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# Public transport service quality: Policy prioritization strategy in the importance-performance analysis and the three-factor theory frameworks

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ABSTRACT

Service quality is a determinant of increasing public transport rider satisfaction. However, understanding of service quality and satisfaction relations has been limited. This study seeks an appropriate method to demonstrate the nature of service quality-satisfaction relations. Thereby, research results can be methodologically, theoretically, and empirically defensible. The importance-performance analysis (IPA) and the three-factor theory, the most widely preferred for public transport service quality prioritization based on the importance of service factors to rider satisfaction, will be utilized. The study takes transit service in Ho Chi Minh City (HCMC), Vietnam, to demonstrate that the three-factor theory, which has been limitedly utilized despite being more advantageous and robust, is superior to the IPA. Although the extent to which the service quality factors affect satisfaction varied across rider segments, the types of service quality factors were found consistent. For example, captive riders considered all service factors as performance. Non-captive riders considered the environment factor as excitement. No basic factor was found across rider groups. This study contributes to the limited understanding of the non-linear and asymmetric relations between service quality and satisfaction of various rider groups, which is rarely found in transit service quality literature. Furthermore, it introduced a case study of Vietnamese urban transit services for the first time. It suggests that enhancing passenger information, rider care, and comfort are recommended as the most practical and economical measures in the short run. However, the city government should improve availability and accessibility to promote public transport ridership in the long run.

## 1. Introduction

Promoting public transport (PT) is a determinant of urban mobility as it provides various benefits. For instance, it encourages modal shifts from private motorized vehicles to PT and non-motorized traffic, e.g., walking and bicycling. Therefore, on the one hand, it reduces traffic congestion, travel time, noise, and air pollution. On the other hand, it positively affects riders' health by stimulating their physical activities or improving the urban environment (de Sá et al., 2017). Increasing PT use also reduces price elasticity because

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attracting more users can boost profits and reduce operating costs (Matzler et al., 2003). Moreover, public transport significantly contributes to social equity by providing vulnerable travelers, e.g., disabled, elderly, non-vehicle ownership people, opportunities to travel. In this light, increasing service performance should be given special attention from service providers' efforts to promote PT use.

Although providers provide PT service performance, users are "the sole judge of service quality" (Berry et al., 1990). Research has widely agreed that there is a strong link between service quality and PT ridership. More specifically, riders' satisfaction, PT use retention, and positive word-of-mouth are significantly associated with rider perception of service quality (Lai & Chen, 2011; Nguyen-Phuoc et al., 2020; van Lierop & El-Geneidy, 2016). Enhancing service quality, based on understanding its effects on rider perception and satisfaction, is a prerequisite for raising PT uses.

The critical question that needs to be addressed is, among service quality factors, how service providers should allocate resources that most effectively stimulate rider satisfaction. Two approaches have been applied, the IPA (importance-performance analysis, Fig. 1) and the three-factor theory (Fig. 2). The IPA has been widely utilized for transport service management and marketing strategies. However, it has several critical methodological and theoretical limitations. For example, the assumption that the perception of importance and satisfaction are independent, locations of the cross-hair are indefensible, and the understanding and interpretation of the importance are vague. Therefore, the applications of the IPA in such circumstances are unreliable.

The three-factor theory (Kano et al., 1984) method is recommended to overcome the limitations of the IPA. It implies that the effects of service quality factors on rider satisfaction are non-linear and asymmetric. The three-factor theory has been applied widely for service quality management (Mikulić & Prebežac, 2011). Interestingly, its applications in the transport field have been limited (twelve articles were found with the keyword "three-factor theory" in all transport journals in the google scholar database in August 2021, Table 1). Furthermore, research has demonstrated that customer perception (or passengers in transport) on service quality varies across rider groups, depending on economic constraints, e.g., high or low income, and country contexts, e.g., developing and developed countries. The three-factor theory has been rare in the transport field compared to the IPA; its utilization to differentiate service quality effects across rider segments is even rarer. Moreover, the research that utilized the three-factor theory and considered heterogeneity among transit riders has merely been found in Sweden and China (see Abenoza et al., 2019; Chee et al., 2020; Fang et al., 2021 in Table 1). Investigation of the same kind has not been acknowledged in Vietnam.

This study seeks an appropriate method for assessing service factors' effects on rider satisfaction and being empirically defensible for policy practices. It contributes to the existing transport service literature on three points. First, it demonstrates that the three-factor theory is superior to the IPA in describing the nature of service quality-rider satisfaction relations. In contrast, the IPA is practically and methodologically insufficient. Second, the study moves one step forward in differentiating passengers into more homogenous segments. More specifically, previous studies distinguished rider groups by either travel frequency or vehicle captivity (Abenoza et al., 2019; Chee et al., 2020; Fang et al., 2021). This study differentiates rider groups by both travel frequency and captivity (Fig. 4). For instance, riders in segment 1 include those who travel frequently and have no vehicle. Finally, for the first time, this study introduces the case study of Vietnam, which is expected to appeal to scholars, practitioners, and policy-makers in transit service quality.

The remainder of this paper is organized as follows. In the next section, we review the application of service quality analysis in the transport field. We emphasize the applications of the IPA, the three-factor theory, and the segmentation of PT riders to investigate research gaps in the fields. Section 3 presents Ho Chi Minh city's PT context and research design, including sampling design, passenger segmentation, and analysis method. Section 4 will explain the research results, including descriptive statistics, key analysis findings, discussions, and policy implications. Conclusions will be presented in section 5.

## 2. Service quality analysis in transport: Literature review

Service quality is vital in any business organization as it determines the business's fall or success. Well-known pioneers (Parasuraman et al., 1985) introduced a model that enables measuring consumers' service quality perception, such that "*service quality perceptions result from a comparison of consumer expectations with actual service performance*." The authors claimed five service quality factors, i.e., tangibles, reliability, responsiveness, assurance, and empathy, were determinants of service quality after the purification (Parasuraman et al., 1988). Their research works have been widely utilized as a fundamental grounding in service quality assessment in many fields. It is generally agreed that service quality is positively associated with customer (rider) satisfaction and word-of-mouth (Lai & Chen, 2011; Nguyen-Phuoc et al., 2020; van Lierop & El-Geneidy, 2016).

The two most well-known service quality analysis and policy prioritization techniques have been acknowledged in the literature, i.e., the IPA (importance-performance analysis) and the three-factor theory. The IPA has been widely recognized in transport (131 academic articles on transport have been found with the keyword "Importance-Performance Analysis" in the google scholar database in August 2021). However, it holds critical methodological and theoretical problems that are not empirically defensible (Oliver, 2014). In contrast to the IPA, the three-factor theory has not been well acknowledged (Table 1), although it relaxes the limitations of the IPA. Furthermore, studies that utilized the three-factor theory and considered the rider segments into account have been limited (three out of twelve, Table 1). In addition, previous research has focused on limited contexts, such as Sweden, the United States, China, Thailand, and India (Table 1). Research on the context of Vietnam has rarely been found. This study contributes to the transport literature by demonstrating that the three-factor theory is superior to the IPA in the context of Vietnam. Moreover, it addresses the existing knowledge on the effects of service factors on rider satisfaction in various segments by their travel characteristic (frequent, infrequent) and vehicle ownership (captive or choice).

### 2.1. The importance-performance analysis

The IPA (Martilla & James, 1977) classifies factors of a service (or product) into four quadrants, which are formed by two axes, i.e., importance and performance (Fig. 1). In practice, the performance of a quality factor is often derived from rating customers' satisfaction. The importance of a service factor can be obtained from either rating (stated or explicit importance) or statistical techniques (implicit importance). The "Low priority" quadrant includes quality factors that are of low performance and low importance. It is not essential to provide additional investment to improve these quality factors. On the opposite side, high performance and high importance quality factors indicate a firm's capability in service providing. They should "Keep up the good work" to maintain competitive advantages over the others. Quality factors with low performance but high importance ("Concentrate here") should be allocated more resources to improve their performance. Factors at the quadrant "Concentrate here" could pose threads to a firm if they are neglected. The last quadrant, "Possible over-kill," contains factors at high performance, but less importance presents that a firm has invested too much for less essential quality factors. The firm should re-allocate its resources to improve other quality factors.

In transport, the IPA has been widely adopted for the quality assessment of transit services and transport facilities. One hundred thirty-one (131) academic papers were found with the keyword "Importance-Performance Analysis" in the google scholar database in August 2021). However, the IPA has some severe conceptual and methodological disadvantages that have been acknowledged in the literature. The first methodological issue is based on the assumption that the importance and performance of service factors are independent. However, consumers often rate service factors as higher (or lesser) important if they are more (or less) satisfied. Consequently, service factors mostly fall into 'Keep up the good work' or 'Low priority' (Oh, 2001). The second issue is the underlined assumption of the IPA that the effects of performance factors on overall satisfaction are linear and symmetric (Matzler et al., 2004). Many studies in transport (Table 1) and other service industries (Füller & Matzler, 2008; Matzler et al., 2004; Mittal et al., 1998) claimed that service factors non-linearly and asymmetrically affect consumers' (riders') satisfaction (Section 2.2). The third methodological drawback of the IPA is that the different identification methods of the cross-hair location (e.g., data-center, scale-center, and iso-rating line) could lead to totally different results. The critical problem is that the three methods produce different results (Fig. 1). Consequently, interpretations and policy implications vary across methods without knowing why (Azzopardi & Nash, 2013; Cao & Cao, 2017; Oliver, 2014; Sever, 2015).

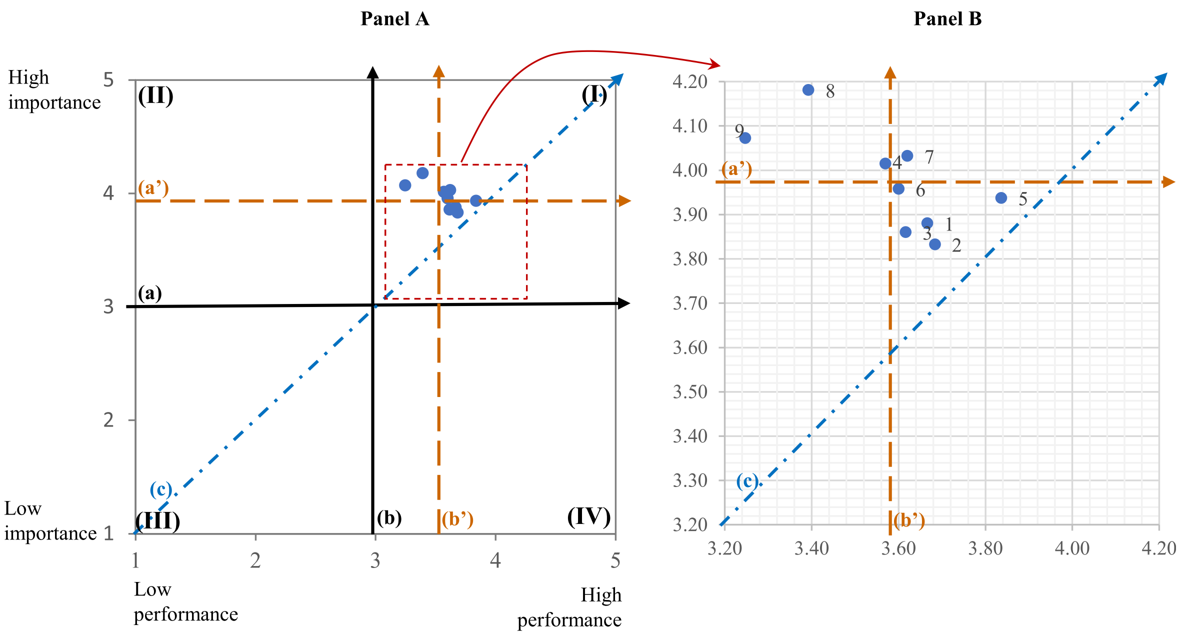


**Fig. 1.** Importance – Performance Analysis. ***Notes***: Quadrants: I - "Keep up the good work"; II - "Concentrate here"; III - "Low priority"; IV - "Possible over-kill". Axes: *a* and *b*, Traditional scale-center cross-hair location (Martilla & James, 1977); *a'* and *b'*, data-center cross-hair location; *c*, isorating line. Service factors: *1*, availability; *2*, accessibility; *3,* passenger information; *4*, travel time; *5*, travel costs; *6*, passenger care; *7*, comfort; *8*, security and safety; *9*, environment friendliness.

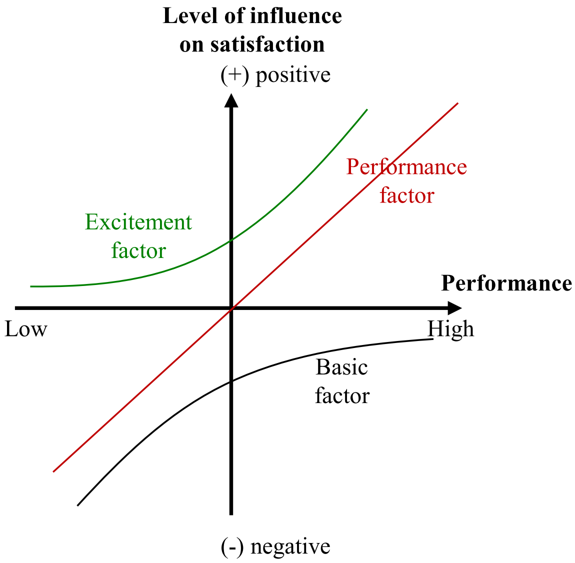


**Fig. 2.** Three-factor theory (adapted from Kano et al., 1984).

Equally crucial to the methodological drawbacks, the theoretical problem of the IPA is that the measures of importance are ambiguous and unreliable. Oliver (2014) pointed out four reasons for the theoretical problem involving misinterpretations between researchers and respondents or between respondents and surveys. First, consumers have different interpretations of importance. For instance, if importance is interpreted as "essential," then the "safety" of the transport service is invariantly rated as important. If importance is interpreted as a particular "preference," it may change as preference changes. For instance, vehicle designs may become less important to riders who prefer street sightseeing. However, it may become more important to those who have a particular interest in sports vehicles. Second, it is unclear whether consumers (riders) interpret a service factor as important because of its presence or absence. For instance, "no smoking on board" might be important for both smokers and non-smokers, but the reasons are completely different. Third, a service factor might be important as it 'must be there,' riders become indifferently familiar with the presence of the factor until the service factor is not fulfilled. Fourth, fulfilled service factors are contextually dependent, and their importance tends to diminish as it becomes less salient, especially when new service features are pursued. For instance, if there is only a bus service, riders have only one choice. If train service is provided to the existing bus service, the riders may turn to be interested in differences across PT services.

Although the IPA has contributed significantly to the literature on service quality analysis and policy practice, there has been growing evidence demonstrating that the underlined conceptual and methodological limitations of the IPA are violated (Abenoza et al., 2019; Cao & Cao, 2017; Wu et al., 2018; Zhang et al., 2019). This fact raises a question about the reliability of the IPA in service quality analyses and policy practices. Oliver (2014) claimed that "*It [the IPA method] is intuitively attractive, but not empirically defensible*" (p. 33).

### *2.2. Three-factor theory and its applications in transport*

The three-factor theory (Kano et al., 1984) method relaxes the limitations of the IPA. In a study on television products, he argued that the quality of products or services could be categorized into three types: "must-be" (basic), attractive (excitement), and one-dimensional (performance) factors. This theory laid a foundation, which has been widely employed in the literature for service quality analyses and policy practices. The three-factor theory facilitates QoS studies and policy practices when the effects of QoS attributes to the overall satisfaction of customers are asymmetric (Fig. 2).

- Basic factors are considered dissatisfiers because they only lead to dissatisfaction if low performance is delivered; however, they do not create customer satisfaction if high performance is delivered or fulfilled. Therefore, delivery of basic factors is necessary but insufficient to produce rider satisfaction. From a policy perspective, basic factors should be delivered at the standard requirement to avoid the dissatisfaction of riders.
- In contrast to basic factors, excitement factors work as satisfiers as they lead to satisfaction if delivered. However, the absence of excitement factors does not lead to rider dissatisfaction. Excitement factors often surprise riders and generate delight. Therefore, they are often used to promote competitiveness.
- Performance factors work as hybrids. They function as dissatisfiers if performance is not fulfilled and satisfiers if performance is fulfilled. Resources should be allocated to performance factors to maximize rider satisfaction.

The three-factor theory has been applied early and widely in various fields (Mikulić & Prebežac, 2011; Shahin et al., 2013).

**Table 1**
Applications of three-factor theory in transport service quality (in alphabetical order).

| Authors, year | Country, region | Transport services | Rider segment | Methods | Sample size |
|---|---|---|---|---|---|
| (Abenoza et al., 2019) | Stockholm, Sweden | Bus, train, metro | Frequency, captivity, mode | Ordered logit model with dummy variables | 1667 per year (9171 in 5.5 years) |
| (Cao & Cao, 2017) | Guangzhou, China | Bus, BRT, metro | NA | Importance grid, Ordered logit model with dummy variables | 1473 |
| (Chee et al., 2020) | Stockholm, Sweden | (trial) automated bus | Experienced and inexperienced riders | Multiple regression and SEM | 574 |
| (Fakfare et al., 2021) | Thailand | Airport (terminal) | NA | Ordered logit regression with dummy variables and (dis)satisfaction generating index | 879 |
| (Fang et al., 2021) | Harbin, China | Bus | Captivity | Gradient boosting decision trees | 742 |
| (Lin & Vlachos, 2018) | China | Airline | NA | Interview (managers) | 289 |
| (Prasad & Maitra, 2019) | Kolkata, India | Shared school transport | Car ownership | Fuzzy c-means clustering | 5929 |
| (Roy & Basu, 2020) | Bhubaneswar, India | Walk-access bus facility | NA | Importance grid (Explicit importance was stated importance; Implicit importance was partial correlation) | 1165 |
| (Sun et al., 2020) | Harbin, China | Bus stop amenities | NA | Linear regression with dummy variables | 742 |
| (Wu et al., 2020) | Minneapolis and St. Paul (Twin Cities), US | BRT | NA | Gradient boosting decision trees | 229 |
| (Wu et al., 2018) | Minneapolis and St. Paul (Twin Cities), US | Local and express bus | NA | Linear regression with dummy variables | 5297 |
| (Zhang et al., 2019) | Indore, India | Bus, BRT, van | NA | Importance grid (Explicit-Implicit Importance) | 1437 |

**Review summaries:**
- Countries: Developed countries, 4/12; Developing countries, 8/12.
- Transport modes*: Bus, 6/12; BRT, 3/12; van, 1/12; train, 1/12; metro, 2/12; air transport, 1/12; facilities (bus, pedestrians, air transport) and others (shared school), 4/12.
- Rider segment: yes, 4/12; no, 8/12.
- Methods*: interview, 1/12; importance grid, 3/12; regression (penalty-contrast analysis, multiple regression), 6/12; others (SEM, decision trees, gradient boosting, clustering), 3/12.

*The number of transport modes (or methods) is greater than the number of studies because some studies considered more than one transport mode (or methods).
NA, not applicable.

Interestingly, applications of the three-factor theory in transport have been limited and only emerged since 2017 (twelve have been found, see Table 1). Previous studies successfully investigated service factors' non-linear and asymmetric effects on rider satisfaction using the three-factor theory (Abenoza et al., 2019; Cao & Cao, 2017; Wu et al., 2018; Zhang et al., 2019). Those studies' findings were consistent in terms of the non-linear and asymmetric effects of various transit services (buses, BRTs, metros, and vans) in different contexts, e.g., Guangzhou (China), Twin Cities (USA), Stockholm (Sweden), and Indore (India).

In transport literature, attempts have been made to investigate the service factors' effects on rider satisfaction by using several forms of regressions (Table 1), such as ordered logit models (Abenoza et al., 2019; Cao & Cao, 2017; Fakfare et al., 2021), linear regression (Sun et al., 2020; Wu et al., 2018), and multiple regression (Chee et al., 2020). Additionally, some machine learning techniques have emerged in the transport studies, such as gradient boosting decision trees (Fang et al., 2021; Wu et al., 2020) and Fuzzy c-mean clustering (Prasad & Maitra, 2019; Roy & Basu, 2020). Empirical studies from various research fields demonstrate that the most superior method is not readily available because each has advantages and disadvantages. It is recommended that the use of an analysis method should be based on the (dis)advantages of the own method, specific circumstances (e.g., data availability, data nature such as types or distribution), and the research goal (Gustafsson & Johnson, 2004).

### *2.3. Effects of service factors on the satisfaction of rider groups*

On the supply side, PT service providers set a standard of quality to provide. On the demand side, PT riders are "the sole judge of service quality" (Berry et al., 1990). Different PT riders expect different levels of PT service with different PT types for different travel needs. Therefore, service quality factors' effects on rider satisfaction levels with different PT services are not unified (Abenoza et al., 2019; Cao & Cao, 2017; Wu et al., 2018; Zhang et al., 2019). As such, various users (or groups) express their needs and priorities differently on service quality factors (Abenoza et al., 2019; Chee et al., 2020; dell'Olio et al., 2010; Fang et al., 2021; Prasad & Maitra, 2019).

Among transport studies that apply the three-factor theory, few (three out of twelve) studies on PT service quality considered the rider segmentations, i.e., Abenoza et al. (2019), Chee et al. (2020), Fang et al. (2021) (Table 1). They consistently demonstrated that the effects of the three service quality factors on rider satisfaction were not unified across rider groups. For instance, in Stockholm, Sweden, Chee et al. (2020) studied on trial first- and last-mile automated buses and found that experienced riders considered bus fares a basic factor while inexperienced riders did not. In the same area, Abenoza et al. (2019) claimed that the ease of getting general information was an excitement factor for infrequent or non-captive riders; however, it was a performance factor for frequent or captive ones. Despite the heterogeneities across rider segments, the transport literature has widely claimed that improving service quality is positively associated with riders' re-intention and word-of-mouth (Lai & Chen, 2011; Mouwen & Rietveld, 2013; Nguyen-Phuoc et al., 2020; van Lierop & El-Geneidy, 2016). It also positively stimulates a modal shift from private to public transport (Efthymiou et al., 2018; Redman et al., 2013).

## 3. Methodologies

### 3.1. Local context

As one of the two largest cities in Vietnam, Ho Chi Minh City is populated by 9.04 million as of 2019 (HCMC Statistics, 2019). On the demand side, the motorcycles and cars were 854 and 36 vehicles per 1,000 inhabitants, respectively, in 2018; the average growth rate of motorcycles and cars was 6.7% and 11.72% per annum from 2011 to 2018 (HCMC DoT, 2020). Of 17.98 million daily trips (excluding walking), most (80%) are served by motorcycles, and seven percent are served by cars. On the supply side, road infrastructure is growing slowly, with a 0.3% network length per annum (HCMC DoT, 2020). Consequently, traffic congestion and pollution have become critical. In this circumstance, PT is expected to be the savior of the urban transport system.

The urban railways are under construction and planned to operate in the next few years. Therefore, buses are the sole service in the local PT system currently. The city government has been developing the bus network since 2002. The network grew to146 routes in 2018 (HCMC DoT, 2020). The bus ridership grew rapidly from 36.2 million (2002) to 413.1 million trips (2012). However, in recent years (2013–2018), the ridership has fallen 6.6% per annum to 290.0 million trips in 2018. Its share of the total demand fell from 9.55% (2012) to 6.7% (2018).

The local bus service providers have been suffering the vicious circle of "low service quality, fall of ridership, fall of revenue, low service quality." The bus routes were reduced from 146 (2018) to 139 (2020) because of ridership reduction. In addition, transit providers have cut down the service to reduce operating costs. The operating time was shortened (finishes at 18:00 or 21:00), and the headway was increased (up to 20 minutes for some routes). Many bus riders have left PT for private vehicles. As a result, this phenomenon can increase traffic congestion and increase PT travel time. It is supposed that the bus ridership's fall is because of the bus service quality. Effectively improving bus service quality within the resource constraints is the most prioritized transport policy of local government endeavor to escape the failure of the PT system.

### 3.2. Bus rider segmentation

The PT service providers' primary aims are to sustain frequent riders, encourage infrequent riders (who have travel demand) to use the PT more frequently, and attract non-public transport users to shift their modes. This study's scope focused on the first two aims of the PT service providers by investigating the effects of service quality factors on overall satisfaction. It distinguished bus riders by combining two categories of frequency (frequent and infrequent) and three categories of vehicle ownership types, i.e., riders who have no vehicles (captive riders), those who own only motorcycles, and those who own at least a car.

### 3.3. Questionnaire design

The questionnaire was designed to obtain three types of information to address the research aim. The first part is to obtain opinions of bus riders on their overall satisfaction and satisfaction of service quality factors. Nine service quality factors were proposed as latent constructs of several measurements based on the review in service quality literature, the adaptation from previous studies in transport, and local characteristics (Table 5). The second part asked for riders' opinions on the importance of service quality factors. A five-point Likert scale, from "very dissatisfied" (or "very unimportant") to "very satisfied" (or "very important"), was utilized due to its great validity (convergent and discriminant). The last part was for personal demographic information (gender, age, occupancy), frequency of bus use, travel purpose, and vehicle ownership.

### 3.4. Sampling and interview method

The sample size should be not only sufficient to derive stable results but also adequate so that the results can be generalized to the population. Hair et al. (2019) recommend that the sample size should be determined by considering the number of model constructs, variables, and some statistical measurements, e.g., communalities. For example, if the model is complex, e.g., the number of factors is larger than seven, and some communalities are less than 0.45, then the sample size should be approximately 500.

This study distinguished bus riders into six segments by combining travel frequency (frequent or infrequent) and vehicle ownership (captive, MC, or car). We expected most communalities (factor loadings) in this study would be from 0.70 and above. However, to ensure the reliability of the analysis results in case some communalities were less than 0.70, we planned to interview 600 samples for each rider segment. We also set approximately 10% contingent samples for each segment to guarantee adequacy if there were mistakes or missing values during the survey.

Consequently, 3960 samples were planned to be collected. The survey was conducted in 2019 by onboard interview to assure that the interviews were the least interrupted by the limited waiting time of bus riders at bus stops. Trained surveyors randomly selected riders on board for interviewing after they consented to join the interview. In total, there were 3913 respondents obtained. After removing missing values, 3607 valid samples were valid for the analysis.

### 3.5. Analysis method

The analysis involved several steps in addressing the research questions: first, in the HCMC context, which method, the IPA or the three-factor theory, is appropriate to demonstrate the transit service quality and rider satisfaction? What are the proper strategies to allocate the limited investment resources to increase transit service quality? The analysis framework (Fig. 3), including the IPA and the three-factor theory, was designed to answer these questions. The IPA, which was based on the stated importance and stated performance (satisfaction) of service factors, was utilized. The “ceiling effects” was tested by examining the mean values of the stated ratings.

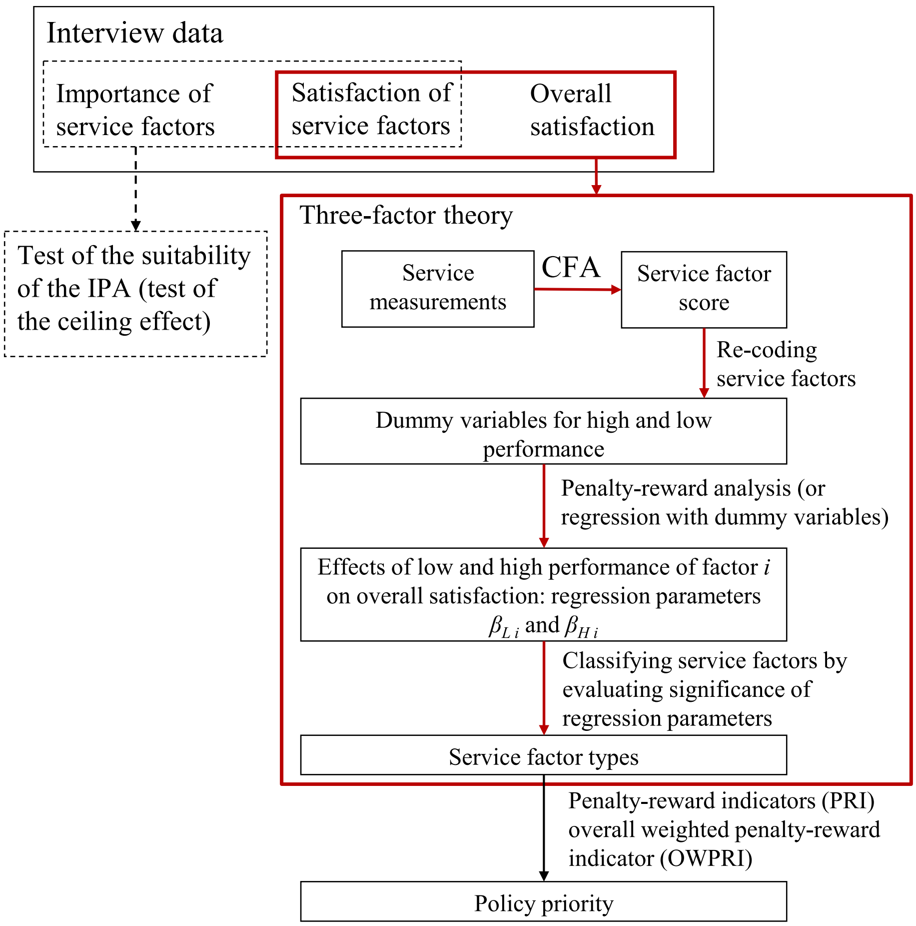


**Fig. 3.** Analysis process.

The methodological and empirical problems of the three IPA approaches, namely scale-center, data-center, and iso-rating line, will be discussed in interpreting the results in considering the actual local context of the bus transport service.

The three-factor theory, which relied on service factor performance (satisfaction) and rider overall satisfaction, was utilized to investigate non-linear and asymmetric relations between service factor performance and overall satisfaction. It involves several techniques, as explained in Fig. 3:

First, confirmatory factor analysis (CFA) will test the service quality factor constructs. This study assumed that service quality factor constructs are not different among rider groups, then the pooled data were used for this step. The assessment of model goodness of fit (GoF) was based on Hair et al.'s (2019) recommendation. The standardized service factor scores, which represented the service performance scores of service quality factors, were then obtained from the CFA model.

Second, two dummy variables were created for each service factor based on re-coding the standardized scores obtained from the CFA analysis. The survey results (Table 2) demonstrated the "ceiling-effect" that the bus riders overstated the performance and the importance of the service quality. The stated performance and overall satisfaction median values were 4.0 on the 5-Likert scale. Therefore, the lower 20% and greater 80% quantile scores were used as thresholds to discriminate the low and high performance. These thresholds were set to overcome the "ceiling effect" that the IPA is limited.

Finally, the penalty-reward contrast analysis was utilized to determine the effects of service factors' low ($\beta_{Li}$) and high ($\beta_{Hi}$) performance. The service factors classification was based on the *p-values* of the regression parameters $\beta_{Li}$ and $\beta_{Hi}$. If $\beta_{Li}$ and $\beta_{Hi}$ are significant, a factor will be an important performance. If $\beta_{Li}$ and $\beta_{Hi}$ are insignificant, a factor will be an unimportant performance. If $\beta_{Li}$ is significant and $\beta_{Hi}$ is not, a factor will be classified as a basic factor. In another case, if $\beta_{Li}$ is insignificant and $\beta_{Hi}$ is significant, a factor will be classified as an excitement factor.

After obtaining the classified service factors, two indicators, namely the penalty-reward indicator (PRI) and overall weighted penalty-reward indicator (OWPRI), were introduced to identify the policy priority. The former is derived by the summation of the absolute values of penalty and reward ($|\beta_{L.factori}| + |\beta_{H.factori}|$) of each service quality factor for each rider segment. For example, the penalty-reward indicator of service factor "Availability" of rider segment "frequent-captive" is calculated as$PRI_{Availability} = 2.78 + 2.35 = 5.13$ (Fig. 4). As such, this indicator demonstrates the effect range of service performance on overall satisfaction. The greater values of PRI, the greater benefit (or cost) if the service factor is at high (or low) performance. Only significant parameters for basic and excitement factors will be considered for PRI estimation. Therefore, the PRI for basic factors demonstrates the cost if the service performance is not delivered at standard requirements. Conversely, the PRI for excitement factors illustrates the benefits if the service performance is delivered.

The OWPRI was derived by summing up PRI across all rider segments considering each rider segment's weight (share) in all the samples. The weight represents the relative importance of a rider segment in overall PT riders. The OWPRI was used to determine the policy priority of service quality for all bus riders. The results of PRI, OWPRI, and policy priority are presented in Table 3.

## 4. Analysis results and discussions

### *4.1. Descriptive analysis*

As car share is small (36 cars compared to 854 motorcycles per 1000 inhabitants) and few riders who own cars utilized PT, the car-owned rider samples derived from the random survey were limited (Table 2). This study combined car-owner frequent and infrequent riders to avoid unreliable results due to the small sample size. Consequently, five rider groups were formed.

Descriptive statistics of bus riders are summarized in Table 2. Overall, most (79%) of bus riders were frequent users. Notably, there were significant differences in demography (gender, age, occupation) and travel purpose between frequent - infrequent and captive-choice riders. For instance, captive riders (segments 1 and 3) were dominated mainly by women (62% and 66%), while those who own vehicles (segments 2, 4, and 5) included a large number of men (52%, 63%, and 58%). Frequent riders (segments 1 and 2) were mostly students (62% and 46%) and aged from 18 to 24 years (53% and 45%). They used buses mainly for commuting (78% and 73%). In contrast to frequent riders, infrequent riders (segments 3 and 4) were older, retired, unemployed, and freelanced. They used buses mainly for shopping, visiting relatives, and recreational purpose. During the survey period, the authors of this study observed 150 valid-responded transit riders who (or whose families) owned at least one car (segment 5). This segment (5) includes 39% of riders aged 18–24 years, 35% of student riders, and 58% of commuting-purpose riders.

This study utilized the non-parametric Kruskal-Wallis test, which is appropriate for ordinal variables, to compare the extent to which the overall satisfaction differed across bus rider groups. It found that, although there were significant differences in demography and travel purpose between groups, the overall satisfaction between the five bus rider segments was not statistically significant (*p-value* $= 0.65$). The tests were also applied for gender, age, occupation, frequency of bus use, travel purpose, disability, and vehicle ownership. We found that all differences in overall satisfaction between groups were not statistically significant (*p-value* $> 0.11$).

**Table 2**
Descriptive statistics of bus riders.

| | | All riders | Segment 1: Frequent - Captive | Segment 2: Frequent - MC | Segment 3: Infrequent – Captive | Segment 4: Infrequent – MC | Segment 5: Car-owned riders |
|---|---|---|---|---|---|---|---|
| N | | 3,607 | 1,261 (35%) | 1,474 (41%) | 192 (5%) | 530 (15%) | 150 (4%) |
| Gender | Male | 1,739 (48%) | 478 (38%) | **773 (52%)** | 66 (34%) | **335 (63%)** | **87 (58%)** |
| | Female | 1,868 (52%) | **783 (62%)** | 701 (48%) | **126 (66%)** | 195 (37%) | 63 (42%) |
| Age | <18 | 204 (6%) | 134 (11%) | 45 (3%) | 16 (8%) | 5 (1%) | 4 (3%) |
| | 18–24 | 1,551 (43%) | **668 (53%)** | **670 (45%)** | 33 (17%) | 122 (23%) | **58 (39%)** |
| | 25–30 | 598 (17%) | 77 (6%) | 325 (22%) | 17 (9%) | 149 (28%) | 30 (20%) |
| | 31–45 | 669 (19%) | 122 (10%) | 308 (21%) | 28 (15%) | **183 (35%)** | 28 (19%) |
| | 46–60 | 369 (10%) | 142 (11%) | 102 (7%) | **52 (27%)** | 56 (11%) | 17 (11%) |
| | >60 | 216 (6%) | 118 (9%) | 24 (2%) | 46 (24%) | 15 (3%) | 13 (9%) |
| Occ | Students | 1,646 (46%) | **776 (62%)** | **674 (46%)** | 46 (24%) | 97 (18%) | **53 (35%)** |
| | Workers | 324 (9%) | 78 (6%) | 147 (10%) | 18 (9%) | 72 (14%) | 9 (6%) |
| | Officers, desk staff | 471 (13%) | 59 (5%) | 261 (18%) | 12 (6%) | 105 (20%) | 34 (23%) |
| | Freelance | 428 (12%) | 88 (7%) | 178 (12%) | 13 (7%) | **127 (24%)** | 22 (15%) |
| | Housewife, retired, Unemployment | 437 (12%) | 187 (15%) | 89 (6%) | **84 (44%)** | 56 (11%) | 21 (14%) |
| | Others | 301 (8%) | 73 (6%) | 125 (8%) | 19 (10%) | 73 (14%) | 11 (7%) |
| Freq | Frequent | 2,844 (79%) | 1,261 (100%) | 1,474 (100%) | - (0%) | - (0%) | 109 (73%) |
| | Infrequent | 763 (21%) | - (0%) | - (0%) | 192 (100%) | 530 (100%) | 41 (27%) |
| Pur | Commuting | 2,293 (64%) | **986 (78%)** | **1,080 (73%)** | 32 (17%) | 108 (20%) | **87 (58%)** |
| | Shopping, visiting, recreational | 758 (21%) | 178 (14%) | 204 (14%) | **107 (56%)** | **230 (43%)** | 39 (26%) |
| | Others | 556 (15%) | 97 (8%) | 190 (13%) | 53 (28%) | 192 (36%) | 24 (16%) |
| Dis | No | 3,572 (99%) | 1,241 (98%) | 1,468 (100%) | 186 (97%) | 528 (100%) | 149 (99%) |
| | Yes | 35 (1%) | 20 (2%) | 6 (0%) | 6 (3%) | 2 (0%) | 1 (1%) |
| Veh | PuT Captive no vehicle) | 1,453 (40%) | 1,261 (100%) | - (0%) | 192 (100%) | - (0%) | - (0%) |
| | Choice (MC) | 2,004 (56%) | - (0%) | 1,474 (100%) | - (0%) | 530 (100%) | - (0%) |
| | Choice (Car, or both Car and MC) | 150 (4%) | - (0%) | - (0%) | - (0%) | - (0%) | 150 (100%) |
| OS: | Mean/Median (SD) | 3.69/4.0 (0.71) | 3.70/4.0 (0.77) | 3.70/4.0 (0.66) | 3.68/4.0 (0.84) | 3.66/4.0 (0.65) | 3.70/4.0 (0.68) |

**Note:**
N, number of observations (after removing missing values).
Occ, Occupation; Freq, Frequency of using bus service; Pur, Purpose of travel; Dis, Disability; Veh, Vehicle ownership; OS, Overall satisfaction.
MC, Motorcycle-owned riders; PuT, Public transport; SD, standard deviation.
Car-owned riders include riders who or whose families own at least a car.
**Bold**, dominant riders in the segments.

### *4.2. Whether the IPA appropriate?*

As explained in the preceded part (section 3.1), HCMC has been facing a critical fall in transit ridership, which is supposed to be because of the vicious circle of "low service quality – ridership fall." In contrast to the actual situation of bus transit in the city, bus riders perceived service performance and importance as relatively high. Specifically, the five groups' overall satisfaction mean value ratings were from 3.66 to 3.70 (Table 2). All service quality measures' performance rating mean values were greater than 3.7 on the 5-Liker scale. Furthermore, the importance rating mean values of the nine service factors were from 3.73 to 4.35. All the mean values were greater than the center point of the Likert scale, suggesting that the "ceiling-effect" existed (Fig. 1). In addition, the Pearson's correlation coefficients between the performance and the importance of the nine service factors were estimated to test if the performance and the importance are independent. It was found that, except for the environmental factor, correlation coefficients of all other eigh service factors' performance and importance pairs were significant even though they were relatively small (0.07 to 0.34). The findings revealed that the dependencies between the performance and the importance of the eight service factors exist. The "ceiling-effect" and the performance-importance dependency inherently demonstrated that the underline assumption of the IPA was violated.

This study also found the empirical problem that emerged in utilizing the IPA framework to analyze the service quality factors (Fig. 1). Particularly, the results with the data-center approach distinguished nine service quality factors into four quadrants. In contrast, the scale-center approach demonstrated that all the service quality factors belong to the "keep up the good work." This means service providers should maintain the existing service performance level as it satisfies the existing riders' requirements, while the actual situation reflects "the fall in service quality – the fall in ridership." Differing from the two above IPA approaches, the iso-rating line approach showed that all the nine service quality factors were at the upper side of the line. This suggests that all the service factors were of high importance but low performance. Consequently, the iso-rating line recommended service providers improve all service quality factors. The three IPA approaches provided three completely different results, which led to contradicting interpretations and policy implications. For the above reasons, it appears that the IPA is insufficient in analyzing service quality in the actual situation of HCMC bus transit. Our findings, with the case study of bus service in HCMC, were consistent with previous well-known scholars' claim that the IPA is attractive but not empirically defensible (Oliver, 2014).

### *4.3. Non-linear and asymmetric effects of transit service quality factors in the three-factor theory*

The service factor constructs were tested with CFA. The result evaluation was based on Hair et al.'s (2019) reference. The test result (Hair et al.'s reference) of the comparative fit index, CFI, was 0.92 ($\geq$0.92); root mean square error of approximation, RMSEA, was 0.056 ($\leq$0.07); and standardized root means square residual, SRMR, was 0.04 ($\leq$0.08). These results indicate that the overall fit of the theoretical measurement model is reasonably good (Table 4). The standardized factor loading of the measurements all exceeded the requirement (>0.5) and were all statistically significant; the values of construct reliability (Cronbach alpha) of all factors were above 0.82 (>0.7), indicating that internal consistency exists. Additionally, almost all factors' average variance extracted (AVE) exceeded

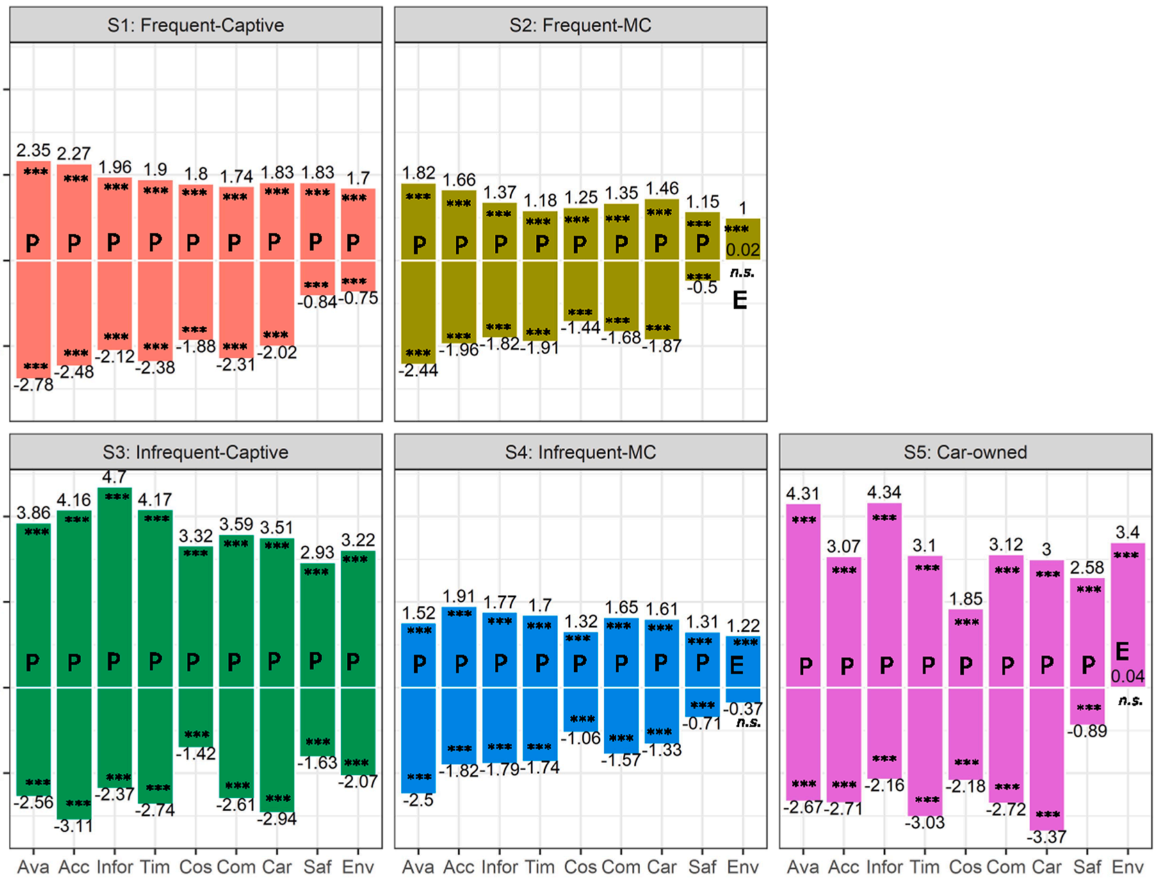


**Fig. 4.** Non-linear, asymmetric effects and service factor classification. **Note:** *Ava*, Availability; *Acc*, Accessibility; *Infor*, Information; *Tim*, Travel time; *Cos*, Travel cost; *Com*, Comfort; *Car*, Rider care service; *Saf*, Traffic safety and security; *Env*, Environmental friendliness. *B,* Basic factor*; P,* Performance factor*; E,* Excitement factor. Statistically significant levels: 0 '***'; 0.001 '**'; 0.01 '*'; 0.05 '.'; not significant '*n.s.*'.

50%; only AVE of availability (Ava) was marginal below 50%, suggesting the model was adequate for convergence. The results with the CFA demonstrated that the theoretical model's overall fit and the measurement construct were reasonably good for further analysis.

The effects of the nine service quality factors on transit rider overall satisfaction, expressed by $\beta_{Li}$ and $\beta_{Hi}$ for low and high performance, respectively, were presented in Fig. 4. It was revealed that service factors' effects on overall satisfaction were non-linear, asymmetric, and varied across the rider segments. Interestingly, no basic factors were identified for the case of the bus service in HCMC. All the service factors were considered important performance for the captive riders (segments 1 and 3). The choice riders, who own at least one vehicle, MC or Car (segments 2, 4, and 5), considered the environmental friendliness as excitement; all the other service factors were considered as important performance.

#### *4.3.1. Frequent and infrequent riders*

Except for traffic safety and security (Saf) and environmental friendliness (Env), for frequent riders (segments 1 and 2), the effects of low-performance service quality factors on rider satisfaction were stronger than those of high-performance service quality factors. In other words, the penalties were greater than the rewards. This means the frequent riders tend to be more dissatisfied if service is not delivered. These findings were consistent in both frequent-captive and frequent-MC. The great consistency in terms of the service quality factors' effects between the two frequent rider segments (S1 and S2) may be because of the great similarity between the two. As stated in Table 2, the majority of segments 1 and 2 were students aged 18–24 years who frequently use buses for commuting. Therefore, the penalties for all seven service quality factors were consistently higher than the rewards. Another plausible reason is that the frequent riders, who are more experienced in PT, tend to be more sensible with the low service quality. Notably, this study also found that the penalties and rewards of each service quality factor affected segment 2 weaker than segment 1, suggesting that captive females may be more affected by service quality factors than choice (MC) males.

In contrast to the frequent riders, infrequent-captive riders (segment 3) consistently perceived all service quality factors' rewards as higher than penalties. Unlike segment 3 where all service factors affected rider satisfaction in the same manner, there was heterogeneity among service quality factors regarding service quality-rider satisfaction relations. Some service quality factors, e.g., accessibility (Acc), information (Infor), and travel time (Tim), affect infrequent-MC riders (segment 4) linearly and symmetrically; while the other factors, e.g., availability (Ava), cost (Cos) effects, comfort (Com), and rider care service (Car), maintained non-linear and asymmetric. The findings would seem to show that infrequent-captive riders are more surprised if the service quality factors are at high performance.

Segment 4 is dominated by middle-aged (25–45 years old) freelance riders, who sometimes (infrequently) travel for shopping and recreational purposes (Table 2). According to the data, among 106 riders (out of 530) who were not satisfied with the bus service availability, eighty-one riders lived far from bus routes. They complained about bus operating (opening and closing) time and frequency. Ninety-four riders assumed that the bus service was not reliable. Insufficient availability would seem to be an important factor that did not attract the bus ridership of this segment. The riders used buses for a few trips of their demand, and the other trips were served by motorcycles.

#### *4.3.2. Captive and choice riders*

At the same travel frequency level, the effects of service quality factors on captive riders (segments 1 and 3) were greater than on those who own MC (segments 2 and 4). In particular, service quality's penalty and reward effects on the overall satisfaction of captive riders (segments 1 and 3) were consistently higher than those of motorcycle-owned riders (segments 2 and 4). This implies that the higher dependency of riders on PT, the more substantial the quality factors affect their satisfaction. On the contrary, the choice (MC) riders did not necessarily have to choose PT if the service quality was not fulfilled their requirement, as they easily shifted to an alternative transport mode. In other words, choice (MC) riders tend to consider the differences between PT and private vehicles. The changes in PT service quality strongly affect shifting transport mode behaviors of choice (MC) riders but less affect their overall satisfaction.

#### *4.3.3. Car-owned riders*

For car-owned riders (Segment 5), the penalties of travel cost (Cos) and rider care (Car) factors were greater than the rewards, suggesting that car-owned riders tended to be more dissatisfied if service factors were at low performance. In contrast, the rewards of all other service quality factors (Ava, Acc, Infor, Com, Saf, and Env) were greater than the penalties. This implies that if these factors are improved, they tend to surprise and attract more car-owned riders. As noted in Table 2, segment 5 was dominated by students (39%) who often used buses for commuting and were economically dependent. This may be why the travel cost penalty (increased cost) had a stronger effect than the reward. As well, they tend to be more sensible with the negative attitudes of ticket collectors and drivers. The effects of the two service factors on riders in the car-owned (S5) segment were consistent with the frequent-captive (S1) and frequent-MC (S2). It is worth noting that the consistency may be because the rider pattern in the three segments (S1, S2, and S5) was relatively homogenous. Specifically, students and commuting trips are the majority of the three segments.

#### *4.3.4. Safety-security and environmental friendliness*

Bus riders in all segments likely underestimated traffic safety-security (Saf) and environmental friendliness (Env) compared to other service quality factors. Specifically, penalties for the overall satisfaction of traffic safety-security and environmental friendliness were significantly lower than rewards and significantly lower than penalties of other service quality factors. This finding was consistent across five segments of bus riders. Safety and security seem likely to be diminished as traveling with buses may be safer than motorcycles and cars.

The results of this study were consistent with previous studies (Abenoza et al., 2019; Chee et al., 2020; Fang et al., 2021; Prasad & Maitra, 2019) in two aspects: the effects of service quality performance on rider satisfaction are asymmetric and non-linear, and the effects vary across rider segments. Interestingly, Abenoza et al. (2019) and this study consistently found that the reward of safety and security was greater than the penalty across all rider segments.

However, differ from Abenoza et al.'s (2019) study, in which safety-security was highly overestimated (2nd rank in twelve service factors), while riders in HCMC ranked it a pretty low priority (8th rank in the nine other factors, see Table 3). The mechanism remains to be elucidated. However, there are some plausible reasons. First, probably the perception of riders on service quality is largely contextual. It (rider perception) depends on the demographical background of riders, social-economic conditions, and the availability of different transport services. Second, the service quality factor constructs are different across studies. Third, different methods to categorize service factors have been utilized across studies. For example, Abenoza et al. (2019) utilized a threshold of 1.5 (ratio of regression coefficients of high/low performance) to identify a basic or excitement factor. Other studies (e.g., Fang et al., 2021) utilized 0.7 and 0.2 (of an impact-asymmetric index, derived by the difference between satisfaction and dissatisfaction-generating potential) as thresholds. This study objectively utilized significant levels as a benchmark for service factor classification. Finally, different analysis approaches, e.g., multiple regression, ordinal regression, and bivariate correlation coefficient, may result differently. Despite some differences across studies, this study and previous studies (Table 1) consistently demonstrate the non-linear and asymmetric effects of transit service quality factors on rider overall satisfaction.

### *4.4. Policy priority and implications based on penalty-reward indicators*

Penalty-reward indicators and policy priority estimation results are presented in Table 3. Excitement factors that can generate rider satisfaction if delivered but do not dissatisfy riders should be the least priority. Performance factors affect rider satisfaction in two ways, dissatisfy riders if not delivered and satisfy riders if delivered. Therefore, the priority of the improvement should be based on the effect ranges (PRIs).

In general, the effect ranges of service quality factors for captive riders were greater than the choice, suggesting that improving bus service quality can affect the satisfaction of captive riders more than others. For frequent riders (segments 1 and 2), except for environmental friendliness (Env) and travel time (Tim), the priority ranks are quite consistent across service factors. The captive riders considered travel time (the third rank) a higher priority than the choice. As explained in section 4.3, PT dependency may play an important role in rider perception. Arguably, the captive riders, who have no choice other than buses, considered saving travel time as fundamental for commuting trips. Conversely, choice riders may easily shift to private vehicles if travel by bus takes longer than expected. Customer care was the third priority for choice riders, implying that negative attitudes of bus drivers and ticket collectors may push choice riders to choose other modes, e.g., MC, as an alternative to buses.

For infrequent riders, the priority was greatly different between captive and choice. We believe that the demographical characteristics, which are pivotal to rider perception, affect the priorities of the service factors. Specifically, the infrequent-captive (segment 3), which includes mostly older (>50% of age from 46 years old) and retired, unemployed (44%), and women (66%) riders (Table 2), ranked accessibility and information as the most critical quality factors. Likely, it is because the walking distance to (or from) bus stops is vital to aged women riders. Furthermore, aged riders are often limited in using smartphones to explore bus information.

Environmental friendliness affected infrequent-captive riders' satisfaction (PRI, 5.29) strongest compared to the other segments. Moreover, it was ranked as a seven$^{th}$ priority in infrequent-captive, higher than its ranking (9th) in other rider segments (Table 3). This demonstrated that, even though most (95%) riders underestimated environmental friendliness, it was more concerned by older bus riders.

The overall rank, based on the values of OWPRI, was availability, accessibility, information, travel time, customer care, comfort, travel cost, and environmental friendliness. It is interesting to note that travel cost is widely known as the determinant of travelers. However, we found that bus riders in Ho Chi Minh City ranked travel costs at relatively low priority (7th) among nine service factors (Table 3). Bus fare in HCMC was probably quite cheap (5,000–7,000 VND/trip; or 0.2–0.3 USD/trip). Therefore, bus riders' perception of travel costs may be diminished.

The local government of HCMC is recommended to maintain the existing ridership while encouraging a modal shift from private to public transport. This study suggests two strategies: one is for the short term, and another is for the long term. Availability and accessibility were the most prioritized service quality factors (Table 3). Adherently, to improve availability and accessibility, it is necessary to improve the PT network (expansion, increase the number of routes), the PT facilities (bus stops and arrangement), and the PT operations (operating time, network coordination, ticket providing system). These tasks take time and need a big budget. The improvement of the PT network, facilities, and operation should be well assisted by limiting the use of private vehicles to reduce traffic congestion. As such, it is expected that travel time can be reduced to some extent. Therefore they are more suitable in the long term.

While the first strategy needs a long time and a big budget, the second can be implemented immediately. It focuses on enhancing passenger information, customer care (attitudes of drivers and ticket collectors, driving skills), comfort (vehicle cleanness, noise and temperature onboard, facilities at stops and onboard), and security-safety (by monitoring inappropriate behaviors). Implementing the two strategies can also encourage a modal shift from private to public transport. Even though the modal shift behavior is beyond this study's scope, research has demonstrated that improving PT service quality can attract alternative transport mode users, such as car and MC users (Redman et al., 2013).

**Table 3**
Policy priority based on penalty-reward indicator (PRI) and overall weighted penalty-reward indicator (OWPRI).

| Service quality factors | Segment 1: Frequent-Captive | | Segment 2: Frequent-Choice (MC) | | Segment 3: Infrequent-Captive | | Segment 4: Infrequent-Choice (MC) | | Segment 5: Car owners | | All bus riders | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PRI | Priority | PRI | Priority | PRI | Priority | PRI | Priority | PRI | Priority | OWPRI | Priority |
| Availability (Ava) | 5.13 | 1 | 4.26 | 1 | 6.41 | 5 | 4.02 | 1 | 6.97 | 1 | 4.76 | 1 |
| Accessibility (Acc) | 4.75 | 2 | 3.63 | 2 | 7.28 | 1 | 3.73 | 2 | 5.78 | 6 | 4.32 | 2 |
| Passenger information (Infor) | 4.08 | 4 | 3.19 | 4 | 7.07 | 2 | 3.55 | 3 | 6.50 | 2 | 3.90 | 3 |
| Travel time (Tim) | 4.28 | 3 | 3.09 | 5 | 6.91 | 3 | 3.44 | 4 | 6.13 | 4 | 3.89 | 4 |
| Travel cost (Cos) | 3.68 | 7 | 2.69 | 7 | 4.74 | 8 | 2.38 | 7 | 4.02 | 7 | 3.15 | 7 |
| Comfort (Com) | 4.05 | 5 | 3.03 | 6 | 6.20 | 6 | 3.22 | 5 | 5.84 | 5 | 3.70 | 6 |
| Customer care (Car) | 3.85 | 6 | 3.32 | 3 | 6.45 | 4 | 2.95 | 6 | 6.37 | 3 | 3.75 | 5 |
| Security and safety (Saf) | 2.66 | 8 | 1.65 | 8 | 4.56 | 9 | 2.02 | 8 | 3.47 | 8 | 2.29 | 8 |
| Environmental friendliness (Env) | 2.45 | 9 | 1.00 | Excitement | 5.29 | 7 | 1.22 | Excitement | 3.40 | Excitement | 1.87 | 9 |

## 5. Conclusions

This study sought an appropriate method for analyzing transit service quality in HCMC. Two most common methods for service quality analysis, namely the IPA and the three-factor theory, were utilized. The evidence from this study suggests that the IPA, which has been widely utilized in the transport literature, was not appropriate for the case of bus transit in HCMC because its methodological and theoretical problems led to empirical indefensibility. In contrast, the three-factor theory, which has been little recognized despite the advantages in relaxing the IPA's limitations and describing rider perception's complexity (non-linear and asymmetric), was superior to the IPA. Using the three-factor theory framework, which integrated the CFA and the penalty-contrast analysis in an ordered logit model with dummy variables, two service factors have been identified: performance and excitement factors.

This study contributes to the service quality-rider satisfaction relations in the transport literature regarding three aspects. First, it widened the limited understanding of the service quality analysis using the IPA and the three-factor theory. It highlighted that the IPA was not appropriate despite being widely utilized. In contrast, the three-factor theory, which has been limited acknowledged in transport literature, was recommended as it sheds light on the non-linear and asymmetric effects of service factors on rider satisfaction. Second, it deepened the understanding of service quality-rider satisfaction across rider groups. Specifically, all the three studies that considered transit rider segments recognized in the public transport literature (Table 1) have segmented bus riders into travel frequency or vehicle ownership (Abenoza et al., 2019; Chee et al., 2020; Fang et al., 2021). For example, the captive (or choice) rider segment included both frequent and infrequent riders. This study has differentiated the frequent and infrequent from the captive riders so that the rider groups were more homogenous. Therefore, the results and interpretations are expected to be more reliable. Finally, this is the first research that has been recognized in Vietnam to date utilizing the three-factor theory in the transport service.

In conclusion, this study has underlined the non-linear and asymmetric relations between bus transit service quality and rider satisfaction in HCMC. Therefore, the three-factor theory was superior. In contrast, the IPA was limited by its theoretical and methodological problems. In this circumstance, the use of the IPA is adherently "*better than conducting no research at all*" (Oliver, 2014, p. 35). The findings indicate that all the service factors were found to be performance factors for captive riders. For non-captive (vehicle-owned) riders, eight out of nine factors were performance, while environment friendliness was excitement. Furthermore, the effects of the service quality factors on rider satisfaction were non-linear, asymmetric, and heterogeneous across segments. This study addressed the world limited knowledge of the three-factor theory in transport service. By distinguishing riders into more homogenous groups, it also provided further evidence that service quality affected rider groups' satisfaction differently. In addition, to the authors' best knowledge, this is the first empirical study in Vietnam that utilized the three-factor theory.

This study has two limitations. First, this study did not clarify vehicle ownership, i.e., individual or family ownership. This issue is caused by the fact that in HCMC, parents own vehicles (motorcycles or cars), but all family members often use the vehicles. Therefore, this issue was assumed not to affect the analysis results. Second, this study interviewed the existing bus riders, who may still be somewhat satisfied with the bus service quality. This study did not interview those who have left buses. Therefore, the real reasons for the bus ridership falling have not been clear. The authors have interpreted the results based on the analysis evidence combined with the observations of local context (e.g., the loss of ridership, the reduction of bus service as explained, and the use of private vehicles) and the existing situation of bus operation for the interpretation to overcome this limitation. Further studies are recommended to address the limitations.

### CRediT authorship contribution statement

**Vu Anh Tuan:** Investigation, Visualization, Writing - original draft, Writing - review & editing. **Nguyen Van Truong:** Conceptualization, Methodology, Visualization, Formal analysis, Writing - original draft, Writing - review & editing. **Shimizu Tetsuo:** Conceptualization, Methodology, Formal analysis, Writing - original draft, Writing - review & editing. **Nguyen Ngoc An:** Investigation, Writing – original draft, Writing – review & editing.

### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Data availability

Data will be made available on request.


### Acknowledgment

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## Appendix A

Table 4 and Table 5

**Table 4**
Factor constructs with CFA.

| | F1: Ava | F2: Acc | F3: Infor | F4: Tim | F5: Cos | F6: Car | F7: Con | F8: Saf | F9: Env |
|---|---|---|---|---|---|---|---|---|---|
| Average variance extracted (AVE) | 47.2% | 53.8% | 53.1% | 70.7% | 73.2% | 61.5% | 52.2% | 67.5% | 78.2% |
| Reliability (Cronbach-Alpha) | 0.82 | 0.82 | 0.85 | 0.83 | 0.84 | 0.82 | 0.89 | 0.91 | 0.88 |
| Q2_1 | 0.68 | | | | | | | | |
| Q2_2 | 0.68 | | | | | | | | |
| Q2_3 | 0.68 | | | | | | | | |
| Q2_4 | 0.70 | | | | | | | | |
| Q2_5 | 0.70 | | | | | | | | |
| Q3_1 | | 0.75 | | | | | | | |
| Q3_2 | | 0.77 | | | | | | | |
| Q3_3 | | 0.75 | | | | | | | |
| Q3_4 | | 0.67 | | | | | | | |
| Q4_1 | | | 0.68 | | | | | | |
| Q4_2 | | | 0.75 | | | | | | |
| Q4_3 | | | 0.70 | | | | | | |
| Q4_4 | | | 0.77 | | | | | | |
| Q4_5 | | | 0.74 | | | | | | |
| Q5_1 | | | | 0.84 | | | | | |
| Q5_2 | | | | 0.84 | | | | | |
| Q6_1 | | | | | 0.81 | | | | |
| Q6_2 | | | | | 0.90 | | | | |
| Q7_1 | | | | | | 0.80 | | | |
| Q7_2 | | | | | | 0.82 | | | |
| Q7_3 | | | | | | 0.72 | | | |
| Q8_1 | | | | | | | 0.69 | | |
| Q8_2 | | | | | | | 0.74 | | |
| Q8_3 | | | | | | | 0.73 | | |
| Q8_4 | | | | | | | 0.72 | | |
| Q8_5 | | | | | | | 0.72 | | |
| Q8_6 | | | | | | | 0.72 | | |
| Q8_7 | | | | | | | 0.73 | | |
| Q8_8 | | | | | | | 0.72 | | |
| Q9_1 | | | | | | | | 0.85 | |
| Q9_2 | | | | | | | | 0.88 | |
| Q9_3 | | | | | | | | 0.86 | |
| Q9_4 | | | | | | | | 0.78 | |
| Q9_5 | | | | | | | | 0.73 | |
| Q10_1 | | | | | | | | | 0.85 |
| Q10_2 | | | | | | | | | 0.91 |

Chi-square, 6923.20; Df, 558; p-value, 2e-16.
Comparative Fit Index, CFI: 0.92.
Root Mean Square Error of Approximation, RMSEA (90%CI): 0.056 (0.055 to 0.057).
Standardized Root Mean Square Residual, SRMR: 0.04.
Goodness-of-Fit Index, GFI: 0.89; Adjusted GFI: 0.87; Normed Fit Index, NFI: 0.91.

**Table 5**
Service quality factor design.

| Service quality (performance) factors | Measurements | References |
|---|---|---|
| Overall service | Q1_1. Overall satisfaction with bus service | |
| F1. Availability | Q2_1. Availability of bus routes nearby home<br>Q2_2. Daily opening time<br>Q2_3. Daily closing time<br>Q2_4. Operation frequently<br>Q2_5. The bus service is reliable | (Eboli & Mazzulla, 2011; Lai & Chen, 2011; Ngoc et al., 2017; Tyrinopoulos & Antoniou, 2008; Wen et al., 2005) |
| F2. Accessibility | Q3_1. Access to the first bus stop<br>Q3_2. Egress from the last bus stop<br>Q3_3. Easy to get on and off the bus<br>Q3_4. The convenience of buying bus fare | (Ngoc et al., 2017; Tyrinopoulos & Antoniou, 2008; Wen et al., 2005) |
| F3. Passenger Information | Q4_1. Pre-trip information<br>Q4_2. Information at bus stops<br>Q4_3. In-board information<br>Q4_4. Information at interchange points<br>Q4_5. Information on service delays or suspended | (Eboli & Mazzulla, 2011; Hu, 2010; Jen & Hu, 2003; Tyrinopoulos & Antoniou, 2008; Wen et al., 2005) |
| F4. Time | Q5_1. Bus service travel time<br>Q5_2. Bus service punctuality | (Eboli & Mazzulla, 2011; Ngoc et al., 2017; Tyrinopoulos & Antoniou, 2008; Wen et al., 2005) |
| F5. Cost | Q6_1. Bus fare for a single route<br>Q6_2. Bus fare multiple routes | (Lai & Chen, 2011; Tyrinopoulos & Antoniou, 2008) |
| F6. Customer Care | Q7_1. Bus ticket collectors' attitude<br>Q7_2. Bus drivers' attitude, driving skill<br>Q7_3. Feedback on complaints and inquiries | (Eboli & Mazzulla, 2011; Hu, 2010; Jen & Hu, 2003; Lai & Chen, 2011; Ngoc et al., 2017; Wen et al., 2005) |
| F7. Comfort | Q8_1. Availability and comfort of the seats<br>Q8_2. Smooth operation and comfortable ride<br>Q8_3. Onboard cleanness<br>Q8_4. Onboard noise and air temperature<br>Q8_5. Cleanness at bus stops<br>Q8_6. Comfort in waiting space<br>Q8_7. Disabled facilities at bus stops<br>Q8_8. Disabled facilities onboard | (Eboli & Mazzulla, 2011; Hu, 2010; Lai & Chen, 2011; Ngoc et al., 2017; Tyrinopoulos & Antoniou, 2008; Wen et al., 2005) |
| F8. Security & Safety | Q9_1. Security at bus stop/transfer point<br>Q9_2. Onboard security<br>Q9_3. Sexual harassment<br>Q9_4. Safety while boarding and alighting<br>Q9_5. Safety while riding | (Eboli & Mazzulla, 2011; Hu, 2010; Lai & Chen, 2011) |
| F9. Environmental friendliness | Q10_1. Air and dust pollution from buses<br>Q10_2. Noise pollution from buses | (Eboli & Mazzulla, 2011) |

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