Mode Choice Behaviour of Non-BRT Commuters Towards a Proposed Bus Rapid Transit System: A Stated Preference Study in Karachi

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ABSTRACT

This paper analyses the behaviour of non-BRT users' selection and preference for the proposed BRT lines in Karachi, Pakistan. The government proposed to implement Bus Rapid Transit (BRT) lines in the city of Karachi, which is in the construction and planning phase. Formerly, Karachi's public transportation system was mainly based on a local informal bus system. The preference survey was performed on three major locations in Karachi. The non-BRT respondents were asked about the current attributes of the existing mode and the proposed BRT system. This study aims to analyse attributes significant towards mode selection, like travel time, travel cost, accessibility and number of transfers, using MNL. Existing literature lacks behavioural modelling of non-BRT users in such megacities. The utility model in MNL developed in this study shows that travel time and number of transfers are more valuable for non-BRT users, whereas accessibility and cost have a relatively less impact. Sensitivity analysis also depicts that a slight increase in fare cost cannot affect the probability towards BRT. The Multinomial Logit (MNL) model was applied to calculate the model's shift towards the proposed BRT service. The results show that more than 50% of users are willing to shift from non-BRT services. The model and output of this paper can be used to strengthen the planning and financial decisions of BRT projects and also increase the demand for the proposed project by improving suggested attributes.

Keywords: Travel behavior modelling, multinomial model, preference survey, travel attributes

INTRODUCTION

In recent years, rapid urbanisation and population growth have greatly increased the demand for better transportation in developing cities [20]. However, many metropolitan cities, including Karachi, are still suffering from heavy traffic congestion and increasing dependence on private cars due to the lack of an efficient and integrated public transport system [16]. Karachi is the largest metropolitan city and commercial hub of Pakistan, with an estimated population of 16.9 million [17]. While Bus Rapid Transit (BRT) has been adopted on some corridors in the city, a significant proportion of commuters still use informal non-BRT public transport services

[21]. Such services are often associated with longer travel times, infrequent service, limited accessibility and varying service quality, hence less attractive for daily commuters [11]. Thus, most commuters prefer to use private vehicles where possible, while low-income groups are dependent on the existing public transport system despite its limitations [2]. With the expansion of BRT services in Karachi, understanding the travel behaviour of commuters using non-BRT corridors has become increasingly important [5]. However, there is limited evidence on the factors influencing commuters' willingness to shift from conventional public transport to BRT services in the local context [21]. Travel behaviour modelling gives a logical approach to analyse users' mode choice decisions based on the attributes of the available travel alternatives [10]. Discrete Choice Models (DCM) have been widely applied in transportation planning to evaluate travellers' preferences and predict the impacts of proposed transport improvements [18]. Therefore, developing a mode choice model can provide insights for the transportation planning process and help policymakers in designing public transport systems. [4].

The DCMs are based on the Random Utility Maximisation (RUM) theory, which states that travellers choose the alternative mode of transport that gives them the highest level of perceived utility [6, 15]. Selection of an appropriate discrete choice model depends on the attributes of the available alternatives, the nature of the collected data and the goals of the study [4]. In view of the aim of the present work and the implementation of the stated preference framework, the Multinomial Logit (MNL) model was adopted to study the preference of the commuters between the existing non-BRT service and the proposed BRT alternative [18].

The development of a reliable mode choice model is dependent on the quality and type of data collected from the selected respondents [14]. In transportation research, travel behaviour is typically analysed using either Revealed Preference (RP) data or Stated Preference (SP) data [9]. RP data captures the real travel behavior of commuters under the current situation, while SP data is gathered by presenting respondents with hypothetical travel scenarios with varied combinations of service attributes [14]. The joint use of RP and SP data is a well-established approach in travel behaviour research because it enhances the behavioural realism and predictive capability of discrete choice models [13]. Therefore, the RP data collected from non-BRT commuters, together with the findings of the pilot survey, were used to develop realistic SP choice scenarios, enabling the assessment of commuters' preferences between the existing non-BRT service and the proposed BRT alternative under different travel conditions.

Discrete choice models have been used in various studies to analyse the travel behaviour of commuters in various transport scenarios [18]. Previous research has consistently shown that travel time, travel cost, access time, and the number of transfers are among the most important factors driving mode choice decisions [7, 11]. Various modelling techniques such as Binary Logit, Nested Logit and Multinomial Logit (MNL) have been successfully used to estimate commuters’ preferences and assess the potential impacts of proposed transport policies and infrastructure upgrades [4].

Several studies have specifically examined commuters' willingness to shift from conventional public transport to BRT systems. Soomro et al. [21] found that travel time savings, service quality, and accessibility were key factors influencing commuters' intention to use the Green Line BRT in Karachi. Similarly, Baig et al. [5] reported that improvements in service quality and operational performance can encourage a greater shift towards BRT among existing public transport users. Likewise, Altarifi et al. [4] demonstrated that travel time, access time, and integration with other transport services significantly influence commuters' preference for BRT over conventional public transport. These research presents the need to understand local travel behaviour before proposing improvements to existing public transport systems. Therefore, the study of preferences of non-users of BRT in Karachi may provide useful information regarding factors that lead to switching towards an proposed BRT service [21].

The literature reviewed indicates that a lot of research has been done on modelling travel behaviour and mode choice using discrete choice approaches [11]. However, there are few studies that specifically looked into the travel preferences of commuters using the traditional non-BRT public transport in Karachi and their willingness to switch to proposed BRT service [21, 5]. This research gap is sought to be filled by developing a mode choice model based on the preferences of non-BRT commuters in this study.

DATA COLLECTION

Mode choice behaviour modelling requires detailed information on commuters' travel characteristics and preferences [6]. For this purpose, a structured questionnaire-based survey (QBS) was designed to collect data from users of non-BRT public transport. The term non-BRT refers to conventional public transport services operating without dedicated Bus Rapid Transit (BRT) infrastructure. These services formed the target population of this research and are referred to collectively as non-BRT services throughout the paper.

Figure 1: Representative non-BRT public transport services (local buses and People's Bus Service) considered in this study.

The questionnaire consisted of three main sections. The first section of QBS collected socio-demographic information. The second part comprised current travel mode and trip characteristics, including current travel time, travel cost, number of transfers, trip purpose, and overall satisfaction with the existing non-BRT service. The third section examined commuters' willingness to shift from the existing non-BRT service to a proposed BRT system. Pilot survey was conducted to identify any doubts in the questionnaire and help identify the real values for SP survey. Make the necessary revisions before final data collection.

The survey was performed on three major non-BRT corridors in Karachi, namely Liaquatabad No. 10, Sindhi Muslim Society (SMCHS), and Gulshan Chowrangi. Respondents were selected using a random sampling approach, and a total of 160 valid face-to-face interviews were completed. Figure 2 presents the survey locations, while Table 1 summarizes the distribution of respondents across the selected study sites. Each questionnaire have 6 SP scenario so collectively there are 960 data set to performe MNL modelling.

The collected Revealed Preference (RP) data were used to examine the existing travel behaviour of non-BRT commuters. Based on the observed travel characteristics, Stated Preference (SP) choice scenarios were subsequently developed to evaluate commuters' preferences between the existing non-BRT service and a proposed BRT alternative, following the established RP–SP framework commonly used in travel behaviour research [13, 14].

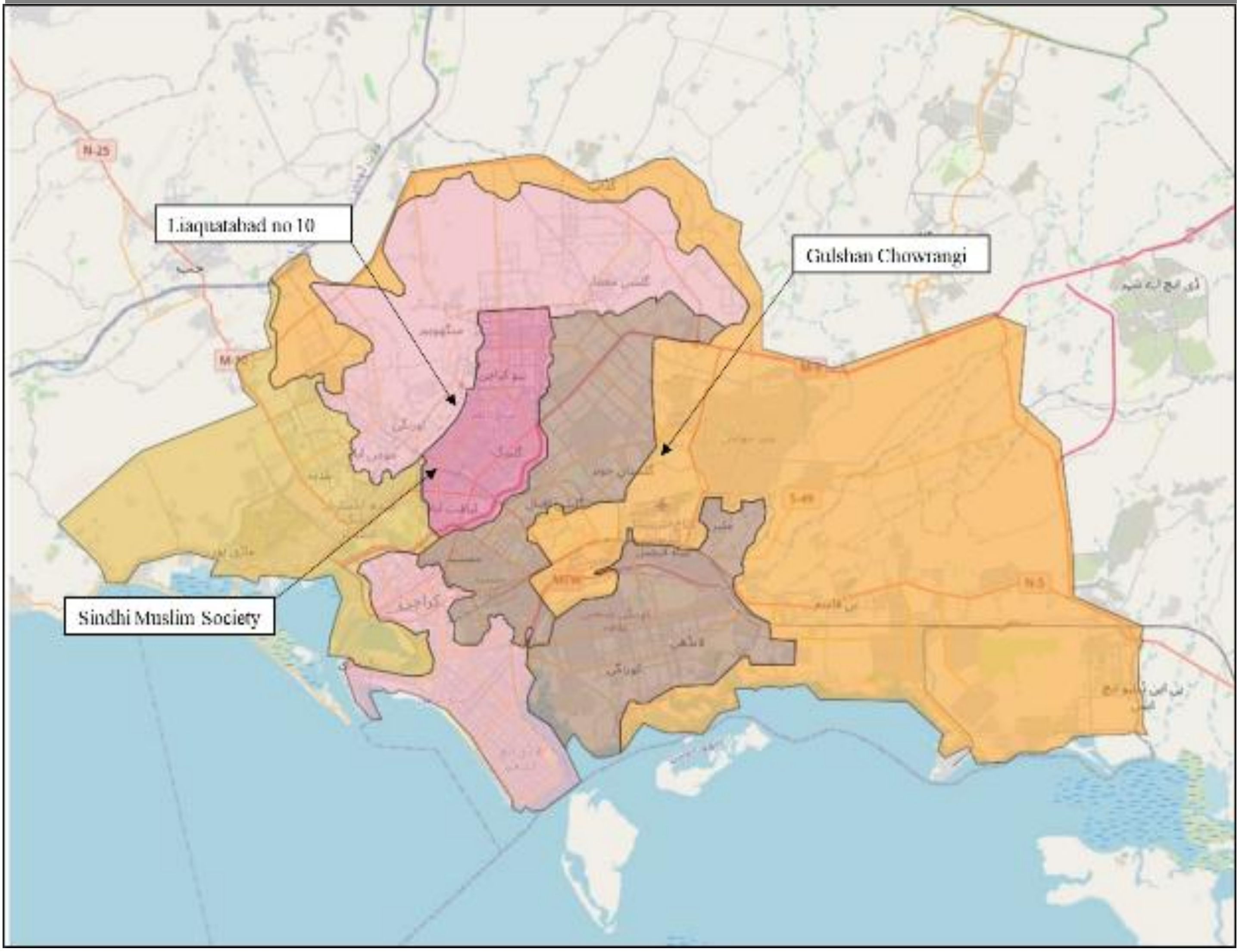

Figure 2 Survey locations selected for the revealed preference (RP) data collection in Karachi. Source: Prepared by the authors using QGIS

Table 1 Distribution of respondents across the selected survey locations

Survey Location	Number of Respondents (n)	Percentage (%)
Liaquatabad No. 10	55	34.4
Sindhi Muslim Society (Tariq Road)	52	32.5
Gulshan Chowrangi	53	33.1
Total	160	100

STATED PREFERENCE (SP) CHOICE DESIGN

The stated preference (SP) technique was adopted to examine commuters' preferences between the existing non-BRT service and a proposed BRT alternative under different hypothetical travel conditions [13]. Four travel attributes were considered in designing the choice scenarios, namely access time, total travel time, travel cost, and the number of transfers, as these attributes were identified from the questionnaire and previous mode choice studies [11]. Each scenario consisted of two alternatives: the existing non-BRT service and a proposed BRT service with varying attribute levels, table 2. Respondents were asked to select the alternative they preferred for each scenario. A total of six choice scenarios were developed and presented to the respondents to evaluate their travel preferences. Each scenario presented respondents with two travel alternatives, the existing non-BRT service and the proposed BRT service.

Table 2 Attributes and levels used in the stated preference experiment

Attribute	Levels
Access Time (min)	5, 10, 15
Total Travel Time (min)	30, 45, 60
Travel Cost (PKR)	80, 120, 160
Number of Transfers	0, 1, 2

Figure 3 Example of a stated preference choice scenario comparing the existing non-BRT service and the proposed BRT service based on four travel attributes.

STATISTICAL DATA ANALYSIS

The Revealed Preference (RP) survey data were first analysed to understand the travel characteristics of commuters using the existing non-BRT public transport system. The observed travel patterns were then used to define realistic attribute levels for the Stated Preference (SP) experiment. Unlike many previous studies that mainly considered travel time and travel cost, this study also incorporated access time and number of transfers as explanatory variables. Both attributes were selected directly from the RP survey to better represent the actual travel conditions experienced by commuters on the selected non-BRT corridors in Karachi.

The RP survey showed that most respondents reached public transport within about 10 minutes, while longer access times were reported less frequently. Similarly, one-way travel times of 30–45 minutes were the most common. Most commuters spent less than PKR 300 on a one-way trip, and travelling with one transfer was the most frequently observed travel pattern, followed by direct trips without any transfer. These findings provided the basis for constructing the SP choice scenarios used in this study.

The estimated mode choice model confirmed that all four travel attributes influenced commuters' travel decisions. However, their relative importance was not the same. Figure 4 summarizes the overall importance of the selected travel attributes based on the survey findings and model results. The figure shows that number of transfers was the most influential attribute affecting commuters' mode choice, followed by access time and travel time, whereas travel cost had a comparatively smaller influence. These findings indicate that commuters are generally more sensitive to additional transfers than to moderate increases in access time or travel cost. The inclusion of access time also provides additional insight into commuter behaviour, as this attribute has received relatively limited attention in previous mode choice studies despite its practical importance in accessing public transport services.

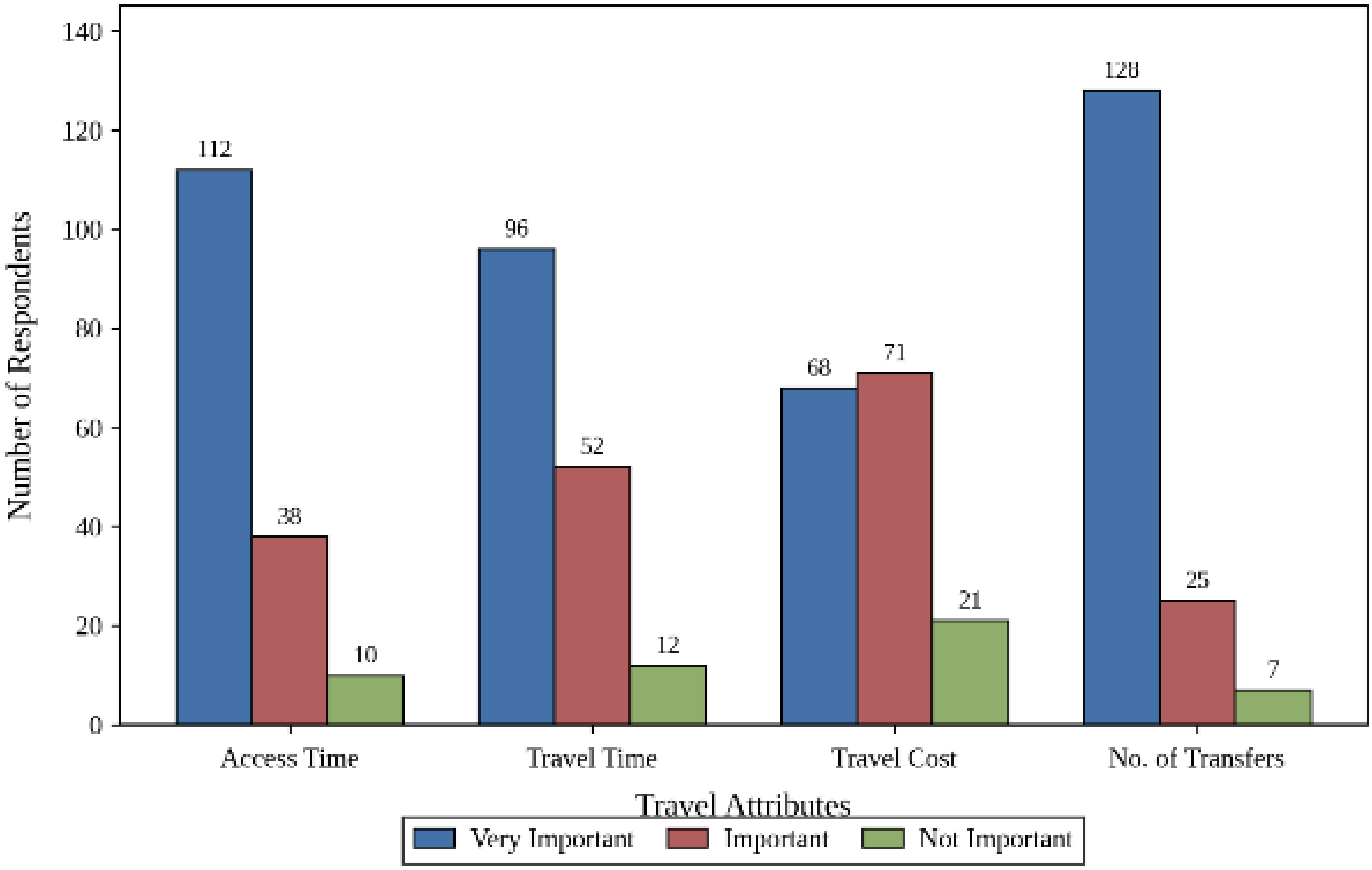

Figure 4: Relative importance of the selected travel attributes based on the RP survey and MNL model results.

MODE CHOICE MODEL SPECIFICATION

The stated preference (SP) data collected from the questionnaire survey were analysed using a Multinomial Logit (MNL) model to examine commuters' preferences between the existing non-BRT service and the proposed BRT alternative. The MNL model is based on the Random Utility Maximization (RUM) theory, which assumes that commuters select the travel alternative that provides the highest utility [6,15]. Model estimation was carried out using the Maximum Likelihood Estimation (MLE) method in SPSS Statistics.

According to the RUM framework, the utility of an alternative consists of a systematic component and a random error component and can be expressed as:

$$Un=Vn+\varepsilon n$$

where Un is the total utility associated with alternative n, Vn represents the systematic utility explained by the observed travel attributes, and εn represents the random error term.

The systematic utility is assumed to depend on the selected travel attributes and is expressed as:

$$Vn=\beta 0+\beta 1ACC+\beta 2TT+\beta 3FAR+\beta 4TRF$$

where ACC represents access time, TT is the total travel time, FAR denotes travel cost, and TRF represents the number of transfers. The coefficients β1–β4 measure the contribution of each attribute to commuters' utility, while β0 is the Alternative-Specific Constant (ASC).

Since this study considers two travel alternatives, namely the existing non-BRT service and the proposed BRT service, the same utility specification was applied to both alternatives by substituting the corresponding attribute values for each mode. The estimated coefficients were subsequently used to evaluate the influence of the selected travel attributes on commuters' mode choice behaviour.

Table 3 Variables used in the mode choice model

Variable	**Description**	**Unit**
ASC	Alternative-specific constant (Existing Non-BRT)	—
ACC	Access time	min
TT	Total travel time	min
FAR	Travel cost	PKR
TRF	Number of transfers	Count

RESULTS AND DISCUSSION

Estimated Model Results

The Multinomial Logit (MNL) model was estimated using the stated preference (SP) dataset developed for this study. The dataset comprised 960 observations obtained from 160 respondents, with each respondent evaluating six stated preference choice scenarios. Table 4 presents the estimated model coefficients and the associated statistical indicators. The estimated coefficients indicate the influence of each travel attribute on commuters' preference between the existing non-BRT service and the proposed BRT service.

Table 4 presents the estimated model parameters together with the corresponding statistical indicators. Among the selected travel attributes, the number of transfers exhibited the largest absolute coefficient ($\beta = -0.428$), indicating that it had the strongest influence on commuters' mode choice decisions. This was followed by access time ($\beta = -0.072$), travel time ($\beta = -0.034$), and travel cost ($\beta = -0.010$). Based on the estimated coefficients, commuters were considerably more sensitive to additional transfers than to changes in travel time or travel cost. This suggests that minimizing transfers would have the greatest impact on increasing the attractiveness of the proposed BRT service. Although travel time and access time also influenced commuters' choices, their effects were comparatively smaller, while travel cost showed the least influence among the selected travel attributes.

The estimated model demonstrated satisfactory statistical performance. All explanatory variables were statistically significant at the 95% confidence level ($p < 0.001$), indicating that the selected travel attributes provide meaningful explanatory power for commuters' mode choice behaviour. Furthermore, the estimated McFadden's pseudo-R^2 value of 0.123 indicates an acceptable level of model fit for stated preference mode choice analysis, confirming that the proposed model adequately captures the observed travel preferences.

Table 4 Estimated parameters of the proposed MNL model

Variable	Coefficient (β)	p-value
Alternative-Specific Constant (ASC)	-1.493	<0.001
Access Time (ACC)	-0.072	<0.001
Travel Time (TT)	-0.034	<0.001
Travel Cost (FAR)	-0.010	<0.001
Number of Transfers (TRF)	-0.428	<0.001

Table 5: Summary Statistics of the MNL Model

Statistic	Value
Number of respondents	160
Number of observations	1,280
Choice scenarios per respondent	6
BRT choice share	64.9%
Non-BRT choice share	35.1%
McFadden's Pseudo-(R^2)	0.123

Table 6 Comparison of Estimated Utility Coefficients with Previous Mode Choice Studies

Study	Study Area	Model	Travel Time (TT)	Travel Cost (TC)	Access Time (AT)	Transfers (TRF)	Key Findings
Chowdhury et al. (2015) [7]	New Zealand	MNL	–	–	–	Negative	Additional transfers significantly reduce public transport preference.
Soomro et al. (2022) [21]	Karachi, Pakistan	Binary Logit	Negative	Negative	Negative	–	Better accessibility and shorter travel time increase commuters' willingness to adopt BRT.
Ranjan & Sinha (2024) [18]	India	MNL	Negative	Negative	–	–	Travel time and travel cost are significant determinants of commuters' mode choice.
Altarifi et al. (2023) [4]	Amman, Jordan	MNL	Negative	Negative	–	Negative	Service quality and transfer-related attributes strongly influence commuters' travel preferences.
This Study	Karachi, Pakistan	MNL	−0.034	−0.010	−0.072	−0.428	Transfers have the greatest influence on commuters' mode choice, followed by access time, travel time, and travel cost.

The comparison presented in Table 6 shows that the estimated coefficients obtained in this study are generally consistent with those reported in previous mode choice studies, with all selected travel attributes exhibiting negative effects on commuters' utility. However, an important distinction of the present study is that the number of transfers emerged as the most influential factor affecting commuters' mode choice, followed by access time, travel time, and travel cost. This indicates that commuters using non-BRT services in Karachi are more sensitive to service convenience and journey continuity than to fare levels alone. The comparatively strong influence of access time increases the importance of first-mile connectivity and convenient access to public transport station. These outcomes suggest that future BRT planning should prioritize by minimizing transfers, improving feeder services, and enhancing station accessibility alongside reducing travel time. Such enhancements are likely to attracts a greater mode shift from conventional non-BRT services to the proposed BRT system. Furthermore, the estimated McFadden's pseudo-R^2 value of 0.123 indicates an acceptable model fit for stated preference mode choice analysis and is comparable to values commonly reported in the travel behaviour literature [6], [18].

Mode Choice Probability Analysis

The estimated Multinomial Logit (MNL) model was further used to evaluate commuters' probability The estimated Multinomial Logit (MNL) model was further used to estimate the probability of commuters choosing the proposed BRT service over the existing non-BRT service. Based on the estimated utility functions, the choice probability for each alternative was calculated using the Multinomial Logit probability function:

$$P_i = \frac{e^{V_i}}{\sum_{j=1}^{J} e^{V_j}}$$

Where, Pi is the probability of selecting alternative i, Vi is the systematic utility of specific alternative, and J is the set of available travel modes.

Overall, 64.9% of the predicted choices favored the proposed BRT service, whereas 35.1% of the choices remained with the existing non-BRT service. The higher probability of chossing the proposed BRT service is due

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to lower access time, shorter travel time, reduced travel cost, and fewer transfers. Futhermore, improvement in service quality can also increase the attractiveness of BRT service.

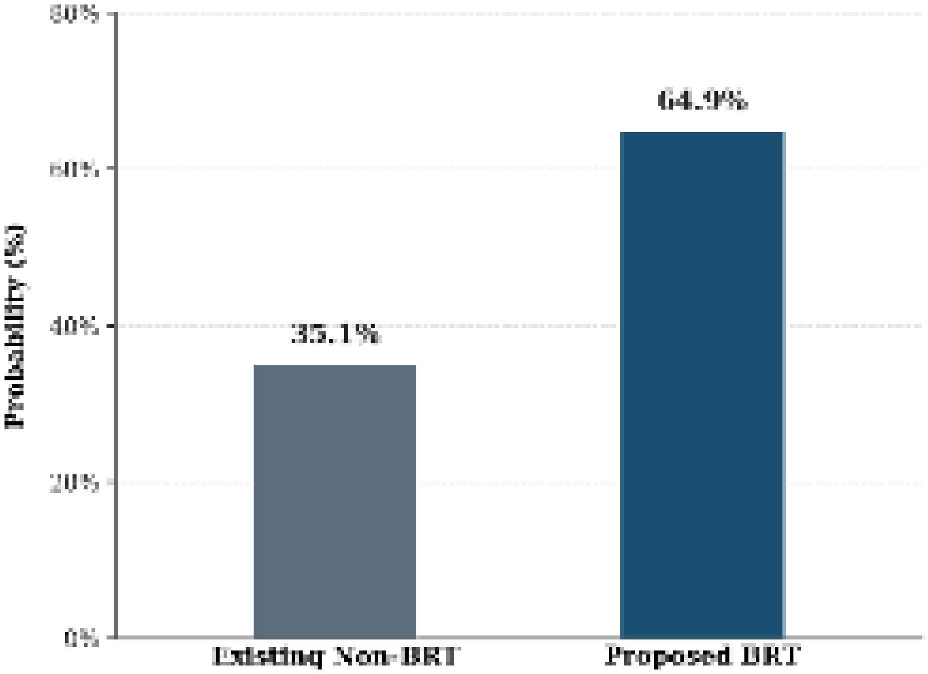

Figure 5 Predicted mode choice probabilities between the existing non-BRT service and the proposed BRT service.

The results indicate that commuters exhibit a clear preference for the proposed BRT service with improved attributes. The relatively higher probability of selecting BRT demonstrates the potential of an efficient mass transit system to attract existing non-BRT users which is higly effective for the policy maker to plan accordingly.

Sensitivity Analysis

Sensitivity analysis is a common method in discrete choice modelling to understand how changes in individual variables affect the probabilities of predicted choice, whereas all other variables are constant. It provides a practical way to assess the relative importance of different travel attributes and to evaluate the behavioural response of commuters to potential policy and service upgradation. This approach has been widely applied in Multinomial Logit (MNL) mode choice studies to investigate the impact of changes in travel time, travel cost, and other service attributes on mode choice decisions [8, 18].

For this study, a sensitivity analysis was performed by varying one travel attribute at a time while holding the remaining attributes constant. The predicted probability of selecting the proposed BRT service was recalculated after each change using the estimated MNL model. The results are presented in Figure 5.

The analysis shows that travel time and the number of transfers have the strongest influence on commuters' mode choice. A reduction in travel time and the number of transfers shows a noticeable increase in the predicted probability of choosing the proposed BRT service. In addition, similar but relatively smaller effect was observed for access time, where shorter access times increased the likelihood of selecting the proposed BRT service. Besides, travel cost also influenced traveler decisions, but having less impact than of travel time and transfers. Its shows that most of the user are willing to pay slightly higher fare cost without compromising travel time and number of transfer attributes.

Overall, the sensitivity analysis confirms that improvements in travel time, service accessibility, and route connectivity are likely to produce a greater shift towards the proposed BRT service than fare reductions alone.

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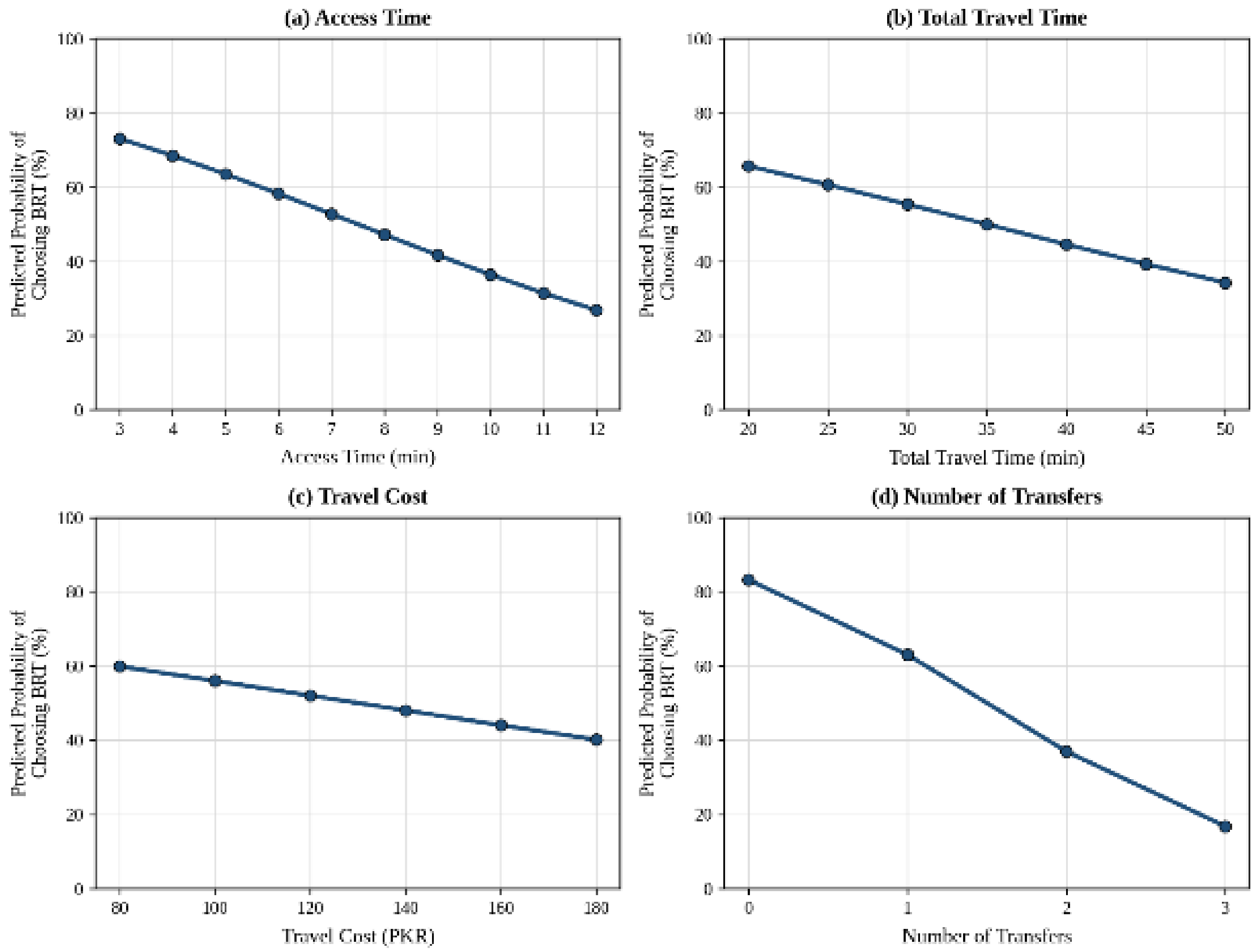

Figure 6: Sensitivity analysis showing the effect of access time, total travel time, travel cost, and the number of transfers on the predicted probability of choosing the proposed BRT service

CONCLUSIONS

This study examined commuters' mode choice behaviour between the existing non-BRT service and a proposed BRT service using a stated preference (SP) and revealed approach (RP) surveys. Survey was conducted on three major junction at Liaquatabad No. 10, Sindhi Muslim Society, and Gulshan Chowrangi. Four travel attributes access time, travel time, travel cost, and the number of transfers were identified for the development of the SP experiment. These attributes were used to developed the MNL model to evaluate commuters' travel preferences.

The estimated model results indicate that all four travel attributes significantly influence travel mode choice selections. The estimated coefficients exhibited the expected negative signs, indicating that increases in access time, travel time, travel cost, and the number of transfers reduce the probability of selecting a travel alternative. The transfers variable having he biggest impact on transoport user travel choices among the other selected variables, followed by trip time and access time. Travel expenses, on the other hand, had very less impact relatively.

The probability analysis shows that the proposed BRT service achieved a predicted choice share of 64.9%, indicating a considerable potential shift from the existing non-BRT system with improved travel attributes. The sensitivity analysis further confirmed that reducing travel time and lesser transfers noticeably increase the attractiveness of the proposed BRT service.

The findings of this study highlight the importance of operational variables efficiency, reducing unnecessary transfers, and enhancing accessibility, while designing and planning future BRT corridors in the study area. These improvements make the transportation towards more sustainable transportation mode. This study also encouagre and strengthen the policy maker and other stakeholder to quicly implement the proposed BRT project. Probability also suggest that the project is a long waited service for tranport user in last three decades.

Although the present study considered four major travel attributes, future research may incorporate additional factors such as service reliability, comfort, waiting time, and socio-economic characteristics further to improve the predictive capability of the proposed model. The modelling framework developed in this study can also be applied to evaluate future public transport projects and support evidence-based transportation planning in Karachi.

REFERENCES

1. Ahmad, N. (1995). Choice of mode for the work trip in a third world city: Karachi. The Pakistan Development Review, 34(2), 149–164. https://ideas.repec.org/a/pid/journl/v34y1995i2p149-164.html
2. Ahmed, A., Mehdi, M. R., Ngoduy, D., & Abbas, M. (2019). Evaluation of accuracy of advanced traveler information and commuter behavior in a developing country. Travel Behaviour and Society, 15, 63–73. https://doi.org/10.1016/j.tbs.2018.11.001
3. AlQuhtani, S. (2022). Commuting mode choice of suburban university population and potential sustainable transportation systems: The case of Najran University. Journal of Urban Planning and Development, 148(2), 05022001. https://doi.org/10.1061/(ASCE)UP.1943-5444.0000805
4. Altarifi, F., Louzi, N., Abudayyeh, D., & Alkhrissat, T. (2023). User preference analysis for an integrated system of Bus Rapid Transit and on-demand shared mobility services in Amman, Jordan. Urban Science, 7(4), 111. https://doi.org/10.3390/urbansci7040111
5. Baig, F., Talpur, A., Das, G., Talpur, M. A. H., & Lee, J. (2024). Willingness to shift towards biogas-fueled Bus Rapid Transit in Karachi, Pakistan. KSCE Journal of Civil Engineering, 28(4), 1501–1512. https://doi.org/10.1007/s12205-024-1636-9
6. Ben-Akiva, M. E., & Lerman, S. R. (1985). Discrete choice analysis: Theory and application to travel demand. MIT Press.
7. Chowdhury, S., Ceder, A. A., & Schwalger, B. (2015). The effects of travel time and cost savings on commuters' decision to travel on public transport routes involving transfers. Journal of Transport Geography, 43, 151–159. https://doi.org/10.1016/j.jtrangeo.2015.01.009
8. Darwish, A. M., Almansour, M., Salah, A., Zagow, M., Saeed, K., & Elkafoury, A. (2024). Sensitivity evaluation of machine learning-based calibrated transportation mode choice models: A case study of Alexandria City, Egypt. Transportation Research Interdisciplinary Perspectives, 24, 101052. https://doi.org/10.1016/j.trip.2024.101052
9. Devika, R., & Harikrishna, M. (2020). Analysis of factors influencing mode shift to public transit in a developing country. IOP Conference Series: Earth and Environmental Science, 491, 012054. https://doi.org/10.1088/1755-1315/491/1/012054
10. Gandhi, S., & Tiwari, G. (2021). Sociopsychological, instrumental, and sociodemographic determinants of travel mode choice behavior in Delhi, India. Journal of Urban Planning and Development, 147(3), 04021028. https://doi.org/10.1061/(ASCE)UP.1943-5444.0000710
11. Göransson, J., & Andersson, H. (2023). Factors that make public transport systems attractive: A review of travel preferences and travel mode choices. European Transport Research Review, 15(1), 32. https://doi.org/10.1186/s12544-023-00609-x
12. Hatzopoulou, M., & Miller, E. J. (2009). Transport policy evaluation in metropolitan areas: The role of modelling in decision-making. Transportation Research Part A: Policy and Practice, 43(4), 323–338. https://doi.org/10.1016/j.tra.2008.11.006
13. Hensher, D. A., & Bradley, M. (1993). Using stated response choice data to enrich revealed preference discrete choice models. Marketing Letters, 4(2), 139–151.
14. Kalyanpad, N. G., Hanni, C. K., & Rao, K. V. K. (2020). Mode choice analysis using web-based revealed preference questionnaire, stated preference experiment and Google Maps API. Transportation Research Procedia, 48, 137–147. https://doi.org/10.1016/j.trpro.2020.08.018
15. McFadden, D. (1974). Conditional logit analysis of qualitative choice behavior. In P. Zarembka (Ed.), Frontiers in Econometrics (pp. 105–142). Academic Press.
16. Noman, S. M., Ahmed, A., Lazi, M. K. A. M., & Gazder, U. (2024). Trends of mode choice and promotion

of sustainable transportation in mega cities of developing countries: A case study for Karachi. Scientific Journal of Silesian University of Technology. Series Transport, 125, 191–212. https://doi.org/10.20858/sjsutst.2024.125.13

17. Pakistan Bureau of Statistics. (2017). Provisional summary results of the 6th population and housing census-2017. https://www.pbs.gov.pk
18. Ranjan, R., & Sinha, S. (2024). Mode choice analysis for work trips of urban residents using Multinomial Logit model. Innovative Infrastructure Solutions, 9(10), 383. https://doi.org/10.1007/s41062-024-01681-5
19. Ranjan, R., & Sinha, S. (2025). Evaluating commuter mode choice behaviour and value of travel time for fuel-based bus alternatives in urban areas. Innovative Infrastructure Solutions, 10, 397. https://doi.org/10.1007/s41062-025-02199-0
20. Sogbe, E., Susilawati, S., & Pin, T. C. (2025). Scaling up public transport usage: A systematic literature review of service quality, satisfaction and attitude towards bus transport systems in developing countries. Public Transport, 17(1), 1–44. https://doi.org/10.1007/s12469-024-00367-6
21. Soomro, R., Memon, I. A., Pathan, A. F. H., Mahar, W. A., Sahito, N., & Lashari, Z. A. (2022). Factors that influence travelers' willingness to adopt Bus Rapid Transit (Green Line) service in Karachi. Sustainability, 14(16), 10184. https://doi.org/10.3390/su141610184
22. Soza-Parra, J., Raveau, S., & Muñoz, J. C. (2022). Public transport reliability across preferences, modes, and space. Transportation, 49, 621–640. https://doi.org/10.1007/s11116-021-10188-2
23. Urbanek, A. (2021). Potential of modal shift from private cars to public transport: A survey on commuters' attitudes and willingness to switch—A case study of Silesia Province, Poland. Research in Transportation Economics, 85, 101008. https://doi.org/10.1016/j.retrec.2020.101008
24. Weng, J., Tu, Q., Yuan, R., Lin, P., & Chen, Z. (2018). Modeling mode choice behaviors for public transport commuters in Beijing. Journal of Urban Planning and Development, 144(3), 05018013. https://doi.org/10.1061/(ASCE)UP.1943-5444.0000444