llosa et al. 1998). Thus, it has been investigated in many studies (Alavi and Majidi, 2015; Mokhtar and Husain, 2015; Nhavira, 2015; Galeeva and Chatterji, 2016). Moreover, Lu and Wu (2010), Kuo and Tang (2013), and Liu et al. (2013) applied the SERVQUAL scale for measuring the service quality of Taiwan HSR.

2.2 Balanced scorecard (BSC)

The BSC is based on the company's vision and strategy and constitutes the starting point, and combined with the performance of financial and non-financial metrics to measure system performance assessment indicators are divided into four dimensions: (1) Financial aspects; (2) customer aspects; (3) internal aspects; (4) learning aspects. That is to say in addition to the BSC, the scoreboard contains financial indicators, but also enhance the results of customer satisfaction, financial performance indicators, internal process metrics, and organizational innovation and improved operational indicators employees. Therefore, the BSC managers will be able to promote all the important operational indicators to a

macro point of view and also consider that allows managers to detect whether improvements in one area, it can affect the other aspects (Kaplan and Norton, 1992).

The BSC has been assessed in many studies for evaluating the service quality. Mendes et al. (2012) adopted the BSC to study the needs of the Portuguese public service in the waste sector. Sainaghi et al. (2013) used the lens of the BSC to measure the hotel performance. Chang et al. (2014) proposed the performance measurement of cloud computing services for enterprises based on the BSC. Hsu (2015) and Lee (2015) applied the BSC to assess the performance on the medical service quality. In the foregoing investigations, the BSC is widely to use for evaluating the service quality performance. Thus, the primary focus of this paper is to establish an effective measurement system for assessing the service quality of Taiwan HSR by using the BSC in order to be able to turn corporate vision strategy and implementation of measurable actions.

2.3 Customer Satisfaction and Loyalty

After customer purchases, customer satisfaction is evaluated after a certain time (Howard and Sheth, 1969). Therefore, customer satisfaction specific situations incites immediate emotional responses. In terms of measuring customer satisfaction, the Likert-type Scale (Likert, 1932) as adopted by the majority of scholars is often used to assess the degree of satisfaction of the subject (Westbrook and Oliver,1981; Hallowell, 1996; Garbarino and Johnson, 1999; McCollough, 2000; Cronin et al., 2000), and this yardstick to measure the contrast with the other measurement methods. Subjects that were evaluated using the Likert Scale were easier to be accepted for this study. Therefore, the Likert-type Scale is used to measure the customer satisfaction in this study.

Customer loyalty can be regarded as personal attitudes and patronage behaviors which can be used to measure the strength of the relationship between the two (Dick and Basu, 1994). The stronger relationship between personal attitudes and patronage behaviors, the higher the probability that customer will patronize the business again, and the higher the level of customer loyalty. Measuring customer loyalty can be a barometer of repeat business by customers, and also measure the customer's level of price tolerance (Fornell, 1992). General, the common indicators of customer loyalty include: (1) customer willingness to repeat purchase: measuring customer satisfaction and intention to repurchase, and the results of measuring these customer satisfaction and intention to repurchase can be used as an indicator to analyze future customer behavior; (2) customer willingness to recommended product brand to others: measuring brand reputation perception by customers, and willingness to publicly recommend and introducing (the product) behavior; (3) the level of customer price tolerance: willingness to purchase at given price; (4) cross-purchase: the willingness to buy the company's other products (Jones and Sasser, 1995). Thus, these four indicators are used to measure the customer loyalty in this study.

On the whole, high customer satisfaction and loyalty means increased customer patronage in the future; that is, to increase frequency of purchases, and volume of purchases. Thus, customer loyalty can bring in substantial profits or revenues.

3. QUESTIONNAIRE DESIGN AND ANALYSIS METHOD

The following introduces the present study: the Balanced Scorecard-designed questionnaire, the grey relational analysis, and IPA analysis method.

3.1 Questionnaire Design

In this study, researchers conducted surveys in the field by soliciting passengers aboard the HSR. The questionnaire content is divided into four parts: (1) survey on the importance of the HSR for the passenger (2) survey on customer satisfaction, (3) survey on customer loyalty, and (4) survey on basic characteristics of customers (Figure 1).
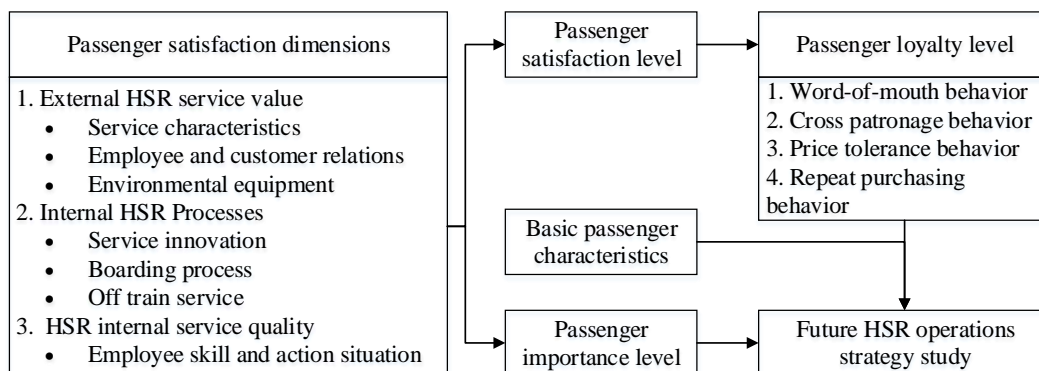

Figure 1: Questionnaire architecture

Among the survey sections on the degree of importance and levels of satisfaction, the questionnaire contains: the value of HSR external services (customer dimension), HSR internal processes (internal processes dimension), and HSR internal service quality (learning and growth dimension), and in accordance with causality to measure the dimensions of each series, detailed metrics listed in Table 1.

(1) External services: if you want to achieve excellence in terms of financial performance, it is necessary to create and provide products and services that passengers want. The questionnaire design includes three parts, (1) the properties of products and services: to provide to the guest a product or service with function, quality, price and time; (2) employees and customer relations: how do passengers feel about employees when aboard the HSR, and (3) environmental equipment: the effect of surrounding equipment on how attractive HSR is to customers.

(2) The HSR internal processes: HSR internal processes should be thinking about how to meet the passengers wants products and services. The questionnaire design includes three parts: (1) service innovation: looking at potential passenger demands, and then create a product or service to meet those demands, (2) the waiting process: providing quality services in an efficient and timely manner to passengers, (3) post-HSR service: after the taking the HSR, how can the company continue increase the number of passengers aboard and HSR service value.

(3) Internal service quality: service quality of internal staff, external service value for the HSR and high-speed internal processes providing for the infrastructure. Employee skill and action atmosphere questionnaire design: first line employees are most familiar with the internal processes and passenger's needs, employees can improve their skills through providing incentives, authorization and cooperation , improve staff enthusiasm, initiative, in pursuit of the organization's goal.

Table 1: Indicator of importance and satisfaction measurement questionnaire

Research dimensions		Indicator of measurement questionnaire	
External service value	HSR service characteristics (function, quality, price, and time)	Q.1	Train punctuality situation
		Q.2	Reasonable price
		Q.3	Convenience level in relation to other forms of public transportation
		Q.4	Train security and safety
		Q.5	Train comfort
		Q.6	Train speed
	HSR employees and passenger relations (communication, attitude)	Q.7	HSR employee's level of attention towards passengers
		Q.8	HSR employee's level of patience towards passengers
		Q.9	HRS employee's explanations when passengers inquire
		Q.10	HSR employee's level of service towards passengers
	Environmental equipment	Q.11	Cleanliness, beauty, and greenness of the environment
		Q.12	Level of cleanliness of HSR train cars and bathrooms
		Q.13	Level of cleanliness of HSR stations
		Q.14	Efficiency level of service in HSR station emergency rooms
Internal processes	Service innovation	Q.15	Online booking
		Q.16	Convenient store booking
		Q.17	Post-booking convenience store policy
		Q.18	Self-service booking service
		Q.19	Early bird discount
		Q.20	Wi-Fi internet and charging service
		Q.21	Handicapped cars
	Waiting process	Q.22	Direction marks or pathway arrangement
		Q.23	Window service waiting times
		Q.24	Service equipment and passenger waiting area design
		Q.25	Level of clarity of content of announcement system
	Off-train service	Q.26	Dealing with customer complaints
		Q.27	Dealing with HSR emergencies
Internal service quality	Employee skill and action atmosphere	Q.28	HSR employee expertise and skills
		Q.29	HSR employee emotional state
		Q.30	HSR employee understanding of service quality

Table 2: Indicator of the questionnaire loyalty metrics

Indicator	Indicator of measurement questions
Willingness to recommended product brand to others	Q.31 Would you be willing to recommend Taiwan HSR to your friends?
Cross-purchasing	Q.32 Would you be willing to purchase food or other products in the HSR station or train car?
Customer's level of price tolerance	Q.33 Would you be willing to tolerate HSR's high price compared to other modes of transport?
Customer's willingness to repeat purchase	Q.34 Would you be willing to patronize Taiwan HSR again?

Customer loyalty can be regarded as personal attitudes and patronage behaviors which can be used to measure the strength of the relationship between the two. The stronger relationship between personal attitudes and patronage behaviors, the higher the probability that customer will patronize the business again, and the higher the level of customer loyalty. On the other hand, the relationship between personal attitudes and patronage behaviors can also go the other way where the weaker the relationship, lower the probability of customers will patronize again. Thus, a measure of customer loyalty in this study includes: (1) word of mouth behavior, (2) crossover patronage behavior, (3) price intolerance, and (4) repeat customer patronage, detailed metrics are listed in Table 2.

3.2 Analysis Method

The "Importance of the HSR Passenger Survey" questionnaire of grey relational analysis was analyzed, and thus extracting the key importance factors for aboard passengers in taking HSR seriously. First, according to the results from the questionnaire we found "comparison sequences" and "target sequences", and then the grey relational coefficient (*r*) for importance of questionnaire items can be calculated, to obtain further the grey relational degree. Thereafter, once the grey relational degree are obtained, a descending sorting order in the grey relational degree can be determined. Important factors consider in regard to this degree when it comes to passenger and their decisions to use the HSR are as detailed steps are as follows:

Step 1. In this paper, the five point Likert scale is utilized as the evaluation standard, where 1= strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. The comparative sequence $x_i=\{x_i(1), x_i(2), …, x_i(k)\}$, where $x_i(k)$ is the ith survey respondents in the questionnaire survey was answered by scores of great importance to the questionnaire asked the kth item; and the reference sequence $x_0=\{x_0(1), x_0(2), ..., x_0(k)\}$, because those who fill in the questionnaire if answered 5 means most of its attention to the impact of the items described, so the definition of $x_0(1)=x_0(2)=...=x_0(k)=5$. The difference sequence is defined as the absolute difference between the reference sequence and comparison of sequences, expressed as $\Delta_{0i}(k) = \left| x_0(k) - x_i(k) \right|$.

Step 2. Grey correlation coefficient formula (1), in which the distinguished coefficient ζ function that this assessment shows a comparison between the sequence and the reference sequence, and it is generally recommended that a value averaged 0.5 reaches to the distinguished coefficient (Deng, 1989). When the grey correlation coefficient close to 1, it indicates the comparative sequence x_i and the reference sequence x_0, the higher the degree of association; whereas the closer to 0, the lower the degree of association between the two.

Step 3. That is, as the grey relational degree formula (2), the average grey correlation coefficient, represents the degree of association between the comparative sequence x_i and the reference sequence x_0 (Deng, 1997). When the grey relational degree greater the degree of importance to ask on behalf of the item is greater.

The value that represents the grey relational degree of association between the comparative sequence x_i and the reference sequence x_0 to be arranged in order to form a relationship that is grey relational sequence can be used as a key basis for analysis and decision-making.

$$r\left(x_0(k), x_i(k)\right) = \frac{\forall_i^{min.} \in i \forall_k^{min.} \Delta_{0i}(k) + \xi \forall_i^{max.} \in i \forall_k^{max.} \Delta_{0i}(k)}{\Delta_{0i}(k) + \xi \forall_i^{max.} \in i \forall_k^{max.} \Delta_{0i}(k)} \tag{1}$$

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

The results of grey relational analysis for "HSR passenger importance Survey" questionnaire can be used as for IPA analysis purposes to provide understanding of passenger's perception of HSR's attributes in terms of quality vis-a-vis passenger satisfaction. The IPA analysis steps are as followed:

Step 1. Passenger satisfaction of HSR passenger satisfaction survey is shown on the horizontal axis, and the grey relational degree of the HSR passenger importance survey representing the degree of importance is shown on the vertical axis.

Step 2. The average values of the grey relational degree and the satisfaction are regarded as the dividing point, and the space is divided into four quadrants.

The first quadrant (I) indicates the evaluations of the importance and satisfaction are high, fall in this quadrant of property should remain the dominant holding area (keep up the good work); the second quadrant (II) represents the low level of importance, but largely satisfied, this quadrant of the property may indicate excess supply (possible overkill), the case may hold too much emphasis on this region; the third quadrant (III) is the difference between all this quadrant attribute indicates improvement priorities low, it is a low priority improvement district (low priority); the fourth quadrant (IV) represents a high degree of importance but poor satisfaction, this quadrant is the key attribute should focus on the supply of services to focus on improving the area (concentrate area).

4. DATA ANALYSIS AND DISCUSSION

The results are comprised of the following: (1) HSR passenger importance survey analysis (2) IPA analysis, and (3) HSR passenger groupings.

4.1 HSR passenger importance survey analysis

In this study, the questionnaire on the "importance of HSR passenger survey" analysis was utilized, and the research methods used for the grey relational analysis to extract important key factor in knowing what HSR passenger aboard value. According to Equation (2), the results for the grey relational degree of the HSR passenger importance survey are shown in Table 3. Then, the table of grey relational degree in Table 3 is converted to the number of lines as a graphical representation is shown in Figure 2, and the position of each point in the right side represents the greater the grey relational degree, that is, the higher the importance of the item asked, according to the tightness of the gap between two points, which can be divided into nine groups. According to Daniel's principal, 3-6 key factors affect the conditions for success if companies lack these key factors, then the business will likely fail (Daniel, 1961). Therefore, this study follows this principal, select 3-6 after stopping factor extraction, and thus use this as a key factor in the way screening is important.

According to Daniel's principle, in part, the HSR passenger survey importance of having taken five important factors, namely: the first group of "Q.1 Trains punctuality situation" (GRE = 0.7721), and "Q.4 Train security and safety" (GRE = 0.7674), a total of two; the second group "Q.5 Train comfort" (GRE = 0.7379), "Q.12 Level of cleanliness of HSR train cars and bathrooms" (GRE = 0.7370) and "Q.19 Early bird discount" (GRE = 0.7369), a total of three.

Table 3: Grey relational degree and grey relational sequence of HSR passenger importance survey questionnaire asked each of the items

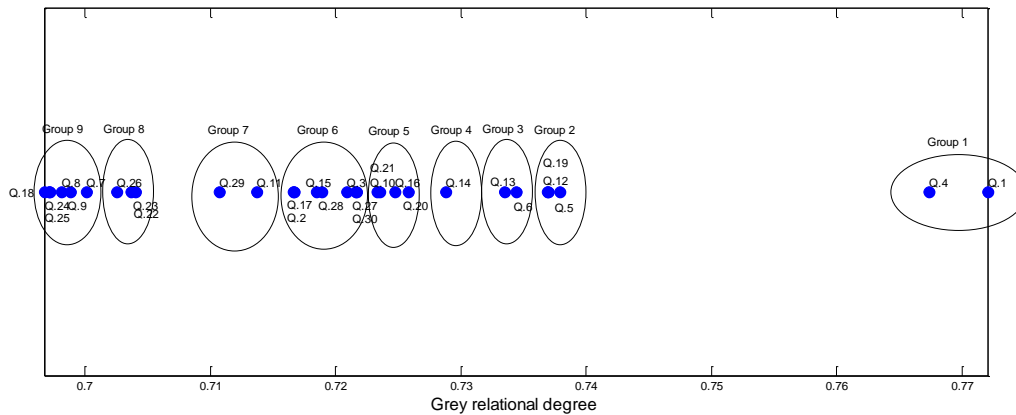| Number	Grey relational degree	Grey relational sequence	Number	Grey relational degree	Grey relational sequence
Q.1	0.7721	1	Q.28	0.7189	16
Q.4	0.7674	2	Q.15	0.7185	17
Q.5	0.7379	3	Q.17	0.7167	18
Q.12	0.7370	4	Q.2	0.7166	19
Q.19	0.7369	5	Q.11	0.7137	20
Q.6	0.7344	6	Q.29	0.7107	21
Q.13	0.7335	7	Q.23	0.7040	22
Q.14	0.7288	8	Q.22	0.7037	23
Q.20	0.7258	9	Q.26	0.7025	24
Q.16	0.7247	10	Q.7	0.7001	25
Q.10	0.7235	11	Q.9	0.6988	26
Q.21	0.7233	12	Q.8	0.6981	27
Q.27	0.7217	13	Q.24	0.6972	28
Q.30	0.7216	14	Q.25	0.6971	29
Q.3	0.7209	15	Q.18	0.6968	30

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

4.2 Result of IPA analysis

The IPA analysis is based on the "HSR Passenger Importance Survey" and "HSR Passenger Satisfaction Survey" where the data recovered is drawn from the scatter plot of importance-performance analysis to analyze HSR passenger service quality in a satisfactory condition.

The scatter plot of importance-performance analysis of the horizontal axis represents the degree of satisfaction, and the vertical axis represents the degree of attention, where the emphasis in Table 3 to GRE expressed as a numerical results are shown in Figure 3. In Figure 3, in regards to the satisfaction and GRE values of Table 3, the average values of the two as the origin, the graphic is divided into four quadrants.

(1) The first quadrant (I) represents the competitive advantage of HSR service, express service quality-related policies in the first quadrant of the decision is correct, which is in line with visitors expected. Thus, it should continue to maintain this advantage, including HSR service characteristics (Q.1, Q.4, Q.5, Q.6), HSR employees and passenger relations (Q.10), Environmental equipment (Q.12, Q.13), service innovation (Q.21), and employee skill and action atmosphere (Q.30). According to the grey relational analysis results in the first quadrant passenger attention items "Q.1 Trains punctuality situation", "Q.4 Train security and safety", "Q.5 Train comfort", and "Q.12 Level of cleanliness of HSR train cars and bathrooms". Since the HSR passenger's preference to spend more money in exchange for the cost of more time, so the most important reference points for passengers of high-speed are the areas of transport, safety and comfort.

(2) The second quadrant (II) represents the excessive aspects of the allocation of resources supply. Taiwan has entered the era of the service economy. If the service providers exhibit bad attitudes, customer satisfaction will be directly affected, thereby resulting in unexpected business losses. From analyzing the results, HSR employees and passenger relations (Q.7, Q.8, Q.9), environmental equipment (Q.11), service innovation (Q.15, Q.17, Q.18), waiting process (Q.25), and employee skill and action atmosphere (Q.28) high passenger satisfaction, the main hope is that the interactions between frontline employees and passengers can create and enhance passenger satisfaction for HSR. However, in the consumer era, travelers tend to take good service for granted, so the results show that passengers do not place as high of a perception on these items as they otherwise would. Nevertheless, Taiwan High Speed Rail Plan should maintain the rational allocation of resources in order to achieve maximum economic efficiency. For example, in the service innovation (Q.15, Q.17, Q.18) section, you can take advantage of Taiwan's developed mobile phone network in terms of an advantage and integration of developing a more convenient booking experience for passengers.

(3) The third quadrant (III) indicates that Taiwan HSR lacks a competitive advantage in certain items related to being unable to meet the different needs of customers but is listed as a minor improvement, such as HSR service characteristics (Q.2), waiting process (Q.22, Q.23, Q.24), off-train service (Q.26), employee skill and action atmosphere (Q.29) and the like. In terms of HSR service attributes (Q2), which is to say high fares, travelers have been complaining about this issue. Hence, how can we implement a price reduction program without negatively affecting the revenue is the focus of HSR reform. In the waiting process (Q.22, Q.23, Q.24), mainly due to a number of HSR stations in which there is a three-iron common configuration, that is, HSR, Taiwan Railway, and shared subway station access. Although this configuration can facilitate the transfer of passengers transport, the complexity of corridors and provided spatial arrangements causes inconveniences passengers and wastes their time. Off-train service (Q.26) and employee skill and action atmosphere (Q.29), that is customer complaints and employee emotional expression are a recoverable customer-oriented quality of service attitude.

This always takes the initiative to care for the needs of passengers, reducing passenger negative emotions and improve their willingness to ride again.

(4) The fourth quadrant (IV) indicates HSR service characteristics (Q.3), service innovation (Q.14, Q.19, Q.20), and employee skill and action atmosphere (Q.27) did not attain customer favor. Thus, among HSR service characteristics (Q.3), the issue of inconvenient station transfer should be resolved, which is responded with the fact that multiple forms of transport such as buses do exist to meet the different needs of customers. In the service innovation (Q.14, Q.19, Q.20) sectors, they should enhance the professional competence of nurses, enhancing the service quality first line workers in a timely fashion in terms of handling of customer complaints in an event capacity in order to achieve customer satisfaction, providing promotional programs to attract passengers aboard, setting up a wireless Internet service and charging devices in the station to provide passengers power using mobile devices. In the employee skill and action atmosphere (Q.27), there is a complete active processing mode or regulatory systems, which combined with improved education and training programs so that each employee can perform in the best possible professional and expeditious manner in order to deal with the problem.

In the fourth quadrant, the fourth quadrant of the item indicates it is low but it belongs to higher satisfaction loyalty where satisfaction is HSR passenger service for all aspects of the comprehensive evaluation, and guest loyalty is indicated on whether or not passengers will continue to use the HSR in the future. Due to the fact that consumers expect a certain product or service from the company, pursuing high satisfaction may not necessarily be able bring profits to the enterprise. That means that just providing and allowing consumers continue to use the product or service is still key. It is noted that maintaining customer loyalty and a strong position do contribute to the enterprise's competitiveness, which translates to consumers willing to continue to use the product or service. Thus, to explain the lower-satisfaction-and-higher-loyalty-phenomenon, showing that passenger loyalty to HSR comes from acts of loyalty rather than an attitude of loyalty, it can be said that passengers exhibit more weak, lukewarm loyalty rather than strong, deep loyalty. Once competitors have grown in size, if satisfaction levels have not risen, the company's competitiveness will decline. Since the HSR is part of an exclusive industry, consumers tend to have a basic motivation to use it, which is the first quadrant of the item, such as convenience, safety, speed and other factors are noted as factors in using the HSR service; moreover, HSR competitors (such as TRA) are not competitive enough yet for consumers to redirect loyalty towards: hence, HSR consumers' attitude of loyalty.

According grey relational analysis, results in the fourth quadrant passenger indicate that the promotion item (Q.19) "Early bird discount" has found that high fares have been the biggest obstacle to improving company earnings. Since the HSR is a monopoly and is backed by government welfare, a lower fare would offer concessions to passengers. This, in turn, will be able to increase passenger satisfaction, avoid losses of passengers, and bring about higher satisfaction. This action will increase the level of loyalty, and so guests will continue spending, and therefore will be able to increase the profitability of HSR.

4.3 Grouping of consumer HSR

Jones and Sasser (1995) pointed out that "complete satisfaction" is defined as to ensure that the customer satisfaction and customer loyalty must reach 4 points or higher on a 1-5 point scale in order to ensure long-term customer loyalty. Therefore, the present study places consumer satisfaction on the horizontal axis, consumer loyalty on the vertical axis, and with the origin defined as (subject satisfaction, loyalty subjects) = (4, 4). According to the HSR consumers, the level of satisfaction and zone of loyalty can be divided into four groups, and the significance of these groups are placed in the quadrants as follows:
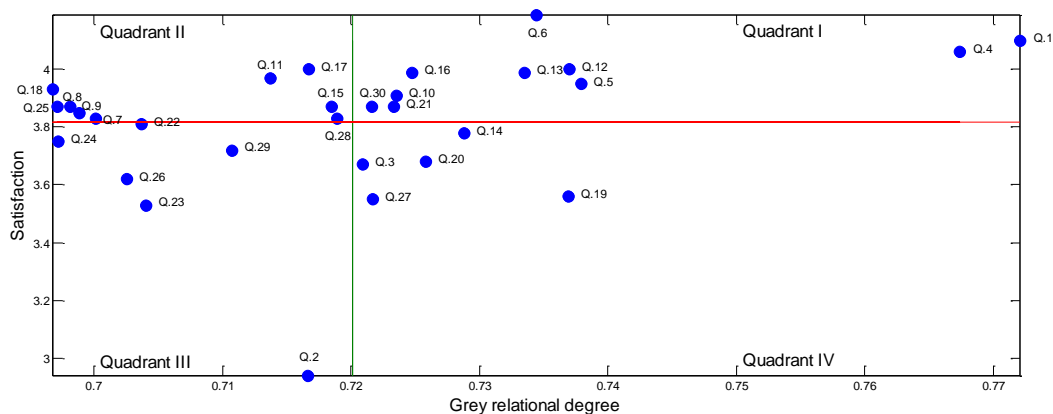

Figure 3: Scatter plot of importance-performance analysis

(1) The first quadrant (I) - loyal consumers: In this group, consumer satisfaction and loyalty towards HSR are high. Therefore, this group of consumers is very satisfied with the services provided by the HSR and are willing to ride Taiwan HSR again.

(2) The second quadrant (II) - dissatisfied-yet-loyal consumers: In this group, consumer satisfaction is low, but the loyalty to HSR is very high. Therefore, although this group of consumers is willing to take HSR again, but the level of complains and dissatisfaction will continue to increase; if the company is unable to improve its HSR - related services, consumers may, therefore, choose another mode of transportation.

(3) The third quadrant (III) - dissatisfied, loyal-less consumers: In this group, satisfaction and loyalty to HSR are low. Therefore, this group of consumers is not only dissatisfied by the services provided by HSR, but also lack any loyalty to it. Hence, they may not want to take the HSR again.

(4) The fourth quadrant (IV) - satisfied-yet-loyal-less consumers: In this group, consumer satisfaction with HSR is high but, paradoxically, loyalty is low. Therefore, although this group of consumers feels satisfied with the services provided by HSR. For this group of consumers, consumers indicated that if competitors can provide better transport products and services, they will consume products and services of competitors for future transport needs.

Among the four groups, the second quadrant said that the HSR's potential could be realized if the company is able to provide improved services. Better services mean higher levels of satisfaction, which would lead to loyal customers among the second quadrant consumers. According to an analysis of the survey results, the second quadrant group (dissatisfied-yet-loyal consumers) reported the lowest level of satisfaction in regards to "Q.2 Reasonable price". For HSR companies, high fare if not accepted by the market, and ultimately will not bring profit for the HSR. From the perspective of HSR companies, high fares must be accepted by the market in order to maintain profitability. If the market cannot accept high fares, then HSR is ultimately not profitable. Thus, if Taiwan HSR can provide special ticket fares such as that asked in item "Q. 19 Early bird discount", passenger satisfaction levels will increase while passenger losses will decrease. Higher levels of satisfaction will also improve consumer loyalty, which will lead to sustainable ridership and thus enhanced profitability for the company.

5. CONCLUSION

Taiwan HSR is currently facing large interests payments and debt burdens, while lacking sufficient passenger traffic; thus affecting operating income. Therefore, the Taiwan HSR must create its own value, obtain the customer favor, and seek out the most favorable strategy for its development. In order for this enterprise to survive, that is maintaining positive, long-term relationships with customers and establishing new positive, long-term customer relations, it will have to enhance customer loyalty. Therefore, this study will use the BSC to understand the value of the enterprise and the situation outside the company's establishment, establish an effective guest satisfaction and loyalty measurement system. This study will also use the use the grey relational analysis and the understanding of IPA analysis of HSR passenger loyalty behavior. The results show that passengers' motivation to take HSR is to utilize HSR in order to save time in exchange for more money; thus, it is important to pay particular attention to the punctuality of HSR trains, along with safety and comfort. In addition, for HSR companies, high fares have been the biggest obstacle to increasing company profit. If the policy will provide preferential fares to passengers, it will be able to increase passenger satisfaction, avoid losing passengers to competitors, and in turn the higher satisfaction levels will increase consumer loyalty. Thus, passengers will be willing to continue riding HSR and therefore enhance company profitability.

6. REFERENCES

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