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Article

An Integrated Ordered Probit Model for Evaluating University Commuters' Satisfaction with Public Transport

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Abstract: Transport policymakers need to have an in-depth understanding of public transport (PT) customers in order to effectively manage transport systems and maintain the attractiveness of these systems to potential users. This research aims to compare the perceptions and satisfaction levels of two groups of PT users (habitual and occasional) among university staff and students regarding the quality of PT through a new integrated approach. A sample of 500 participants from Budapest, Hungary was used. Two stages of analysis were conducted: a descriptive analysis was conducted in the first stage, and Student's t-tests of two independent samples were applied to identify the varying perceptions and overall satisfaction. Second, a new integrated ordered probit model (OPM) and an importance–performance analysis (IPA) were used to envisage how best to prioritize actions for transport enhancement. The results show that in the circle of commuters, the habitual PT users were more satisfied with the existing PT service than the occasional PT users. According to the findings of the IPA, for habitual users, the attribute "information provided" has a high priority for improvement, whereas the cost for both user types was found to be significant for all models, contributing to overall satisfaction. This factor was included in the possible overkill quadrant, suggesting that there might be more cost resources than needed. The new model, along with the case study results, may help policymakers and transport operators to make better decisions regarding the identification of service priority areas.

Keywords: public transport; travel satisfaction; university commuters; probit logit model; IPA

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1. Introduction

Recently, there has been an apparent need to alter transport systems to achieve the goals of the 2030 Agenda of the United Nations, which include Sustainable Development [1]. Ibrahim et al. [2] stated that the development of an alternative sustainable transport mode for car users (e.g., public transport) is essential. This can be achieved by improving service quality attributes (SQAs). In previous studies, several attributes have been shown to have a definite association with public transport (PT) passenger satisfaction and an increase in PT ridership [3,4]; for instance, safety, availability of service [2], price, and comfort [5]. Other researchers have examined how the priority of service quality enhancement differs among PT riders with disparate sociodemographic characteristics, such as gender [6]. Moreover, another study investigated the effects of different demographic characteristics on the PT service quality [7]. However, De Oña [8] have pointed out that the determination of the main factors affecting the attractiveness of PT is a complicated issue for researchers and policymakers. PT improvement involves several different factors, such as determining which aspect needs to be addressed and which participants should be involved in the decision-making process [9]. In addition, the service quality (SQ) has several complex properties [10]; for instance, intangibility, inseparability, perishability, and heterogeneity, because all people are different, and individuals are heterogeneous and have individual perceptions [11]. This is a key factor that motivated the present study. Moreover, depending on various characteristics, such as the location, economy, and demographics, the elements influencing the SQ may differ significantly [12]. In addition, the European Committee for Standardization 2002 identified one standard of SQ for different nations and times, which may not be an appropriate or applicable method [13]. Therefore, understanding the perspectives of people from other geographical areas is vital to making better and proper decisions.

Additionally, manuals and standards may adjust their objective criteria and indicators to be more user centered based on the research's subjective indicators. Because statistical studies give insight into the understanding of consumers' opinions and expectations, thereby increasing ridership, PT providers and policymakers could use the findings in their strategies. People may utilize a certain service, but that does not mean they are necessarily happy with it. Recent technological advancements, the last pandemic, and economic growth may have altered travel behaviors in a way that is consistent with sustainability goals. Moreover, the recent literature highlights the existence of cognitive dissonance among PT users in high-income European countries and emphasizes its relevance as a fascinating and important area of discussion that could enhance the research's alignment with the existing literature on transportation preferences and user satisfaction [14,15].

Therefore, there is a need in the literature to pay more attention to the travel characteristics (habitual and occasional) of influential commuters related to satisfaction with PT, such as among university staff and students [16]. Commonly, several approaches have been highlighted to understand public transport service quality and satisfaction, including three main categorical approaches: discrete choice models (DCM), structural equation models (SEM), and multi-criteria decision-making (MCDM) techniques [1,9]. Finding methods to develop transportation planning and, accordingly, attract more people to use sustainable transportation is one of the most important subjects for transport planners and decision makers [1,9]. Thus, this research utilized novel hybrid decision-making techniques that facilitate better decision making and help to avoid wasting important resources in service implementation planning and the development of sustainable transport projects.

A hybrid technique can be beneficial for capturing more information and simplifying it so that the results can be shown clearly to allow decision makers to avoid resources being wasted on irrelevant attributes. The findings of this research are expected to contribute to the current state-of-the-art techniques used in urban PT planning by providing methodological and practical knowledge. To the best of our knowledge, no work has been conducted to understand the satisfaction levels of habitual and occasional PT users with the SQ in the circle of university commuters. The present research is particularly motivated by the fact that educational institutions not only serve as major employers but also generate a substantial number of trips, thereby exerting significant influence on traffic externalities, specifically in urban areas, and therefore demanding more research [16].

Moreover, we fill the current gap in the analysis by using an integrated (hybrid) approach comprising the ordered probit model (OPM) and importance–performance analysis (IPA). These methods are less complex and transparent and require less data than structural equation modelling (SEM) and multiple-criteria decision-making (MCDM). In addition, we hope that this method will allow planners to envisage how best to prioritize actions to improve service aspects.

To achieve the main objectives of this study, we aim to answer the following three research questions: (1) Are there significant differences in ratings of service quality between habitual and occasional PT university users? (2) What service attributes affect the overall satisfaction of PT university users? (3) How should the improvement of service quality be prioritized for each PT university user (i.e., which service attributes should be prioritized for improvement)? This research uses real-world Eastern European data on the relationship between overall travel satisfaction and satisfaction with PT service quality attributes. In this way, PT providers, policymakers, and scholars may become more informed and have the appropriate analysis techniques for assessing and managing PT systems by considering the most significant factors. After describing the theoretical background and research problems, the remaining parts of this paper are organized as follows: Section 2 presents the related literature. Section 3 presents the methods applied in this study. Section 4 describes the details of the case study and data collection. The results are shown in Section 5. Section 6 discusses the results and compares them with the literature. Some concluding remarks, managerial implications, and limitations for future research are presented in the last section.

2. Literature Review

To effectively position our work within the context of the current literature, we must analyze two aspects of the analysis: the variables considered and the methodologies utilized. To improve decision making, the measurement and analysis of satisfaction with PT service quality are vital to determine the areas of improvement that should be prioritized, and a market analysis from different viewpoints should be conducted [17,18]. Table 1 presents studies that measured the PT service quality and commuters' attitudes. The literature agrees that the use of robust results to consider the specific segmentation of changing travel behavior is probably more efficient than using a "one size fits all" technique [19,20]. Additionally, the availability of alternative transport modes is a challenge for transport planners in terms of maintaining and accelerating PT ridership [21]. It has been suggested that segmentation can help to address the challenges associated with transport planning. Moreover, Thøgersen concluded that a specific group of PT customers should be considered, such as research on frequent users, as this will provide a good understanding of travel mode choices [22]. For example, passengers who prefer to use PT and irregular users have different levels of knowledge about or experience with the provided PT service, making their opinions valuable [12,23].

Recently, researchers have focused on the frequency of PT use. For example, De Vos [24] studied the desire to use and the actual frequency of PT use (never, rarely, occasionally, regularly, and mostly) among university students. These variables can be significant indicators of customers' willingness to use PT. The results indicate that the frequency of PT use is influenced by the user's living context and graduation status. The authors suggested that, in future research, the relationship between the desired PT frequency and the satisfaction level should be considered. It has also been proven that travel satisfaction plays a key role in shaping habitual PT use; for instance, by providing reliable and free PT [25]. Moreover, in the last ten years, researchers have investigated and assessed the relationship between travel satisfaction and trip characteristics [26], such as the mode choice and travel time [27,28], as well as how these factors correlate with the built environment [29]. Nonetheless, there are still prominent gaps in the literature in terms of travel satisfaction and characteristics [26]. These factors could provide important information on the PT service quality because of the groups' heterogeneity. Furthermore, SQAs are not equally important for users, and if any of these attributes were improved, the level of approval by the individual users would be different [30].

On the other hand, according to the vast body of literature represented in Table 1, the consideration of university commuters may be crucial for the fulfilment of the goals of the mobility plan. It is possible to better target and increase the effectiveness of actions through the correct division and understanding of group characteristics [31]. For example, a study investigated the differences in mode choice between genders and the spatial and temporal differences between student commuters; males were found to be more likely to change their mode of transport over a year than females [28]. Furthermore, Rodríguez and Joo [32] showed that the car is mostly preferred by students, followed by public transport, and then walking and bicycling. Likewise, Zhou [33] concluded that approximately 40% of students use PT, followed by other active modes. According to Whalen, students are more likely than the overall population to use active modes of transport [34]. There is a consensus that active travel (e.g., walking and cycling) is more satisfying than public transport [35]. However, another study pointed out that PT qualifies as an "active mode" because it frequently requires walking or cycling at either the start or end of the trip [36]. Assessing travel satisfaction by considering one particular trip (e.g., the most frequent trip) or satisfaction related to the purpose of the trip (e.g., leisure trips) may result in problems, because the satisfaction measure may be used for those who are taking leisure trips. Therefore, the development of specific transport demand management (TDM) policies is necessary to meet the needs of commuters while also enhancing the economic and environmental viability of the PT system [36,37]; for instance, to meet the travel satisfaction needs of users with different daily travel patterns [35]. The literature also confirms that college students are not only likely to play important roles in society in the future but also have the potential to influence policymakers to create sustainable transport infrastructure [31,38,39]. Mobility Managers (MM) have made efforts to increase the awareness of PT options among employees who commute privately due to the increased interest in promoting sustainable options. University students make up a sizable portion of the working population because they frequently commute to their campuses. However, few studies have examined the commuting behaviors of college students [40]. This is a key motivator of this research because educational institutions are not only large employers but also major trip producers [36,41] with significant influence on traffic externalities, particularly when they are located in urban areas [37].

Service can be defined as a business transaction that occurs between a service provider and a customer to create an outcome that satisfies the customer [42]. "A common standard definition of service quality is that service should correspond to customers' expectations and satisfy their needs and requirements" [43]. In summary, the definition of PT SQ can vary depending on the context, the level of service, and the stakeholders involved. Moreover, PT users' perceptions of PT SQ often differ greatly from those of the users of other modes (e.g., private vehicle). Therefore, to gain an accurate and well-rounded understanding of PT SQ, it is important to gather data on PT SQ from both captive (frequent) PT users and non-captive (occasional) PT users. Indeed, even if an individual does not use PT, their insights can still be valuable if they have knowledge about or experience with PT services [8].

The term "satisfaction" has commonly been defined in previous research as "a judgment that a product or service feature, or the product or service itself, provides a pleasurable level of consumption-related fulfilment, including levels of under- and over-fulfilment" [44]. It is worth noting that the terms "satisfaction" and "service quality" have been measured and reported on interchangeably [45]. One study highlighted single satisfaction measures with specific attributes [46], while another study considered the overall satisfaction over time [47]. Therefore, the satisfaction concept can be measured as the overall satisfaction or in terms of a particular service quality attribute. Hence, it is possible to measure it by latent constructs [48]. A single or multi-item measure can be used to measure overall travel satisfaction. A previous study included the question "In general, how satisfied are you with public transport?" as a single common item in the assessment, which may be a beneficial approach for complicated surveys [49]. Nevertheless, transport managers may prefer to use single-item measurements to reduce the cost and effort associated with the collection and processing of data, among other factors [1]. In this way, the overall satisfaction can be determined by the individual SQAs. PT service providers have generally concentrated on obtaining an adequate service quality that contributes to increased overall travel satisfaction. Thus, the outcomes may vary between different segments, and there is a need to study other mobility characteristics, such as the frequency of PT use.

According to the literature, two main techniques have been used to evaluate commuter satisfaction. The first is an objective (indirect) measure, including speed, capacity etc., which can be collected through terminal surveys or automated customer counts [50]. The second method is subjective (direct), and data collection and measurement focus on passengers' perceptions [51]. A previous study developed the Satisfaction With Travel Scale (STS), which is now commonly used as an assessment approach with effective and cognitive components [52]. However, for this study, we adopted the Customer Satisfaction Survey (CSS) technique in the research questionnaire, with a five-point Likert scale to assess passengers' perceptions. The judgement of transit users could be used as a foundation for evaluating service quality [50]. These assessments, which are regarded as a subjective gauge of service quality, typically come from the well-known CSS, which assists transit providers in determining which aspects of service quality are most valued by customers. For example, one study applied a seven-point Likert scale from one (very unhappy) to seven (very happy) [53]. Similarly, another study applied five statements regarding travel satisfaction, which were rated on a five-point scale from one (strongly disagree) to five (strongly agree) [36]. Thus, many models measure PT service quality and satisfaction with various sample sizes and contexts, thus resulting in different outcomes [9,19].

Table 1. Previous literature on the research themes.

Sources	Contexts	Themes	Segments	Techniques *	Findings
[9]	Jordan	Validation of the created model and PT quality improvement	Focus groups	AHP–BWM	The hybrid model can be applied to random hierarchically structured decision problems.
[16]	Portugal	Frequency of PT and satisfaction	Students researchers	Bayesian SEM	A negative link was found between the frequency of use and satisfaction with PT.
[25]	Canada	Actual and desired PT frequency	University students	OLM	Attitudes towards and contentment with public transport influence willingness to utilize it regularly.
[28]	Moscow	Modal choice and gender differences	Student commuters	GIS, general statistics	Male students are more likely to alter their mode of transport over a year, whilst females are more likely to use active transport modes or PT.
[31]	Iran	Environmentally friendly behaviours (EFBs)	University students	Qualitative research	Direct relationships were found among the sociodemographic characteristics of students and their EFBs.
[34]	Canada	Mode choice	University students	Multinomial logit model (MLM)	For the automobile and bicycle, the trip time has a positive effect on their utility; however, this occurs at a diminishing rate as the travel time grows.
[36]	Australia	Commuting patterns	University staff and student	Bivariate and multivariate analyses	Reducing barriers to adopting active modes, particularly bus and bicycle trip time, would have the biggest impact on commuting patterns.
[38]	Slovenia	Mode choice	University students and staff	QGIS and descriptive statistics	Trip origins, bus subsidization, the availability or lack of free parking, and parking costs were found to be the primary drivers of mode switches.
[54]	Spain	Developing a method to measure users' satisfaction	Bus line operators	Best–Worst scaling—OLM and IPA	The levels of satisfaction attained from the alternative techniques were quite similar.

Table 1. *Cont.*

Sources	Contexts	Themes	Segments	Techniques *	Findings
[55]	Jordan	Student satisfaction and loyalty	University area	PLS-SEM and BLR	The four factors influencing passenger loyalty were perceived service quality, user satisfaction, cost, and environmental factors.
[56]	Hong Kong	Satisfaction with public transport	Elderly users	OPM importance–satisfaction analysis	The condition of stations and stops was highlighted as a priority for enhancement and the most important element influencing the overall satisfaction with PT services.

* AHP: analytic hierarchy process; BWM: best worst method; OLM: ordered logit model; GIS: geographic information system; PLS-SEM: partial squares—structural equation model; BLR: binary logistic regression.

Recently, researchers have comprehensively proposed and concentrated on the analysis of PT service quality to improve the efficiency of systems by using hybrid approaches. For instance, the use of MCDM models in transport has become increasingly important [9]. These methods are beneficial in terms of saving time and reducing costs during data collection and when dealing with the observed variables. However, other researchers have focused on the integration of discrete choice models (DCMs), such as the OLM and/or the IPA, to investigate the heterogeneity of preferences and assess the satisfaction of PT passengers to determine the suitability of these methods as replacements for more traditional approaches [54,57]. Further studies have integrated the PLS-SEM and the necessary condition analysis (NCA) [1], whereas others have relied on the PLS-SEM/SEM and Bayesian network (BN) to investigate the PT service quality and satisfaction with PT [58,59]. Table 1 shows that recent research used the PLS-SEM and BLR [51] with varied statistical methods, such as OLM/MLM, rather than Artificial Neural Network (ANN) approaches, to build better prediction models [12]. In addition, ordinal regression models are widely used to avoid the pitfalls of using ANOVA-type models on ordered categorical data [60]. In [61], it was stated that the OLM/OPM, by nature, is an appropriate method for questions related to satisfaction, as it can be used to assess attitudes. The ordered regression models are very appropriate for treating categorical variables; they have good applicability for analyzing responses to customer satisfaction and behavior surveys [62]. The regression model can be divided into two groups: OLM and OPM. It is worth noting that the results of ordered probit and logit models are similar [63]. However, there is no general agreement on which model is more appropriate and robust.

A hybrid (integrated) method combines more than one methodology to investigate a particular problem or issue from diverse important angles or points of view. For instance, Ben-Akiva [64] stated that the DCM hybrid method needs to be studied to analyze the complex relationships among variables, because the combinations lead to several challenges. Furthermore, the author pointed out that it is difficult to measure the latent psychological factors with the DCM, including with ordered/probit logit models. One study used a hybrid latent class and the OPM to determine the differences in the impacts of explanatory variables on commuter satisfaction [53]. Azzopardi and Nash [65] stated that many studies have utilized IPA to evaluate SQAs and managerial implications, and they suggested that future research should be conducted to improve the reliability and validity of IPA [65]. For instance, Esmailpour [66] integrated the IPA with the Exploratory Factor Analysis (EFA) to improve its validity and reliability. This method can be used to determine the limitations in PT service attributes relative to their importance levels. One study applied IPA to highlight the practical implications of acquiring results from the SEM [67]. A further study integrated the IPA with the AHP as a straightforward and practical technique to assess SQAs and satisfaction in transport planning decision making [68]. Another study proposed the use of a hybrid OPM and importance–satisfaction analysis to visualize the priority areas of improvement [56]. This evidence shows that the integrated techniques are more robust and accurate and produce results that are simpler and more transparent than those of traditional techniques, allowing for better decision making, avoiding the waste of important resources, and providing specific policy measurements [56]. In this research, we propose an integrated OPM and IPA approach for the analysis of travel satisfaction and the identification of priority areas for the improvement of service attributes.

3. The Integrated Model

After checking the reliability of the data, two main steps were undertaken for the analysis: first, descriptive and comparative analyses were conducted, including the determination of the mean and standard deviation. A parametric Student's t-test was conducted for two independent samples. Second, this study used the OPM and IPA to conduct heterogeneity and segmentation analyses. All statistical analyses were conducted using STATAMP-16 and IBM SPSS-25 software.

3.1. Comparative Analysis

A previous study proved that ordinal data with a Likert scale can be examined through parametric tests and produce reliable results [69], while the independent *t*-test is used for normally distributed data [70]. There has been significant discussion over whether or not Likert scale data can be subjected to parametric statistical testing. There is significant evidence that Likert data can be analyzed using parametric statistics, even when there is a small sample size, non-normal distribution, or unequal variance without a "fear of coming to the wrong conclusion" [69,71]. For example, for data with a five-point Likert scale, studies have found that the Student's *t*-test and Mann–Whitney U test results have very similar levels of robustness and power [69,72]. Thus, in this study, a Student's *t*-test for two independent samples was applied in order to identify any significant differences in the perceptions of service quality and overall satisfaction between habitual and occasional PT users. Equation (1) was used to conduct a comparison between the means:

$$\boldsymbol{t} = \frac{\boldsymbol{m_A} - \boldsymbol{m_B}}{\sqrt{\frac{\boldsymbol{S^2}}{\boldsymbol{n_A}} + \frac{\boldsymbol{S^2}}{\boldsymbol{n_B}}}} \quad (1)$$

where is the students *t*-value; $\boldsymbol{m_A}$ and $\boldsymbol{m_B}$ are the mean values of groups $\boldsymbol{A}$ and $\boldsymbol{B}$, respectively; $\boldsymbol{n_A}$ and $\boldsymbol{n_B}$ are the sizes of groups $\boldsymbol{A}$ and $\boldsymbol{B}$, respectively; and $\boldsymbol{S^2}$ is the common variance of the two groups.

3.2. Multiple Regression: Ordered Probit Model

McKelvey and Zavoina [73] developed the OPM. This model is a regression model for ordinal response variables [61]; it is also claimed that the ordered logistic model is an extension of the binary response model in the DCM. The OPM can identify statistically significant relationships between the travelers' explanatory variables and a dependent variable, such as the satisfaction state while travelling. Several studies have applied the OPM to analyze other transport issues [62,63]. The OPM has often been applied for customer satisfaction analysis to obtain the data structure required for an ordinal response. It has been claimed that a simple regression would create bias in data in which the dependent variable has an ordinal scale. Yet, due to the data's nature, this complex issue can be easily and conveniently analyzed by the presented methodology [62]. There is an ordinal variable Y in the ordered probit model, which is a function of a variable Y^* that is not measured. β_k is the coefficient of the X_{ki} independent variable, and Z_i is the linear combination of both coefficients and independent variables; it denotes the deterministic portion. The expected average value of *Yi** can be estimated with the ordered probit model (see Equation (2)):

$$E(Y_i{}^*) = Z_i = \sum_{k=1}^{k} \beta_k X_{ki} \quad (2)$$

3.3. Importance–Performance Analysis (IPA)

Many scholars analyze the service quality with different planning concepts (perception, satisfaction, behavioral intention, and loyalty) to identify the service attributes that have the most significant contributions to the attractiveness of PT. The IPA can be used to obtain this target information. Usually, it is used in questionnaires related to satisfaction. The importance–performance Analysis (IPA) was first developed by Martilla [74]. The IPA has been applied for SQAs and explores managerial implications, thus leading to recommendations for service providers and decision makers. Figure 1 illustrates that IPA plotting can be used to classify the performance and importance levels of service attributes into four quadrants according to passengers. The *X*-axis shows the performance or satisfaction level, and the *Y*-axis presents the importance [75]. Researchers have stated that the results of conventional approaches may be biased, which is a limitation in solving this problem [54]. Another study used an ordered probit model and importance–satisfaction analysis to determine the priority levels of service improvement areas with nine cells. In this study, we used the ordered probit model (OPM) to determine the attribute importance, because the overall satisfaction was evaluated on an ordinal scale. The mean values of the attributes and the coefficients of significant values were calculated to construct the IPA, which included four cells. PT operators and policymakers can better address customers' needs through the use of this type of analysis [68]. Introducing this method undoubtedly prevents decision makers from wasting important resources (e.g., computational expenses, cost, and effort) on irrelevant attributes. Moreover, PT operators and policymakers can better address customers' needs in the decision process by highlighting the most significant service attributes as priorities for enhancement from the point of view of different PT commuters.

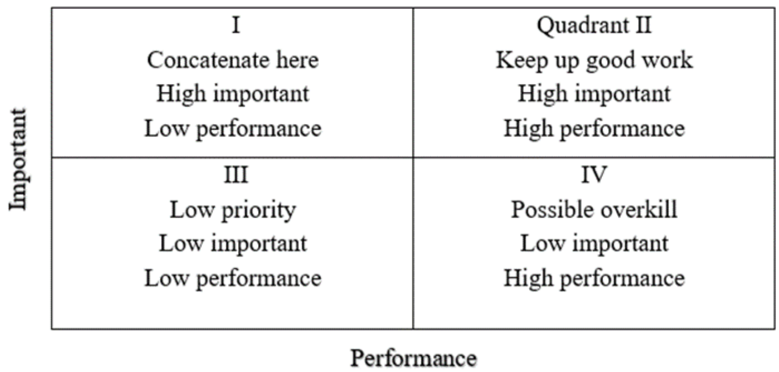

Figure 1. The original IPA standard chart [68].

4. Case Study and Data Collection

4.1. Case Study on PT

Budapest is the capital of Hungary and covers an area of 525 km^2. The size of the urban area has increased, and the population has also been increasing. Budapest is an attractive capital city with unique characteristics. Since 2014, the Budapest Road network has expanded to a total size of 4500 km [76]. Budapest provides an interesting case study for Eastern Europe, because it has one of the highest levels of urban PT (including 328 bus lines, 4 metro lines, 34 tram lines, 16 trolleybus lines, and 16 railway lines) with 2073 public transport vehicles in use per day. PT is provided by a company called BKK. Additionally, there are 390 motorized vehicles per 1000 inhabitants and 7000 licensed taxis in operation, as well as enhanced micromobility (i.e., 157 Bubi bike docking stations) compared to other cities with around the same population (1 million inhabitants) [76,77]. Furthermore, according to the Hungarian Central Statistical Office, the number of car passengers per day has increased from 2.6 million to 3.4 million, which is lower than that of cities of around the same population in Western Europe (4.3 million travelers per day) [76]. Recently, economic and social reforms in Budapest have escalated the employment of the young population compared to in recent decades. This evolution of the working quantity is predicted to be reflected in huge alterations in mobility patterns. An increase in the population and the use of personal cars are crucial factors that can influence the incidence of traffic accidents and congestion. In particular, educational institutions and services represent the main attraction and trip generator in Budapest. For example, the Budapest University of Technology and Economics (BME), founded in 1782, is considered one of the oldest technological institutes in the world. It is located almost in the city center and has approximately 21,000 students, of whom 1000 or more are international students. A monthly student PT pass is HUF 3450 (about EUR 9), which is a fairly affordable price for Central Europe [78].

Thus, one of the main aims of the Budapest Mobility Plan is to solve the general and specific transport-related problems revealed in an analysis of the current situation in the area [76]. The key targets of the EU transport policy include the reduction of greenhouse gas emissions, an increase in the competitiveness of the regions of Europe, and, hence, an improvement in the quality of life of European citizens. However, it is worth mentioning that based on the mobility plan for Budapest, current transport planning is focused on technical–operational aspects rather than on the comfort of passengers [76]. This is another motivating factor for this research. Therefore, it is crucial to explore the impact factors among traveler groups to enhance the development of the public transport project in Budapest. This study will provide recommendations for PT operators regarding the adoption of various group policy measures to improve PT services and increase ridership.

4.2. Data Collection and Survey Design

This study used data on the public transport SQ. The data were gathered through paper-based and online panel customer satisfaction surveys that were completed by university employees and students who were PT commuters. This survey was carried out by BME university staff and students in Budapest, a city that consists of 23 districts and multiple postcodes. The data were collected to serve the research objective, which focuses on an individual base-level theory because the problem comes from the individuals. The sampling method was convenience sampling, a nonparametric sampling method that includes random sampling. This research collected data from different commuters in English. Additionally, to cover the citizens' perspectives and avoid cultural and language barriers, the questionnaire was translated into the local language (Hungarian). The survey was carried out on weekdays by transport planning experts (see Appendix A).

The survey questionnaire was adapted and developed from previous studies [8,17]. The questionnaire included the following sections:

(i) Sociodemographic characteristics, including age, gender, occupation, income, education level, and geographical area.
(ii) Questions contributing to the identification of the target population (regular PV and PT).
(iii) Questions on usage and mobility characteristics (occasional and habitual) of PT users.
(iv) Questions relating to users' experiences of and satisfaction with public transport service quality.

This study focused on the segmentation of frequency of using public transport: occasional users (less than 1–2 times per week) and habitual users (3–7 times per week). The categorization of habitual and occasional users was based on relevant questionnaire designs contained in the literature [8,17,23,79]. In our study, we asked university commuters about their frequency of PT use, and some modifications were made for the case study and used for the analysis. We extracted data from both groups (habitual and occasional users) as segments for analysis. In addition, questions on the satisfaction level with the 14 SQAs (independent variables) were included. The overall satisfaction (OS) was assessed as a single question (dependent variable) about the current PT service quality, with responses given on a 5-point Likert scale (from very dissatisfied to very satisfied), which is in line with methods used in previous studies [23,79]. A total of 500 complete responses to this questionnaire were collected during September and October 2020. Table 2 shows the socioeconomic data collected. Predictably, most habitual PT users lived in the city center (59.1%), whereas the majority of occasional PT users lived in suburban areas (58.8%). Regarding gender, the male-to-female percentage split was similar for the habitual (55.2% male and 44.8% female) and occasional (54.4% male and 45.6% female) groups. Not surprisingly, a higher percentage of the habitual PT users (61.8%) were in the 25–44 year age range compared to the occasional PT users (49.3%). For both groups (considering either university staff or students as respondents), the majority of participants had a university degree (95.3% of habitual users and 92.6% of occasional users). Most habitual users were students (55.7%), while occasional users were mostly university workers (48.5%). It can be seen from Table 2 that 94% of the habitual group respondents were regular PT users, while for the occasional group, 79.9% were regular private vehicle (PV) users. The questionnaire responses revealed that, in both groups, most participants earned less than HUF 563,000/month (EUR 1500), including 74.2% for habitual users and 53.6% for occasional users.

Table 2. Socioeconomic characteristics and samples.

Characteristics	Categories	Habitual Users		Occasional Users	
		N	%	N	%
Geographical area	City center	215	59.1%	56	41.2%
	Urban area	149	40.9%	80	58.8%
Gender	Male	201	55.2%	74	54.4%
	Female	163	44.8%	62	45.6%
Age	18–24	97	26.6%	19	13.9%
	25–44	225	61.8%	67	49.3%
	45–64	32	8.8%	40	29.4%
	65+	10	2.8%	10	7.4%
Education	Without university degree	17	4.7%	10	7.4%
	With university degree	347	95.3%	126	92.6%
Occupation	Self-employed	20	5.5%	19	13.9%
	Employee	114	31.3%	66	48.5%
	Unemployed	07	1.9%	02	1.5%
	Student	203	55.7%	31	22.8%
	Retired/Pensioner	10	2.8%	8	5.9%
	Other tasks	10	2.8%	10	7.4%
Target	Regular PT user	342	94%	30	22.1%
	Regular PV user	22	6.0%	106	77.9%
Income	Less than HUF 563,000/month (EUR 1500)	270	74.2%	73	53.6%
	HUF 563,000–1,127,000/month (EUR 3000)	42	11.5%	30	22.1%
	Above HUF 1,128,000/month	12	3.3%	17	12.5%
	Unsure	40	11%	16	11.8%
Total sample		364	100%	136	100%

4.3. *Reliability of data*

Before moving to the main analysis procedure, the reliability of the data was investigated through the variance inflation factor (VIF) using IBM SPSS Statistics 25. In the literature, there are several rules that are generally employed. For instance, some researchers consider values of 5 or 10 [80,81]. However, many studies regard a value of 10 as being related to VIF [82–84]. In addition, the tolerance suggestion of 0.10 corresponds to the VIF recommendation of 10 (i.e., 1/0.10 = 10) [85]. Table 3 shows that, in the current study, the tolerance was greater than 0.10 and the VIF was less than 10 for each independent variable, demonstrating that there was no multicollinearity issue (i.e., a situation in which the independent/predictor variables are highly correlated) between the independent variables [86]. Table 3 reveals the collinearity results for the independent variables. For example, in the case of S1, the tolerance level of 0.56 implies that 56% of the variance in service hours is unique to S1 and, therefore, not affected by other predictors. In addition, for habitual users, the reliability of Cronbach's Alpha based on standardized items was found to be 0.902. The validity is the significance for all variables in the two-tailed bivariate correlation test. Similarly, for occasional users, the reliability statistic of the Cronbach's Alpha is 0.942, and validity is the significance for all variables in the bivariate correlation test [87]. This is evidence that the data have sufficient reliability and validity.

Table 3. Reliability and collinearity of the data.

			Habitual User		Occasional User	
	Variables	Scale *	Tolerance	VIF	Tolerance	VIF
S1	Service hours	1–5	0.56	1.79	0.21	4.76
S2	Proximity	1–5	0.46	2.16	0.20	5.00
S3	Frequency	1–5	0.39	2.59	0.22	4.54
S4	Punctuality	1–5	0.48	2.10	0.27	3.73
S5	Speed	1–5	0.50	1.99	0.26	3.87
S6	Cost	1–5	0.74	1.35	0.38	2.65
S7	Accessibility	1–5	0.51	1.97	0.29	3.43
S8	Intermodality (connection)	1–5	0.52	1.91	0.34	2.91
S9	Space available inside the vehicle	1–5	0.52	1.94	0.26	3.83
S10	Temperature inside the vehicle	1–5	0.48	2.10	0.30	3.36
S11	Cleanliness of the vehicle	1–5	0.46	2.17	0.29	3.50
S12	Safety on board regarding accidents	1–5	0.53	1.90	0.25	4.10
S13	Safety regarding robbery	1–5	0.58	1.73	0.24	4.14
S14	Information provided	1–5	0.76	1.31	0.51	1.97

* Note: 1 = very dissatisfied, 2 = dissatisfied, 3 = neutral, 4 = satisfied, 5 = very satisfied.

5. Results

5.1. Comparative Analysis Results

Table 4 illustrates the comparative descriptive statistics for the service quality attributes (i.e., the mean and standard deviation). The results show that, for habitual users, the cleanliness inside the vehicle and stations obtained the lowest average score, while for occasional users, the temperature inside the vehicle and cleanliness had the lowest mean scores, suggesting that investment inside the vehicles may be required. On the other hand, service hours, proximity, and frequency had relatively higher average scores for both groups. In terms of the overall satisfaction, habitual users were found to be more satisfied (4.18) than occasional users (3.76). A further analysis was carried out on the mean values shown in Table 4 to identify any significant differences between the results of habitual and occasional users. Table 4 presents the results of the comparative analysis in which the two groups of PT users and the average perceptions of service quality attributes were assessed. For this purpose, Student's t-tests were conducted for independent samples to compare the mean SQA scores and the average overall satisfaction score. The results showed significant differences for S6, S7, S10, S11, and OS (cost, accessibility, temperature, cleanliness, and overall satisfaction) between habitual and occasional users, with *p*-values of <0.05. This answered the first research question.

Table 4. Comparative analysis results.

Variables	Habitual Users		Occasional Users		Independent *t*-Test		
	Mean	SD	Mean	SD	*t*-Value	DF	*p*-Value
Service hours (S1)	4.11	0.89	3.98	0.96	−1.167	463	0.244
Proximity (S2)	4.03	0.83	3.89	0.90	−1.515	463	0.131
Frequency/number of daily trips (S3)	3.90	0.92	3.92	1.00	−1.786	463	0.075
Punctuality (S4)	3.77	0.96	3.79	0.88	−1.131	463	0.259
Speed (S5)	3.83	0.95	3.64	0.92	−1.110	463	0.268
Cost (S6)	3.83	1.10	3.50	1.11	−3.020	463	0.003 *
Accessibility (S7)	3.81	0.98	3.41	1.06	−3.570	463	0.000 *
Intermodality (connection) (S8)	3.85	0.96	3.66	0.98	−1.488	463	0.138
Individual space inside the vehicle (S9)	3.24	1.10	3.15	1.07	−0.717	463	0.474
Temperature inside the vehicle (S10)	3.08	1.14	2.80	1.21	−2.223	463	0.026 *
Cleanliness of the vehicle (S11)	2.94	1.15	2.71	1.22	−2.062	463	0.040 *
Safety on board (accidents) (S12)	3.73	0.97	3.56	0.97	−1.564	463	0.119
Safety regarding robbery (S13)	3.38	1.05	3.24	0.10	−1.316	463	0.189
Information provided (signage, displays, maps, schedules, kiosks) (S14)	3.68	1.05	3.56	0.96	−1.579	463	0.115
Overall satisfaction (OS)	4.18	0.82	3.76	1.06	−4.457	463	0.00 *

* Significant values at the 5% level of confidence.

5.2. Results of the Ordered Probit Model

This section displays the results for the importance and effects of the service quality attributes on the overall satisfaction level by applying an OPM. All statistical analyses were conducted using STATAMP 16 without missing values. The results for all models and for the segmentation models for both groups can be seen in Table 5. All groups had 14 degrees of freedom, and the Pseudo R2 values indicate overall satisfaction variability values for the three models of 18.06%, 17.08%, and 25.87% for the overall sample, habitual users, and occasional users, respectively. Among the fourteen SQAs, four attributes (frequency, punctuality, and information) were significant at the 10% confidence level, and "cost" was significant at the 1% confidence level for the general model. For habitual users, only three attributes were significant (cost at the 10% level and accessibility and information at the 5% confidence level). For the occasional users, five attributes were significant (punctuality, cost, intermodality, and cleanliness at the 5% level and accessibility at the 10% confidence level). Cost was found to be a significant variable for all models. In addition, the provided information was also significant for two of the models.

5.3. Marginal Effect Estimation

Marginal effects are valuable and indispensable techniques that are used to explain regression parameters in nonlinear models, such as the OLM/OPM. They can be calculated as "what if" the change occurs in terms of the probability when the independent variable is raised by one unit. They are usually employed after the logit models for categorical data have been estimated. Given that the "unit" may be very small, this indicates an instantaneous change for continuous variables. The change in binary variables is from 0 to 1, which is commonly referred to as one "unit" [88]. The results, including the positive (+) and negative (−) coefficients derived from the applied OPM, may not be sufficient to assess the influences of the independent variables on the satisfaction of PT passengers (SAQs). The marginal effects can be used to determine how the dependent variables change in response to changes in the independent attributes [89]. Table 6 provides a more practical interpretation of the results. The outcomes show that the probability of improving the overall satisfaction rating can be increased through the enhancement of each of the SQAs. The positive signs represent probability increases, and probability decreases are shown by the negative signs in terms of percentages (%) and their significance levels. The main information that should be extracted from Table 6 is the impact of the SQA improvement on the probability that users will rate the overall satisfaction from one to five. We provide an example of an SQA (S1), which corresponds to the service hours. If this attribute is improved (e.g., the authority extends their service hours), the probability that users will rate the overall service as very satisfactory (rating 5) will increase by 1.2% for habitual users and by approximately 4% for occasional users. However, this effect is nonsignificant. Furthermore, the change in probability following an improvement in punctuality (S4) is 3.6% for habitual users and 8.2% for occasional users, and this result is significant (i.e., $p > |z|$, for significance at a value of 95%, which is <0.05).

Table 5. Results of the ordered probit model.

SQAs		All Samples	Habitual Users	Occasional Users
		Coefficients	**Coefficients**	**Coefficients**
S1	Service hours	0.091	0.412	0.186
S2	Proximity	0.120	0.062	0.165
S3	Frequency	0.171 *	0.179	0.197
S4	Punctuality	0.146 *	0.119	0.391 **
S5	Speed	−0.003	0.006	−0.069
S6	Cost	0.179 ***	0.125 *	0.273 **
S7	Accessibility	0.095	0.194 **	−0.289 *
S8	Intermodality	0.091	−0.013	0.390 **
S9	Space available in vehicle	0.033	0.069	0.350
S10	Temperature in vehicle	0.026	0.040	0.006
S11	Cleanliness	0.040	−0.032	0.296 **
S12	Safety/accidents	0.066	0.105	0.093
S13	Safety/robbery	0.043	0.110	−0.269
S14	Information provided	0.114 *	0.172 **	−0.022
Model fit information				
N° obs (N)		465	342	123
Log-Ll zero		−553.85233	−383.03018	−159.58396
Log-Ll final		−453.8273	−317.59803	−118.2982
Pseudo R2		0.1806	0.1708	0.2587
Prob > chi2		0.0000	0.0000	0.0000
LR chi2(14)		200.05	130.86	82.57

*** Value significant at 0.01, ** value significant at 0.05, * value significant at the 0.1 level of the interval.

5.4. Results of the IPA

From a practical viewpoint, this research is the first study to combine the OPM and IPA for the recommendation of specific policy measures. Following the OPM results for the disaggregating analysis (Table 5) and the mean rate of satisfaction (Table 4), the IPA results present the importance–satisfaction quadrants for both habitual and occasional PT users. Figure 2 shows that the importance index and the performance index are presented as separately colored for the habitual users (blue) and the occasional users (orange) in the vertical and horizontal lines. The boundaries for habitual and occasional users were established by using the average of the positive significance of coefficients from the OPM results and the mean rates of satisfaction (i.e., for habitual users, cost, accessibility, and information, and for occasional users, punctuality, intermodality, cost, and cleanliness).

Table 6. The results for the marginal effects.

SQA	Habitual Users					Occasional Users				
	Very Dissatisfied %	Dissatisfied %	Neutral %	Satisfied %	Very Satisfied %	Very Dissatisfied %	Dissatisfied %	Neutral %	Satisfied %	Very Satisfied %
S1	−0.05	−0.2	−0.5	−0.5	1.2	−1.4	−0.9	−1.5	−0.03	3.8
S2	−0.07	−0.3	−0.7	−0.7	1.8	−1.2	−0.8	−1.4	−0.02	3.4
S3	−0.2	−0.9	−2.3	−0.2	0.5	−1.5	−0.9	−1.6	−0.03	4.1
S4	−0.2	−0.6	−1.5	−1.3	3.6	−2.9	−1.9	−3.2	−0.06	8.2 *
S5	−0.008	−0.03	−0.07	−0.07	0.2	0.5	0.3	0.6	0.01	−1.4
S6	−0.2	−0.6	−1.5	−1.4	3.7	−2.0 *	−1.3	−2.2 *	−0.04	5.7 *
S7	−0.3	−0.9 *	−2.4 *	−2.2 *	5.8 *	2.2	1.4	2.4	0.05	−6.0
S8	0.02	0.06	0.2	0.1	−0.4	−2.9	−1.9	−3.2	−0.06	8.1 *
S9	−0.08	−0.3	−0.9	−0.8	2.1	−0.3	−0.2	−0.3	−0.006	0.8
S10	−0.04	−0.2	−0.5	−0.4	1.2	−0.05	−0.03	−0.05	−0.001	0.1
S11	0.04	0.2	0.4	0.4	−0.9	−2.2	−1.5	−2.5 *	−0.05	0.2 *
S12	−0.1	−0.5	−1.3	−1.2	3.1	−0.6	−0.5	−0.8	−0.02	1.9
S13	−0.1	−0.5	−1.4	−1.2	3.3	2.0	1.3	2.2	0.04	−5.6
S14	−0.2	−0.8	−2.2 *	−1.9 *	5.2 *	0.2	0.1	0.2	0.004	−0.4

* Value significant at 0.05 level of the interval.

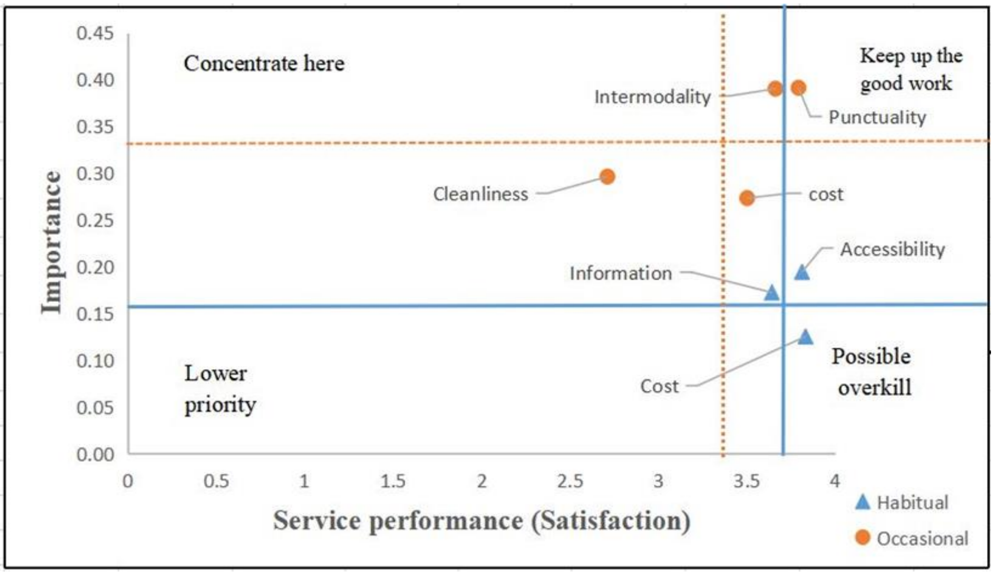

Figure 2. The results of the importance–performance analysis.

As shown in Figure 2, only the significant attributes with positive coefficients were calculated. The “keep up the good work” quadrant contains the intermodality and punctuality attributes for the occasional users and the accessibility attribute for the habitual users. These factors are important and perform well. Only the information attribute for habitual users is contained in the “concentrate here” quadrant. Interestingly, for the occasional users, the attribute in the “lower priority” quadrant is cleanliness. Cleanliness is in the lower priority quadrant for occasional users because these users sometimes use private vehicles due to safety issues. A possible explanation for this is the COVID-19 pandemic. Additionally, this is supplemented by the results presented in Table 3, which show that, for habitual users, cleanliness inside the vehicle and stations was given the lowest average score, while for occasional users, the temperature inside the vehicle and cleanliness had the lowest mean scores. Finally, for both user groups, the cost was in the “possible overkill” quadrant, which indicates unimportance but good performance. This suggests the application of more resources than needed to address cost.

6. Discussion

Based on this study's results, question (1) could be answered as differences exist between habitual and occasional users. For example, for habitual users, cleanliness inside the vehicle and stations was perceived as less positive, while for the occasional users, the temperature inside the vehicle and cleanliness were perceived as less positive, suggesting that investment inside the vehicle may be required. In line with previous studies, this may be related to the COVID-19 pandemic [17,77,90]. Conversely, service hours, proximity, and frequency were associated with more positive attitudes in both groups. In accordance with the literature, in terms of the overall satisfaction determined using our new outcome measure, habitual PT users were found to be generally more satisfied than occasional PT users [17,23,79]. On the other hand, a negative link between the frequency of PT use and satisfaction with PT was found in a previous study on university travelers [16].

With regard to question (2), the overall satisfaction level, the findings reveal that cost was a significant variable for all models. This is inconsistent with previous research, which has highlighted the condition of stations or stops as the priority for enhancement and as the most important element in overall satisfaction with PT services [56]. This suggests that transport providers should continue to focus on maintaining affordable passenger costs, particularly regarding discounts for university students and elderly passengers. In line with a further study in the literature, the provision of PT subsidization or any discounts on costs are the key drivers of mode switches towards sustainable transport, particularly for university students [38]. Meanwhile, other studies have found that trip time is the most influential factor in university commuters' mode choices [34,36].

The question of which service attributes should be prioritized for improvement for each group is connected to question (3), which can be answered by the finding that interestingly, the only attribute included in the "concentrate here" quadrant was the information attribute for habitual users. This means there is a higher priority for policymakers to improve this attribute. Improving the information provided for the PT system will likely encourage students to use PT. For example, transport service providers create user information systems that provide messages, such as signage, displays, maps, schedules, information kiosks, ticket offices and machines, and help stations. In the IPA results, cleanliness is in the lower priority quadrant for occasional users because they sometimes use private vehicles due to safety issues; a possible explanation is that due to the COVID-19 pandemic, some satisfaction issues became more important, while others had less of an impact. This finding is in agreement with the literature [17,77,90]. Despite transport planning considerations, as mentioned in a recent review, improvements are recommended to find better ways to measure PT service quality [91]. The new integrated method applied in this study shows a better visualization of the results, which can be used to prioritize actions for enhancement. This is in line with [54–56,65–68,92]. The proposed model is a straightforward and practical technique that is more integrated than the existing methods in the literature. For example, the proposed model using the ordered logit model can be appropriate in certain situations compared to SEM and hybrid discrete choice models. While SEM and existing hybrid models offer advantages in capturing complex relationships [57,58], there are cases where the simplicity and interpretability of the OLM make it a suitable choice, which is in line with the literature [54,92]. In comparison with hybrid MCDM techniques, a clear advantage of the proposed OLM model is that it is capable of revealing latent influences of the attributes, while all MCDM techniques consider these interconnections a priori excluded. The only exception is the Analytic Network Process (ANP) [93]. However, in that method, the influences are revealed by the evaluators themselves and are therefore more subjective. The OLM model explores the interconnections by statistical computing in a more objective and more trustworthy way. Finally, this method encourages users to provide feedback on their experiences and to become involved in development schemes for the transport system. Thus, the quality of life of PT users could be improved by small improvements in the quality of the PT service.

The strength and unique contribution of this study along with the case study and the comparison among different PT users' perspectives include the use of an integrated OPM and IPA model to improve the public transport system. However, there are a few problems that still need to be acknowledged. First, this research analyzed the perception and satisfaction levels of university staff and students from one Eastern European capital city. This case study was chosen because the city has a unique geography and climate and a good PT system. Without a doubt, this study is restricted by the small sample size due to the COVID-19 pandemic. Data size is a limitation not only for this study but for most studies on PT planning, and more research interventions may be needed to improve decision making. Last but not least, this study did not consider the disparities between PT modes.

7. Conclusions

7.1. Summary and Managerial Implications

This study used descriptive statistical analysis, Student's t-tests, and an integrated OPM-IPA model to investigate the perceptions and factors affecting the overall satisfaction level of habitual and occasional PT users. The analysis procedures were based on a practical survey that was conducted among 500 university staff and students in the real urban area of Budapest City in Hungary. This study contributes to the current literature in several ways. First, it provides an understanding of the perceptions of two PT user types and their satisfaction with the existing service. Moreover, the most significant service attributes are highlighted as priorities for decision makers from the point of view of different PT commuters from a single university in an Eastern European country. It can be used as a source of comparison for different campuses. From a methodological viewpoint, the new integrated OPM and IPA models applied to the analysis in this study produce more visual results than traditional techniques and can be employed to prioritize actions for enhancing PT service quality.

To sum up, these results can provide PT service providers, policymakers, and researchers with a better tool for measuring service quality and passenger satisfaction, thereby enabling them to identify strategies that will make the PT system more attractive to existing and potential users. The results show that the habitual users were more satisfied with the provided service than the occasional users. Cost was shown to be significant for all models, while punctuality, accessibility, and information were significant for the two models in terms of their contributions to overall satisfaction. The results of this study can provide significant insights for decision makers and transport service providers, which can be used for the planning of transport policy controls related to PT service quality improvement. Specifically, the outcomes of this research shed light on the following specific policy recommendations for policymakers, filling a current gap in the literature by adding practical research to the field of transport planning. First and foremost, the IPA can categorize service attributes according to their importance/satisfaction levels, which can allow service providers to identify the fundamental service attributes that require improvement. The most significant service attributes are highlighted as priorities for decision makers from the point of view of different users. For instance, looking at the findings of the IPA, for the habitual users (shown in blue), "information provided" is the only service attribute that should be made a top priority for improvement in the "concentrate here" quadrant. We note that this service is important and performs poorly compared with other attributes. Transport providers should introduce more resources and put extra effort into satisfying passengers' perceptions; hence, this is an area that requires immediate concentration. Areas of intervention could include the provision of services in different languages and the addition of Mobility as a Service (Maas) as a new service in the PT system. These changes could help passengers to plan, book, and pay for PT.

The "keep up the good work" quadrant contains the intermodality and punctuality attributes for the occasional users (shown in orange) and the accessibility attribute for the habitual users. These are factors that are important and perform well. The attributes that fall in this quadrant represent major strengths and can meet passengers' needs and provide satisfaction. Additionally, the attributes in this category show the potential for beneficial competitiveness, and it is recommended that policymakers maintain their action strategies or enhance them. For both user types, the cost is in the possible overkill quadrant, indicating its high performance and low importance. This suggests that the application of resources for the cost may be excessive. Cost reduction strategies may be effective if the budget allows, but this factor has the lowest priority. In this case study analysis, most respondents were students or university staff with low monthly salaries. This suggests that public transport is an optimal option for people on a low income, especially students who may benefit from a monthly discount ticket.

Likewise, for occasional users, cleanliness is in the "lower priority" quadrant, indicating its low importance and low performance. This is potentially due to the lower ridership during the COVID-19 pandemic. In addition, it is worth mentioning that most of the occasional PT users are regular PV users, and private cars are generally more secure and relaxing in terms of their cleanliness and temperature than PT. When suggesting specific policy recommendations related to university commuters, it is vital to consider the impact of the COVID-19 pandemic, which provided policymakers with the opportunity to reconstruct the PT system. In this study, data were collected, analyzed, and compared. As a consequence, it is advised that the use of PT could be increased among university workers and students by improving the quality of the service; for example, by improving the transit schedule and providing information in different languages. Additionally, vehicles should be cleaned regularly, and the ventilation system should be improved to increase the use of this form of transport. These results can help policymakers to make better decisions regarding the identification of service priority areas. In this way, small changes have the potential to have significant impacts on the development of a sustainable environment.

7.2. Directions for Future Research

Much could be learned from conducting a similar approach in other cities and involving other major stakeholders who contribute to convolution, such as alumni or students' parents. In future research, the geographical context should be expanded to investigate others' perspectives internationally, because people's attitudes differ based on the area, transport policies, services provided, and demographic characteristics to find similarities and contracts and determine which service attributes are relevant and how much certain groups use PT. However, our method can be adapted for applications in other areas according to their defined measurements. In addition, future studies should consider the use of longitudinal studies to use data from different waves at the university environment in order to conduct an in-depth analysis of the interrelation between travel characteristics and travel satisfaction as well as obtain valuable information; this is due to changes in travel patterns and attitudes. Thus, some of this study's findings may or may not vary when repeated or applied in other parts of the country. Moreover, in-depth understanding is still essential for policymakers, such as qualitative analysis for specific groups (e.g., vulnerable commuters, including children or disabled people) is a potential area that can also be useful to enhance the understanding of policymakers.

Further, longitudinal studies would be necessary to better understand how PT service can affect travel satisfaction (i.e., compare satisfaction during and after COVID-19). The sample comprised mostly university commuters, and considering a specific ridership group is a challenge. Further research should consider increasing the sample size and networking to make the results more generalizable. Instead of focusing only on a broader statement, it would be beneficial to look at specific behaviors among certain University commuters. Future research should consider these factors. Because the perceptions of passengers may vary in different circumstances. Hence, another promising empirical policy that could be investigated in future studies is the relationship between different modes and user satisfaction. Additionally, consideration should be given to the use of other logistic regression models, such as the ordered logit model with different segments (e.g., socioeconomic characteristics), to attain more heterogeneity in the analysis. Lastly, analyzing other transport planning concepts, for instance, the behavioral intentions of PT users, is also recommended for future research. In terms of the methodology, the present study used an integrated statistical method to measure SQAs and significant values to determine the areas of priority. Future integration is vital to explore how observed and unobserved variables relate to satisfaction.

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Appendix A

Details about the survey design and its contents can be viewed at the following link: https://drive.google.com/file/d/19v1u7dkigyLM4aItr63eXXQypi3c4kwy/view?usp=sharing.

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