

## Predicting Transit Mode Choice Behavior from Parents' Perspectives: A Case Study in Lahore, Pakistan

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### ABSTRACT

In the recent decade, an emerging trend is escalating in developing countries named as 'Ridesharing Services' or 'Transportation Network Companies (TNCs)' and in Pakistan, TNCs are recently introduced. In this study, an online questionnaire survey included a stated preference experiment for three different transport alternatives: own vehicle, TNCs (i.e., Uber and Careem) and public transport. A total of 317 parents (149 females and 168 males) reported their preferences to use given alternatives based on their personal and trip characteristics. A multinomial logit model was used to describe the mode choice mechanism. The impacts of travel cost, privacy and safety concerns and travel time were identified based on household income, gender and type of profession. Results manifested that parents with middle-income and employees prefer TNCs, while high-income, female and business parents prefer personal vehicles considering trip characteristics. The extracted findings would provide a clear understanding of mode choice factors for the selected travel alternatives.

**KEYWORDS:** Mode choice, Transportation network companies, Stated preference, Travel behavior, Public transport, Parents' perspectives.

### INTRODUCTION

It is commonly perceived that cars, buses and taxis would remain as local dominant transit mode choices in coming years (Enoch, 2015). However, traditional trips using conventional transport modes, such as cars, buses and taxis, are losing market share because of increased Demand Responsive Transport (DRT) services (Miller, 2006). Because of the increased demand in urban centers, newly emerged Transportation Network Companies (TNCs) are expanding in many parts of the world. TNCs, such as Uber and Careem, are providing peer-to-peer dynamic ridesharing, where ordinary people are offered pick-up and drop-off services in exchange for fares (Y. Zhang et al., 2016). With improved internet connectivity, TNCs can be reserved

conveniently using cell phone applications, which significantly improves the possibility of hiring a dedicated service in urban centers, especially in rush hours. The trend of using TNCs has changed the way of travel in metropolitan cities (Chen et al., 2016). However, there are still some deficiencies in the laws regarding passengers' right protection as they are traveling in TNCs. The Uber/Careem drivers' sexual assault and privacy cases may further worsen the situation and passenger security concerns may appear while utilizing these TNCs.

DRT systems combine the use of both public and private transport services which provide on-demand mobility needs using mobile transportation applications. They might be combining multiple transport modes, helping passengers plan and book their trips. Usually, the service providers of DRT own the vehicles and hire drivers for providing transit services (Alonso-González et al., 2018), while TNCs, such as Uber, Careem or Lyft, use mobile applications for enabling people to book

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individual or shared rides from drivers who own vehicles and are not officially employed by service providers (Koffman, 2016).

Although the pros and cons of these taxicabs coexist, it is important to understand the importance of different conventional travel mode choices (i.e., own vehicle with driver, public transport) and TNCs from parents' perspective for pick-up and drop-off their children. With limited resources in developing countries, like Pakistan, it is important to understand the travel choices for better long-term transit solutions. Many factors influence mode choice behavior. These factors include the individual's socio-economic characteristics, personality traits, attitudes and norms (Malodia & Singla, 2016). Other influencing factors include service quality characteristics of the available travel alternatives; e.g. travel time, cost, safety, reliability, comfort and convenience (Catalano et al., 2008). However, the characteristics of the travelers, transportation infrastructure and available travel alternatives differ from region to region. The car ownership and its usage trends also vary significantly between developed and developing regions. Therefore, it is necessary to identify the significant factors that influence the parents' choice of mode for their children daily traveling to educational institutes. The remainder of the paper is divided in the following sequence; relevant literature is presented in Section 2. Section 3 discusses the methodology adopted for carrying out this research study. Section 4 highlights the discussion of the results and impacts of different trip characteristics, while Section 5 describes the conclusive remarks from this research study and possible future research directions.

## LITERATURE REVIEW

Lahore city is the second-largest city in Pakistan and its population has doubled in the last two decades with a current population of around 8.65 million people and car ownership has risen 17% *per annum*. The population density ranges from 450 residents per hectare in interior zones to 100 residents per hectare in exterior zones (JICA, 2012). The major reasons for population attraction and increased vehicle ownership are less focused on the development of surrounding areas and public transport networks. Unfortunately, the condition

of public transport is still substandard despite significant improvements in the road infrastructure. So, it is important to investigate the mobility pattern choices of potential traveler groups by TNCs with restricted access to public transport. Many studies have been conducted on conventional transit mode choices. Muhammad Ashraf Javid (2016) conducted a study in Lahore to comprehend the behavioral intention of travelers in using public transport in three different scenarios: the role of situational constraints, mobility restrictions and incentives. He suggested that improved public transport along with restricted access to a car can be proved as an effective strategy in modifying travelers' behaviors. Muhammad Ashraf Javid et al. (2017) also investigated the travelers' behavior of using carpooling in Lahore and proposed that disincentives on car use and preferential parking for carpooling can be the significant determinants of carpooling policy in the city. TNCs are emerging as an attractive mode of transport as compared to conventional transit modes. Many of the studies have evaluated the operations and selections of the transit modes based on different perspectives of users. For example, Gholami et al. (2014) analyzed the operational costs of taxi jitney with fixed routes and fixed stops in the US. They evaluated and proposed a methodology to replace the uneconomical lines with other modes of transit. Javid (2017) investigated the influence of travelers behavior in Lahore city and reported that attitudes, status and auto-consciousness are among the underlying factors affecting travel mode. Cervero & Golub (2007) discussed the cost and benefit analysis of the informal transit (e.g. minibus, jitney, vans and station wagons) modes in global perspectives. Brake et al. (2007) focused on Demand Responsive Transport (DRT) for Flexible Transport Service (FTS) in Tyne and Wear, UK and Italy. They developed the guidelines and strategies for better accessible and friendly implementation of FTS. They suggested that DRT is majorly dependent upon low floor buses and taxicabs for achieving transportation tasks. They proposed that well-implemented FTS has the potential to invigorate bus-based transit modes. It is also believed that DRT is an economically viable transport solution, where traditional services are not feasible because of wide-ranging barriers preventing their operations (Davison et al., 2014). The travel behaviors of passengers are also subject to the variability of the day-to-day activities of

the respondents (Pas & Koppelman, 1987). Muhammad Ashraf Javid et al. (2015) identified the key factors which influence the acceptability of public transport based on people's behavioral intentions and response to travel demand management (TDM) measures and highlighted that social and personal norms are significant determinants. Libardo & Nocera (2008) studied the relationship of the transport demand and its elasticity in the regional area of Italy and inferred that the GDP variable behaves exogenously in predicting the transportation demand. Hawkins et al. (2019) studied the implications for public transport policies based on price and income elasticities for passenger fuel and found that fuel taxes also play an important role in determining the mode choice behaviors and model shift between public and private transit modes. Decades-old researches have shed light on predicting travel behaviors based on three core factors; namely, socio-demographics (i.e., age, gender, education, household income, ... etc.), built environments (i.e., density, diversity, design, distance decay effect, ...etc.) and trip characteristics (i.e., trip purpose, travel time, travel cost, reliability, ...etc.) (Atasoy et al., 2015; Beirão & Sarsfield Cabral, 2007; Cervero & Golub, 2007; Chen et al., 2016; Enoch, 2015; Gholami et al., 2014; Muhammad Ashraf Javid, 2016; Kang & Scott, 2010; Kim et al., 2017; Lee et al., 2013; Li et al., 2018; Liu et al., 2012; Malodia & Singla, 2016; Miller, 2006; Rayle et al., 2016; Sim & Miros, 2008; Sohail et al., 2006; Spasojević & Božić, 2016; Thøgersen, 2006; Valenzuela et al., 2005; Van & Fujii, 2011; A. Zhang et al., 2018).

Different researchers studied the factors that influence parents' choices for the transportation of their kids to educational centers. For example, Westman et al. (2017) qualitatively explored the reasons and motives of why parents drive their kids to school and found that convenience of cars and the frequency of using them are among the prime factors. Another study by Potoglou & Arslangulova (2017) tried to explain the factors which influence the active travel to primary and secondary schools in Wales and Australia and concluded that female adolescents are less likely to walk to school as compared to male adolescents. A study conducted by Muhammad Ashraf Javid et al. (2013) reported that time and functional factors are the main causes of reduced satisfaction with public transport (wagon service) in Lahore city. McDonald & Aalborg (2009) investigated

the possible reasons why parents drive their kids to schools and inferred that for shorter distances (usually <2 km), convenience and time-saving are major factors, while for longer distances, parental household devotes constitute an important consideration. For the identification of the barriers which hinder the active commuting to school in Spain, Huertas-Delgado et al. (2017) referred that it is affected by traffic volumes and dangerous interactions which are greatly subject to age, gender and mode of commuting to educational centers by kids. Review studies by Larouche et al. (2018) and Mitra (2013) highlighted the effectiveness of active transportation and independence of school commutes and reported that independent mobility is subject to household activity-travel paradigm. Another study by Hsu & Saphores (2014) explained the impacts of the parental gender behaviors and attitudes for providing commute to their kids based on the National Household Travel Survey of 2009 in California state and manifested that female parents are more concerned than males. Many of the studies identified the factors (McCarthy et al., 2017; Oluyomi et al., 2014), challenges (Hinckson, 2016), opportunities (Kelly & Fu, 2014), parental perceptions based on walking and school bus (Nikitas et al., 2019) and motivations to drive because of fear of stranger dangers (Francis et al., 2017).

From the literature mentioned above, most of the studies discussed the conceptual levels of implementing different transit modes and highlighted possible factors affecting travel choices. The personalized travel mode choices are dependent upon traveler's characteristics; age, income and education level, as well as upon transit mode characteristics; travel costs, privacy and safety concerns and travel time. However, the access of the TNCs through internet-based applications with fare choices has attracted the people. Also, most of the researchers focused on factors which they consider important based on school bus and walking travel choices (Atasoy et al., 2015; Gholami et al., 2014; Henne et al., 2014; Hensher, 1998; Huertas-Delgado et al., 2017; Jang & Hwang, 2009; Muhammad Ashraf Javid et al., 2015; Muhammad Ashraf Javid, 2016; McDonald & Aalborg, 2009; Mitra, 2013; Potoglou & Arslangulova, 2017; Westman et al., 2017; A. Zhang et al., 2018) for commuting of parents' kids. However, a study to comprehensively understand the parents' choices quantitatively is necessary to comprehend the

preferences and behaviors for transit mode choices in comparison with TNCs. So, this study is particularly aimed at understanding the travel behavior of parents' perspective to choose travel mode for pick-up and drop-off their kids at educational centers. Their personalized travel mode choice is characterized by their characteristics and trip characteristics in three different alternatives of private vehicles, TNCs and public transport.

## METHODOLOGY

In this study, the parents' choice to choose a transit mode for their kids is discussed based on their perceptions and convenience. Three different alternative transit modes are suggested to the respondents, including personal vehicles with drivers, tailored taxis and public transport. The choice of any mode of transport can be attributed to the personal characteristics of the traveler, such as age, gender, income and education level and trip characteristics, such as travel costs, privacy and safety concerns and travel time. Hence, the parents' choice to select a particular transit mode choice can be the result of the combined considerations of the above-named characteristics. Different people hold different perspectives for the selection of a particular mode to satisfy their personal needs in a better way.

### *Questionnaire Design*

The questionnaire was designed by keeping in mind the characteristics of the target respondents (i.e., parents whose children are studying in educational centers and potentially educated individuals). The length and number of questions were kept short and precise, deeming the busy schedule of the potential respondents for extracting reliable data. The objectives of the study conducted and the instructions for filling the questionnaire were provided at the start of the questionnaire and the use of complex terminologies in the survey was avoided to get reliable and accurate information needed. The questionnaire was pretested by experts from the Traffic Engineering and Planning Agency (TEPA) before sharing the link with the respondents to ensure clear meaning of each statement asked. The questionnaire was revised based on the suggestions of the experts. The questionnaire consisted

of four parts. In the first part, personal information (i.e., gender, age, income, education, profession type) was collected. The respondents who do not have any vehicle or driver were supposed to have one vehicle with a driver. In the second part, respondents were asked to rate their manifestations of chosen transit mode (i.e., own vehicle with driver, TNCs and public transport) concerning different perceptions of the travel cost on a five-point Likert scale; extremely unimportant (1), unimportant (2), neutral (3), important (4) and extremely important (5). Questionnaire items were designed in such a way that a proper response can be collected from potential respondents about various aspects of travel cost. In part three, all questions were evaluated based on parents' perceptions regarding the privacy and security concerns of their kids while selecting a particular transit mode. Again, a Five-point Likert scale was used to collect responses against stated preferences. In the last section, different manifestations regarding travel time importance were rated on a five-point Likert scale among chosen transit modes. The respondents were requested to provide the requisite information deeming their concerns about the above-mentioned situations in selecting a specified transit mode choice based on their characteristics. A complete summary of the distributed questionnaire is shown in Appendix 1.

### *Sample Size and Survey*

A total of 360 participants were selected for collecting the response of their perceptions to use a particular transit mode, out of whom a total of 317 participants responded completely for three weeks. We got a very good ratio of successful response (i.e., the response rate of 88.05%) because of the involvement of the students, as they were advised to make sure that their parents have responded within the defined time of three weeks. The survey was conducted during November-December of 2018. One objective of the questionnaire was to select the parents whose children are currently studying and it was completed with the help of undergraduate students. The participants were selected *via* a sampling survey administrated in the Lahore urban area. The students of the University of Management and Technology were asked to provide the e-mail addresses of their parents. Also, the questionnaire was sent to the employees of the University and they were requested to participate voluntarily. So, the potential participants

were either the employees of the above-named university or the parents of the students studying at the campus. It was assured that each of the participants must have a clear understanding of the research study purpose and fully comprehend the question definitions before responding to the questions. The contents of the questionnaire incorporated were; the demographic features (gender, age, income and education level) of the respondents and manifestations for choosing a particular transit mode for their kids (personal vehicle with driver, tailored taxi and public transport). The evaluation of action principles in choosing the personalized transit mode for their kids included travel costs, privacy and safety concerns and travel time.

### *Data Analysis Methods*

The details of the personal characteristics along with their units are also shown below. Each question in the given manifestations for trip characteristics (travel costs, privacy and safety concerns and travel time) is optioned from 1 (extremely unimportant) to 5 (extremely important). The respondents were asked to rate travel choice preferences of choosing transit mode following their inclinations (definition of variables in the scale), as communicated in Table 1. The multinomial logit model was employed in predicting transit mode choices based on stated preferences.

**Table 1. The definitions of the variables according to their units and scale**

<b>Variable</b>	<b>Description</b>
Gender	Respondent's gender: 1-male, 2-female
Age	Respondent's age, unit: year
Income	Respondent's household income, unit: thousand PKR per month
Travel costs	The evaluation of travel costs in choosing transit vehicle, five-point Likert scaling, from 1-extremely unimportant to 5-extremely important
Privacy and safety concerns	The evaluation of privacy and safety concerns in choosing transit vehicle, five-point Likert scaling, from 1-extremely unimportant to 5-extremely important
Travel time	The evaluation of travel time in choosing transit vehicle, five-point Likert scaling, from 1-extremely unimportant to 5-extremely important

### *Modal Development*

In this study, own vehicle with driver refers to that each of the participants has his/her private vehicle with a driver and can commute as per his/her desires. The respondents who do not have a personal car were supposed to have one vehicle available for commuting. However, "TNCs" refers to the immediate flexible transport services (i.e., car, rickshaw, motorcycle, ... etc.) provided by Uber / Careem operators. The potential participants can order the DRT services by application software, choosing fare rates and drivers based on the historical reviews of them by previous travelers. Also, the potential travelers can reduce the waiting time by arranging ordered transit service at a desired fixed time at a fixed location. However, public transport refers to the transport services operated by the Government of

Punjab (i.e., Speedo Bus, Metro Bus Services, ... etc.), administrated by Punjab Metro Bus Authority, which run along specific routes and time intervals.

The choice of a particular transit mode can be somehow associated with the personal characteristics (i.e., gender, age, education level, household income, profession, ... etc.) and trip characteristics (i.e., travel costs, privacy and security concerns, travel time, ... etc.). Hence, the choice of the particular transit mode can be the combination of the above-named characteristics and different parents may have a varying perspective of using alternative transit modes. As respondents will choose the most adequate transit mode to fulfill their demands of maximum utilization, transit mode choices can be well described by the utility maximization theory.

The logit model is used to predict the occurrence of an event and is widely used in transportation for travel behavior prediction (Wang & Ross, 2018; Ye et al., 2017; Zhao et al., 2020). In this study, we predicted traveling by own vehicle as an event with probability (A), traveling with TNCs as an event with probability (B) and traveling with public transport as an event with probability (C), thus travel mode prediction is referenced by traveling with own vehicle, TNCs or public transport. The total number of samples collected is treated as  $m$  collected through stated preference survey. In each respondent's sample case, a set of variables was used in predicting the probability of event occurrence (traveling through own vehicle, TNCs and public transport). Let us suppose that there are  $k$  variables that exist, named as  $x_1, x_2, x_3 \dots x_k$ . They prefer the  $i^{th}$  traveler in choosing the transit mode.  $\beta_j$  is computed based on the maximum likelihood estimation, which characterizes the contribution of the  $j^{th}$  variable to the logit probability ( $j = 1, 2 \dots k$ ). Also, it is important to note that  $\beta_0$  shows the intercept value. The logit value of multinomial probability can be defined as;

$$\log \left( \frac{p(A)}{p(C)} \right) = \beta_{10} + \beta_{11} * x_{11} + \dots + \beta_{1k} * x_{1k} \quad (1)$$

Let us suppose that:

$$RHS_A = \beta_0 + \beta_{11} * x_{11} + \dots + \beta_{1k} * x_{1k} \quad (2)$$

$$\frac{p(A)}{p(C)} = e^{(RHS_A)} \quad (3)$$

$$p(A) = p(C) * e^{(RHS_A)} \quad (4)$$

Similarly,

$$\log \left( \frac{p(B)}{p(C)} \right) = \beta_0 + \beta_{21} * x_{21} + \dots + \beta_{2k} * x_{2k} \quad (5)$$

Let us suppose that:

$$RHS_B = \beta_0 + \beta_{21} * x_{21} + \dots + \beta_{2k} * x_{2k} \quad (6)$$

$$\frac{p(B)}{p(C)} = e^{(RHS_B)} \quad (7)$$

$$p(B) = p(C) * e^{(RHS_B)} \quad (8)$$

As we know,

$$p(A) + p(B) + p(C) = 1 \quad (9)$$

Putting the above values of Eq. (4) and Eq. (8) in Eq. (9) yields:

$$p(C) * e^{(RHS_A)} + p(C) * e^{(RHS_B)} + p(C) = 1 \quad (10)$$

$$p(C) = \frac{1}{(1 + e^{(RHS_A)} + e^{(RHS_B)})} \quad (11)$$

$$\text{So, } p(A) = \frac{e^{(RHS_A)}}{(1 + e^{(RHS_A)} + e^{(RHS_B)})} \quad (12)$$

$$p(B) = \frac{e^{(RHS_B)}}{(1 + e^{(RHS_A)} + e^{(RHS_B)})} \quad (13)$$

And for 'k' class scenario, the logistic regression form can be formulated as:

$$p(R) = \frac{e^{(RHS_R)}}{(1 + e^{(RHS_A)} + e^{(RHS_B)} + \dots + e^{(RHS_{k-1})}) \dots} \quad (14)$$

As per the concept of the stochastic utility theory, each of the transit alternatives will have varying utilities, which will influence the transit choice. It is hypothesized that the utility function of each transit alternative is influenced by each of the explanatory variables of personal characteristics and trip characteristics.

The model fit gives information about how well your data is best fitted and described by the applied model. The value of  $R^2$  and  $p$ -value are among the criteria which determine the strength of the predicted models. In the multinomial logit model, there were several  $R^2$  values and the model with the highest value of 0.648 was utilized for the consideration of the best model. However, in the t-test regarding  $p$ -value, the predictor variables greater than 1.96 were included in the maximum utility function, as they may affect the transit choice-making at 95% probability. All other variables which fail to reach 1.96 values at the above-mentioned probability were excluded from the model.

### Discussion of Results

This study aimed at understanding the preference of parents' perspective in choosing transit mode for their kids among personal vehicles with driver, tailored taxi and public transport based on trip characteristics of travel costs, privacy and safety concerns and travel time. The following analysis is very important to

comprehend the parents' transit mode choice for their kids. Also, the statistical evaluations are performed to understand whether the impacts of the defined personal characteristics (gender, age, income, education level and profession type) are statistically significantly different in given perceptions of (travel costs, privacy and safety concerns and travel time) based on their preferences.

### *Distribution of Respondents' Socio-economic Demographics (SEDs)*

The questionnaire was shared with the parents of the students at the University of Management and Technology, Lahore. The online link was shared through e-mail to 360 targeted respondents, out of whom n=317 (88.05%) respondents filled the form. The basic socio-economic demographic features of the respondents are shown in Table 2.

**Table 2. SEDs of the respondents**

Respondents' features		Frequency (n=317)	Percentage (%)
Gender	Male	168	53.00
	Female	149	47.00
Age	< 30 years old	87	27.44
	30 - 50 years old	135	42.59
	> 50 years old	96	30.28
Household Income (per month)	< 50000 PKR	143	45.11
	50000 - 100000 PKR	107	33.75
	> 100000 PKR	67	21.14
Education Level	Primary Schooling	8	2.52
	Secondary Schooling	12	3.79
	High Schooling	44	13.88
	University Graduate	253	79.81
Profession Type	Business	105	33.12
	Employee	76	23.97
	Others	136	42.90

The survey results showed that 124 (39%) of the respondents manifested their inclination to use a personal vehicle with driver, 174 (54.8%) of the respondents showed their manifestation to use a tailored taxi (Uber/Careem) and only 20 (6.2%) of the respondents preferred public transport.

### *Effect of Travel Cost*

Travel cost is an important characteristic that can affect the travel mode choice. It is directly linked with the monthly income of the earning family members of the household. The multinomial logit model is used for sensitivity analysis to check whether the monthly household income is an important factor in selecting a

transit mode for kids to pick-up and drop-off. The results demonstrate that as the monthly income increases from 50,000 PKR, there is a modal shift from public transport to personalized transit modes. However, there is a further increase in the household income yield in choosing a personal vehicle with a driver (selection ratio 0.43) if the monthly household salary exceeds 100,000 PKR. Average salaried parents somehow prefer TNCs (selection ratio 0.63), which may be attributed to appealing discount offers for regular customers by TNC operators. It is evident from Fig. 1 that the probability of using a personalized vehicle with driver is less (selection ratio 0.27) if the monthly income is lower than 100,000 PKR.

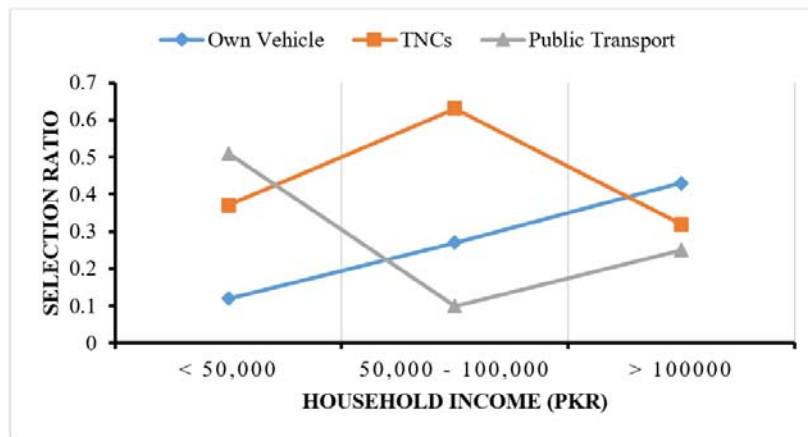


Figure (1): Selection ratio of transit mode choice due to monthly household income

**Effect of Privacy and Safety Concerns**

It is important to evaluate the importance of privacy and safety concerns in the decision of traveling by TNCs or public transport, especially in the case of female travelers. The results showed that privacy and safety concerns increase while choosing TNCs and public transport as a mode of choice for female travelers. The selection response is more in choosing a private vehicle with its driver (selection ratio 0.65), while merely, selection ratio for choosing TNCs and public transport is 0.27 and 0.08, respectively. These results are following the fact that the parents would choose their private vehicle as a mode of travel while considering the safety and security of their kids. As there are still legal gaps for the protection of the passengers against sexual assault and harassment while traveling with TNCs and public transport, so privacy and safety constitute another important factor which could affect decision-making. In

other words, if a parent is more sensitive to privacy and safety concerns, he/she would choose a private vehicle with a personal driver as a preferred travel mode (male selection ratio 0.52 and female selection ratio 0.65). As evident from Fig. 2, male parents are less concerned about the privacy and security of their kids while traveling with TNCs (selection ratio 0.33) and public transport (selection ratio 0.15), respectively. If a traveler is sensitive to privacy and safety concerns, then he or she is likely to choose own vehicle with the driver as a transit mode. The privacy and safety concerns of both parents (male and female) are somehow similar in pattern with the selection ratio of 0.33 and 0.27, respectively. However, the descending order of parents' preference in selecting transit mode with concerns of safety and security is; own vehicle > TNCs > public transport.

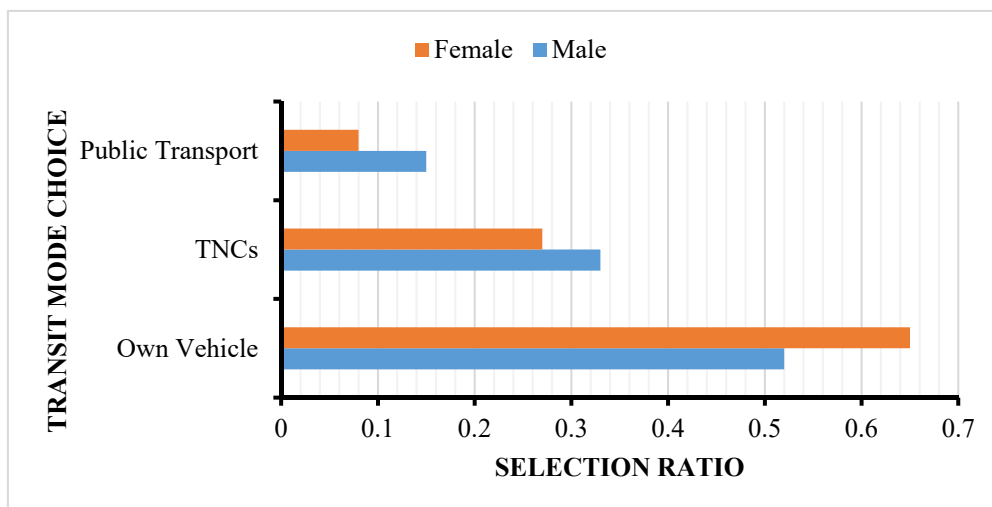


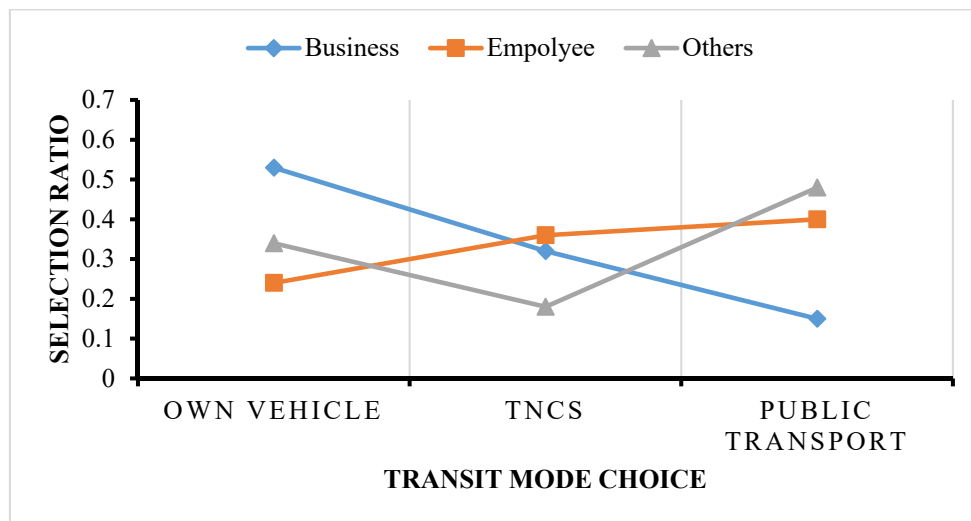
Figure (2): Selection ratio of transit mode choice due to gender



**Effect of Travel Time**

The role of the travel time factor is also important in determining or choosing the transit mode. As shown in Fig. 3, when parents care more about time, they prefer own vehicle, TNCs and public transport in descending order of choice with a selection ratio of 0.53, 0.32 and 0.15, respectively, if they are business individuals. However, the percentage of selecting TNCs (selection ratio 0.18) and own vehicle (selection ratio 0.34) is relatively low if they lie in other categories of profession type. Other categories also include the option if they don't want to reveal their means of earnings. The selection ratio of choosing TNCs is relatively low for all categories except for business individuals choosing public transport which may be attributed to that it may take several minutes to order Uber/ Careem services (TNCs) *via* a mobile software application. As observed by the authors, during peak hours, waiting time may

exceed 15 minutes and sometimes, the estimated waiting time showing on mobile application is not in compliance with reality and usually takes longer. The least interest in using public transport as a mode choice as compared with other transit choices while considering travel time as a factor can also be attributed to almost non-availability of an effective and efficient public transit system in the country. However, as evident from Fig. 3, the choice of transit mode changes from own vehicle to public transport as the travel time factor is shifted from extremely important (5) to extremely unimportant (1). Moreover, parents who do not consider travel time as an important factor usually prefer using public transport as a mode choice. In other words, if parents are more sensitive to travel time, they would prefer their private vehicles with a driver as a preferred mode choice for pick-up and drop-off their children.



**Figure (3): Selection ratio of transit mode choice due to profession type**

**CONCLUSIONS**

This paper discusses the parents' travel mode choice for their children to pick-up and drop-off with the consideration of personal characteristics and trip characteristics. The perceptions of the parents were collected *via* an online questionnaire survey in Lahore city. A multinomial logit model is used to describe the transit mode choice among own vehicles, TNCs and public transport. Based on the results discussed above, the following conclusions can be drawn:

- The transit mode choice can be well described by the multinomial logit model.

- The results showed that parents with high household income, female respondents and those who consider travel time as an extremely important factor prefer personalized transit mode of own vehicle with a driver.
- However, female respondents of the questionnaire survey are more concerned about the safety and security of their kids and preferred their private vehicles as transit mode over TNCs and public transport.
- The waiting time of TNCs can be a potential reason for preference in choosing personalized own vehicle as a transit mode while considering travel time as one

of the prime concerns for parents.

- Well-designed fiscal policies on the improvement of public transport may shift the travel mode choice from personalized transit modes (i.e., own vehicle, TNCs, ... etc.) to public transport.
- The existing gap of sexual assault policies and laws should be addressed by policymakers in addressing the security and privacy concerns of the potential traveler groups.
- Female respondents feel more insecurity and less privacy while sending their kids with TNCs.
- Most of the respondents feel that personalized transit modes provide more accessibility as compared with public transport because of the insufficient availability of infrastructure and information regarding public transport systems.
- It is found that parents of the students have a very negative attitude towards public transport in Lahore city, so unprecedented improvements are required from all aspects of serviceability to change their attitude from negative to positive for a targeted group of travelers.
- In this study, the perceptions of the students regarding the mode choice for traveling to educational centers are not incorporated. Only the perceptions of the parents are included at this stage of the research study. The findings of this study can help transport planners and other key stakeholders in shaping guidelines for improved appropriate operations design for public transport and other TDM measures. The above-mentioned findings can help in understanding the transit mode choice from parents' perspectives.

The findings of this research study may be expanded

by researchers working on similar domains to study the parents' perspectives regarding mode choice behaviors, especially in developing countries. Although personal characteristics and trip characteristics are considered while explaining the potential transit mode choices, some deficiencies are existent in this research study. For example, neglecting some of the influential factors, such as convenience, comfort, reliability, travel purpose and land-use type, may affect the model in terms of accurately predicting variables comprehensively. Additionally, TNCs and public transport are strongly influenced by the government's regulations and policies.

For the continuation of this study, the regulation factor for TNCs and public transport will be explored to better understand the transit mode choices by parents for younger kids. However, some more factors, such as number of earning members, residence type, vehicle ownership and convenience, would be incorporated in explaining transit mode choices from parents' perspectives. The factor analysis technique may be employed to determine the most influential parameters which affect the choice of a particular mode as per the discretions of the kids. Also, the effects of constrained parking environments and insufficient public transport on travel mode choices would be explored.

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### **Appendix 1. Questionnaire Summary**

#### **Part – 1: Basic Information**

##### *Gender*

Male

Female

##### *Age*

< 30 years old

30 – 50 years old

> 50 years old

##### *Monthly Household Income*

< 50,000 PKR

50,000 – 100,000 PKR

> 100,000 PKR

*Education Level*

- Primary Schooling  
 Secondary Schooling  
 High Schooling  
 University Graduate

*Profession Type*

- Business  
 Employee  
 Others

*What is the preferred mode of transport for pick up and drop off your child to educational centers?*

- Own Vehicle  
 Tailored Taxi (Uber / Careem)  
 Public Transport

**Part – 2: Travel Cost** (Note: Please rate your response against five-point Likert scaling system) as follows:

- 1 - extremely unimportant  
 2 - unimportant  
 3 - neutral  
 4 - important  
 5 - extremely important

1. Commute cost concern of transport
2. Congestion cost concern
3. Driver cost concern
4. Vehicle maintenance cost concern
5. Fuel cost concern

**Part – 3: Safety and Security** (Note: Please rate your response against five-point Likert scaling system) as follows:

- 1 - extremely unimportant  
 2 - unimportant  
 3 - neutral  
 4 - important  
 5 - extremely important

1. Traffic education and road safety concern of the driver
2. Accident safety concern of child
3. Sexual harassment concerns for female child
4. Driving experience of the driver
5. Quality of the vehicle
6. Breach of privacy concern

**Part – 4: Travel time** (Note: Please rate your response against five-point Likert scaling system) as follows:

- 1 - extremely unimportant  
 2 - unimportant  
 3 - neutral  
 4 - important  
 5 - extremely important

1. Commute time
2. Waiting time
3. Congestion time
4. Mode transfer time
5. Transfer walking time

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