An investigation on Travel mode preferences of university students travelling to home during vacation: An Indian experience

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Abstract

University travel undertaken by students needs to be analyzed for improved mobility planning in India. Universities with residential accommodation facilities for students become one of the largest trip generators particularly during vacation as most of the students travel to their respective hometown. This study provides an insight into the travel mode choices of typical Indian university students travelling to home during vacation, by examining the travel patterns of students belonging to National Institute of Technology, Durgapur, an Indian higher education institution situated in a tier-II industrial Indian town. Initially, a web-based travel behavior survey was designed to elicit socio-economic, mode-specific information from a total of 618 students. Based on the collected data, multinomial logit model was developed to analyze the mode choice decisions of the students. Results indicate that family income, vehicle ownership, travel-characteristics (whether travelling alone or with others) and time of travel significantly affect the mode preferences of student-travelers. It was also observed that with economic prosperity, the use of flexible and comfortable modes of transport like car and bus increases. Family vehicle ownership was also found to play a major role on car usage. Interestingly, bus was found to be the least preferred mode for night-time travel by students travelling alone. The proposed methodology and study findings would help to understand the university students' travel characteristics while travelling to home during vacations and devise necessary transportation planning policies.

Keywords: Travel behavior, University students, Mode choice, Multinomial logit model.

1. Introduction

The growing demands and opportunities for higher education have led to the growth of university campuses in terms of population and area. University students comprise a large proportion of the total trips in a developing country such as India, which has a substantial student population, next to the working population. According to an All-India Survey of Higher Education 2018-19, the higher education sector in India consists of 37.4 million enrolled students who are spread across 993 universities, 39,931 colleges and 10,725 stand-alone institutions (AISHE 2020). The Gross Enrolment Ratio (GER) in Higher education in India is 26.3%, which is calculated for the 18-23 years of age group (AISHE 2020). Hence, the universities are amongst the largest trip generators and attractors in India. In addition, some surveys report that the education-related journeys account for

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25% of the total journeys made across the world (Rotaris and Danielis 2015). University generated trips have a significant effect on the environment (Tolley 1996). Consequently, the city-based university trips contribute to a significant share of the daily urban traffic. Furthermore, regardless of the regional location of the campuses, universities in both urban and suburban or rural areas are instrumental in shaping the travel demand of those areas. A significant share of Indian universities has residential campuses where the students reside inside the campus, attend classes, work and participate in several other activities. Indian university students' can broadly be divided into two categories, namely, hostellers: who reside inside the campus, and day scholars: who have their residence outside the campus and commute daily to the university. A study has identified that there is a difference in travel behaviour between students living on campus and students living off-campus (Khattak et al. 2011). It is also highlighted by the study that the socio-demographic characteristics and travel behaviour of university students were contrasting in comparison to those of the general population. Even so, university students are a neglected populace, often missed in mode choice surveys. Most of the studies exploring the travel behaviour of university students have been conducted in the North American and western European context in general. Particularly, despite being a significant proportion of trips, longer trips made by hostellers as part of their journey towards their hometown have not been studied in any of the existing literatures. The mode choice decisions of students particularly for longer trips during vacation play a major role in deciding the transportation infrastructure planning decisions in the vicinity of the university campuses, which also significantly influences the local economy. In this regard, an in-depth understanding of university student's mode choice determinants would help the appropriate planning bodies to make informed decisions specifically for managing longer trips during vacation period.

A brief review of the existing research literature clearly indicates that there is a lack of understanding of travel behaviour and mode choices of university students from a developing country such as India. Moreover, the limited literature investigating the mode choice behaviour of Indian university students has mostly concentrated on the day scholars who stay off-campus. Studies on the mode choices and travel patterns of hostellers with respect to their journey between their permanent residence and their respective in-campus hostel residence have been limited. Such trips between a student's on-campus residence and permanent residence are in general long-distance trips and are not undertaken on a daily basis. Unlike commuting trips, these long-distance trips are undertaken only during vacations or holidays and it is approx 3-4 times a year for a hosteller of a national institute in India. Even, the length of these trips and the huge populace of students travelling at a particular time, given the student population in India make these trips highly essential to monitor. Due to sudden surge in travel demand at a particular time namely, during such vacations, the transportation systems that are already in service may not able to cater to this demand. Hence, provision of special additional transport systems particularly in these times of vacations are of significant importance. Such journeys by the students contribute significantly to the university trips in a country and need to be assessed.

In this background, this study presents a methodological approach with the following basic objectives. First, to analyze the mode choice decisions taken by the hostellers belonging to a typical Indian university campus. Second, to identify the socio-economic and trip-specific determinants of their mode choice decisions. Third, to estimate the marginal effect of these determinants on mode choice decisions and recommend suitable

policy measures for improving the hosteller's travel in and around a university particularly during vacations. For demonstration of the methodology, this study has developed a survey questionnaire and collected modal preference data along with socio-economic information from in-campus resident students or hostellers of National Institute of Technology Durgapur, India. Subsequently, Multinomial Logit (MNL) model was employed to analyze the data and provide suitable recommendations.

The paper begins with a brief review of the existing research literature. This section is followed by the proposed methodological approach, data collection. Further, the MNL model development and relevant findings are presented and interpreted, followed by the concluding remarks.

2. Literature review

Several existing studies have investigated the factors influencing mode choices of the general population. However, only a limited number of studies have specifically focused on university students' travel behaviour in general and in-campus students' mode choice decisions in particular (Wang et al. 2012). University students have complex and unique travel behaviour, which is understated in most travel studies (Tolley 1996). The following section presents a brief review of existing studies on students' travel behaviour and identifies specific scopes of work for this study.

Some of the existing literatures made an attempt to identify the influencing factors associated with trips made by university students. Du Toit (2013) in his study at the University of Pretoria, South Africa focused on studying students' preference for modes of transport, including (i) pedestrian routes, (ii) bicycle routes, (iii) a hop-on/hop-off campus bus, (iv) park-and-ride and (v) a fare-free bus. The study results indicated that a fare-free bus was preferred even by car commuters, while bicycle routes were least preferred. Busari et al. (2015) in their study reported trip distance to be a significant determinant influencing university students' travel behaviour in Nigeria. The authors inferred that with increase in distance, the use of walking and bicycle significantly reduced for the students. Etminani-Ghasrodasht et al. (2018) used a multilevel integrated Multinomial Logit and Structural Equation Models to investigate the travel behaviour of Iranian university students. They observed that students preferred to use private cars over other travel modes, including walking/cycling and public transit. A few studies observed that the students preferred their personal cars over public transportation (Nash and Mitra 2019; Singhirunnusorn et al. 2012). They also found that gender, age, year of study, locations of the students' living places and their monthly allowance play a major role towards influencing university students' travel behaviour (Nash and Mitra 2019; Singhirunnusorn et al. 2012). Several of the past studies found travel time, travel cost, income status, auto ownership, comfort, gender, and residential location to influence the mode choice decisions of students statistically significantly (Danaf et al. 2014; Nasrin 2020; Tolley 1996). Existing Indian case studies on students' travel behaviour indicated that trip-specific factors such as travel time, travel cost, and socio-economic attributes like age, gender, distance, vehicle ownership influence their travel pattern and mode choice significantly (Gopi et al. 2019; Das et al. 2015; Krishnapriya and Soosan George 2020). A few of the past researchers also studied the dissimilarities in travel behaviour, mode choice decisions, and trip purposes between students living on campus and students living off-campus. Khattak et al. (2011) collected an aggregate travel behaviour dataset from four specific universities in Virginia, USA, namely, Virginia Polytechnic Institute

and State University, the University of Virginia (UVA), Virginia Commonwealth University (VCU), and Old Dominion University (ODU). They found significant differences in travel behaviour, mode choice decisions among students residing on-campus and off-campus (Khattak et al. 2011). Wang et al. (2012) also found that in contrast to the students living off-campus, students living on-campus had a higher daily trip rate. They tended to drive less and more likely to walk and use bicycle (Wang et al. 2012). Based on their study, Zhou (2014) suggested that the distance of travel and accessibility to public transportation modes significantly influence university students' mode preferences. The study also observed that female students or graduate students are less likely to use alternative transportation modes such as transit or non-motorised modes like bike and walking. Whereas undergraduate university students were observed to have a relatively shorter trips and were more willing to use alternative modes of transports. With respect to travel modes, some of the past works considered bus, personal car, bicycle, and walking, public transit as a mode of travel in students' travel pattern-based studies (Etminani-Ghasrodasht et al. 2018; Khattak et al. 2011). Also, few of the researchers, in their studies on the context of the travel demand of long-distance trips, considered travel mode such as airplane, train etc. (Miskeen et al. 2013; Bai et al. 2001; De Vos et al. 2016; Verplanken et al. 1997; Schafer 1998). Table 1 presents a summary of the past researches in this context for better understanding.

Based on a brief review of existing research literature, it can be observed that majority of the studies are conducted in the context of the developed countries (Khattak et al. 2011; Nash and Mitra 2019; Rotaris and Danielis 2015; Tolley 1996; Wang et al. 2012). Very few studies have investigated the travel patterns and commuting mode choices of university students in the context of a typical emerging economy such as India. This observation clearly indicates that there is no consensus on what factors influence university students' travel characteristics in a typical Indian setting specifically for longer home-bound trips. Furthermore, the results and policies derived from the studies conducted in developed country context could not be directly transferred to an emerging economy such as India due to differences in travel preferences and socio-demographic profile of population in general, students in particular. Hence, there is a need for conducting a separate study in the context of India. Secondly, it can be also observed that majority of the Indian university-specific studies have explained the mode distribution and travel behaviour of students using descriptive analysis only (Singhirunnusorn et al. 2012; Gopi et al. 2019; Das et al. 2015) only. There is a dearth of quantitative investigations in terms of student mobility planning. In summary, it can be inferred that literature discussing the travel mode choices of university students in the context of developing countries such as India, is inadequate. In addition, studies exploring the mode choice decisions during vacation trips of the students who reside on-campus remain scant. Also, as the mode of travel is different for long-distant home bound trips, modal split for those modes needs to be studied in detail for better strategic planning. In an attempt to fill these research gaps, this study proposes a comprehensive methodology and applies it based on travel behaviour data collected from students belonging to NIT Durgapur, a typical Indian university.

Table-1: Summary of existing research on university students' travel behaviour

Literature	Country	Objective	Travel type	Key factors studied	Key outcomes
Krishnapriya and Soosan (2020)	India	Modelling travel behaviour of students considering residential location	Work trip and education trip	Travel distance, travel cost, household size, no. of workers in house, vehicle ownership, distance to bus stop/city center	• Two-wheelers were observed to be most popular mode with respect to travel time. • Bus was the most preferred for long distance travel. • Access distance and workers in household was found to be key factors.
Nash and Mitra (2019)	Canada	Travel pattern of students and its variation due to socio-demographics, neighbourhood type, residential location	Any type of trip taken by the university of students throughout a day	Frequency of using public transit, private car, population density, street network density, cycling facility, new residential built-ins	• Walking is the most opted mode instead of having driving license. • The transit dependent students make least no. of trips and have high average trip length but the opposite happens for multimodal travellers.
Rotaris and Danielis (2015)	Italy	To study the effectiveness of travel demand management policies for university students	Home to university daily trips	Walking time, in-vehicle time, parking time, parking fare and bus ticket	• Subsidizing bus fares and parking restrictions are the most efficient policy.
Danaf et al. (2014)	Lebanon	To study the university students' mode choice, effectiveness of sustainable transport policy and value of time	Work trip and education trip	Travel cost, income, gender, vehicle ownership, travel time, parking fees	• Travel time and parking cost are found out to be the most substantial factor whereas, travel cost being the least important factor for university students' mode choice.
Zhou (2014)	USA	To study the university students' mode choices to investigate reduction in car dependence	Place of residence to university daily trips	Commuting time & distance, education level, transit pass, parking permit, bus proximity, part-time job at campus, gender	• Transit pass, gender and education level are the most significant factors for mode choice decisions.
duToit (2013)	South Africa	To examine students' preference for sustainable mode of transport	Travel to-and-from the main campus, including current place of residence	Preference ratings for sustainable modes of transport at different scenario	• A fare-free bus is most preferred by the students which will reduce car usage and parking shortages.
Wang et al. (2012)	USA	To understand the travel behaviour of university students from a travel demand modelling perspective and comparing it with general population	Any type of trip taken by the university of students	Trip characteristics, academic characteristics, socio-demographics	• Students have higher trip rates than general population. • Compared with on-campus students, near-campus students and farther-from-campus students made fewer daily trips.
Khattak et al. (2011)	USA	To explore the travel behaviour of university students by comparison with general population	Academic, work, shopping, recreational, meals-based trips	Trip rate, travel purpose, education level, gender, income, marital status, time-of-day	• Trip rate is higher than general population on weekdays and slightly higher on weekends. • Use of non-motorized mode is more among students. They make trips mostly at noon.

3. Method

In this current study, multinomial logistic regression model is implemented to investigate the student respondents' mode choice and travel characteristics during
vacation. Multinomial logistic regression models being simple and easy to interpret compared to other available models such as nested logit, error component mixed logit (Mitra and Buliung 2014; Yarlagadda and Srinivasan 2008) was adopted in this study for modelling the categorical dependent variable (mode choice in this case).

Furthermore, multi-collinearity among the independent variables causes a serious problem in logistic regression. It doesn't change the parameter estimates of the model rather it reduces the reliability of the parameter estimates. In other words, the presence of multi-collinearity between predictor variables lead to misinterpretation of the model coefficients and thereby decrease the prediction accuracy of the model. Hence, it is important to estimate the correlation between the independent variables before model development. Cramér's V determines the association between the categorical variables. It is used for multi-collinearity detection as the variables of this study are categorical variables.

4. Study area and Data collection

Durgapur is the fourth-largest urban agglomeration in the state of West Bengal and has a population of more than 0.5 million. This is a major industrial and tier-II city in the eastern part of India. The city has a total area of 154 km^2 and a population density of 3000 people per km^2. Durgapur is home to quite a few institutions of higher education that include the NIT Durgapur, Central Mechanical Engineering Research Institute (CSIR-CMERI Durgapur), Durgapur Government College, Dr B.C. Roy Engineering College, IQ City Medical College and a few more. Hence, the city attracts a significant number of university students from all over the country. Durgapur is well connected by roadways, airways, and railways. The city is located at 160 km from Kolkata, the administrative capital of West Bengal. The study on mode choice characteristics at Durgapur will help to procure strategic planning for sustainable transportation facility in the cities which is home to several educational institutions and an industrial area. The case study university i.e. NIT Durgapur has a completely residential campus; all students need to stay in the campus only. NIT Durgapur has been chosen for the study since it is a completely residential university. Also, it has the highest number of residential students in Durgapur. These qualities of NIT Durgapur such as, residential institute, located in a small university-cantered township and large number of in-campus students make this particular university an ideal representative for understanding the travel pattern and mode-choice behaviour of Indian university students. The findings of the study could be generalized to devise key policy measures in university towns located in mid-sized cities.

In this study, a web-based survey method (i.e.; google form) was adopted for data collection. The key advantages of adopting a web-based survey are: i) a web-based survey procedure is a more cost and time-efficient way of collecting responses for research purposes and ii) data collected through a web-based survey can be easily prepared for analysis purposes owing to specific features provided by the survey-administration platforms (Mateo-Babiano et al. 2017). Questionnaire was prepared in such a manner that it can be understood easily by the respondents. This questionnaire was circulated by the Server Support Team of NIT Durgapur through email amongst all its current students.

The potential respondents or students were sent 2 reminders during the period of data collection to help increase the response rate for the study.

The questionnaire was designed to elicit the in-campus NIT Durgapur resident students' socio-demographic and home-bound trip specific information of the university studentsthrough multiple choice question (MCQ) based travel behavior survey. The first section of the questionnaire contained a brief overview of the study, followed by a description of the survey attributes and a set of instructions about filling up the form. The second section contained hostel resident student's information on travel mode choice decisions for journeys between their permanent residence and the university campus. Questions regarding personal information of the students (e.g., age, gender and course of study), household information (e.g., annual family income and vehicle ownership) and trip characteristics (e.g., time-of-day of travel, accompany and mode choice) were also included in the final section of the questionnaire. This survey form was distributed amongst 4265 current residential in-campus students of NIT Durgapur (NIRF 2020). However, the form garnered a total of 661 responses, yielding a net response rate of 15.4%during its period of collection, i.e., April 22, 2020 to June 21, 2020. After filtering out the incomplete and erroneous responses, 618 complete responses were used to develop a comprehensive database for the study.

The sample size is a very important factor for getting accurate and statistically significant models. In this study, the adequacy of the sample size is estimated through a set of empirical formulas (Eq. 1 and Eq. 2) with the assumption that the population is normally distributed (Levy and Lemeshow 2013). According to Eq. (1) and Eq. (2), minimum number of samples for 95% confidence interval is 354, whereas 618 responses has been considered for this current work.

$$n_\infty = \frac{Z^2 pq}{e^2} \tag{1}$$

$$N = \frac{n_\infty}{\left[1 + \frac{(n_\infty - 1)}{n}\right]} \tag{2}$$

Where, n_∞ and N denotes sample size for infinite population and finite population respectively, Z is statistical parameter in accordance with confidence interval, n is population size, p symbolizes hypothesized true proportion for population (0.5 for worst case) and $q = 1 - p$.

5. Analysis and Results

In this section, the analysis and results of this study is illustrated. Firstly, it discusses about the descriptive analysis and then multinomial logit model results have been discussed.

5.1 Descriptive analysis

This section presents a descriptive analysis of the survey data for a preliminary understanding of the data. The total number of observations, percentage of collected responses of the categories of mode choice and other socio-economic and trip-related variables associated with their home-bound trips are presented in Table 2.

A preliminary observation clearly indicates train to be the mostly preferred mode among students for making long-distance trips. It is also observed that most of the students were male, i.e., about 81.9% and the rest 18.1% were female. The age of the students ranges from a minimum of 17 years to a maximum of 30 years, since it was

planned to involve both undergraduate and postgraduate students in the study. 88.3% of total respondents are enrolled in the undergraduate programs. Amongst the rest, 8.7% are in the post-graduate programs while only 2.9% are enrolled to doctoral programs. The descriptive study also suggests that the most preferred time for availing the transport between permanent residence and the university is between 7 AM to 11 AM in the morning. The per capita net national income in India is 1.32 lakh INR (USD1600) (Ministry of Statistics & Programme Implementation, India 2022). It was also observed that most of the students who responded to the questionnaire had an annual family income of less than 3 lakh INR (USD3635) per annum, about 46.1%. Around 41.3% of the respondents had an annual family income between 3 lakh INR (USD3635) per annum and 10 lakh INR (USD12115) per annum. Only a small group of students, about 12.6% belonged to the sector having an annual family income of more than 10 lakh INR (USD12115) per annum. The following sections present a brief descriptive overview of the data with respect to each variable category.

Travel mode category: A descriptive analysis of the travel modal category used by the students to reach home during vacations indicates that most of the in-campus students availed train (66.5%) as travel mode whereas other modes such as airplane, car and bus were availed by 13.8%, 3.7% and 16% of students respectively.

Table 2: Descriptive summary

Dependent variable	Category	Coding Pattern	N	Percentage
Travel mode	Airplane	1	85	13.8%
	Train	2	411	66.5%
	Bus	3	99	16.0%
	Car	4	23	3.7%
Gender	Male	0	506	81.9%
	Female	1	112	18.1%
Time-of-day	Morning (7AM - 11AM)	1	272	44.0%
	Afternoon (11AM - 4:30PM)	2	120	19.4%
	Evening (4:30PM - 8PM)	3	98	15.9%
	Nighttime (8PM - 10PM)	4	37	6.0%
	Late night-Early morning (10PM - 7AM)	5	91	14.7%
Course of study	Bachelors	0	546	88.3%
	Masters	1	54	8.7%
	Ph.D.	2	18	2.9%
Vehicle ownership	No vehicles	1	293	47.4%
	Only 2-wheeler	2	41	6.6%
	Only 4- Wheeler	3	127	20.6%
	Both 2-wheeler and 4-wheeler	4	157	25.4%
Accompany	Alone	1	408	66.0%
	With fellow students	2	210	34.0%
Family income	Less than ₹3 LPA (USD 3635)	1	285	46.1%
	₹3 LPA (USD 3635)-₹10 LPA (USD 12115)	2	255	41.3%
	Greater than ₹10 LPA (USD 12115)	3	78	12.6%
Total			618	100.0%

Family Income: Figure 1(a) provides a visual representation of the modal share of the university students with respect to family income. It suggests that the train is a very popular mode of transport for students belonging to low and middle-income households. On the other hand, airplane and bus were relatively more preferred by the high-income group of students. This trend suggests that with development in financial well-being, the

inclination towards using more comfortable modes such as airplane and bus increases. However, private car was not preferred by the students for their travel needs, which could be attributed to longer trip lengths.

Gender: The descriptive study also suggests that airplane and bus were relatively more preferred by female students in comparison to male students. On the contrary, the train is a much more preferred mode of transport for male students compared to their female counterparts. This modal split is presented through Figure 1(b).

Vehicle ownership: Notably, Figure 2(a) displays that train as the most favored mode of transport for students who do not own any vehicle and even for the students who own both 2-wheelers and 4-wheelers. As expected, car has been observed to be the most popular mode for students having four-wheeler in the family.

Course of study: It can be clearly observed from Figure 2(b) that the train is the most preferred mode of transport for the Master's students in comparison to students enrolled in the Bachelor's and PhD courses. The bus is almost an equally chosen mode of transport by the PhD and bachelor's candidates while the airplane is more preferred by the bachelor's and master's students. We can also see that the motorized two-wheeler is a more popular mode of transport amongst the PhD students. The variation in modal choice across different student categories could be attributed to their relative affluence, ease of access of a particular mode and their relative geographical locations.
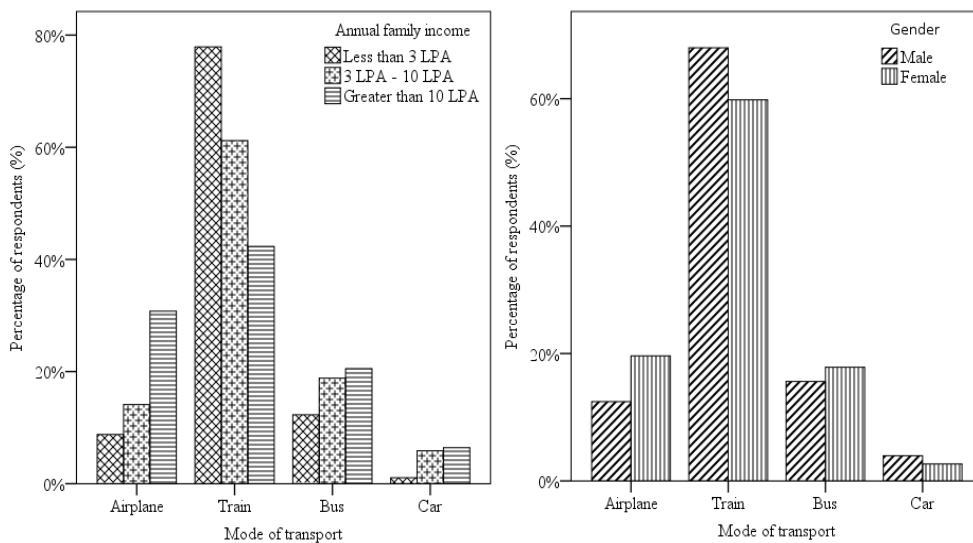

Figure 1: (a) Family income-wise and (b) gender specific mode choice characteristics of university students

Time-of-day: Figure 2(c) illustrates the modal share with respect to the time of travel. It is observed that when the students travel between permanent residence and the university, the airplane is the most popular mode of transport if the time of travelling is at night or early morning between 10 PM to 7 AM. On the other hand, the bus is mostly availed if the student is travelling in the morning between 7 AM to 11 AM. However, it can be noticed that train is an equally popular.

Travel accompany characteristics: Figure 2(d) illustrates that bus and car are preferred more, as modes of transport by students who travel alone. On the other hand, airplane and train are equally preferred by students who travel alone and with fellow students.
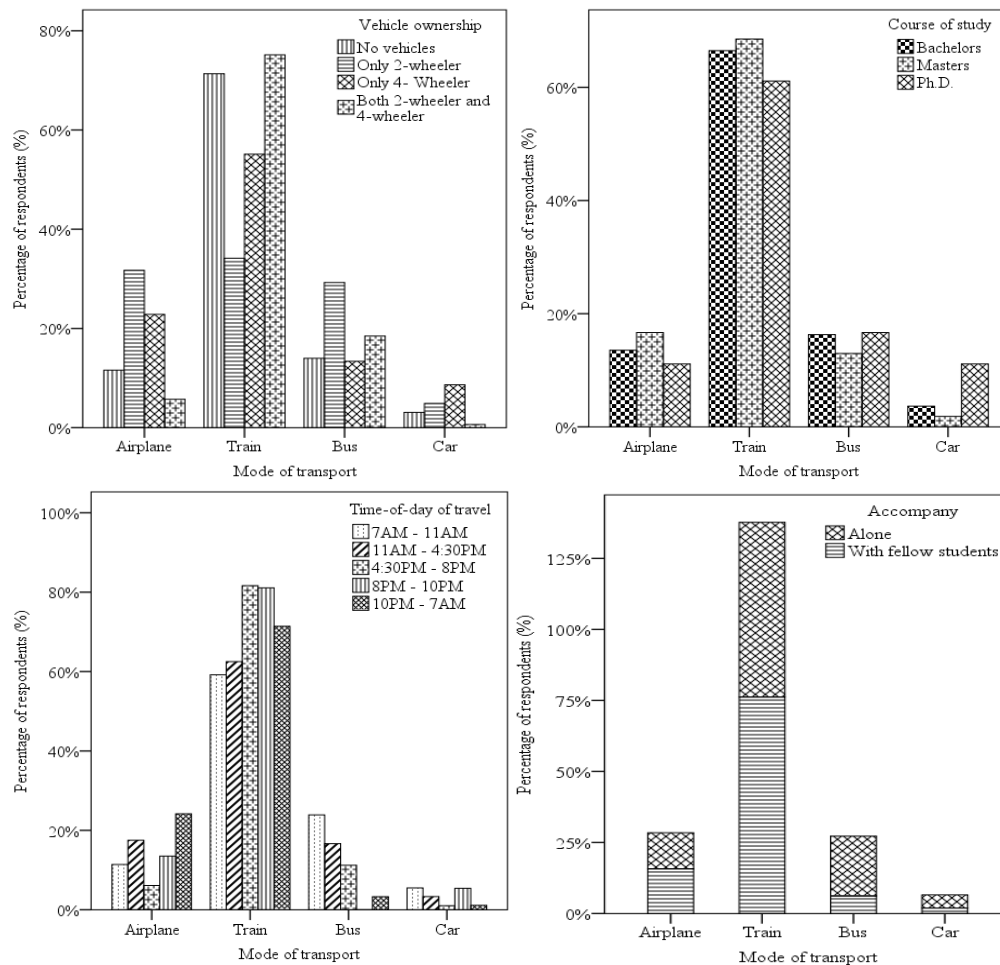
Figure 2: Travel mode choice characteristics of university students based (a) vehicle ownership, (b) course of study, (c) time-of-day of travel and (d) accompany

5.2 Multinomial Logistic Regression Model Details

This section presents the travel mode choice analysis using multinomial logistic regression. One category of the dependent variable is selected as reference category. All other parameters in the model are to be estimated based on the reference category. The category with the highest response frequency, i.e., the train has been chosen as the base category for the dependent variable.

The contribution of each variable to the model is generally determined by the likelihood ratio test. Only the variables such as time-of-day of travel, respondent's preference to travel alone or with fellow students, annual family income and vehicle ownership are found to be significant at 95% confidence interval (p-value<0.05). Of these, time-of-day of travel and preference to travel, are most significant one. Hence, predictor variables used in the utility function for the final model are time-of-day of travel, preference to travel, family income and vehicle ownership. Moreover, to study the impact of the explanatory variable on the model, a comparison between intercept only model and a full model has also been performed. It is found that the -2log likelihood value for final model is less than that of intercept-only model which implies that the predictor variables have substantial impact on making the final model statistically significant. Additionally, pseudo-R^2 is defined as the proportion of the variance of the dependent variable (i.e.,

mode choice) associated with the predictor variables (Hu et al. 2006). For the model the values of Cox and Shell, Nagelkerke, and McFadden are reported as 0.229,0.268 and 0.135 respectively, which unveils that the model can predict 13-27% variation.

The parameter estimates for choice of airplane, bus and car with respect to train have been shown in Table 3. B in the table indicates the regression coefficients of the explanatory variables and Exp(B) denotes the odds ratio of the various categories of the explanatory variables. Odds ratio explains the change in the outcome variable category with respect to reference category owing to a unit change of an independent variable while other independent variables remain constant.Effect of every attribute has been described in detail as follows.

Time-of-day: In this variable, late night-early morning travel is considered as reference category. Odds ratios in Table 3 indicates that those who travel in the morning (7 AM-11 PM) choose airplane 0.505 times more than train, whereas it is 6.518 times for bus and 5.034 times for car/bike. Similar trends have been observed for those who travel during the afternoon (11AM-4:30PM). Student trips show a clear peak during afternoon in the outcome of the research conducted by Khattak et al. (2011). In this case the chances of choosing airplane, bus, and car/bike are 0.663 times, 4.277 times and 2.820 times, respectively. It has been noted that for evening travel (4:30PM-8PM), the chances of choosing airplane and car/bike are quite less (i.e., odds ratios 0.186 and 0.579) and for bus it is 2.45 times. The higher likelihood of choosing a bus during morning and afternoon could be due to availability of buses and security perception during commute. The model also reveals that probability of selecting bus as a mode is least for night travel (8PM-10PM) compared to the other modes. This aspect could be attributed to safety, security and lower frequency of buses during night. It has been also noted that preference to car has been increased in night-time than evening hours. This attribute could be attributed to relatively lower travel distance. As anticipated by Eboli and Mazulla (2011) and TCRP Report that cleanliness, overcrowding, information system, safety, personnel security, helpfulness of personnel, and physical condition of bus stops are decisive factors that influence customer satisfaction for bus transportation.

Table 3: Multinomial Logistic Regression Model Parameter Estimates and odds ratio (Train is reference mode)

Predictors		Airplane		Bus		Car	
		B	Exp(B)	B	Exp(B)	B	Exp(B)
Time-of-day	Intercept	-1.171	-	-3.406	-	-5.938	-
	Morning	-0.684	0.505	1.875	6.518	1.616	5.034
	Afternoon	-0.411	0.663	1.453	4.277	1.037	2.820
	Evening	-1.680	0.186	0.895	2.448	-0.546	0.579
	Night-time	-0.951	0.386	-20.022	0.000	0.955	2.598
Vehicle ownership	No vehicles	0.675	1.965	-0.208	0.812	1.460	4.307
	Only 2-wheeler	1.960	7.100	1.014	2.757	2.186	8.897
	Only 4- Wheeler	1.380	3.974	-0.148	0.863	2.457	11.666
Accompany	Alone	0.120	1.128	1.349	3.853	0.989	2.689
Family income	Less than 3 LPA	-1.018	0.361	-0.764	0.466	-1.328	0.265
	3 LPA-10 LPA	-0.622	0.537	-0.106	0.900	0.090	1.094

Vehicle ownership: The vehicle ownership was found to have significant impact on the mode choice of the students for their vacation trips to home. To identify the impact of vehicle ownership, possession of both 2-wheeler and 4-wheeler is considered as reference category. The odd ratios 1.965 and 4.307 indicates that those who don't own any vehicle, choose airplane and car more than the bus and train. Desire to avail a better level of comfort could be attributed to the choice of these modes specifically who stay far away from Durgapur city. Students with only two-wheeler have 7.100 times, 2.757 times and 8.897 times more probability of choosing airplane, bus and car, respectively compared to train. Further, those who own four-wheelers, likely to choose airplane, bus, and car3.974 times, 0.863 times, and 11.666 times higher compared to train, respectively. The highest and least likelihood of choosing a car and bus could be attributed to the four-wheeler ownership.

Accompany: It can be observed from the model that the hostellers travelling alone have the chance of choosing airplane 1.13 times more than train. The chances of choosing bus and car for this case are 3.85 times and 2.68 times more than train. The lower chance of commuting by railways could be attributed to the uncertainly of getting confirmed seat reservation or/and possible delay. Furthermore, the underlying rationale behind the lesser odds of choosing railways while travelling alone could also be the rising concern about travel-safety in trains which is supported by the findings of Vanniaranjan and Stephen (2008). The chances of choosing rail-travel over other modal choices can be improved by upgrading the safety measures for passengers, i.e., provision of safety lockers for the passengers' valuables, appointment of security personnel to ensure passenger security etc. In addition, a positive image about railway travel can also be created by publishing the railway services in India with the help of celebrities, which would encourage people to use trains over other modes of transportation.

Family Income: Annual family income was found to have a substantial contribution towards mode selection while travelling between permanent residence and the university. The model reveals that the chance of selecting airplane is 0.36 times more than train for the respondents having family income of less than 3 LPA whereas it is 0.46 and 0.26 times for bus and car modes respectively. When the family income of the hostellers is between 3 LPA to 10 LPA then they have 0.53 times more chance of choosing airplane than train. For the same category, the chances for choosing bus and car are 0.9 times and 1.09 times more than the train. This finding clearly indicates that better economic prosperity leads to choose private cars for facilitation of desired comfort level and flexible travel experience, whereas a higher chance of choosing bus could be attributed to lower trip length and ease in accessibility of that mode. Modal choices with respect to annual family income were found to be in line with the results as observed by Krishnapriya and Soosan (2020).

6. Marginal effects and Discussion

To understand the individual effect of time-of-day, vehicle ownership, accompany and family income on travel modes, marginal effect analysis has been performed and represented in Table 4. The analysis reveals that for the morning time, travel share drops by 12.17% and 14.93% for airplane and train respectively, while it increases for bus and car up to 22.67% and 4.43% respectively. Despite similar trend being observed for travel during afternoon time, the modal share in the afternoon is less compared to early morning. For evening time, the share for airplane and car decreases to 19.5% and 1.46% respectively, whereas it increases to 6.37% and 14.59% for train and bus respectively.

Table 4: Marginal effect for different travel modes

Predictor variables	Categories of Predictor variables	Marginal effect for travel modes (%)			
		Airplane	Train	Bus	Car
Time-of-day	Morning	-12.17	-14.93	22.67	4.43
	Afternoon	-8.01	-12.12	17.51	2.63
	Evening	-19.50	6.37	14.59	-1.46
	Night-time	16.70	132.05	-163.39	14.63
Vehicle ownership	No vehicles	6.73	-6.38	-5.01	4.66
	Only 2-wheeler	17.59	-29.46	6.53	5.32
	Only 4- Wheeler	13.53	-14.57	-6.49	7.53
Accompany	Alone	-2.07	-15.36	15.22	2.20
Family income	Less than 3 LPA	-8.53	17.87	-6.10	-3.23
	3 LPA-10 LPA	-6.53	5.83	-0.09	0.79

There is a significant decrease to choose bus (i.e., 163.39%) and a significant increase in choosing train (i.e., 132.05%) which happens during night-time. Besides, the marginal effect analysis elicits that choice of airplane and car as a mode increases by 6.73% and 4.66% for the students' family having no vehicle. In contrary, it decreases for train and bus by 6.38% and 5.01% respectively. Students' family with only 2-wheeler vehicle has propensity of 17.59% for airplane, 6.53% for bus and 5.32% for car. Further, the choice for train gets reduced by 29.46%. Also, the marginal effect analysis unveils that the students' family having 4-wheeler vehicle are more prone to choose car than other category of students' family based on vehicle ownership. Furthermore, the choice for bus and car increases by 15.22% and 2.2% while travelling alone. The students' family income of less than 3 LPA is more likely to choose train while taking university trips. Simultaneously it has also been observed that choice of airplane and car increases for the students' family with family income 3LPA-10LPA.

7. Policy Implications and Practical Applications

The Indian case study of university students' travel behaviour would help to formulate the possible policy frameworks associated with transportation planning strategies to incorporate student-travel characteristics in India in particular and in countries with similar GER (Gross Enrolment Ratio) and student population in general. Furthermore, the survey technique and adopted methodology is generic, which could also be adopted by researchers and planners attempting to develop specific travel demand models for other population sub-groups and critical trip generators such as pilgrimage and tourist destinations during peak hours (Wang et al. 2012). Based on the key findings and results derived from the present study, potential policies aimed at sustainability and low-carbon environment friendly transportation planning could be formulated. In the following section, key policy recommendations are mentioned.

The results illustrate that the odds for choosing a public bus for travel for night-time travel are the least. This observation could be attributed to lower levels of safety, security and availability associated with bus transport during night time. Hence, provision of bus tracking services and hygienic washrooms at bus stops and shelters, ensuring safety and security of passengers and their belongings, improving seating arrangement and physical condition of buses and reducing overcrowding would help increase the usage of buses

even at night-time, thus minimising private vehicle utilization. Besides, improvement in bus infrastructure in terms of appropriate on-board security system, improved fare collection system etc. needs to be implemented by the concerned authorities. Such policy decisions are expected to significantly improve the share of public transport modal share (Rotaris and Danielis 2015; Zhou 2014; du Toit 2013), thereby reducing the carbon emissions from private motorized trips.

Results also indicate a significant proportion of students using trains for their long-distance trips. This observation clearly points towards the need to improve mobility planning in terms of feeder modes as first mile connectivity in similar cities. In several of the European countries, students are provided with free travel pass or concession passes for students to travel in public transport modes. Similar policies would be useful for Indian students thereby making the public transport more attractive particularly in university cities.

Time of day has also been observed to be a key variable influencing the modal choice and transportation characteristics of student travellers. Hence, appropriate scheduling of public transit system according to travel demand in specific routes could play a major role in seamless transportation of students specifically during early hours and late night. Improved security through manual or CCTV-camera based surveillance would significantly improve the travel quality during night especially for female students.

Monthly family income has also been observed to directly influence the choice of modes by students. Hence, reduction of fares or provision of affordable public transportation modes specifically during holidays could be planned by the local planning bodies (Rotaris and Danielis 2015). Additionally, design of public transport modes according to different income segments such as air-conditioned and non-air-conditioned services would play a major role towards improving the quality of transportation.

It was observed that students travelling alone provided higher priority to bus and car over railway. Such behaviour points towards improving safety and security measurements in trains such as lockers and appointing security personnel in the rail wagons. Further, reducing delays in travel time, smoothening the seat-booking process, improved catering system at affordable prices on railway platforms, improving behaviour of railway staff, porters, parking staff and quality of information system; and publicizing railway services with the help of celebrity endorsements are effective ways to promote railway adoption for long-distance travel (Nandan, 2010).

Beyond the observations and concluding remarks specific to both case study cities and unique contributions to the body of knowledge, the possible practical applications based on the analysis and results are as follows:

- Firstly, due to limited available resources, it is not always possible to carry out a detailed investigation to develop and evaluate the key factors influencing student mode choice. In such cases, the identified factors can be used as a basis for formulating key policy measures in a city with similar socio-economic setting.

- Secondly, the results of detailed travel choice analysis provide government bodies with a clear direction of the areas requiring higher emphasis and where students would be willing to spend more money to have desirable infrastructure conditions. Such understandings could be further adopted for carrying out cost-benefit analysis of infrastructure improvement measures.

- Thirdly, the results could be used to develop hypothetical scenarios with improved infrastructure and check the possible shift from private motorized mode to public transportation modes in terms of potential shift in user probability to choose a

particular attribute with respect to improvement in public transport infrastructure. Further, a sensitivity analysis could be carried out to understand change in user behaviour with respect to improvement in modal infrastructure conditions. Results of such analysis will serve as important inputs for facility planners.

8. Key Contributions and Limitations

This study made an attempt to explore and understand the travel mode choices of Indian university students who reside inside the campus i.e., the hostellers. Based on the research results and findings, the following novel contributions are made to the existing body of research. Firstly, this study is one of the preliminary attempts in Indian context attempting to analyze the mode choice behaviour of residential students' trip to their hometown. The results and key recommendations would help to understand the mode choice behaviour of the in-campus residents of a university in similar cities. Second, the study will help the local transport providers in planning safe and sustainable transport infrastructure for university students. The authors would also like to mention that the results were not tested for transferability, however, the adopted methodology and relevant findings could be used by cities of similar size and characteristics as a preliminary basis for an improved mobility planning for students. The following sub-section presents a set of limitations and future scopes of work based on the derived results.

The study considered the university situated in a tier-II city in India. Such analysis may not be representative of the entire student population across India. As a future extension of the study, investigation of the students' mode choice behaviour for other cities could be taken up. Also, only the mode choices of students using a single mode of transport throughout their journey have been explored. However, some respondents need to avail more than one mode of transport during their university trips. Since this study is focussed only on place of residence to university trips, it may not portray actual travel behaviour undertaken by the university students. Henceforth, it is also needed to analyse for all other trip purposes inclusively to better understand the travel behaviour. Furthermore, the examination of the travel characteristics of the students, who stay outside the university campus and commute everyday should also be taken up as a future extension of this study. Also, multinomial logistic regression assumes the independence of irrelevant alternatives (IIA) assumption, which is one of the drawbacks of these models. Hence, use of advanced models such as random parameter logit models need to be adopted in future. Subsequent studies on this topic may take into consideration the influence of importance and satisfaction of the factors such as comfort, cost of travel and travel time on the mode choice for university trips of students.

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