MODAL SPLIT ESTIMATION OF NUST STUDENT COMMUTERS

MUHAMMAD ZAEEM SHEIKH

(00000118537)

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Signature: _____

Name of Supervisor: **Dr. KAMRAN AHMED**

Date: _____

Signature **(HOD)**: _____

Date: _____

Signature **(Dean/Principal)**: _____

Date: _____

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By

MUHAMMAD ZAEEM SHEIKH

(00000118537)

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DEDICATED

TO

FRIENDS

AND

FAMILY

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Abstract

Transportation is the backbone of infrastructure of any nation. Studying the demand and travel characteristics of commuters assists in the effective planning of transportation systems of a nation. Travel demand modeling is a mathematical relationship between travel demand and traveler and system characteristics. Furthermore, the study of special trip generators within a population is important as their travel choices are different as opposed to the general public. Activity based modeling is an approach which assumes each trip to have maximum utility. Using this approach this paper explains the development of a mode choice model of an urban university in Islamabad, Pakistan, namely National University of Sciences and Technology (NUST) considering the attitudinal factors and socioeconomic factors.

The required data was acquired by carrying out a Revealed Preference Survey at the project Site. A total of 428 surveys were conducted among students of Undergraduate and Postgraduate level. Mode choice models were developed for Hostelites and Day Scholars to determine the factors affecting it's selection for commute. It was determined that Walking is the predominant mode of choice among students. Degree Level does not affect travel behavior whereas Study and Home trips are most frequent activities among Day Scholars and Study and Out of NUST are most frequent activities. Hostelites and Female students make more trips than day Scholars and Male students on an average day. Shuttle Service within NUST is provided, but students tend to not use it. It may be attributed to 76.8% of the respondents believing that shuttle service has not improved in NUST or have not used it at all. NUST Van is the other mode most utilized by students living out of NUST. Policy implications and further research is also discussed.

Keywords: *Transportation Planning, Econometric Modeling, Mode Choice, Travel Behaviour*

Chapter 1

INTRODUCTION

1.1. BACKGROUND

Travel behavior studies are important to be conducted for further studies of sustainable transportation and/or environmentally friendlier modes of transportation. The baseline study of travel behavior of university students is needed to evaluate the travel patterns and determine the modal splits and frequency of trips occurring within the university as well as to and from it.

University students are often ignored in travel studies. Travel surveys throughout the world primarily focus household trips and commercial/office trips. This fact is visible from the little literature available on university student travel behavior (Dellmelle et. al, 2012 & Xing, 2012).

Large university campuses are major trip generators and such campuses can affect the regional traffic. Travel patterns for special generators (universities) are different from standard land uses and they have received little attention in the four step travel demand forecasting methods.

Travel demand models in Pakistan have been studied at city level by various researchers. (Memon, 2011). However, a travel demand model specific to universities has yet to be seen.

Travel studies are important for prediction of commuters to and from different regions and the type of traffic that is observed in these areas. They are also important for making planning and policy decisions for the area of study.

Travel behavior of university students has been given little attention (T. Limamond, 2011) and little to no literature is available regarding the travel behaviour of

student commuters. Various research papers indicate how researchers are focusing on studying travel demand of subgroups, especially students. Following the same trend, this study aims at creating a model for an urban university in the capital city of Pakistan in the National University of Sciences and Technology (NUST) to understand the commuting patterns of students in this region. Travel behavior will be modeled against attributes including age, gender, academic status, car ownership among other attributes.

1.2. PROBLEM STATEMENT

Studying of travel behavior and modal preference of commuters is essential for understanding the timings and various modes used for travel which in turn help in the understanding of type and number of vehicles in a traffic stream. Student commuting varies differently as compared to travel in a community. The timings and motives of travel are different and during specific hours of the day whereas may be haphazard at night. The timings of classes cause increased traffic on the service roads leading to and from NUST during 0800-0900, 1300-1400 and 1600-1700 hours. The shuttle service of NUST is not available during off hours i.e. after 1000 hours. Passenger commute between campuses is required for this as well.

1.3. RESEARCH OBJECTIVES

The scope of the study is to determine the commuting patterns and modes of commuters within campus via survey forms and then create trip models and mode preference models with the following objectives:

- Determine the factors affecting modal split and develop a model based on those trips.
- Compare mode choice of Hostelites and Day Scholars and analyze their motivating factors.
- Provide policy changes for change in mode selection of students.

1.4. SCOPE OF THIS THESIS

To achieve the aforementioned stated objectives, a methodology for research was deliberated. Few of the key tasks are mentioned as following.

- Literature review on mode choice modeling carried out earlier to get detail of the relevant socio-economic and demographic parameters for analysis.
- This study involved the NUST H-12 campus. Survey form was developed with relevant questions and data obtained from participants from the departments of NUST using pen and paper survey.
- Digitized data was analyzed using SPSS software to determine the frequencies, cross-comparisons, correlations and model.
- Results of descriptives and models on the basis of residential status, gender and activities were compared.

1.5. ORGANIZATION OF THESIS

This thesis is organized in five (5) chapters. Every Chapter is briefly described below:

Chapter 1 provides brief overview about transportation modeling approaches carried out throughout the world and especially Pakistan. An overview about the objectives, problem statement scope of the research and tests performed is also stated.

Chapter 2 gives detailed explanation of the transportation modeling and planning approaches carried out throughout the world. It also includes literature review and findings of previous researchers on mode choice modeling, travel behavior and transport planning.

Chapter 3 explains the methodology adopted for achieving the research objectives. It encompasses the description of project site, selection of survey instrument,

and determination of significant factors and the modeling method as well as procedure adopted.

Chapter 4 particularizes the outcomes of the survey form and analysis of the results obtained from the descriptive analysis and modeling of the data.

Chapter 5 enlightens the findings and conclusions of this research work. Recommendations for forthcoming research work are also outlined.

The organization of the thesis is also illustrated by Figure 1.

1.6. SUMMARY

This chapter discusses the background of this study, its problem statement, research objectives and scope of the research. The sequence of the thesis is also written.

Chapter 2

LITERATURE REVIEW

2.1. GENERAL

The chapter contains the literature review and the associated theory behind the mode choice modeling of student commuters which have been carried out in various countries. The details of the survey conducted and the questions asked of the respondents, the methodology used, type of model developed and a summary of the results of past literature are also discussed.

Travel behavior studies have been carried out throughout the world. Travel mode choices and factors are based on the socio-economic factors of commuters, their age and the trip purpose. The usual approach of modeling for city planning has been utility-based approach in which mode selection and trips are calculated on the basis of a utility function. This utility function is a trip generation multinomial logit model. However, student travelling is a population attractor which acts differently.

A lot of studies have been carried out to determine the mode choice and trip generation of a sample population for planning purposes of cities. Subpopulations need to be studied to evaluate the travel behavior and mode choice of a particular region or commuter type. The travel behavior of students is different from normal commuters (Limmamond et. al, 2010, Khattak et. al, 2011). A number of studies have been conducted in the past two decades on this topic, which are discussed below.

2.2. MODE CHOICE MODELING OF RURAL UNIVERSITIES

(Limmamond et. al, 2010) Limmamond et. al studied the travel mode choice and behavior of students in a rural university of Thailand as their travel behavior is complex. For this purpose a travel diary of 130 students was selected and their travel behavior

compared. There wasn't much difference in the travel characteristics of the sub-group which were male car-owners, male car non-owners, female car-owners and female car non-owners. However, there was a difference in the mode selection. Vehicle owners chose to use their personal vehicles and rather than any other mode. Also, students chose to car-pool with a vehicle owner as opposed to using another mode.

(Delmelle, 2012) Delmelle conducted a research in 2012, to study the gender and temporal effects of traveling behavior and mode choice selection of students based on their gender in a rural university in Moscow, Idaho. He found that male students were more inclined to non-motorized transportation as opposed to female students and males change their commuting modes according to the climate. Parking permits were also found to be a major factor.

(Bilabao, et. al, 2003) The affect of price of commuting and ease of travelling was studied in Spain by Bilbao Et. al in 2003. After acquiring a sample of 1780 students of Elementary, high school and university level, it was found that students use the commuting methods as paid for by their parents. However, the with a decrease in price of commuting and increase in ride quality, a lot of students will be willing to leave their current mode of travel and commute via public transport.

(Bonham, 2009) The possibility of cycling as the predominant mode of commute was explored in a case study at Mawson Lake Campus of the University of South Africa. The university was situated in a rural setting and bicycle commute comprised 2% of the total modal share. Cycling could be made the major mode of commute to reduce the ecological footprint of cars by enforcing some laws.

(Ripplinger, 2009) The inclination of student travel via public transport was evaluated via a longitudinal survey carried out in North Dakota State University (NDSU), Fargo. Students were asked to fill a survey form over a process of three years.

The longitudinal analysis suggested that students prefer to commute via the public transport available. However, walking and cycling trips were frequent and an increase in fuel cost resulted in the prediction that transit commute will increase.

2.3. MODE CHOICE MODELING OF URBAN UNIVERSITIES

(Wang et. al, 2012) Wang et al. studied the travel behavior of university students and found that travel distance and from university played an important role in the mode selection. Higher percentage of students who lived near or on campus walked to the university whereas percentage increased for commuters far away from campus. Both student age and number of vehicles available showed positive associations with automobile trips, but negative associations with non-motorized trips.

(Eom et. al, 2009) An activity based negative binomial model for analyzing student activities and mode choices was developed. Activity based-modeling was selected because four-step modeling assumes travel behavior to be uniform in a Traffic Assignment Zone (TAZ) (McNally, 2000) which is not the case of student travel (Limmamond et. al, 2011). Also activity based and tour-based modeling has been established to be better predictors of travel behavior for special generators of traffic like universities. It was found that on-campus students prefer to use walking as their mode of transport and off-campus prefer cars and motorized transport. Meals were the most frequent activities whereas gender, residential status and educational status did not affect travel behavior.

(Dibaj et. al, 2017) Poisson and regression model were generated for travel characteristics and mode choice of students of Amir Kabir University of Technology. Activity-based modeling approach was used to evaluate the mode choices and it was found out that walking was the major mode used by students. Non-owners of cars

travelled more than car owners whereas car-owners preferred to use their cars but resulted in less activities.

(Gurrutxagaet. al, 2017) A modal choice survey was carried out in Basque County/San Sebastian with the intent of shifting the mode choice of students from motorized to active transport or public transport as there was a massive increase in the use of private cars over the past 30 years. A survey was carried out to determine the habits, attitudes and desires of people. It was found the public transport was the most used mode followed by walking and cars. An incentive for shift in mode choice resulted in 3.4% increase in bicycle trips, 1.4% decrease in walking trips and reduced car and motorbike trips by 7.3% and 3.4%.

(Danaf et. al, 2014) A mode choice study was carried out in the AUB of Beirut using survey data, to analyse the difference in mode choice of university students as opposed to the general public of Beirut. The results of the discrete choice model indicated that travel time, travel cost, income, gender, residence location, and car ownership were the factors affecting mode choice of students and students have a higher value of time for their travel than the general public and student commuters prefer to use their cars for travelling to the university.

(Mohammed, 2013) To determine the factors which would encourage students to shift their mode to public transport, mode choice study was carried out in Taylor University of Malaysia. Survey was carried out of 456 students with questions of their socioeconomic and demographic features and potential to shift the mode. It was found that travel time reduction, decrease in travel time, reduction in travel cost, charging of parking spaces, reduced waiting time in bus station and improved bus stop services would encourage students to shift to public transport.

(Guzman et. al, 2015) Due to excessive use of cars in the Metro Manila area, factors affecting modal shift were evaluated focusing on shifting commuters to public transport or carpooling. It was found that commuters found travel time, convenience and travel cost to be factors affecting modal shift. This was also proven when the respondents were asked to rank travel time, travel cost, convenience, and other factors from first to the last in terms of priority. Passengers are willing to carpool without any incentive or change in factors of travel.

(Whalen, 2013) Students tend to utilize walking and cycling more than the average commuter. A study at McMaster University was conducted to find the factors which affect mode choice among university students. For this purpose, a utility based model was developed and it was determined that modal choices are influenced by a combination of cost, individual attitudes, and environmental factors such as street and sidewalk density. A key finding is that travel time by car and bicycle positively affect the utilities of these modes, although at a decreasing rate as travel time increases. It was also determined, that the choice of commuting by cycle depends solely on the individual, irrespective of external factors.

(Paez, 2010) An earlier study carried out at McMaster University in 2010 was carried out to find the willingness to travel via a certain commute through determining it's enjoyment. Survey was conducted with questions regarding travel behavior, socio-demographic information, and attitudes toward travel, land use, and the environment. Results indicated that active travellers were most satisfied with their commute than personal vehicle and transit travellers. Social environment, availability of local activities, quality of facilities, productive use of the commute, and the intrinsic value found in the commute travel are responsible for frequent travel via a certain mode.

(Chen, 2012) The modal choice study of Virginia Commonwealth University found that the travel behavior of university students is different from the general population. Urban universities have less non-motorized trips than rural universities on-campus students make more trips than off-campus students and most frequent activities of students are home and study.

(Lekshmi, 2014) A multinomial logit activity-based model was developed for mode selection in an urban university in India and its was found that the characteristic variables such as age, income, vehicle ownership, time of day and cost of travel were the significant variables in the model and the population falling in the age group of 3 to 20 are more users of public transportation, while the vehicle ownership reduces the preference of bus as well intermediate public transport. A negative impact is seen on tours by cars with old age people as well as with low income group. Also, as expected, low income people are seen to prefer the use two wheelers.

2.4. MODE CHOICE MODELING IN BUILT ENVIRONMENT

(Sun, 2016) Built environment was studied against mode choice selection in Shanghai, China. By applying a discrete-continuous copula-based model it was found that dense and pedestrian- and cyclist-oriented development help to reduce travel distance and encourage walking, biking, and transit modes of travel.

(Lavery 2013) A study was carried out at McMaster Univeristy to study the factors affecting polymodal travel. An ordered probit model was developed and it was found that modality is dependant on demographic, attitudinal and spatial/land use variables. Car users have low modality whereas walking mode users have high modality.

2.5. SUMMARY

This chapter includes brief introduction of the models developed for different case studies throughout the world. Various models have been developed based on the

survey instrument and resulting trend of the data. Previous findings using multinomial logit model, regression model, ordered-probit model and discrete-continuous copula-based model are also discussed.

Chapter 3

METHODOLOGY

3.1. GENERAL

This chapter contains the devised methodology for accomplishing the defined objectives of this research which include determination of factors affecting modal split and develop a model based on those trips, determination of change in modal preference based on factors and comparison of modeling choice of Hostelites and Day Scholars and analyze their factors. The methodology carried out is illustrated in figure below and elaborated in this chapter.

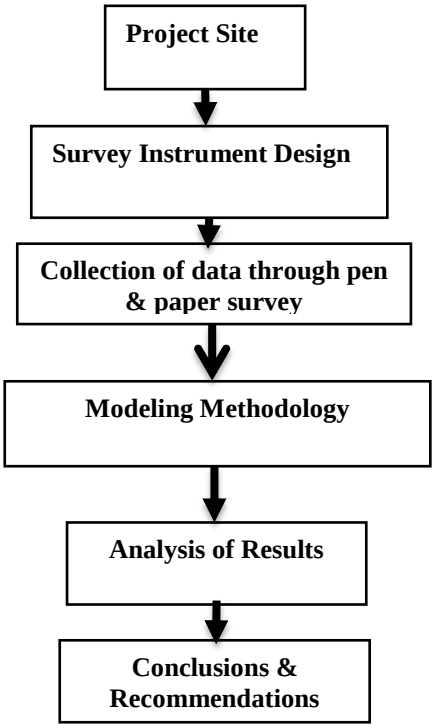

Figure 3.1: Methodology of Research

3.2. PROJECT SITE

National University of Sciences and Technology (NUST) is located in the city of Islamabad, which is the capital city of Pakistan. It is situated in the sector H-12 of the

city, which has an area of 2 square kilometers as per the demarcation of Capital Development Authority (CDA) of Pakistan federal capital.

In 2017, 5281 students were enrolled in the university of which 1995 were graduate students. The university is located adjacent to a few other major traffic attracting universities which are the International Islamic University, Islamabad (IIUI) and FAST National University (FNU) which are connected through the Kashmir Highway which connects the major part of urban Islamabad.

The university is located at a slightly inaccessible pathway. The travellers using the roads leading to the university are specifically students. Anyone travelling to NUST will have to use the Kashmir Highway and access either Aligarh Avenue or Luqman Avenue.

Figure 3.2: Map of NUST

Due to its secluded location, students use multiple modes to reach the university and some even use multiple modes to reach the university/their departments. In terms of public transportation system students have access to public transportation which is a series of wagons which connects the routes of the city and is regulated by the CDA,

private taxies or Careem/Uber. The university also has a van system which picks and drops students to and from their residential places in the Islamabad and Rawalpindi regions. Within the university, a shuttle service is operational with headway of 10-15 minutes from 0830 hrs in the morning to 1000 hrs, which are the peak traffic hours, for ease of commute of students/staff/faculty to their respective departments.

3.3. SURVEY INSTRUMENT DESIGN

The survey instrument selected for this study was Revealed Preference (RP) type for collection of student travel data. The survey questionnaire consisted of questions which were divided into four parts.

The first part was the social standings of the students which included questions of Age, Gender, Physical Disability, Residential Status, Department of study, degree level and car ownership.

The second part consisted of Travel behavior factors which were Travel Time, Use of Public Transport, Easy time and day out of NUST and Shuttle service improvement.

The third part consisted of potential for modal change to carpool and public transport. A number of factors were provided of which the respondents could choose more than one.

The fourth part was where the respondents had to state their travel routine for a typical working day. Zones were defined based on the departments or recreational centres within NUST they were travelling to.

Survey Questionaire for Transportation Planning of NUST student commuters					
What is your age?	Less than 20	21-23	24-29	30+	
Are you disabled?	Yes	No			
Gender?	Male	Female			
You are?	Hostelite	Day Scholar			
If "Day Scholar", please write your address					
Your Department?					
Degree?	Bachelors	Masters	PhD		
Do you own a car?	Yes	No			
How long does it take to commute to your department?	Less than 30 mins	30-45 mins	45-60 mins	more than 60 mins	
How often do you use public transport out of NUST?	Never	Ocassionally	Prefer Taxi / Careem / Uber		
What day do you feel the hardest to go out of NUST?	Working Days	Saturday	Sunday		
What time do you feel the easiest to go out of NUST?	Morning	Daytime	Evening	Night	
Would you be willing to commute via Metro bus upon its completion?	Yes	No			
Do you work?	Part time	Fulltime	Online Work	No, I do not work	
Shuttle service within the campus has improved?	Yes	No	Don't Know	Never used	
Which department has less space for parking?					No idea
Speed limit within campus should increase to?	40-50 km/hr	50-60 km/hr	30-40 km/hr	No change	60-70 km/hr
What is your primary mode of transportation from home/hostel to campus	Walk (more than 7 minutes)	Drive yourself (arrive/depart alone)	Carpool/vanpool (arrive/depart with others)	Get a ride (dropped off by someone who goes elsewhere ... not in campus)	Ride a bus and use NUST shuttle at gate/lift
What is the main factor for your using this mode **(tick more than one if applicable)**?	Travel Time	Comfort	Economy	Personal responsibilities	Public transport not available/unrealistic
	Lack of cycling infrastructure	Mobility difficulties			
Which factors would encourage you to shift to public transport **(tick more than one if applicable)**?	Reduced Travel Time	Comfort	Reduced Waiting Time	Reduced Travel Cost	Parking Fees
Which factors would encourage you to shift to carpooling **(tick more than one if applicable)**?	Reduced Travel Time	Comfort	Reduced Waiting Time	Reduced Travel Cost	Parking Fees

Figure 3.3: Survey Form

Note: First and last trip must be to and from home

Trips	Origin	Destination	Mode	Time	Purpose
1					
2					
3					
4					
5					
6					
7					
8					
9					

Purpose	Study	Enjoyment	Meal	Sports	Other/All

Mode	Car	Bike	Bicycle	Shuttle Service	Walk
	NUST VAN	Taxi/Careem/ Uber			

Figure 3.4: Trip data on a typical work day

Department	Code	Department	Code	Department	Code	Mode	Code
S3H	1	IESE	8	Admin / Bank	16	Car	1
SADA	2	SMME	9	CIE	17	Bike	2
NBS	3	IAEC	10	Playground	18	Bicycle	3
IGIS	4	ASAB	11	NBC Café (C1)	19	Shuttle Service	4
SEECS	5	Animal house	12	SEECS Café (C2)	20	Walk	5
NICE	6	SNS	13	Main Office / C3	21	NUST Van	6
NIT	7	Girls Hostel	14	Gate 10	22	Taxi/Careem/Uber	7
		Boy's Hostel	15	Gate 1	23		

Figure 3.5: Coding of Zones

The survey was carried out in October-November 2017 where students were approached in their respective departments and pen and paper survey filling out method was utilized. Random-stratified sampling was utilized to acquire a total of 428 responses from 14 departments all around NUST. Results and analysis are discussed in the next Chapter.

3.4. DATA COLLECTION

Stratified random sampling was used to collect samples from different departments of the university. The total number of students within the university and each subsequent department of the university were acquired from the main administration building of NUST. An online sample calculator against a confidence interval of 90% was used to determine the total number of participants required for the analysis. The total sample size thus acquired was 300 but 400-450 sample were still targeted to be acquired to be on the safer side. The resulting percentages of sample forms from the calculator and the existing number of students were used to determine the sample size from each department. The resulting number was equally divided among all departments. Final numbers of participants are enlisted in the next chapter.

3.5. MODELING METHODOLOGY

Travel behavior studies have been carried out throughout the world. Travel mode choices and factors are based on the socio-economic factors of commuters, their age and the trip purpose. The usual approach of modeling for city planning has been utility-based approach in which mode selection and trips are calculated on the basis of a utility function. This utility function is a trip generation multinomial logit model. It estimates the travel behavior after assigning utility values to individual socio-economic factors. However, student travelling is a population attractor which acts differently. Activity based approach would be more effective for modeling NUST mode choice behavior.

3.5.1. Activity Based Modeling

There are four major differences in trip-based modeling and activity based modeling.

- Trip based modeling focuses solely on the count of the trip whereas as Activity based modeling focuses on the purpose and motivation of that trip.

- Trip based modeling focuses on individual trips and ignores the choice attributes such as time, mode and destination which the activity based model does not.
- Trip based modeling uses trip as a mere cost of travel and considers only peak and off-peak travel whereas activity based models are a result of their time-use decisions within a continuous time domain.
- Activity based model can accommodate the socio-demographic factors of individuals and helps in long terms forecasting whereas trip-based models predicts using these factors at an aggregate level (Phinjari and Bhat, 2011).

The utility maximization econometric model will be utilized (Becker, 1965) which assumes that individuals make their activity-travel decisions to maximize the utility derived from the choices they make. However, the two main criticisms of this approach are that:

- individuals are not necessarily fully rational utility maximizers (Timmermans et al., 2002)
- the approach does not explicitly model the underlying decision processes and behavioral mechanisms that lead to observed activity-travel decisions.

Ranking and Rating type system requires a linear regression analysis as opposed to non-linear logit or probit type models which are the usual choice for discrete choice data. The rating system suffers from a shortfall that a rating may or may not be the same value for the same evaluation from a 2 different raters (Rose, 2009)

The utility maximization econometric models are mostly multinomial logit or nested logit models. As the survey instrument comprised of discrete choice questions, the multinomial logit model was selected for analysis.

3.5.2. Multinomial Logit Model

We now consider models for the probabilities πij. In particular, we would like to consider models where these probabilities depend on a vector xi of covariates associated with the ii-th individual or group.

Typically we pick the last category as a baseline and calculate the odds that a member of group ii falls in category jj as opposed to the baseline as πi1/πiJ

In the multinomial logit model we assume that the log-odds of each response follow a linear model.

where α_{ji}s a constant and β_{ji}s a vector of regression coefficients, for j=1,2,…,J−1j=1,2,…,J−1. Note that we have written the constant explicitly, so we will assume henceforth that the model matrix X does not include a column of ones.

The multinomial logit model may also be written in terms of the original probabilities πijπij rather than the log-odds. Starting from r<>q:mlogit and adopting the convention that ηiJ=0ηiJ=0. (Rodriguez, 2017)

3.5.3. Assumptions of Multinomial Logistic Regression

Logistic regression does not require a linear relationship between the dependent and independent variables. Second, the error terms (residuals) do not need to be normally distributed. Third, homoscedasticity is not required. Finally, the dependent variable in logistic regression is not measured on an interval or ratio scale.

However, some other assumptions still apply:

First, binary logistic regression requires the dependent variable to be binary and ordinal logistic regression requires the dependent variable to be ordinal.

Second, logistic regression requires the observations to be independent of each other. In other words, the observations should not come from repeated measurements or matched data.

Third, logistic regression requires there to be little or no multicollinearity among the independent variables. This means that the independent variables should not be too highly correlated with each other.

Fourth, logistic regression assumes linearity of independent variables and log odds. although this analysis does not require the dependent and independent variables to be related linearly, it requires that the independent variables are linearly related to the log odds.

3.6. SUMMARY

This chapter encompasses the data collection technique, the survey methodology utilized and carried out as well as the modeling methodology to be carried out.

Chapter 4

RESULTS AND ANALYSIS

4.1. INTRODUCTION

The descriptive statistics of individual variables of the respondents and cross-tabulations will be described in this chapter. Analysis was carried out separately for Hostelites and Day Scholars which was followed by a collated model. The comparison of mode choices and factors affecting those mode choices are discussed in this chapter. The results gathered by analysis of data are presented using graphs, figures and plots.

4.2. DESCRIPTIVE STATISTICS

4.2.1. Age

Majority of the survey participants were in between ages 21-23 in both cases of residential status. However, students of ages 24-29 are mostly day scholars, which is the age group of graduate students.

Table 4.1: Response of Variable Age

Age		All		Hostelites model		Day Scholar model	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
	<20	169	39.4	90	45.0	79	34.6
	21-23	207	48.3	96	48.0	110	48.2
	24-29	52	12.1	13	6.5	39	17.1
	30+	1	0.2	1	.5	0	.0
	Total	429	100	200	100.0	228	100.0

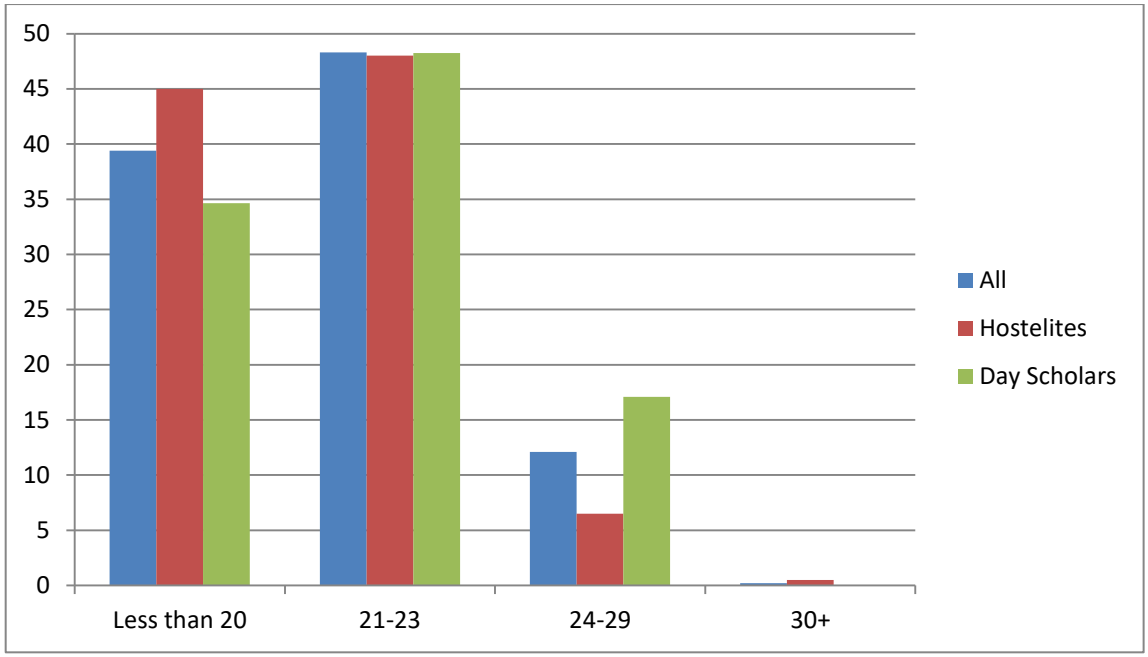

Figure 4.1 Response of Variable Age

4.2.2. Gender

Day Scholars and hostelite representation in the survey is almost similar to the collated data collected from survey forms.

Table 4.2: Response of Variable Gender

Gender	All		Day Scholar model		Hostelite model	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Male	248	57.8	135	59.2	113	56.5
Female	180	42.0	93	40.8	87	43.5
Total	428	99.8	228	100.0	200	100.0

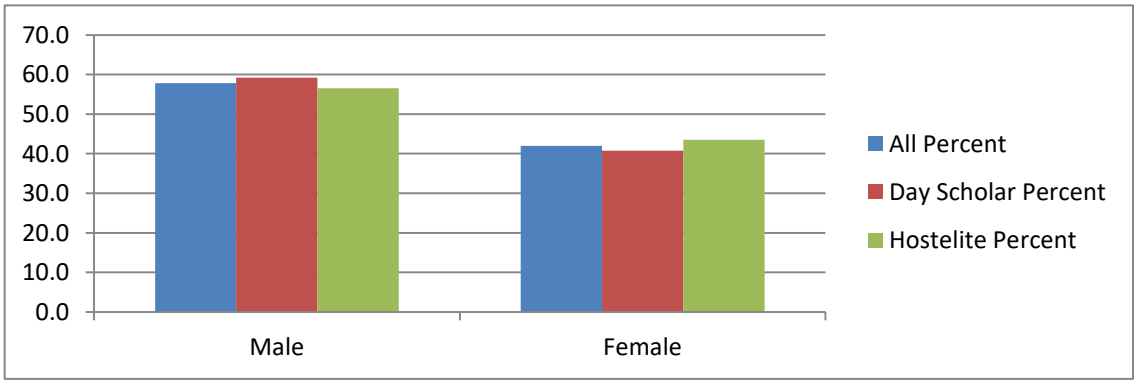

Figure 4.2: Response of Variable Gender

4.2.3. Residential Status

Out of the total 428 survey forms collected, 200 respondents were Hostelites, which totaled to 46.6% of the total survey forms collected, whereas 228 were Day Scholars, the percentage of which was 53.1%.

Table 4.3: Response of Variable Residential Status

Residential Status	All	
	Frequency	Percent
Hostelite	200	46.6
Day Scholar	228	53.1
Total	428	99.8

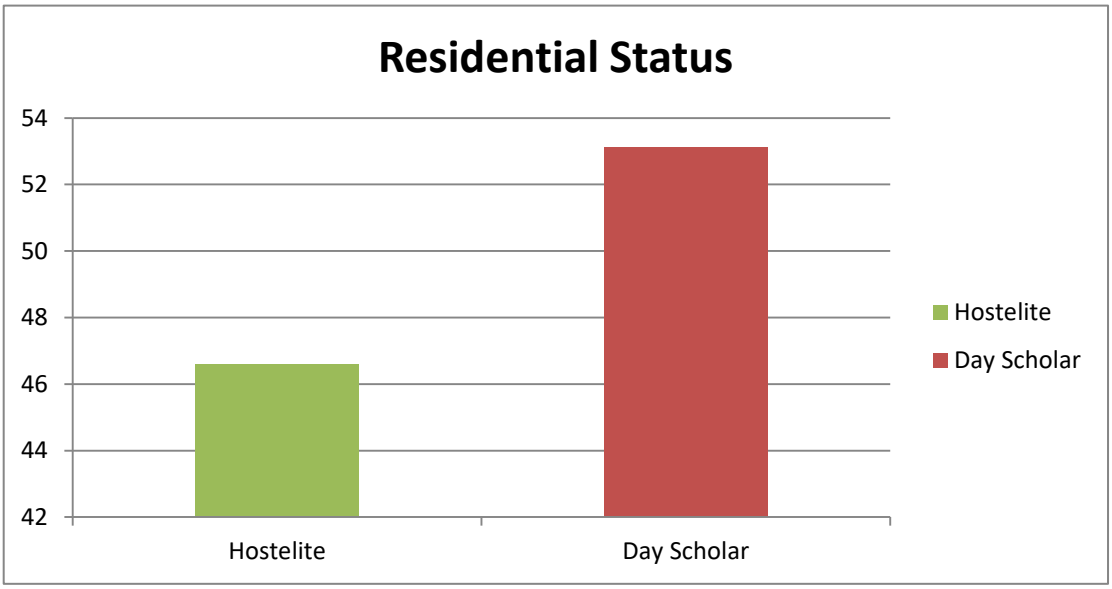

Figure 4.3: Response of Variable Residential Status

4.2.4. Department

Random stratified sampling was carried out from 14 departments of NUST and are shown below. Majority of the participants were selected from SEECS, SCEE (NICE, NIT, IGIS, IESE) and NBS because these schools offer a wide variety of disciplines to study which results in a lot of students.

Table 4.4: Response of Variable Department

Department	All		Day Scholar model		Hostelite model	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
ASAB	23	5.4	14	6.1	9	4.5
CASEN	8	1.9	3	1.3	5	2.5
IESE	36	8.4	26	11.4	10	5.0
IGIS	9	2.1	5	2.2	4	2.0
NBS	48	11.2	30	13.2	18	9.0
NICE	70	16.3	40	17.5	30	15.0
NIT	5	1.2	4	1.8	1	.5
RCMS	10	2.3	2	.9	8	4.0
S3H	32	7.5	25	11.0	7	3.5
SADA	18	4.2	4	1.8	14	7.0
SCME	33	7.7	13	5.7	20	10.0
SEECS	81	18.9	37	16.2	44	22.0
SMME	31	7.2	15	6.6	16	8.0
SNS	21	4.9	9	3.9	12	6.0
Total	425	99.1	227	99.6	198	99.0
	429	100.0	228	100.0	200	100.0

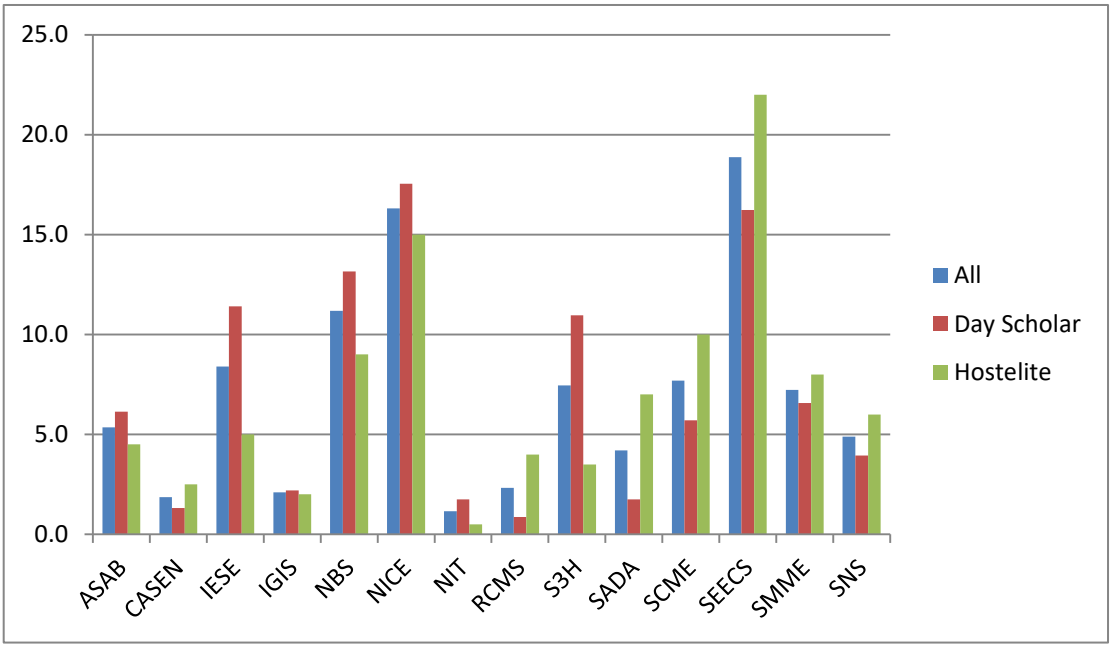

Figure 4.4: Response of Variable Departments

4.2.5. Degree

The participants of the survey were primarily Bachelors students. The main reason for this was the timings in which survey was conducted i.e. daytime and MS and PhD classes are in the evening.

Table 4.5: Response of Variable Degree Level

Degree	All		Day Scholar model		Hostelite model	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Bachelors	358	83.4	183	80.3	175	87.5
Masters	68	15.9	45	19.7	23	11.5
PhD	1	.2	0.0	0.0	1	.5
Total	429	100.0	228	100.0	200	100.0

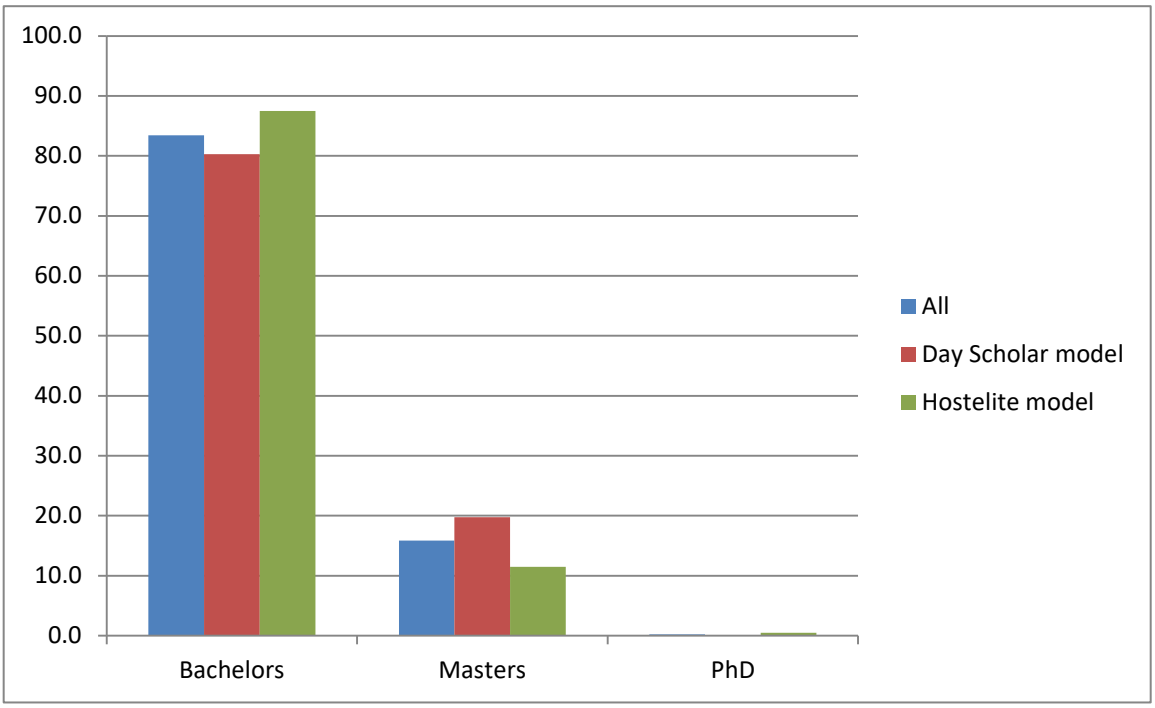

Figure 4.5: Response of Variable Degree level

4.2.6. Car Ownership

A very low percentage of hostelites reported owning a car i.e. 3 (1.5)% whereas the count of day scholars who own a car was 73 (32%).

Table 4.6: Response of Variable Car Ownership

Car Ownership	All Model		Day Scholars Model		Hostelites Model	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Yes	76	17.7	73	32.0	3	1.5
No	352	82.1	155	68.0	197	98.5
Total	428	99.8	228	100.0	200	100.0

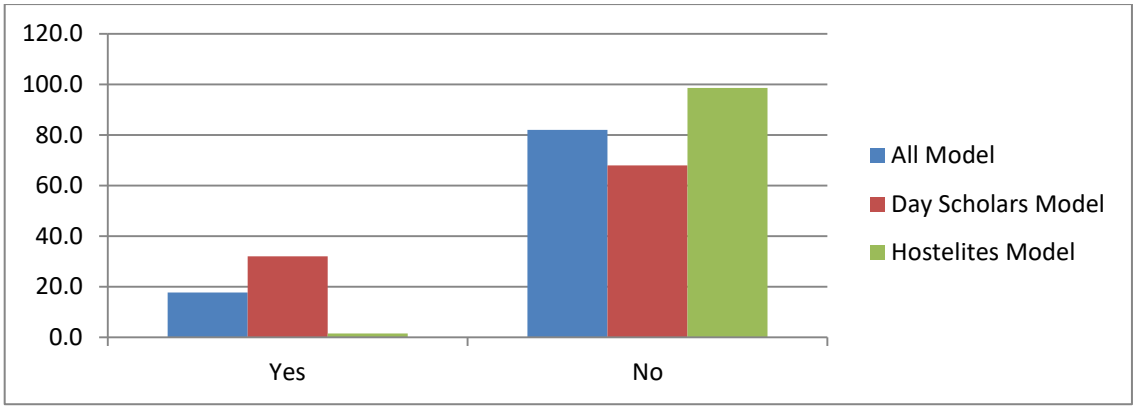

Figure 4.6: Response of Variable Car Ownership

4.2.7. Travel time

About 50% of Dayscholars live within 45 minutes of travel from NUST. Meager 8.5% participants live outside of NUST.

Table 4.7: Response of Variable Travel Time

Travel Time	All Model		Day Scholars Model		Hostelites Model	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Less than 30 mins	256	59.7	83	36.4	173	86.5
30 - 45 mins	61	14.2	46	20.2	15	7.5
45 - 60 mins	47	11.0	45	19.7	2	1.0
More than 60 mins	41	9.6	41	18.0		
Total	405	94.4	215	94.3	190	95.0
	429	100.0	228	100.0	200	100.0

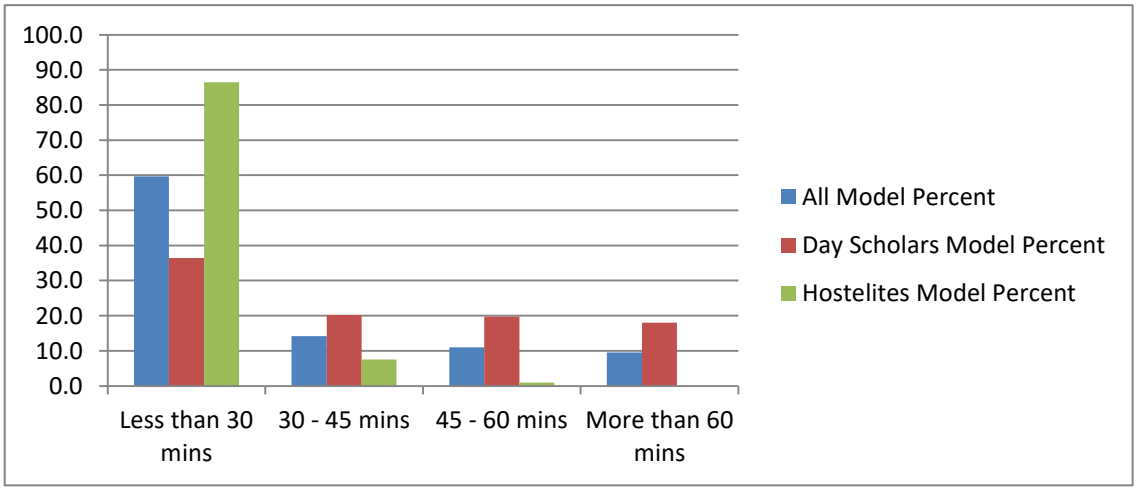

Figure 4.7: Response of Variable Travel Time

4.2.8. Public Transport Frequency out of NUST

Students prefer using Careem/Uber over public transportation when traveling out of NUST. This is evident from the percentage of students who reported their trips. 168 (39.2%) students prefer to use Taxi/Careem/Uber whereas 144 (33.6%) occasionally use public transport and 92 (21.4%) never use public transport.

Table 4.8: Response of Variable Public Transport Frequency

Public Transport frequency out of NUST	All Model		Day Scholars Model		Hostelites Model	
	Frequency	Per cent	Frequency	Per cent	Frequency	Per cent
Never	92	21.4	67	29.4	25	12.5
Occasionally	144	33.6	81	35.5	63	31.5
Prefer Taxi/Uber/Careem	168	39.2	67	29.4	101	50.5
Working Days	1	.2			1	.5
Total	405	94.4	215	94.3	190	95.0
	429	100.0	228	100.0	200	100.0

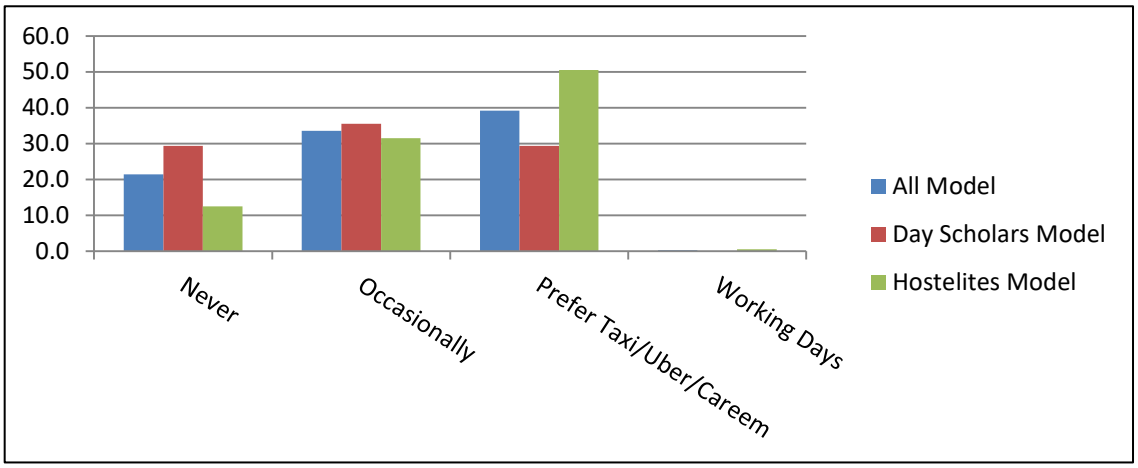

Figure 4.8: Response of Variable Public Transport Frequency

4.2.9. Hardest day out of NUST

Students find working days difficult to leave NUST. This can be attributed to little to no vehicles available to leave NUST. 252 (58.7%) out of the 428 responses were stated that they find it hard to travel out of NUST on working days.

Majority of the students, both hostelites and day scholars are willing to use metro upon its completion i.e. 156 (68.4%) Day Scholars and 175 (87.5%) Hostelites.

Table 4.9: Response of Variable Hard Day out of NUST

Hardest Day out of NUST	All Model		Day Scholars Model		Hostelites Model	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
All	1	.2			1	.5
None	2	.5			2	1.0
Saturday	25	5.8	8	3.5	17	8.5
Sunday	32	7.5	14	6.1	18	9.0
Weekends	5	1.2	3	1.3	2	1.0
Working Days	252	58.7	132	57.9	120	60.0
Total	317	73.9	157	68.9	160	80.0
	429	100.0	228	100.0	200	100.0

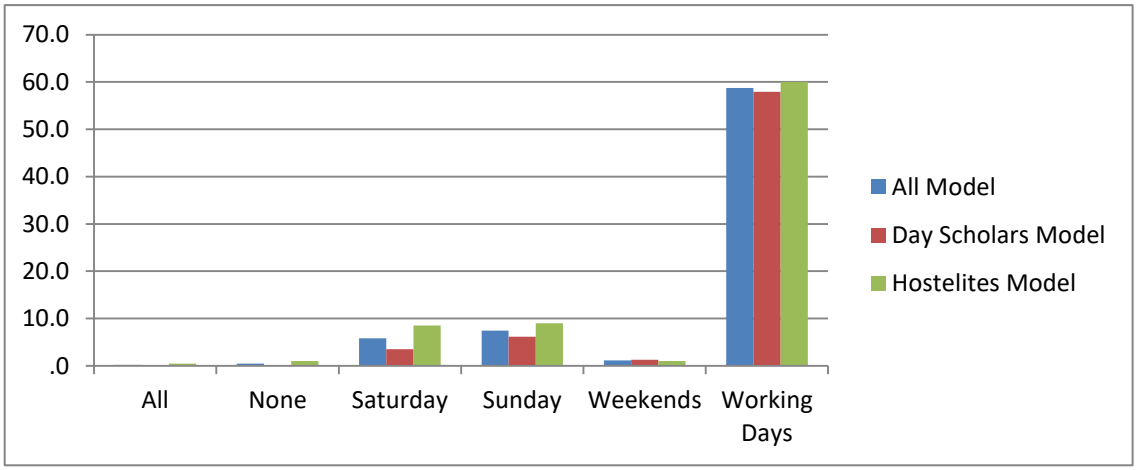

Figure 4.9: Response of Variable Hard Days out of NUST

4.2.10. Easy time out of NUST

A high percentage of students find it easy to leave NUST during the Daytime, Evening and Morning timings, with respondents reporting 130 (30.3%), 96 (22.4%) and 69 (16.1%) respectively.

Table 4.10: Response of Variable Easy Time out of NUST

Easy time out of NUST	All Model		Day Scholars Model		Hostelites Model	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Daytime	130	30.3	75	32.9	55	27.5
Evening	96	22.4	34	14.9	62	31.0
Morning	69	16.1	39	17.1	30	15.0
Night	19	4.4	7	3.1	12	6.0
Total	316	73.7	156	68.4	160	80.0
	429	100.0	228	100.0	200	100.0

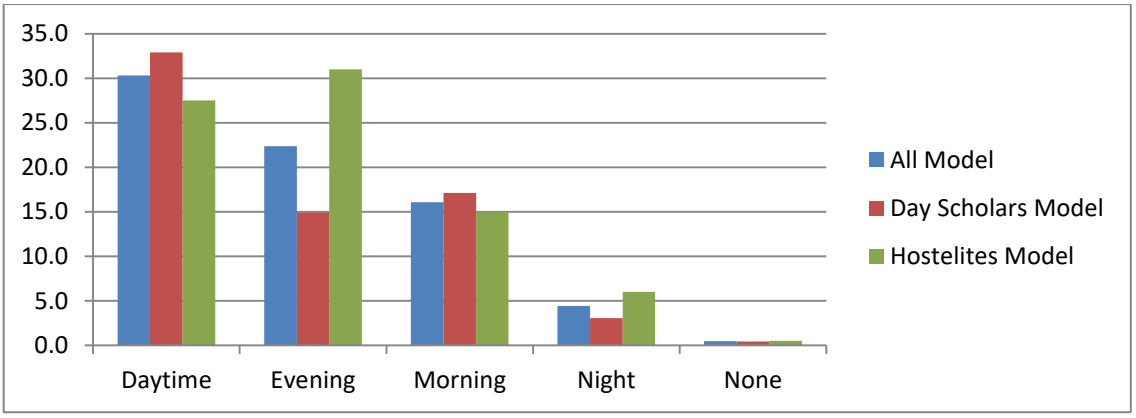

Figure 4.10: Response of Variable Easy time out of NUST

4.2.11. Metro Use upon completion

Majority of the students, both hostelites and day scholars are willing to use metro upon its completion i.e. 156 (68.4%) Day Scholars and 175 (87.5%) Hostelites.

Table 4.11: Metro use upon completion

Metro use	All Model		Day Scholars Model		Hostelites Model	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Yes	331	77.2	156	68.4	175	87.5
No	74	17.2	59	25.9	15	7.5
Total	405	94.4	215	94.3	190	95.0
	429	100.0	228	100.0	200	100.0

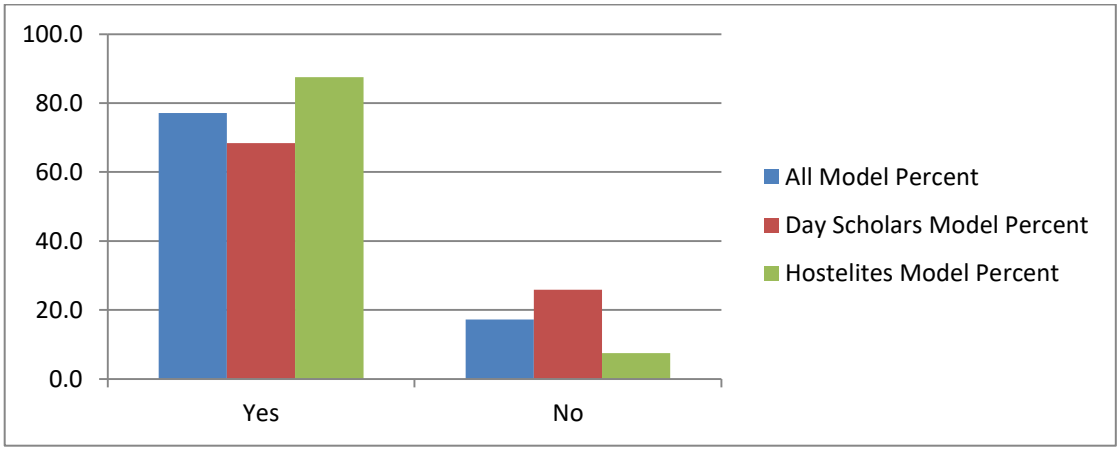

Figure 4.11: Response of Variable Metro use upon completion

4.2.12. Work

337 (78.6%) students, both hostelites and day scholars are full time students. 10 (2.3%) students have fulltime jobs, 23 (5.4%) do online work and 35 (82%) do part-time work.

Table 4.12: Response of Variable Work Status

Do you work	All Model		Day Scholars Model		Hostelites Model	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Full time	10	2.3	9	3.9	1	.5
No	337	78.6	172	75.4	165	82.5
Online Work	23	5.4	11	4.8	12	6.0
Part time	35	8.2	23	10.1	12	6.0
	429	100.0	228	100.0	200	100.0

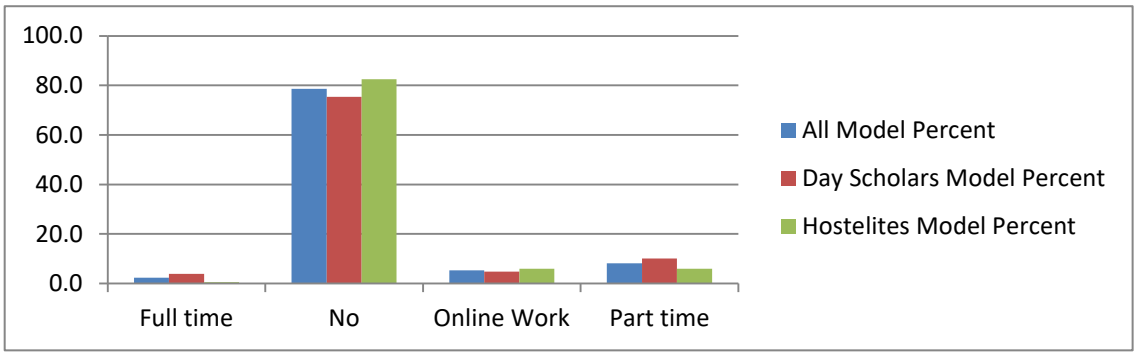

Figure 4.12: Response of Variable Work Status

4.2.13. Shuttle service improvement

About 50% of the students think that shuttle service in NUST has not improved and needs improvement. 172 (81.6%) Day Scholars think that shuttle service has not improved within NUST whereas 138 (69%) hostelites think that shuttle service has not improved within NUST.

Table 4.13: Response of Variable Shuttle Service Improvement

Shuttle service improvement	All Model		Day Scholars Model		Hostelites Model	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Don't Know	76	17.7	49	21.5	27	13.5
Never Used	41	9.6	26	11.4	15	7.5
No	182	42.4	97	42.5	85	42.5
No Idea	1	.2	0	0.0	1	.5
Yes	104	24.2	42	18.4	62	31.0
System	25	5.8	14	6.1	10	5.0
Total	404	94.2	214	93.9	190	95.0
	429	100.0	228	100.0	200	100.0

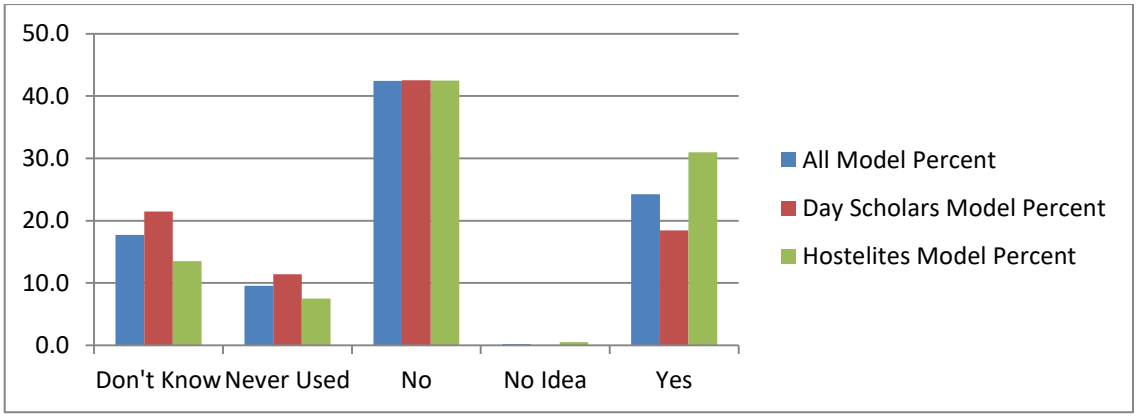

Figure 4.13: Response of Variable Shuttle Service Improvement

4.2.14. Purpose

Study trips were the frequent purpose of travel with more than 35% trips from among both students groups. 2nd most frequent purpose of travel for Home for Day Scholars and Sports/out of NUST Trips for Hostelites.

Table 4.14: Response of Variable Purpose

Purpose	All Model		Day Scholars Model		Hostelites Model	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Meal	305	18.2	151	18.7	153	17.8
Other	420	25.2	113	14.0	313	36.4
Recreation	96	5.7	27	3.3	67	7.8
Study	658	39.3	332	41.1	324	37.7
Home	191	11.4	183	22.7	0	0.0
Total	1670	99.8	806	99.9	857	99.8
	1673	100.0	807	100.0	859	100.0

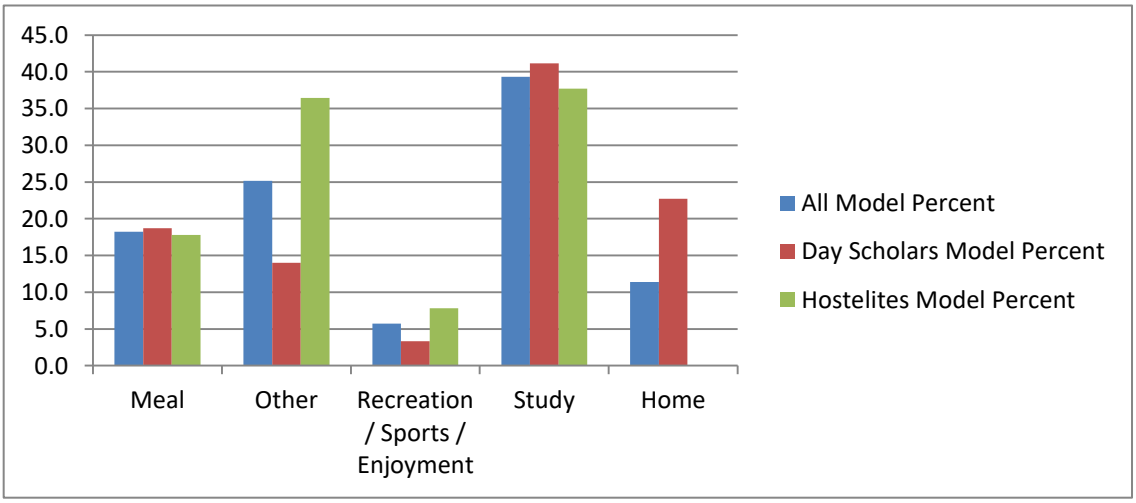

Figure 4.14: Response of Variable Purpose

4.2.15. Mode

Most frequently used mode was Walk with 43.5% for Day Scholars and 85.8% for Hostelites. 2nd most used mode is Car (25.4%) for Day Scholars and Bike (7.5%) for Hostelites. The Shuttle trips reported were less than 2 percent for each student group, which shows less inclination towards the use of this mode.

Table 4.15: Response of Variable Mode

Mode	All Model		Day Scholars Model		Hostelites Model	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Bicycle	6	.4	1	.1	5	.6
Bike	110	6.6	46	5.7	64	7.5
Car	236	14.1	205	25.4	24	2.8
NUST Van/Bus	178	10.6	178	22.1		
Shuttle Service	23	1.4	15	1.9	8	.9
Taxi/Careem/Uber	29	1.7	10	1.2	19	2.2
Walk	1088	65.0	351	43.5	737	85.8
Total	1670	99.8	806	99.9	857	99.8

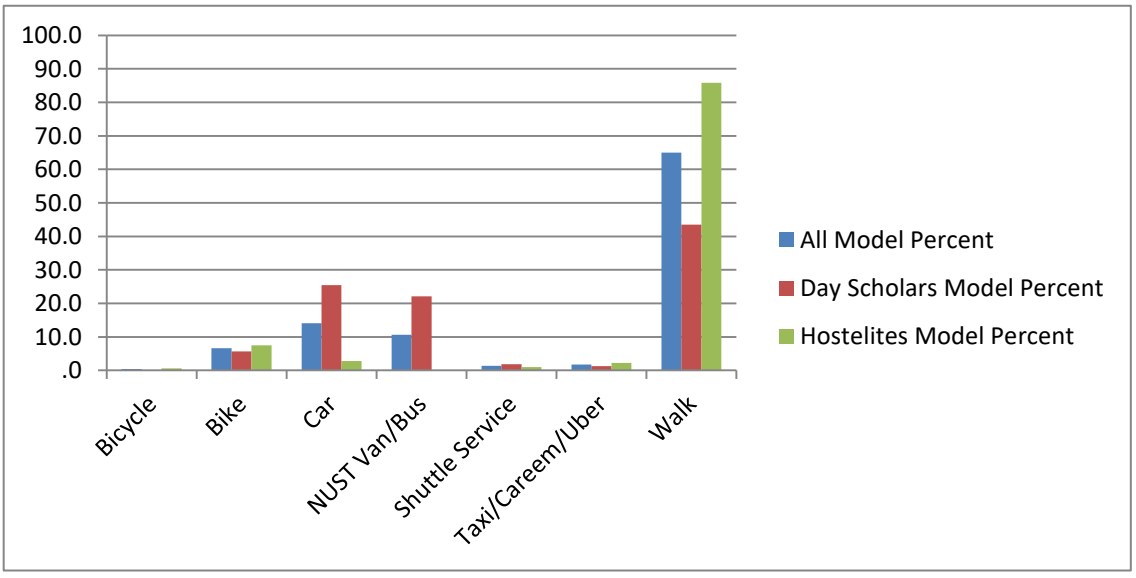

Figure 4.15: Response of Variable Mode

4.3. CROSS TABULATIONS

4.3.1. Average trip

Average trip rate for collated model is 1670/428 = 3.90 trips, for Day Scholars 807/228 = 3.54 trips and for Hostelites is 859/200 = 4.30 trips. Maximum number of

trips were 4 and 5 which shows that mostly students just stay in campus and go for meals to café only.

Table 4.16: Comparison of Variables Number of Trips vs Residential Status

Trips	All Model		Day Scholars Model		Hostelites Model	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
2	227	13.6	153	19	74	8.6
3	127	7.6	76	9.4	51	5.9
4	568	34	304	37.7	264	30.7
5	325	19.4	164	20.3	161	18.7
6	240	14.3	78	9.7	162	18.9
7	112	6.7	7	0.9	98	11.4
8	63	3.8	24	3	39	4.5
9	10	0.5			9	1
Total	1672	99.9	806	99.9	859	100
	1673	100	807	100		

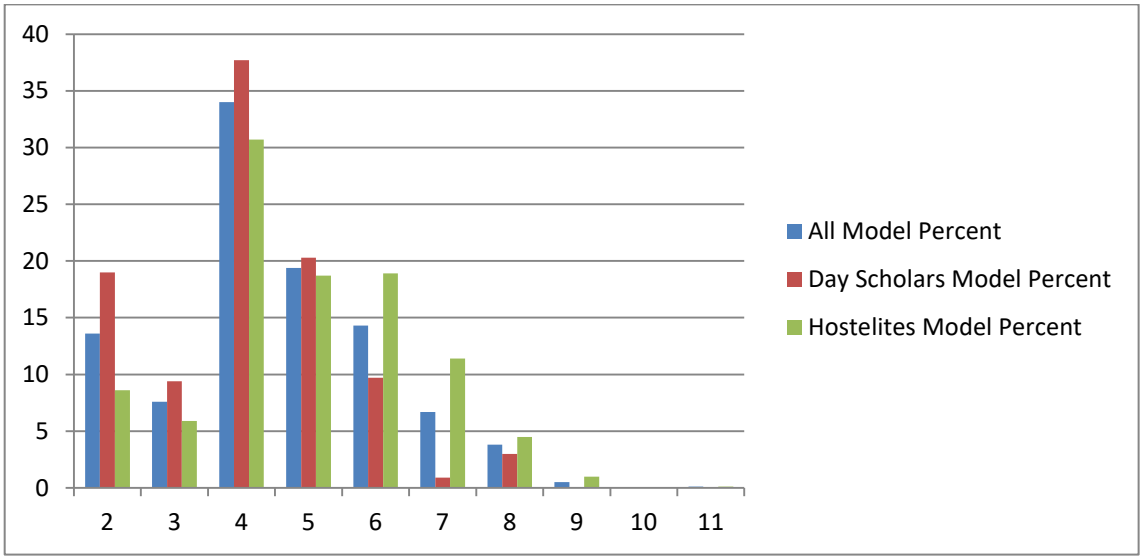

Figure 4.16: Comparison of Variables Number of trips vs Residential Status

4.3.1.1. Gender trip rates

Male students take less frequent trips than female students on average and with respect to each separate student group with 3.86 trip per student per day as compared to 3.92 trip per female student per day.

Table 4.17: Comparison of Variables Number of Trips vs Gender

Gender	All Model			Day Scholars Model			Hostelites Model		
	Trip	Student	Trip/ Gender Student	Trips	Students	Trip/ Gender Student	Trips	Students	Trip/ Gender Student
Male	958	248	3.86	485	135	3.59	473	113	4.19
Female	707	180	3.92	321	93	3.45	386	87	4.45
	1665	428		805	228		1665		

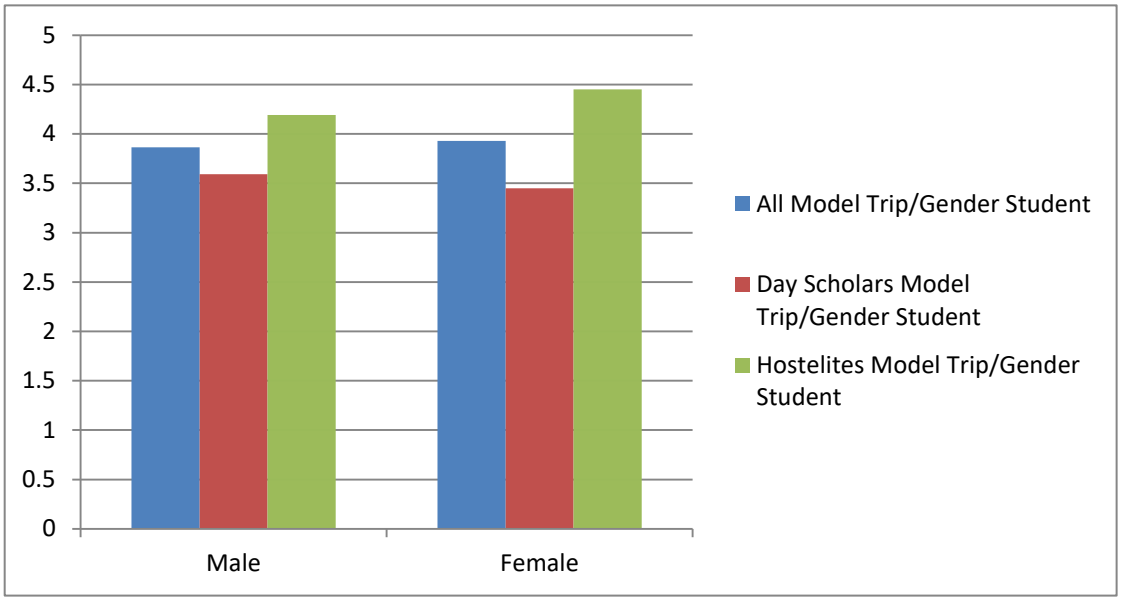

Figure 4.17: Comparison of Variables Number of Trips vs Gender

4.3.1.2. Degree level trip rates

Graduate students make more trips per day on average and within respective student groups as well. This can be attributed to their working status, and the research work they partake in. It may also be affected by the number of study hours they have i.e. Undergraduate students have to take 6-7 hours of classes whereas a Graduate students has to take 3 hours of classes.

Table 4.18: Comparison of Variables Number of Trips vs Degree level

Degree	All Model			Day Scholars Model			Hostelites Model		
	Trip	Student	Trip Rate	Trip	Student	Trip Rate	Trip	Student	Trip Rate
BS	1386	357	3.88	646	183	3.53	740	175	4.23
MS	272	68	4	160	45	3.56	112	23	4.87
PhD	5	1	5	0	0	0	5	1	5
		428		806	228			200	

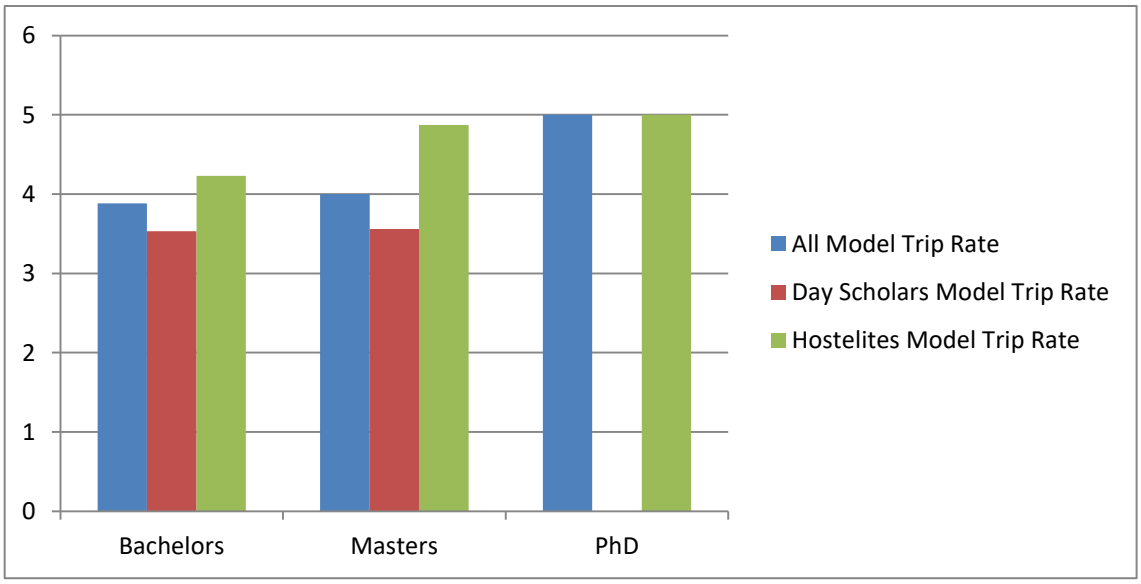

Figure 4.18: Comparison of Variables Number of Trips vs Degree level

4.3.1.3. Residential Status trip rates

Hostelites make more trips than day scholars, which can be attributed to the greater amount of time they spend in the campus.

Table 4.19: Comparison of Variables Number of Trips vs Residential Status

Residential Status	Trips	Students	Trip Rate
Hostelite	859	200	4.30
Day Scholar	806	227	3.55
	1665	427	

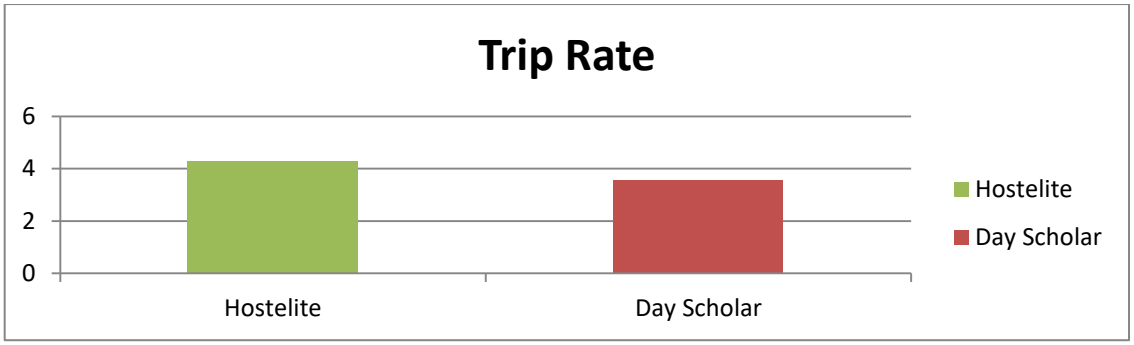

Figure 4.19: Comparison of Variables Number of Trips vs Residential Status

4.3.2. Activities

4.3.2.1. Activities vs Residential Status

Study trips are the most frequent trips within NUST. It comprises 37.8% of total hostelite activity and 41.19% of Day Scholar activity. Other trips, which include out of NUST trips, shopping and medical facility trips are more among Hostelites (35.7%) than Day Scholars (14.02). Home trips comprise 22.7% of the total trips of NUST Day Scholars.

Table 4.20: Comparison of Variables Activities vs Residential Status

Purpose	Hostelite	Day Scholar	
Meal	153	151	304
Other	306	113	419
Recreation / Sports	67	27	94
Study	324	332	656
Home	7	183	190
Total	857	806	1663

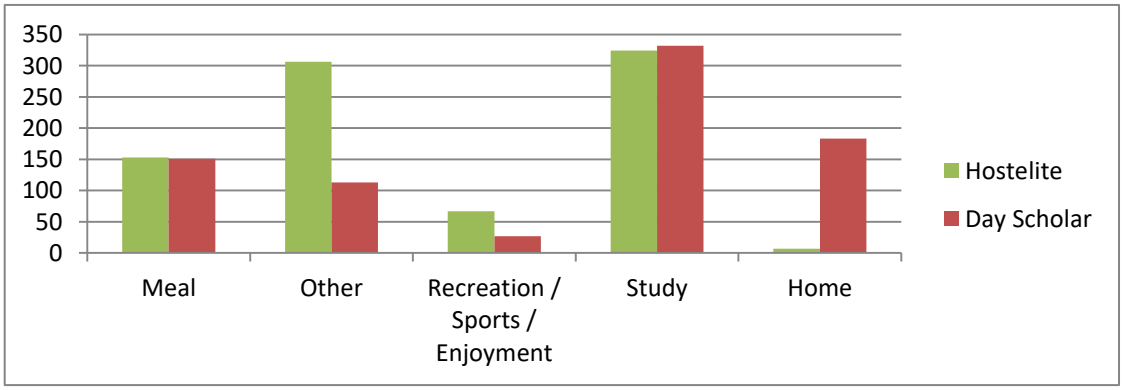

Figure 4.20: Comparison of Variables Activities vs Residential Status

4.3.2.2. Activities vs Age

The age group of students comprising the 21-23 age group has the most number of trips. The same trend is observed amongst all age groups in which the order of trip frequency are Study, Out of NUST trips, Meal, Home and Recreation trips in descending order.

Table 4.21: Comparison of Variables Activities vs Age

What is your Age ?						
	Less than 20		**21-23**	**24-29**	**30+**	**Total**
Purpose	Meal	123	150	31	1	305
	Other	159	211	47	3	420
	Recreation / Sports	37	49	10	0	96
	Study	274	307	75	2	658
	Home	69	91	31	0	191
Total		662	808	194	6	1670

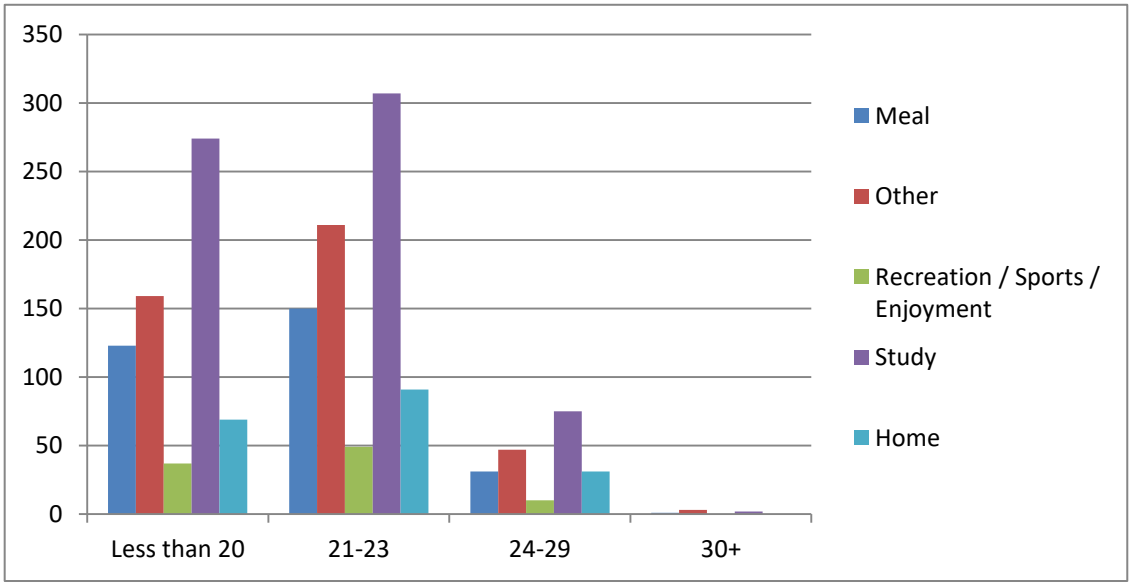

Figure 4.21: Comparison of Variables Activities vs Age

4.3.2.3. Activities vs Degree

Bachelors students are the most active bunch in the university. 82.8% trips were reported by Bachelors students and the remaining by Masters students. Of the Bachelor student trips, 40.17% were study trips, 24.06% were out of NUST trips, 18.71% were meal trips and the remaining were Recreation and home trips.

Table 4.22: Comparison of Variables Activities vs Degree level

All model				
	Degree			
Purpose	**Bachelors**	**Masters**	**PhD**	**Total**
Meal	259	44	1	305
Other	333	84	2	420
Recreation / Sports	84	10	0	96
Study	556	97	2	658
Home	152	37	0	191
	1384	272	5	1670

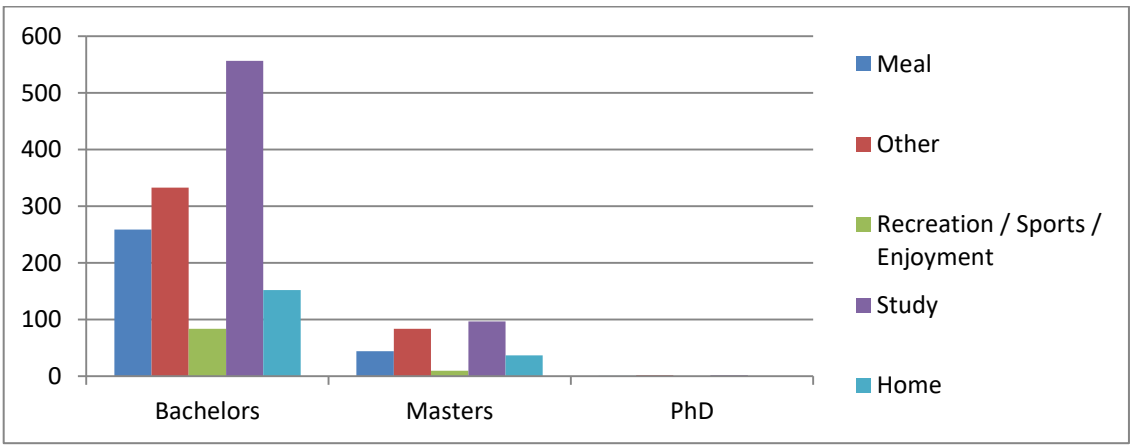

Figure 4.22: Comparison of Variables Activities vs Degree Level

4.3.2.4. Activities vs Car Ownership

17.7% students reported to own a car. 16.17% of total trips were reported by students who owned cars. The general trend of activities is similar to remaining trips. However, students who own a car did less "Out of NUST" trips which can be attributed to their doing it on their own time after reaching home.

Table 4.23: Comparison of Variables Activities vs Car ownership

All Model			
	Do you own a Car ?		**Total**
Purpose	**Yes**	**No**	
Meal	50	254	304
Other	39	380	419
Recreation / Sports	7	87	94
Study	115	541	656
Home	58	132	190
	269	1394	1663

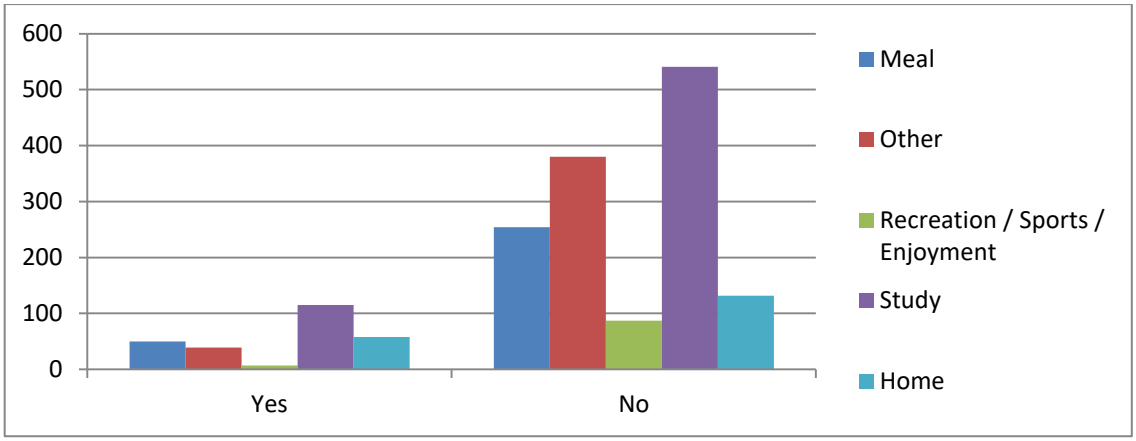

Figure 4.23: Comparison of Variables Activities vs Car Ownership

4.3.2.5. Activities vs Gender

Female student-trips were observed to be significantly lower than male trips for the purpose of Recreation/Sports/Enjoyment. Male-trips were more than the female-trips for all the stated purpose. DayScholars also took less out of NUST and recreational trips than Hostelites, irrespective of Gender.

Table 4.24: Comparison of Variables Activities vs Gender

All Model			
	What is your Gender ?		**Total**
Pupose	**Male**	**Female**	
Meal	170	134	304
Other	230	189	419
Recreation / Sports	79	15	94
Study	373	283	656
Home	105	85	190
	957	706	1663

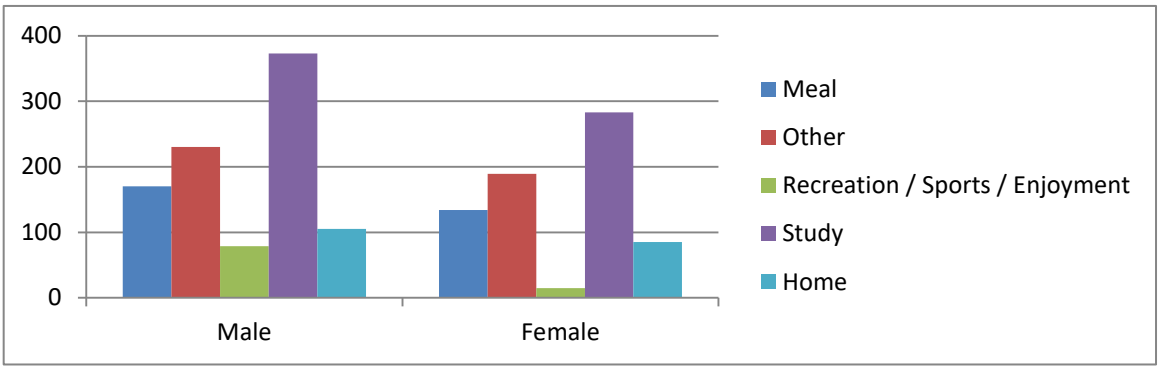

Figure 4.24: Comparison of Variables Activities vs Gender

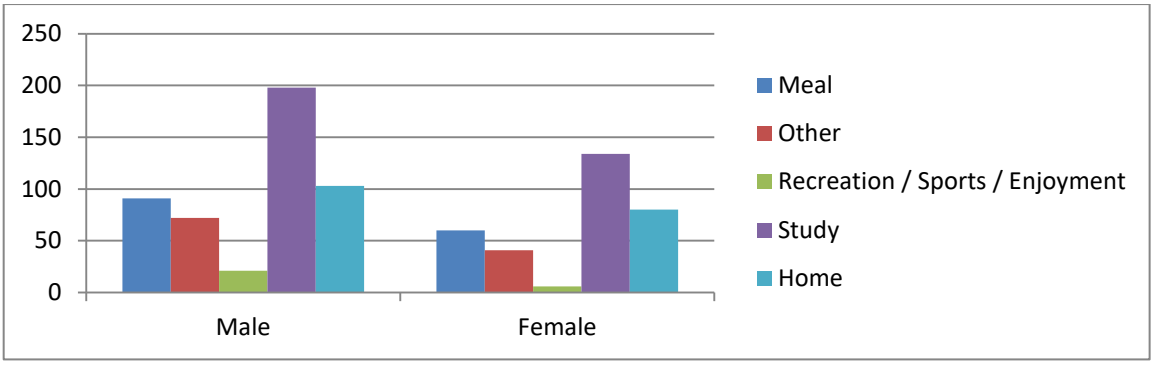

Figure 4.25: Comparison of Variables Day Scholar Activities vs Gender

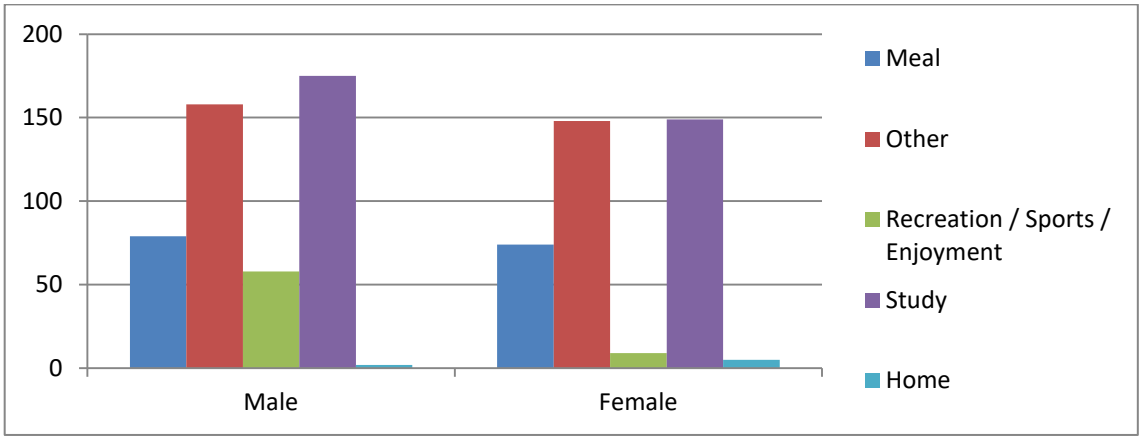

Figure 4.26: Comparison of Variables Hostelite Activities vs Gender

4.3.3. MODE

4.3.3.1. Mode vs Gender

There were zero bike trips reports by female students. Walk trips are more for male-students than female-students. Female usage of cars and NUST Van is almost equal, whereas male students do prefer car more than NUST Van.

Table 4.25: Comparison of Variables Mode vs Gender

All model								
	[Mode							**Total**
	Bicycle	**Bike**	**Car**	**NUST Van/Bus**	**Shuttle Service**	**Taxi/Careem/Uber**	**Walk**	
Male	6	110	134	83	13	18	593	957
Female	0	0	95	95	10	11	495	706
	6	110	229	178	23	29	1088	1663

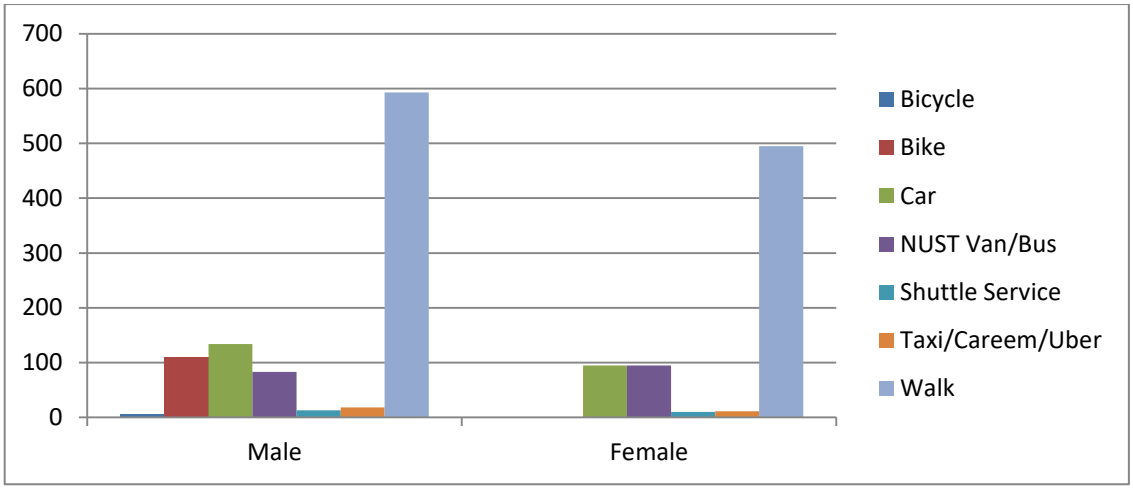

Figure 4.27: Comparison of Variables Mode vs Gender

4.3.3.2. Mode vs Residential Status

Stated Mode preference of hostelites is walk and comprises 44.32% of the total reported trips. Day Scholars prefer motorized transport for commute to NUST which accounts for 25.7% of the total reported trips and 53.2% of Day Scholar trips.

Table 4.26: Comparison of Variables Mode vs Residential Status

Residential Status	Mode							Total
	Bicycle	Bike	Car	NUST Van/Bus	Shuttle Service	Taxi/ Careem/ Uber	Walk	
Hostelite	5	64	24	0	8	19	737	857
Day Scholar	1	46	205	178	15	10	351	806
Total	6	110	229	178	23	29	1088	1663

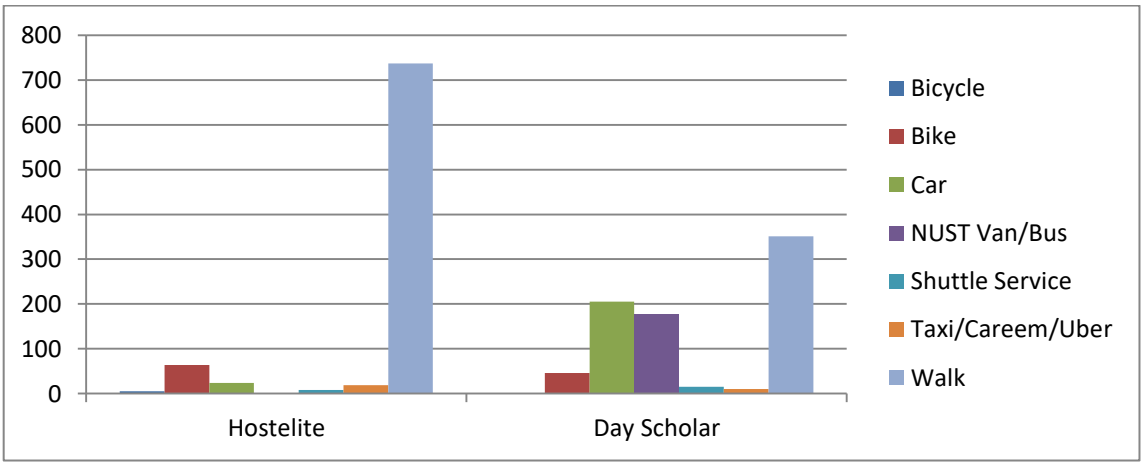

Figure 4.28: Comparison of Variables Mode vs Residential Status

4.3.3.3. Mode vs Travel Time

Walk is the dominant mode choice irrespective of travel time. Students living within 30 mins of travel from NUST prefer to travel via bikes. A noteworthy trend here is that the further away students live from NUST, the more they will prefer to commute via NUST Van as opposed to using their own vehicle (Bike, Car) or Walk.

Table 4.27: Comparison of Variables Mode vs Travel Time

All Model								
Travel Time	**Mode**							**Total**
	Bicycle	**Bike**	**Car**	**NUST Van/Bus**	**Shuttle Service**	**Taxi/ Careem/ Uber**	**Walk**	
>30 mins	3	84	112	36	8	22	758	1023
30 - 45 mins	2	11	54	32	2	6	120	227
45 - 60 mins	1	9	24	44	9	1	84	172
>60 mins	0	2	25	55	4	0	44	130
Total	6	106	215	167	23	29	1006	1552

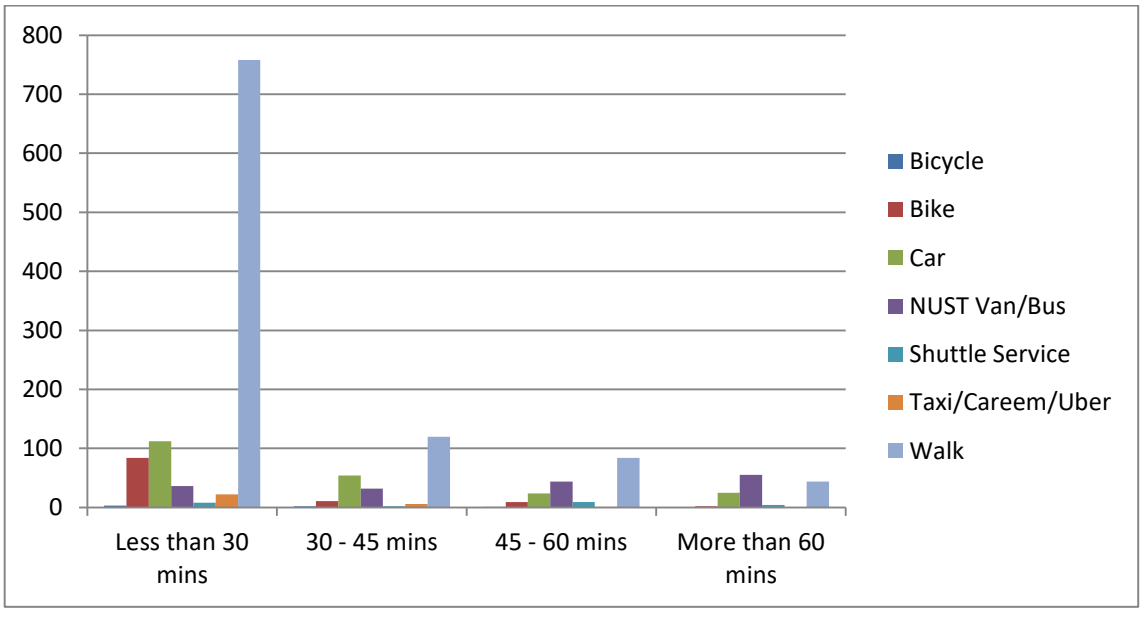

Figure 4.29: Comparison of Variables Mode vs Travel Time

4.4. COLLINEARITY OF VARIABLES

Variable including socioeconomic factors and attitudinal variables wre selected to develop the multinomial logit model was selected. The mutual exclusivity of the variables was checked and it was determined that all variables selected were mutually exclusive (Appendix-I). The selected variables were Age, Gender, Residential Status, Degree, Car Ownership, Travel Time, Public Transport Frequency, Hard Day out of NUST, Easy Time out of NUST, Work, Shuttle Improvement and Purpose.

4.5. CORRELATIONS

Details of the values of correlations tabulated are listed in Appendix-II.

4.5.1. All model

The significant variables determined for each mode are as follows:

- Walk: Age, Gender, Residential Stauts, Car Ownership, Travel Time, Public Transport Frequency, Shuttle Improvement and Purpose.
- Taxi/Careem/Uber: Car Ownership, Travel Time, Public Transport Frequency, Shuttle Improvement and Purpose
- Shuttle Service: Age, Travel Time and Purpose
- NUST Van: Gender, Residential Status, Car, Travel Time, Hard Day out of NUST, Easy Time out of NUST and Purpose
- Car: Age, Residential Status, Car Ownership, Travel Time, Public Transport Frequency, Easy Time out of NUST, Shuttle Improvement and Purpose.
- Bike: Gender, Car Ownership, Travel Time and Public Transport Frequency.

4.5.2. Day Scholar Model

The significant variables determined for each mode are as follows:

- Walk: Car Ownership and Purpose.

- Taxi/Careem/Uber: Car Ownership, Travel Time, Public Transport Frequency and Purpose.
- Shuttle Service: Travel Time and Purpose
- NUST Van: Age, Gender, Car Ownership, Travel Time, Public Transport Frequency and Purpose
- Car: Car Ownership, Travel Time, Public Transport Frequency and Purpose.
- Bike: Gender, Car Ownership, Travel Time, Public Transport Frequency and Hard Day out of NUST.

4.5.3. Hostelite Data

The significant variables determined for each mode are as follows:

- Walk: Gender.
- Taxi/Careem/Uber: Public Transport Frequency, Easy Time out of NUST and Purpose.
- Bike: Gender, Travel Time and Work.

4.6. MODEL

4.6.1. Walk

Male Students are twice more likely (exp 0.758) to walk whereas Male Day Scholars are 30% less likely to use walk as a mode of commute. Students living within 30 minutes of traveling distance are twice more likely (Exp 0.717) to travel by walking than using other modes Walk trips are about 50% more likely because of the purpose of the trip. Walk trips are more likely to happen among DayScholars by (exp -2.516) 8% if they hold a fulltime job. 56% (Exp -0.571) Car owners (Day Scholars) will walk despite owning a car

Table 4.28: Significant Variables for Mode Walk all data

Mode Walk	B	Sig.
Intercept	25.553	0.976
[Gender=1]	**-0.758**	**0**
[Gender=2]	0c	.
[Res_Stat=1]	**1.143**	**0**
[Res_Stat=2]	0c	.
[CarOwn=1]	**-0.864**	**0**
[CarOwn=2]	0c	.
[PubTrans_Freq=1]	**-16.302**	**0**
[PubTrans_Freq=2]	**-16.194**	**0**
[PubTrans_Freq=3]	-16.264	.
[PubTrans_Freq=4]	0c	.
[Shuttle_Imp=1]	0.023	0.912
[Shuttle_Imp=2]	-0.111	0.669
[Shuttle_Imp=3]	**0.295**	**0.09**
[Shuttle_Imp=4]	0^c	.
[Shuttle_Imp=5]	0^c	.
[Purpose=1]	4.953	**0**
[Purpose=2]	4.104	**0**
[Purpose=3]	3.605	**0**
[Purpose=4]	3.312	**0**
[Purpose=5]	0^c	.

Table 4.29: Significant Variables for Model Walk Hostelite

Mode Walk	B	Sig.
Intercept	36.551	0.983
[Gender=1]	-1.354	**0**
[Gender=2]	0c	--
[CarOwn=1]	0.062	0.932
[CarOwn=2]	0c	--
[PubTrans_Freq=1]	-0.199	0.677
[PubTrans_Freq=2]	**0.875**	**0.006**
[PubTrans_Freq=3]	0c	--
[Hard_Day=1]	1.127	0.376
[Hard_Day=2]	-0.862	0.445
[Hard_Day=3]	0.15	0.762
[Hard_Day=4]	-0.284	0.521
[Hard_Day=5]	**-2.094**	**0.033**
[Hard_Day=6]	0c	--
[Easy_Day=1]	0.352	0.5

Mode Walk	B	Sig.
[Easy_Day=2]	0.204	0.674
[Easy_Day=3]	**1.004**	**0.072**
[Easy_Day=4]	0c	--
[Easy_Day=5]	0c	--
[Work=2]	**-1.475**	**0.039**

Table 4.30: Significant Variables for Model Walk Day Scholar

Mode Walk	B	Sig.
Intercept	0.112	0.935
[Gender=1]	-0.045	0.858
[Gender=2]	0b	--
[Degree=1]	**-0.847**	**0.088**
[Degree=2]	0b	--
[CarOwn=1]	**-0.571**	**0.041**
[CarOwn=2]	0b	--
[TT_Home=1]	0.466	0.145
[TT_Home=2]	0.309	0.369
[TT_Home=3]	**0.627**	**0.064**
[TT_Home=4]	0b	--
[PubTrans_Freq=1]	0.209	0.469
[PubTrans_Freq=2]	0.027	0.92
[PubTrans_Freq=3]	0b	--
[Work=1]	**-2.516**	**0.027**
[Work=2]	0.153	0.692
[Work=3]	-0.689	0.263
[Work=4]	0b	--
[Shuttle_Imp=1]	-0.218	0.499
[Shuttle_Imp=2]	-0.686	0.111
[Shuttle_Imp=3]	0.162	0.558
[Shuttle_Imp=5]	0b	--
[Purpose=1]	**2.544**	**0**
[Purpose=2]	**-0.389**	**0.067**
[Purpose=3]	**3.269**	**0.004**
[Purpose=4]	0b	--

4.6.1.1 All data model

Gender, residential status, Car Ownership, Travel Time Home and Purpose are the factors which affect students mode choice of walking. The model R value lies in the good predictability range and is validated by the close R values of validated tables.

Mode Walk = exp(2.655 + (-0.204*Age) + (0.649*Gender) + (-1.267*Res_Stat) + (0.187*Car) + (-0.181*TT_Home) + (-0.705*Purpose))

McFadden R = 0.283

Correlation of predictor and actual value = 0.358

McFadden R = 0.286 (70% Data)

McFadden R = 0.303 (30% Data)

4.6.1.2 Day Scholar model

Car Ownership and Purpose are the factors which affects Day Scholar's mode choice of walking. The model R value of 0.286 lies in the good predictability range and is validated by the close R values of validated tables.

Mode Walk(Day Scholars) = exp(1.202 + (1.109*Car) + (-1.005*Purpose))

McFadden R = 0.286

Correlation of predictor and actual value = 0.480

McFadden R = 0.309 (70% Data)

McFadden R = 0.309 (30% Data)

4.6.1.3 Hostelite model

Gender is the only factor which affects Hostelite's mode choice of walking. The model R value of 0.040 does not lie in the good predictability range and is validated by the close R values of validated tables. This model shows that hostelites do not prefer to walk within NUST.

Mode Walk(Hostelites) = exp(0.291 + (1.127*Gender))

McFadden R = 0.040

Correlation of predictor and actual value = 0.175

McFadden R = 0.046 (70% Data)

McFadden R = 0.046 (30% Data)

4.6.2. Mode Taxi/Careem/Uber

Students who never use Public Transport 11% (Exp-2.15) more likely to use Careem and students who occasionally use public transport are 32% (Exp -1.118) more likely to use Taxi or Careem. A very low percentage of Day Scholar (1%) prefer to use Careem, because at the time of this Survey, Careem was not allowed to enter NUST premises. Students who find it ease to leave NUST during the day prefer to use Careem. The model is not very strong due to the limited responses of students.

Table 4.31: Significant Variables for Model Taxi/Careem/Uber All Data

Mode Taxi/Careem/Uber	B	Sig.
Intercept	**-21.594**	**0**
[CarOwn=1]	-18.49	0.997
[CarOwn=2]	0c	--.
[PubTrans_Freq=1]	**-2.15**	**0.037**
[PubTrans_Freq=2]	**-1.118**	**0.017**
[PubTrans_Freq=3]	0c	--.
[Easy_Day=1]	**18.915**	**0**
[Easy_Day=2]	**18.268**	**0**
[Easy_Day=3]	18.07	.--
[Easy_Day=4]	-0.079	1
[Easy_Day=5]	0c	--.

`Table 4.32: Significant Variables for Model Taxi/Careem/Uber Day Scholar

Mode Taxi/Careem/Uber	B	Sig.
Intercept	-0.968	1
[Gender=1]	-0.878	0.641
[Gender=2]	0c	--
[Degree=1]	17.441	0.992
[Degree=2]	0c	--
[CarOwn=1]	-23.112	0.992
[CarOwn=2]	0c	--
[TT_Home=1]	38.695	0.99
[TT_Home=2]	35.394	0.991
[TT_Home=3]	32.986	0.991
[TT_Home=4]	0c	--
[PubTrans_Freq=1]	**-6.106**	**0.022**
[PubTrans_Freq=2]	**-4.69**	**0.019**
[PubTrans_Freq=3]	0c	--
[Shuttle_Imp=1]	-1.176	0.556
[Shuttle_Imp=2]	-15.995	0.996
[Shuttle_Imp=3]	-2.858	0.185
[Shuttle_Imp=5]	0c	--
[Purpose=1]	-16.269	0.995
[Purpose=2]	0.977	0.235
[Purpose=3]	-17.758	0.998
[Purpose=4]	0c	--

4.6.2.1 All data model

Public Transport Frequency is the factor which affects students mode choice of walking. The model R value of 0.117 does not lie in the good predictability range and is validated by the close R values of validated tables.

Mode Taxi/Careem/Uber = exp(-38.963 + (1.17*Pub_Trans_Freq))

McFadden R = 0.117

McFadden R = 0.109 (70% Data)

McFadden R = 0.383 (30% Data)

4.6.2.2 Day Scholar model

Public Transport Frequency, Car Ownership and Travel Time are the factors which affects Day Scholar's mode choice of walking. The model R value of 0.304 lies in

the good predictability range and is not validated by the close R values of validated tables.

Mode Taxi/Careem/Uber$_{\text{Day Scholar}}$ = exp(-45.585 + (1.607*CarOwn) + (-1.234*TT_Home) + (1.407*PubTrans_Freq))

McFadden R = 0.346

McFadden R = 0.304 (70% Data)

McFadden R = 0.878 (30% Data)

4.6.2.3 Hostelite model

Public Transport Frequency, Easy time out of NUST and Purpose are the factors which affects Hostelite's mode choice of walking. The model R value of 0.124 does not lie in the good predictability range and is not validated by the close R values of validated tables.

Mode Taxi/Careem/Uber$_{\text{Hostelite}}$ = exp(-3.491 + (1.067*PubTrans_Freq) + (-1.18*Easy_Day) + (-0.433*Purpose))

McFadden R = 0.124

Correlation of predictor and actual value = 0.169

McFadden R = 0.140 (70% Data)

McFadden R = 0.160 (30% Data)

4.6.3. Shuttle Service

4.9% (Exp -3.012) of students prefer to use Shuttle service if they live within 30 minutes of walking distance from NUST. Male students prefer using the shuttle 6 times more than female students (Exp 1.792).Students are 89% (exp 0.418) more likely to use shuttle to make out of NUST trips using the shuttle service.

Table 4.33: Significant Variables for Model Shuttle

Mode Shuttle Service	B	Sig.
Intercept	-21.825	0
[WhatisyourAge=1]	-1.519	0.389
[WhatisyourAge=2]	0.214	0.893
[WhatisyourAge=3]	0[b]	.--
[Gender=1]	**1.792**	**0.02**
[Gender=2]	0[b]	.--
[Degree=1]	-0.644	0.689
[Degree=2]	0[b]	.--
[CarOwn=1]	-0.238	0.748
[CarOwn=2]	0[b]	.--
[TT_Home=1]	**-3.012**	**0.014**
[TT_Home=2]	-1.891	0.111
[TT_Home=3]	0.626	0.374
[TT_Home=4]	0[b]	.--
[PubTrans_Freq=1]	0.432	0.546
[PubTrans_Freq=2]	-0.698	0.345
[PubTrans_Freq=3]	0[b]	.--
[Shuttle_Imp=1]	**19.897**	**0**
[Shuttle_Imp=2]	0.684	1
[Shuttle_Imp=3]	18.536	.--
[Shuttle_Imp=5]	0[b]	.--
[Purpose=1]	-18.474	0.997
[Purpose=2]	-0.109	0.854
[Purpose=3]	0.418	0.727
[Purpose=4]	0[b]	.--

4.6.3.1 All data model

Age, Travel Time and Purpose are the factors which affects student's mode choice of walking. The model R value of 0.088 does not lie in the good predictability range and is not validated by the close R values of validated tables.

Mode Shuttle = exp(-7.68 + (0.586*Age) + (0.531*TT_Home) + (0.394*Purpose))

McFadden R = 0.088

Correlation of predictor and actual value = 0.123

McFadden R = 0.067 (70% Data)

McFadden R = 0.266 (30% Data)

4.6.3.2 Day Scholar model

Travel Time and Shuttle improvement are the factors which affects Day Scholar's mode choice of walking. The model R value of 0.100 does not lie in the good predictability range and is validated by the close R values of validated tables.

Mode Shuttle$_{(Day\ Scholar)}$ = exp(-4.515 + (0.685*TT_Home) + (-0.469*Shuttle_Imp))

McFadden R = 0.100

Correlation of predictor and actual value = 0.106

McFadden R = 0.102 (70% Data)

McFadden R = 0.099 (30% Data)

4.6.3.3 Hostelite model

No significant factors/value for model development.

Hostelite data for shuttle mode was not significant for mode development, but we can clearly see that including the responses of the hostelites into the model includes some significant factors which were not present before.66.8% hostelites think that shuttle service has not improved.

4.6.4. NUST Van

Females are more inclined to use NUST Van as a mode of transport. Students who do not use public transport for commuting to and from NUST are cumulatively 90% more inclined (exp-1.127 + exp-0.5) to use NUST Van to commute to NUST. NUST Van is a preferred mode despite students owning their cars.

Table 4.34: Significant Variables for Model NUST Van

Mode NUST Van	B	Sig.
Intercept	**-17.929**	**0**
[Gender=1]	**-0.723**	**0.017**
[Gender=2]	0[b]	--
[CarOwn=1]	-2.196	**0**
[CarOwn=2]	0[b]	--
[TT_Home=1]	**-0.756**	**0.027**
[TT_Home=2]	**-0.754**	**0.04**

Mode NUST Van	B	Sig.
[TT_Home=3]	-0.53	0.139
[TT_Home=4]	0[b]	--
[PubTrans_Freq=1]	**-1.127**	**0.001**
[PubTrans_Freq=2]	**-0.5**	**0.088**
[PubTrans_Freq=3]	0[b]	--
[Hard_Day=3]	0.382	0.515
[Hard_Day=4]	**-0.814**	**0.079**
[Hard_Day=5]	0.409	0.672
[Hard_Day=6]	0[b]	--
[Easy_Day=1]	**18.12**	**0**
[Easy_Day=2]	**18.125**	**0**
[Easy_Day=3]	**18.101**	**0**
[Easy_Day=4]	17.573	--
[Easy_Day=5]	0[b]	--

4.6.4.1. Day Scholar model

Age, Gender, Car Ownership, Travel Time, Public Transport Frequency and Purpose are the factors which affects Day Scholar's mode choice of walking. The model R value of 0.359 lies in the good predictability range and is validated by the close R values of validated tables.

Mode NUST Van$_{(Day\ Scholar)}$ = exp(-12.588 + (-0.373*Age) + (1.059*Gender) + (2.158*arOwn) + (0.337*TT_Home) + (0.318*PubTrans_Freq) + (1.037*Purpose))

McFadden R = 0.359

McFadden R = 0.353 (70% Data)

McFadden R = 0.392 (30% Data)

4.6.5. Car

Students are more inclined to use car upon owning them and hostelites are more inclined to use car as a mode of travel, which can be attributed to carpool of lift. Students who find it difficult to travel out of NUST on all days prefer their own transport.

Table 4.35: Significant Variables for Mode Car All Data

Mode Car	B	Sig.
Intercept	**-2.633**	**0.038**
[Purpose=1]	**-1.205**	**0.001**
[Purpose=2]	0.031	0.897
[Purpose=3]	-0.825	0.429
[Purpose=4]	0b	--
[Shuttle_Imp=1]	0.35	0.289
[Shuttle_Imp=2]	0.569	0.155
[Shuttle_Imp=3]	0.481	0.122
[Shuttle_Imp=5]	0b	--
[Gender=1]	0.15	0.515
[Gender=2]	0b	--
[Res_Stat=1]	**-1.069**	**0.001**
[Res_Stat=2]	0b	--
[CarOwn=1]	**3.116**	**0**
[CarOwn=2]	0b	--
[TT_Home=1]	-0.589	0.114
[TT_Home=2]	-0.134	0.734
[TT_Home=3]	-0.604	0.222
[TT_Home=4]	0b	--
[Hard_Day=1]	2.785	0.1
[Hard_Day=2]	-16.432	--
[Hard_Day=3]	**-1.129**	**0.035**
[Hard_Day=4]	0.148	0.691
[Hard_Day=5]	-16.797	0.997
[Hard_Day=6]	0b	--
[Easy_Day=1]	-0.195	0.873
[Easy_Day=2]	0.326	0.789
[Easy_Day=3]	0.837	0.496
[Easy_Day=4]	-0.961	0.47
[Easy_Day=5]	0b	--

Table 4.36: Significant Variables for Model Car Hostelite

Mode Car	B	Sig.
Intercept	**-14.563**	**0**
[Gender=1]	**-0.986**	**0.074**
[Gender=2]	0b	.--
[TT_Home=1]	**14.451**	**0**
[TT_Home=2]	16.319	.--
[TT_Home=3]	0b	.--
[Easy_Day=1]	**-4.802**	**0.001**
[Easy_Day=2]	**-3.54**	**0.007**
[Easy_Day=3]	**-2.998**	**0.021**
[Easy_Day=4]	**-3.262**	**0.024**

Mode Car	B	Sig.
[Easy_Day=5]	0b	.--
[CarOwn=1]	**3.049**	**0**
[CarOwn=2]	0b	.--

Table 4.37: Significant Variables for Model Car Day Scholar

Mode Car	B	Sig.
Intercept	**-5.163**	**0.003**
[WhatisyourAge=1]	**2.152**	**0.021**
[WhatisyourAge=2]	0.333	0.656
[WhatisyourAge=3]	0b	.--
[Gender=1]	-0.074	0.831
[Gender=2]	0b	.--
[Degree=1]	-1.013	0.197
[Degree=2]	0b	.--
[CarOwn=1]	**4.819**	**0**
[CarOwn=2]	0b	.--
[TT_Home=1]	-0.375	0.41
[TT_Home=2]	0.083	0.865
[TT_Home=3]	-0.365	0.545
[TT_Home=4]	0b	.--
[PubTrans_Freq=1]	**0.849**	**0.056**
[PubTrans_Freq=2]	**2.08**	**0**
[PubTrans_Freq=3]	0b	.--
[Hard_Day=3]	**-2.045**	**0.004**
[Hard_Day=4]	0.703	0.138
[Hard_Day=5]	-18.562	.--
[Hard_Day=6]	0b	.--
[Easy_Day=1]	-0.484	0.727
[Easy_Day=2]	0.118	0.931
[Easy_Day=3]	0.251	0.86
[Easy_Day=4]	-2.285	0.181
[Easy_Day=5]	0b	.--
[Work=1]	**2.207**	**0.04**
[Work=2]	0.186	0.725
[Work=3]	0.003	0.998
[Work=4]	0b	.--
[Shuttle_Imp=1]	**1.134**	**0.019**
[Shuttle_Imp=2]	**0.992**	**0.058**
[Shuttle_Imp=3]	**0.796**	**0.063**
[Shuttle_Imp=5]	0b	.--
[Purpose=1]	**-1.593**	**0**
[Purpose=2]	0.164	0.569
[Purpose=3]	-0.468	0.684
[Purpose=4]	0b	.--

4.6.5.1 All Data model

Residential Status, Car Ownership and Easy Time out of NUST are the factors which affects students mode choice of walking. The model R value of 0.355 lies in the good predictability range and is validated by the close R values of validated tables.

Mode Car= exp((0.88*Res_Stat) + (-2.859*CarOwn) + (0.277*Easy_Time) + (0.441*Purpose))

McFadden R = 0.355

McFadden R = 0.329 (70% Data)

McFadden R = 0.436 (30% Data)

4.6.5.2 Day Scholar model

Public Transport Frequency, Car Ownership and Purpose are the factors which affects students mode choice of walking. The model R value of 0.295 lies in the good predictability range and is validated by the close R values of validated tables.

Mode $Car_{(Day\ Scholar)}$ = exp(2.311 + (-2.708*CarOwn) + (-0.263*PubTrans_Freq) + (0.465*Purpose))

McFadden R = 0.295

McFadden R = 0.301 (70% Data)

McFadden R = 0.282 (30% Data)

4.6.6. Bike

- Students who do not use public transport are twice as likely to use this mode.
- Despite owning a car, 15% students will prefer commuting via motorcycle (exp-1.849)
- Students living within 30 minutes of NUST prefer commuting via motorcycle

Table 4.38: Significant Variables for Model Bike All Data

Mode Bike	B	Sig.
Intercept	-17.339	0.852
[PubTrans_Freq=1]	**0.995**	**0**
[PubTrans_Freq=2]	0.391	0.119
[PubTrans_Freq=3]	0.241	--
[PubTrans_Freq=4]	0b	--
[Gender=1]	13.64	0.883
[Gender=2]	0b	--
[CarOwn=1]	**-1.849**	**0**
[CarOwn=2]	0b	--
[TT_Home=1]	**1.613**	**0.028**
[TT_Home=2]	1.227	0.121
[TT_Home=3]	1.16	0.149
[TT_Home=4]	0b	--

Table 4.39: Significant Variables for Model Bike Day Scholar

Mode Bike	B	Sig.
Intercept	-51.143	0.957
[WhatisyourAge=1]	**-4.998**	**0.032**
[WhatisyourAge=2]	**-6.559**	**0.008**
[WhatisyourAge=3]	0b	--
[Gender=1]	16.898	0.977
[Gender=2]	0b	--
[Degree=1]	**4.773**	**0.042**
[Degree=2]	0b	--
[CarOwn=1]	**-3.619**	**0.004**
[CarOwn=2]	0b	--
[TT_Home=1]	**4.036**	**0.05**
[TT_Home=2]	**3.985**	**0.048**
[TT_Home=3]	0.913	0.604
[TT_Home=4]	0b	--
[PubTrans_Freq=1]	18.985	0.98
[PubTrans_Freq=2]	16.05	0.983
[PubTrans_Freq=3]	0b	--
[Hard_Day=3]	**6.758**	**0.007**
[Hard_Day=4]	-1.319	0.305
[Hard_Day=5]	1.625	1
[Hard_Day=6]	0b	--
[Easy_Day=1]	**16.032**	**0**
[Easy_Day=2]	**12.763**	**0**
[Easy_Day=3]	**11.562**	**0**
[Easy_Day=4]	18.782	--
[Easy_Day=5]	0b	--
[Work=1]	2.151	0.353

Mode Bike	B	Sig.
[Work=2]	**-4.126**	**0.002**
[Work=3]	-1.095	0.529
[Work=4]	0b	--
[Shuttle_Imp=1]	0.604	0.643
[Shuttle_Imp=2]	0.588	0.652
[Shuttle_Imp=3]	1.095	0.446
[Shuttle_Imp=5]	0b	--
[Purpose=1]	**-1.56**	**0.069**
[Purpose=2]	0.692	0.229
[Purpose=3]	-13.434	0.989
[Purpose=4]	0b	--

4.6.6.1 All Data model

Travel Time, Car Ownership and Public Transport Frequency are the factors which affects students mode choice of walking. The model R value of 0.218 lies in the good predictability range and is validated by the close R values of validated tables.

Mode Bike = exp(14.582 + (1.81*CarOwn) + (-0.389*TT_Home) + (-0.367*PubTrans_Freq))

McFadden R = 0.218

Correlation of predictor and actual value = ---

McFadden R = 0.232 (70% Data)

McFadden R = 0.232 (30% Data)

4.6.6.2 Day Scholar model

Car Ownership, Public Transport Frequency and Hard Day out of NUST are the factors which affects Day Scholars mode choice of walking. The model R value of 0.294 lies in the good predictability range and is validated by the close R values of validated tables.

$\text{Mode Bike}_{\text{(Day Scholar)}}$ = exp(19.321 + (1.391*CarOwn) + (-1.292*PubTrans_Freq) +(-0.338*Hard_Day))

McFadden R = 0.294

Correlation of predictor and actual value = ---

McFadden R = 0.300 (70% Data)

McFadden R = 0.304 (30% Data)

4.6.6.3 Hostelite model

Work is the factors which affects Day Scholars mode choice of walking. The model R value of 0.053 does not lie in the good predictability range and is validated by the close R values of validated tables.

Mode Bike(Hostelite) = 17.348 + ln(-1.287*Work) McFadden R = 0.053

McFadden R = 0.059 (70% Data) McFadden R = 0.038 (30% Data)

4.7. MODE CHOICE PREDICTION

The Variance Inflation Factors (VIF) of 12 factors were determined which included socioeconomic factors and attitudinal variables towards mode selection. All variables were found to be mutually exclusive. Correlations of 12 variables were determined with individual modes and significant variables used to create mode choice models. Model for mode choice was developed with McFadden R values ranging from 0.2-0.4.

Table 4.40: Table of Mode choice prediction results

Mode	N	Mean
Walk Predicted probability	1549	.648
Taxi Predicted probability	1272	.0188
Shuttle Predicted probability	1552	.0148
Van Predicted probability	1272	.129
Car Predicted probability	1280	.114
Bike Predicted probability	1555	.068

4.8. SUMMARY

In this chapter, the descriptive statistics, model results and validations were discussed. The results of the responses against the variables are discussed in the first part of this chapter. Any existing relationships between variables were discussed and

analyzed. Lastly, the results of the model, the resulting equation and the validation of the model against each mode were developed and the results were discussed.

Chapter 5

CONCLUSION AND RECOMMENDATIONS

5.1. SUMMARY

The current study aimed at studying the travel behavior of students of an urban university in Pakistan. The objective was to determine the factors affecting mode choice of students, and mode preferences of students on the basis of sub-groups of hostelites and day scholars. For this purpose, the site of H-12 campus of NUST was selected, the data of which was collected using a survey form. The survey form designed was a revealed preference survey i.e. multiple choices were provided to the respondents against each available variable i.e. the socio-economic variables and the attitudinal variables of each respondent. The data was digitized and model was prepared using SPSS software. The data was digitized and a statistical model was developed using Activity based Multinomial Logit modeling approach.

5.2. CONCLUSIONS

The statistical analysis, descriptive analysis and developed models revealed the following results:

1. Factors affecting modal split of Hostelites and Day Scholars vary as follows:
    a. Mode choice of Day Scholars depends on Age, Gender, Car Ownership, Travel Time, Public Transport Frequency, Hard Day out of NUST & Purpose.
    b. Mode choice of Hostelites depends on Gender, Travel Time, Work, Public Transport Frequency, Easy Time out of NUST & Purpose.

2. Policy Implications:

a. Walk is a preferred and predominant mode of commute among the students. Covered walkways should be provided for ease of commute using this mode during harsh weathers season.

b. Despite owning cars, students prefer to Walk and commute via NUST Van. This shows that some other attitudinal factors in play.

c. Shuttle is one of the least favoured mode of commute with hardly 2% of reported trips. 42.6% of the respondents think that shuttle service within NUST has not improved whereas 9.6% have not even bothered using it. Improvement in the waiting time and frequency of shuttle service is required to ensure maximum usage to reduce car and bike usage within campus.

d. Bikes and Cars are used by students who own this mode of vehicle and mostly depends on ease of commute and not preferring the public transport system. Non-motorized modes need to be incentivized to reduce motorized trips to, from and within the University.

5.3. RECOMMENDATIONS

1. This was a cross-sectional study of a single year with Survey conducted in November 2017. A longitudinal model can be prepared by floating the same model in the four different weather seasons, to address temporal changes of modes.
2. Modality can be address by asking students whether their primary, secondary and tertiary modes of commuting, if they travel in such a manner.

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Appendixes

Appendix-I

AGE

Coefficients[a]			
Model		Collinearity Statistics	
		Tolerance	VIF
	What is your Gender ?	.857	1.167
	You are ?	.441	2.269
	Degree ?	.851	1.175
	Do you own a Car ?	.738	1.356
	How long does it take to commute to your Dept ?	.596	1.678
	How often do you use public transport out of NUST ?	.842	1.188
	What day do you feel the hardest to go out of nust ?	.928	1.078
	What time do you feel the easiest to go out of NUST ?	.941	1.063
	Do you work ?	.925	1.081
	Shuttle service within the campus has improved ?	.914	1.094
	Purpose	.912	1.096
a. Dependent Variable: What is your Age ?			

GENDER

Coefficients			
Model		Collinearity Statistics	
		Tolerance	VIF
	You are ?	.447	2.235
	Degree ?	.423	2.366
	Do you own a Car ?	.708	1.412
	How long does it take to commute to your Dept ?	.596	1.677
	How often do you use public transport out of NUST ?	.841	1.189
	What day do you feel the hardest to go out of nust ?	.933	1.071
	What time do you feel the easiest to go out of NUST ?	.960	1.042
	Do you work ?	.895	1.118
	Shuttle service within the campus has improved ?	.862	1.161
	Purpose	.912	1.096
	What is your Age ?	.414	2.418
a. Dependent Variable: What is your Gender ?			

DEGREE

Coefficients[a]			
Model		Collinearity Statistics	
		Tolerance	VIF
1	Do you own a Car ?	.741	1.350
	How long does it take to commute to your Dept ?	.608	1.645
	How often do you use public transport out of NUST ?	.840	1.190
	What day do you feel the hardest to go out of nust ?	.925	1.081
	What time do you feel the easiest to go out of NUST ?	.941	1.062
	Do you work ?	.919	1.089
	Shuttle service within the campus has improved ?	.914	1.094
	Purpose	.913	1.095
	What is your Age ?	.854	1.171
	What is your Gender ?	.878	1.138
	You are ?	.445	2.246
a. Dependent Variable: Degree ?			

CAR OWNERSHIP

Coefficients[a]			
Model		Collinearity Statistics	
		Tolerance	VIF
1	What is your Age ?	.432	2.316
	You are ?	.528	1.893
	Degree ?	.442	2.263
	How long does it take to commute to your Dept ?	.638	1.569
	How often do you use public transport out of NUST ?	.851	1.176
	What day do you feel the hardest to go out of nust ?	.938	1.066
	What time do you feel the easiest to go out of NUST ?	.963	1.039
	Do you work ?	.920	1.087
	Shuttle service within the campus has improved ?	.862	1.161
	Purpose	.913	1.095
a. Dependent Variable: Do you own a Car ?			

TRAVEL TIME

Coefficients[a]			
Model		Collinearity Statistics	
		Tolerance	VIF
1	What is your Age ?	.416	2.402
	You are ?	.696	1.437
	Degree ?	.432	2.314
	How often do you use public transport out of NUST ?	.848	1.179
	What day do you feel the hardest to go out of nust ?	.940	1.064
	What time do you feel the easiest to go out of NUST ?	.961	1.040
	Do you work ?	.899	1.112
	Shuttle service within the campus has improved ?	.862	1.160
	Purpose	.913	1.095
	Do you own a Car ?	.757	1.320
a. Dependent Variable: How long does it take to commute to your Dept ?			

PUBLIC TRANSPORT FREQUENCY

Coefficients[a]			
Model		Collinearity Statistics	
		Tolerance	VIF
1	What is your Age ?	.414	2.413
	You are ?	.483	2.069
	Degree ?	.423	2.366
	What day do you feel the hardest to go out of nust ?	.944	1.060
	What time do you feel the easiest to go out of NUST ?	.973	1.028
	Do you work ?	.898	1.114
	Shuttle service within the campus has improved ?	.864	1.158
	Purpose	.914	1.095
	Do you own a Car ?	.716	1.396
	How long does it take to commute to your Dept ?	.601	1.663
a. Dependent Variable: How often do you use public transport out of NUST ?			

HARD DAY OUT OF NUST

Coefficients[a]			
Model		Collinearity Statistics	
		Tolerance	VIF
1	What is your Age ?	.415	2.412
	You are ?	.457	2.187
	Degree ?	.423	2.366
	What time do you feel the easiest to go out of NUST ?	.961	1.041
	Do you work ?	.897	1.115
	Shuttle service within the campus has improved ?	.885	1.130
	Purpose	.913	1.096
	Do you own a Car ?	.712	1.405
	How long does it take to commute to your Dept ?	.600	1.666
	How often do you use public transport out of NUST ?	.850	1.176
a. Dependent Variable: What day do you feel the hardest to go out of nust ?			

EASY TIME OUT OF NUST

Coefficients[a]			
Model		Collinearity Statistics	
		Tolerance	VIF
1	What is your Age ?	.414	2.417
	You are ?	.453	2.209
	Degree ?	.424	2.359
	Do you work ?	.898	1.114
	Shuttle service within the campus has improved ?	.868	1.152
	Purpose	.913	1.096
	Do you own a Car ?	.710	1.408
	How long does it take to commute to your Dept ?	.597	1.675
	How often do you use public transport out of NUST ?	.852	1.173
	What day do you feel the hardest to go out of nust ?	.934	1.071
a. Dependent Variable: What time do you feel the easiest to go out of NUST ?			

WORK

Coefficients[a]			
Model		Collinearity Statistics	
		Tolerance	VIF
1	What is your Age ?	.428	2.337
	You are ?	.448	2.235
	Degree ?	.434	2.304
	Shuttle service within the campus has improved ?	.862	1.160
	Purpose	.912	1.096
	Do you own a Car ?	.728	1.373
	How long does it take to commute to your Dept ?	.599	1.669
	How often do you use public transport out of NUST ?	.844	1.185
	What day do you feel the hardest to go out of nust ?	.935	1.069
	What time do you feel the easiest to go out of NUST ?	.963	1.038
a. Dependent Variable: Do you work ?			

SHUTTLE SERVICE IMPROVEMENT

Coefficients[a]			
Model		Collinearity Statistics	
		Tolerance	VIF
1	What is your Age ?	.439	2.276
	You are ?	.452	2.213
	Degree ?	.449	2.227
	Purpose	.912	1.096
	Do you own a Car ?	.708	1.412
	How long does it take to commute to your Dept ?	.596	1.677
	How often do you use public transport out of NUST ?	.843	1.186
	What day do you feel the hardest to go out of nust ?	.959	1.043
	What time do you feel the easiest to go out of NUST ?	.967	1.034
	Do you work ?	.895	1.117
a. Dependent Variable: Shuttle service within the campus has improved ?			

PURPOSE

Coefficients[a]			
Model		Collinearity Statistics	
		Tolerance	VIF
1	What is your Age ?	.414	2.418
	You are ?	.467	2.143
	Degree ?	.423	2.363
	Do you own a Car ?	.709	1.411
	How long does it take to commute to your Dept ?	.597	1.676
	How often do you use public transport out of NUST ?	.842	1.187
	What day do you feel the hardest to go out of nust ?	.934	1.071
	What time do you feel the easiest to go out of NUST ?	.960	1.041
	Do you work ?	.895	1.118
	Shuttle service within the campus has improved ?	.862	1.161
a. Dependent Variable: Purpose			

Appendix-II

All Model

Mode		Age	Gender	Res_Stat	Degree	Car	TT	Public Transport Frequency	Hard Day	Easy Time	Work	Shuttle Improvement	Purpose
Walk	Correlation	**-.080****	**.085****	**-.446****	0.002	**.299****	**-.279****	**.147****	-0.045	0.007	-0.007	**.063***	**-.427****
	N	1670	1663	1663	1661	1663	1552	1552	1274	1277	1552	1549	1670
Taxi / Careem / Uber	Correlation	-0.021	-0.012	-0.037	-0.035	**.059***	-0.048	**.091****	-0.026	**-.068***	0.016	0.044	-0.004
	N	1670	1663	1663	1661	1663	1552	1552	1274	1277	1552	1549	1670
Shuttle Service	Correlation	**.048***	0.002	0.04	0.001	-0.004	**.097****	0.014	-0.013	0.019	0.003	-0.033	**.072****
	N	1670	1663	1663	1661	1663	1552	1552	1274	1277	1552	1549	1670
NUST Van	Correlation	-0.016	**.076****	**.357****	0.009	**.078****	**.385****	-0.041	**.069***	**-.067***	-0.014	-0.035	**.367****
	N	1670	1663	1663	1661	1663	1552	1552	1274	1277	1552	1549	1670
Car	Correlation	**.114****	-0.008	**.328****	0.023	**-.573****	**.084****	**-.162****	0.034	**.066***	0.04	**-.052***	**.208****
	N	1670	1663	1663	1661	1663	1552	1552	1274	1277	1552	1549	1670
Bike	Correlation	0.011	**-.229****	-0.035	-0.023	**.091****	**-.080****	**-.060***	-0.027	0.034	-0.037	-0.012	0.04

Day Scholar

Mode		Age	Gender	Residential Status	Car	TT	Public Transport Frequency	Hard Day	Easy Time	Work	Shuttle Improvement	Purpose
Walk	Correlation	0.022	-0.009	.[b]	**.180**[**]	-0.067	0.061	-0.013	-0.001	0.001	-0.009	**-.569**[**]
	N	806	806	806	806	750	750	588	586	750	747	806
Taxi/ Careem/ Uber	Correlation	-0.021	0	.[b]	**.075**[*]	**-.079**[*]	**.091**[*]	0.01	-0.007	-0.005	0.046	**.097**[**]
	N	806	806	806	806	750	750	588	586	750	747	806
Shuttle Service	Correlation	0.033	-0.037	.[b]	0.013	**.113**[**]	0.026	0.024	-0.051	-0.02	**-.086**[*]	.075[*]
	N	806	806	806	806	750	750	588	586	750	747	806
NUST Van	Correlation	**-.103**[**]	**.147**[**]	.[b]	**.268**[**]	**.252**[**]	**.092**[*]	0.049	-0.072	-0.038	0.039	**.403**[**]
	N	806	806	806	806	750	750	588	586	750	747	806
Car	Correlation	0.056	-0.01	.[b]	**-.549**[**]	**-.144**[**]	**-.120**[**]	0.009	0.071	0.025	0.017	**.187**[**]
	N	806	806	806	806	750	750	588	586	750	747	806
Bike	Correlation	0.021	**-.200**[**]	.[b]	**.119**[**]	**-.073**[*]	**-.131**[**]	**-.092**[*]	0.031	0.021	-0.055	0.055
	N	806	806	806	806	750	750	588	586	750	747	806

Hostelite Data

Mode		Age	Gender	Residential Status	Car	TT	Public Transport Frequency	Hard Day	Easy Time	Work	Shuttle Improvement	Purpose
Walk	Correlation	-0.062	**.175****	.[b]	0.058	-0.009	-0.024	0.02	-0.043	0.026	-0.013	-0.038
	N	857	857	857	857	802	802	686	691	802	802	857
Taxi / Careem/ Uber	Correlation	-0.011	-0.024	.[b]	0.022	0.052	**.081***	-0.047	**-.117****	0.038	0.033	**-.074***
	N	857	857	857	857	802	802	686	691	802	802	857
Shuttle	Correlation	0.057	0.059	.[b]	0.014	0.007	0.028	-0.03	0.068	0.036	0.048	0.047
	N	857	857	857	857	802	802	686	691	802	802	857
NUST	Correlation	.[b]	.[b]	.[b]	.[b]	.[b]	.[b]	.[b]	.[b]	.[b]	.[b]	.[b]
	N	857	857	857	857	802	802	686	691	802	802	857
Car	Correlation	.111**	0.06	.[b]	**-.222****	.080*	0.018	0	**.132****	0.049	-0.031	0.028
	N	857	857	857	857	802	802	686	691	802	802	857
Bike	Correlation	0.013	**-.257****	.[b]	0.042	**-.091****	-0.029	0.017	0.035	**-.092****	0.006	0.047
	N	857	857	857	857	802	802	686	691	802	802	857

Appendix-III

MODEL WALK

All Data

Pseudo R-Square

McFadden	.283

Mode Walk or not[a]		B	Sig.
Walk	Intercept	2.655	.000
	WhatisyourAge	-.204	.039
	Gender	.649	.000
	Res_Stat	-1.267	.000
	CarOwn	.981	.000
	TT_Home	-.181	.016
	PubTrans_Freq	.065	.462
	Shuttle_Imp	-.004	.937
	Purpose	-.705	.000

MODEL DAY SCHOLAR WALK

Pseudo R-Square

McFadden	.286

Mode Walk or not		B	Sig.
Walk	Intercept	1.202	.002
	CarOwn	1.109	.000
	Purpose	-1.005	.000

MODEL HOSTELITE WALK

Pseudo R-Square

McFadden	.040

Mode Walk or not[a]		B	Sig.
Walk	Intercept	.291	.338
	Gender	1.127	.000

MODEL TAXI/CAREEM/UBER

Pseudo R-Square

McFadden	.117

Mode Taxi/Careem/Uber		**B**	**Sig.**
Taxi/Careem/Uber	Intercept	-38.963	.000
	CarOwn	16.169	.
	PubTrans_Freq	1.170	.004
	Easy_Day	-.328	.222
	Gender	-.592	.187
	Res_Stat	.625	.194
	Hard_Day	-.299	.136
	Shuttle_Imp	.242	.141
	Purpose	.060	.719
	Work	.500	.107

MODEL DAY SCHOLAR TAXI/CAREEM/UBER

Pseudo R-Square

McFadden	.346

Mode Taxi/Careem/Uber[a]		**B**	**Sig.**
Taxi/Careem/Uber	Intercept	-45.585	.000
	CarOwn	16.934	.
	Purpose	1.607	.006
	TT_Home	-1.234	.007
	PubTrans_Freq	1.407	.015

MODEL HOSTELITE TAXI/CAREEM/UBER

Pseudo R-Square

McFadden	.124

Mode Taxi/Careem/Uber[a]		**B**	**Sig.**
Taxi/Careem/Uber	Intercept	-3.491	.031
	PubTrans_Freq	1.067	.041
	Easy_Day	-1.180	.007
	Purpose	-.433	.054

MODEL SHUTTLE SERVICE

Pseudo R-Square

McFadden	.088

Mode Shuttle Service		**B**	**Sig.**
Shuttle Service	Intercept	-7.680	.000
	WhatisyourAge	.586	.040
	TT_Home	.531	.004
	Purpose	.394	.033

MODEL DAY SCHOLAR SHUTTLE SERVICE

Pseudo R-Square

McFadden	.100

Mode Shuttle Service		**B**	**Sig.**
Shuttle Service	Intercept	-4.515	.000
	TT_Home	.685	.006
	Shuttle_Imp	-.469	.035

MODEL NUST VAN

Pseudo R-Square

McFadden	.532

Mode NUST Van		**B**	**Sig.**
NUST Van	Intercept	-47.717	.000
	Gender	.788	.001
	Res_Stat	18.250	.
	CarOwn	2.046	.000
	TT_Home	.334	.001
	Hard_Day	-.024	.868
	Easy_Day	-.169	.168
	Purpose	1.298	.000

MODEL DAY SCHOLAR NUST VAN

Pseudo R-Square

McFadden	.359

Mode NUST Van		B	Sig.
NUST Van	Intercept	-12.588	.000
	WhatisyourAge	-.373	.022
	Gender	1.059	.000
	CarOwn	2.158	.000
	TT_Home	.337	.001
	PubTrans_Freq	.318	.029
	Purpose	1.307	.000

MODEL CAR

Pseudo R-Square

McFadden	.344

Mode Car		B	Sig.
Car	Intercept	-.162	.866
	WhatisyourAge	.009	.955
	Res_Stat	.880	.007
	CarOwn	-2.859	.000
	TT_Home	-.007	.950
	PubTrans_Freq	-.112	.430
	Easy_Day	.277	.012
	Shuttle_Imp	-.109	.147
	Purpose	.441	.000

MODEL DAY SCHOLAR CAR

Pseudo R-Square

McFadden	.295

Mode Car		B	Sig.
Car	Intercept	2.311	.000
	CarOwn	-2.708	.000
	TT_Home	-.145	.134
	PubTrans_Freq	-.263	.046
	Purpose	.465	.000

MODEL BIKE

Pseudo R-Square

McFadden	.218

Mode Bike		B	Sig.
Bike	Intercept	14.582	.000
	Gender	-18.628	.
	CarOwn	1.810	.001
	TT_Home	-.389	.005
	PubTrans_Freq	-.367	.010

MODEL DAY SCHOLAR BIKE

Pseudo R-Square

McFadden	.294

Mode Bike		B	Sig.
Bike	Intercept	19.321	.000
	Gender	-19.371	.
	CarOwn	1.391	.013
	TT_Home	-.251	.168
	PubTrans_Freq	-1.292	.000
	Hard_Day	-.338	.068

MODEL HOSTELITE BIKE

Pseudo R-Square

McFadden	.053

Mode Bike		B	Sig.
Bike	Intercept	17.348	.000
	Res_Stat	0[b]	.
	TT_Home	-17.002	.
	Work	-1.287	.014