Mode Choice Behaviour of University Students: A Review

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Abstract: Transportation planning plays a very important role in the development of any country. The population throughout the world is increasing at an exponential rate. As the population increases, the number of vehicles also rise leading to congestion and other traffic problems. Transportation planning traditionally considers only the general population whereas certain subgroups like college going students are completely overlooked. Colleges and Universities are a major platform, attracting and generating numerous trips per day, on the account of a large number of students and employees. Moreover, the university campuses have higher concentration of regular work or education trips, during some specific time or hour, which can increase the congestion in the nearby areas and streets. Thus, studying the travel behaviour of university students is very important, as they form a significant part of the travelling community. Besides, it is seen that students exhibit distinct travel characteristics, which makes it vital to understand their daily commuting habits and their reliance on private vehicles. The mode choice of students is also likely to be altered by the availability of parking space within the campus. This is a literature review based paper that aims at studying various researches already done in the field and drawing conclusions thereon.

***Index Terms*- colleges, mode choice, students, transportation planning, travel behaviour.**

I. INTRODUCTION

Transportation holds a very high place in today's modern lifestyle. It largely affects a country's development in all aspects. It is considered to be the lifeline of a country as all the human activities/ movements are carried out through communication/ transportation channels and thus proper transportation facilities are essential for the growth of the nation. Transportation planning is thus gaining more and more importance in today's world. Transportation planning can be defined as a science that attempts to identify the problems arising during provision of transportation facilities and providing solutions in the form systematic planning of such facilities.

The introduction of motor vehicles has made life very easy, comfortable and convenient, but at the same time it has created various problems like lack of safety, congestion, pollution etc. Today many cities and towns face extensive traffic congestion, making the situation unmanageable. Transportation planning thus helps deal with these problems and provide effective solution for the transportation of people as well as goods.

The transportation planning has always focused on studying the trip making behaviour of the general population by means of survey; however, certain subgroups are significantly underrepresented. College going students form one of these subgroups. They are a significant part of the community and their travel patterns tend to be different from the general population. Moreover, the colleges attract regular work trips as well. Also, the design and strategies adopted considering the general population may or may not be adequate for the student population due to substantial differences in their commuting patterns. Thus it becomes necessary to study their travel behaviour in order to understand and resolve the traffic problems as well as for designing of new transportation facilities.

Web-based surveys can be efficiently used for collecting the travel information of students, in order to understand their general travel patterns and mode choice behaviour. For designing the questionnaire, it might be helpful if all the questions are assembled in various groups so that any important factor / parameter is not left out. These can be grouped as under:

1. Individual factors / personal attributes
   (Includes age, income, gender, occupation, car ownership, possession of driving license, etc.)
2. Mode-specific factors
   (Includes availability, comfort, convenience, access, travel time, travel cost, etc.)
3. Trip-specific factors
   (Includes origin, destination, travel distance, travel time, etc.)
4. Built environment variables
   (Includes type of land use, availability of infrastructure, streets, intersections, sidewalks, etc.)
5. Travel Demand Management measures
   (Includes increased cost of parking, transit subsidy, certain restrictions on car use, etc.)
6. Psychological factors
   (Includes attitude, habit, health, etc.)

Some or all of these factors can be included in the survey keeping in mind the requirements of the study area.

Mode choice behaviour is one of the most important attributes of the overall travel pattern. It can be studied by generating various models – Discreet Choice Models, Multinomial Logit Model, Binomial Regression Models, Bi-variate and Multi-variate Analysis, Hierarchical Tree Based Regression Model, etc. Discreet Choice Models can be defined as the one that can explain, describe as well as predict a choice between two or more discreet alternatives. It make use of the utility theory, which includes assigning ranks to the various alternatives, depending on their utility. In case of transportation planning, it can be used to predict the mode choice of travelers. Multinomial Logit Model is the one that can be used to predict the likelihoods of different probable outcomes of categorically distributed dependent variables for a known set of independent variables. It can be used when there is a dependent variable falls into any set of categories consisting of a limited number of items which cannot be arranged in a meaningful way, given that there are at least two such categories, in addition to a set of independent variables, which are then used to predict the independent variable. Binomial regression is a method in which the outcome is a result of a series of one of two possible disjoint outcomes; i.e. success or failure. Bivariate analysis is a method that can be used to determine the empirical relationship between two variables, i.e. dependent and independent variables. Multivariate analysis is a technique used for the analysis of one or more statistical outcome variables simultaneously. It is used when the effects of a number of variables on the final outcome are to be considered. Hierarchical Tree Based Regression Model (HTBR) is a non-parametric statistical model that can be used to understand the data structure and establish relationship between the variables. The predictions made using HTBR have a very high degree of accuracy due to the development of tree structure, in which the complete dataset is represented as the root node that is further split up into internal or terminal nodes depending on certain decision rules. Three types of algorithms can be used to create tree based classification model: 1. CART (Classification and Regression Trees), 2. CHAID (Chi-squared Automatic Interaction Detection) and 3. QUEST (Quick, Unbiased, Efficient, Statistical Tree).

A number of researches have been done in this field. The study of mode choice behaviour of university students has been carried out by various researchers covering a number of colleges across the world. They have used different statistical and mathematical models to analyse the travel behaviour. Some of the works have been discussed in the following section.

II. LITERATURE REVIEW

Guangjun Zhan, Xuedong Yan, Shanjiang Zhu, Yun Wang (2016) [7] study the travel frequency and mode choice patterns of university students in China. Eight colleges – four in Beijing, two in Nanjing and two in Shanghai were selected for the survey: Beijing – 1. Beijing Jiaotong University (BJTU), 2. Beihang University (BUAA), 3. Tsinghua University (THU) and 4. Minzu University of China (MUC); Nanjing – 1. Nanjing University (NJU) and 2. Southeast University (SEU); Shanghai – 1. Fudan University (FDU) and 2. Tongji University (TJU). A web-based travel survey was used for data collection. The authors use a non-parametric statistical method called hierarchical tree-based regression (HTBR) model to predict the travel frequency and categorize the mode choice of students. The university students were provided with three different travel modes, including walking, cycling and public transit, out of which they could select their governing mode choice under specific conditions. School location city, family income and public transit station cover age ratio (PTSCR) were found to have significant influence on the travel frequency of students, whereas travel distance, school location city, bicycle ownership, student gender and PTSCR had an impact on student mode choice. The study helps in identifying the factors affecting the mode choice and travel frequency of students through HTBR models. This in turn provides better understanding of the travels patterns and new perceptions in the travel pattern of students. This research could provide more information and better understanding about the traffic conditions prevailing near the university campuses, like traffic facilities, service levels of the roads, atmospheric conditions etc. This in turn, helps us recognize the existing traffic status, and then draw attention to the problems that need to be improved.

Lisa Davison, Aoife Ahern, Julian Hine (2015) [1] studied the consequences of energy released due to on the account of university related travel by students. This research emphasizes the significant differences in culture and the complications in travel behaviour related with travel to universities across the United Kingdom (UK) and Ireland. This research scrutinizes three different traits of the transport repercussions of travel to and from the university; first of all the trip between university and temporary or term time address (permanent address is taken if the student does not have a separate temporary address), then the trip between the university campus and a distinct permanent address if applicable; and lastly, the consequences of the emissions caused on the account of travel related to the university. Total 1049 responses from 17 colleges across Ireland and UK were recorded. In the northern areas of Ireland, the travel of students from permanent as well as term time addresses, were found to be more reliant on cars than other dominions observed in this research. This was perhaps due to the lack of public transport availability in the northern parts of Ireland and the huge investments in the road network, which has made car travel effortless and faster than the alternative modes of transportation in northern areas of Ireland. In England, the student travel was found to be more car dependent when travelling from permanent address to university as compared to the term time address. However, the probability of car-pooling was found to be high among the students in England. The travel frequency was found to be significantly affected by mode choice. The users of the active transportation modes – walking, bicycle and public transportation, accessed the college campus more often, possibly because the students lived nearby the college campus. The transport choices were found to have a significant impact on the emissions and reflected the prominence of university related travel in the evolution of a transport policy response as compared to the conventional emphasis on the work related trips. Because of the diverse travel choices demonstrated by students in northern areas of Ireland and their

dependence on cars, as opposed to the other dominions there is possibly a higher opportunity for reduction strategies related to carbon emissions.

Mazen Danaf, Maya Abou-Zeid, Isam Kaysi (2014) [3] studied the travel behaviour of the students of American University of Beirut (AUB). The study explored only the trips from home to school and school to home for the students of AUB, which is a portion of the general travel behaviour of students. The study analyzes the amount to which the travel mode choices of the students at AUB differ from the travel behaviour of the common people with respect to their social background and financial situation as well as the existing public transportation system in the Greater Beirut Area(GBA). A total 594 responses were received from AUB and 430 responses from general population. The authors developed discrete choice models to analyze the mode choice of university students. AUB students were found to have a greater time value as opposed to the common people owing to their busy timetables and classes, mandatory attendance requirements, and the fact that several of them belonged to wealthy families. The authors used discrete choice models to analyze the mode choice behaviour of university students and the general public of the Greater Beirut Area. Total journey time, cost of travel, residence location, salary, gender and ownership of car were found to have significant impacts on the choices made by students. Also, the parking costs appeared to be an important factor affecting the mode choice.

Kate E. Whalen, Antonio Páez, Juan A. Carrasco (2013) [6] studied the mode choice behaviour of students at McMaster University located in Hamilton, Canada. The authors observed that scrutinizing the mode choice of the students at university provided an exclusive chance to recognize the travel behaviour of a population that had a huge fraction of active travelers at a location generating a large number of trips. Consecutively, this study can offer valuable perceptions regarding the factors affecting travel by active modes. The descriptive variables considered for the analysis are assembled into the following groups: individual/ person-specific factors (social background, economic status, outlooks, demographic, income, gender, etc.), mode-specific parameter (availability of mode, comfort, convenience, etc.), trip-specific factors (origin, destination, travel distance, travel cost, etc.), built environment variables (intersections, junctions, sidewalks, etc.) and presence of Travel Demand Management (TDM) measures. The mode choices were found to be affected by a combination of factors such as cost, individual attitudes, and built environment factors like street and sidewalk density. Moreover, the time of travel by bicycle and car affected the efficacies of these modes in a positive way, though at a declining rate as time travel increases.

Asad J. Khattak, Sanghoon Son (2012) [5] attempt to recognize the travel patterns of the students of university from the perspective of travel demand modeling. The survey is carried out at the Old Dominion University in Virginia. Owing to the distinctive life-cycle stage of the students, the research reflects the distinct nature of their individual attributes, their way of life (both working and studying), and the spatial features of the place where they live, study and work. This study comprehensively explores the travel behaviour of the students of university and provides strenuous statistical models of the travel demand. The study computes the relationships between the residential location of the university students, travel patterns and demographics. The travel demand model based on university trips developed in this study can help in improving the efficacy of regional models, particularly in areas with greater student populations. The results revealed significant information about student travel behaviour, which could help in designing feasible strategies for improvement of the traffic conditions around the university campus. It could be achieved by providing satellite communities in the vicinity of campus, by establishing near-campus or on-campus villages for students, development of the neigbourhoods that are within walking or cycling distances from the university, providing pedestrian and bicycle friendly amenities on and around campus, provision of public services in neighboring communities and linking regional transit corridors with the university campus.

Jiangping Zhou (2012) [8] studied the travel and housing behaviours of the students at University of California located in Los Angeles (UCLA) via online travel survey. The significant factors affecting the mode choice were classified into six groups: 1. Built environment (intersections, sidewalks, etc.), 2. Individual-specific factors (socio-economic, demographic, attitudes, income, gender, etc.), 3. Mode-specific factors (availability of mode, comfort, convenience, etc.), 4. Trip-specific factors (origin, destination, travel distance, travel cost, etc.), 5. Travel Demand Management (TDM) measures and 6. Psychological factors. Group 2-4 were more likely to affect the general population whereas, the students were found to be affected by group 4-6. L.A is multimodal and provides transit pass at a discounted rate, thus increasing the likelihoods of alternative travel modes. UCLA issued seasonal parking permits to the students which in turn reduced the likelihoods of alternative modes, making cars a dominant choice. Commute distance was found to be positively associated to telecommuting and carpool. Age, gender and status (undergraduate or graduate) were found to be substantially linked to biking, walking or usage of public transit. Moreover, the students living alone were found to be more dependent on cars, while the ones having friends in the neighbourhood were more likely to use active modes. A few findings were commonly compatible with those in prevailing studies, for example, transit pass increased the likelihoods of alternative modes like transit. The paper endorses a wide-ranging travel demand management program, application of information contagion impacts of students and enhancement of multimodal travel to encourage alternative travel modes among university students. Owing to data restraints, this research cannot demonstrate whether there is any relationship between information contagion and the impacts of living single-handedly and having families and friends living in the vicinity on alternative modes, but it recommends that the issue is worthwhile of further investigations.

Asad Khattak, Xin Wang, Sanghoon Son, Paul Agnello (2011) [2] observed that the university students form a substantial proportion of a region's population, and despite of this fact, the travel behaviour of university students was not well comprehended or accurately characterized. The other vital reason to carry out the survey of university students was that universities represented surroundings that were more livable, responsive to alternative travel modes, had a higher density than other settings, and offered

mixed travel modes. Thus it was found that the examination of the students' travel behaviour could be informative and disclose valuable facts about relations with the physical environment and the magnitude of dissimilarities in travel (e.g., mode choice and trip generation) as compared to the overall population. As a result, Internet-based surveys were carried out by the Virginia Department of Transportation (DOT) to study the travel behaviour of university students. Four universities of Virginia selected for the study from which additional National Household Travel Survey (NHTS) data were collected were: Virginia Polytechnic Institute and State University (VT), Virginia Commonwealth University (VCU), the University of Virginia (UVA) and Old Dominion University (ODU). The Internet-based survey methodology was found to be practical, suitable, and effective means of gathering travel information from the students. In general, the outcomes of this research of student travel behaviour at these four universities of Virginia revealed vital information, thus providing a deep understanding of the university students' travel behaviour, which in turn helped in designing practical transportation strategies, for instance, improvement of traffic flow around campuses by laying more emphasis on usage of alternative modes like walking, cycling or public transportation. The behavioural data could be utilized as a foundation to develop travel demand models based on university-related trips and to aid other transportation planning endeavors.

Tya Shannon, Billie Giles-Corti, Terri Pikora, Max Bulsara, Trevor Shilton, Fiona Bull (2006) [4] conducted an online survey at the University of Western Australia (UWA) that examined the travelling patterns, probability for a change and the barriers and motivators influencing transport choices among University students. Bi-variate and multi-variate analysis was used. Total 46.8% of students and 21.5% of staff at The University of Western Australia were found to be using active modes – walking, cycling and public transport on a daily basis, and possibly an extra 30% of students and staff were likely to shift to active modes. The results recommended that a reduction in barriers to active modes, especially decreasing the actual and apparent time of travel by bicycle and bus would have the utmost impact on travelling patterns. Moreover, the UWA survey results indicate that decreasing impediments is likely to be more effective than endorsing the benefits of active modes. Travel time was found to be the most substantial barrier to active commuting for staff and students, irrespective of the distance between their home and University or their travel mode. The results showed that almost 30% students and 20% staff could be persuaded to change their travel behaviour in the short-term.

III. CONCLUSION

Different aspects of the travel behaviour of students of different colleges, located in various countries have been studied. Some focus on the role of active travel – walking, bicycle and public transportation, how to reduce barriers hindering active travel and various motivators that help people switch to active modes, whereas the others focus on the effects of vehicular emissions on the environment and encourages active modes in order to reduce the pollution, while some emphasize the importance of students' travel behaviour in the transportation planning. Thus the travel pattern of students has been given due importance in all the papers.

The surveys were carried out by means of web-based / internet based methods, which proved to be quite efficient. The questionnaire was designed to include the significant factors affecting the mode choice classified into six groups – physical environment and urban form factors, individual-specific factors, mode-specific factors, trip-specific factors, Travel Demand Management (TDM) measures and psychological factors. Out of all these, the trip specific factors, TDM measures and psychological factors are found to be affecting the mode choice behaviour of students to a great extent.

Discreet choice models, hierarchical tree based regression, random utility theory, multinomial logit model, bi-variate and multivariate analysis have been used to study the travel behaviour. Any of these models can be effectively used to study the travel behaviour keeping in mind the above factors.

It has been observed that cars are a dominant mode of transportation amongst the students living far from the college or universities whereas the students living in hostels or in the vicinity of the university prefer active modes – walking, cycling or public transport. Moreover, carpooling is found to be the first choice amongst the students who live in the same neighbourhood as their friends and classmates. Also carpooling and other active modes are a preferred choice when the universities have limited parking space or high parking charges.

The travel behaviour of college going students is to be given due importance in transportation planning. It should thus be considered in all the significant transportation decisions especially the ones in and around the university areas where a large amount of traffic is concentrated at certain time of the day, owing to the large number of students coming in and leaving the universities.

IV. REFERENCES

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