ACCESSIBILITY TO MEDICAL SERVICES FOR A LARGER AREA UNIVERSITY CAMPUS – A CASE STUDY OF NUST

FINAL YEAR PROJECT UG 2018

By

Kinza Asif (Group Leader)	255023
Muhammad Nauman	247655
Muhammad Omar	248236
Muhammad Jawad Haider	254844

NUST Institute of Civil Engineering

School of Civil and Environmental Engineering

National University of Science and Technology Islamabad,

Pakistan

2022

This is to certify that the

Final Year Project Titled

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Muhammad Omar	248236
Muhammad Jawad Haider	254844

has been accepted towards the requirementsfor the undergraduate degree

in

CIVIL ENGINEERING

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Dr. Muhammad Asif Khan

(Assistant Professor)

Department of Transportation Engineering
School of Civil and Environmental Engineering (SCEE)
National University of Sciences and Technology (NUST)
Islamabad, Pakistan

ABSTRACT

Transportation plays a vital role in daily lives of human beings. Its importance is more critical in case of emergency situations like accessibility to a medical service or a hospital. This study is focused on measuring the accessibility to medical services both inside and outside larger area university campus. The case study selected for the study was the National University of Sciences & Technology, Islamabad. At first, need of the study was observes through survey form circulated among the university students and faculty members. This survey depicted the general user opinion about the accessibility to the medical facilities inside and outside the campus. Gravity model was employed to obtain the accessibility indexes, after data collection for each medical facility nearby campus. Obtained values were used to draw a comparison with the standard values and rate the accessibility. Conclusion drawn from the study will provide concerned authorities with the appropriate recommendations to enhance the accessibility and avoid unalarming situations.

Keywords: Accessibility, Medical Services, University Campus, Gravity Model, and Emergencies

DEDICATED

We would like to dedicate our works to our parents, our teachers, NUST and friends.

ACKNOWLEDGEMENTS

In the name of Allah, the most Beneficent, the most Merciful as well as peace and blessings be upon Prophet Muhammad, His servant and final messenger.

We are thankful to Allah almighty for bestowing us an opportunity to be here in a prestigious institute and intellectual strength with continuous guidance to work up to the mark.

This work would not have been possible without support of generous faculty of NUST Institute of Civil Engineering & Transportation Engineering. We are especially indebted to Dr. Muhammad Asif Khan, assistant professor at NIT, NUST who provided us with his unending guidance and motivation as supervisor of the project. We are extremely grateful to the university students and faculty members who filled the survey form and helped us in data collection.

Most importantly, we are grateful to our families for unconditional, unequivocal, and loving support.

We are thankful to our department and school for providing us with a leaning environment which helped us in achieving we dreamt of.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Travel behavior of a university campus, in its own sense is an intrinsic property which does not show coherence with the norms of general travel dynamics outside the campus. Analyses of travel habits in the Hampton Roads area indicated that ODU (Old Dominion University) students had greater trip rates than the local population as a whole. Around the perimeter of the campus, you'll find a cluster of locations that are easier to reach. More specifically, the proximity of the students' residences to campus was strongly associated with their travel (Wang & Khattak, 2012).

Travel behavior of university students has been given little attention (Limanond, Butsingkorn, & Chermkhunthod, 2011) and little to no literature is available regarding the travel behavior of student commuters. Students are a powerful demographic in society, and they have the potential to influence widespread behavioral shifts toward more environmentally responsible transport mode selection and the development of sustainable mode-based communities. In order for campuses to meet their current and future needs, it is essential to gain insight into how people move throughout the campus.(Das, Kumar, Prakash, Dharmik, & Subbarao, 2016).

Evidence of positive time utility for an active mode is significant because it can inform policies that promote (rather than discourage) a desired (rather than undesired) activity.(Whalen, Paez, & Carrasco, 2013).

Moreover, Students' travel decisions, which in this case include the journey mode and travel frequency, are influenced by environmental conditions surrounding the university, such as

the availability of walking and cycling facilities, regional density, and public transit accessibility. These governing factors affect the transport accessibility inside the university campus (Devi, Roychansyah, & Herwangi, 2019).

Transportation systems perform a vital role for making a university campus self-sustainable. This specific study was conducted inside NUST H-12 campus Islamabad. It is a widespread campus with almost seven hundred acres of area and approximately five thousand people residing in the campus. Travel behavior and mode choices inside a campus is very much different from regular outside traffic.

Accessibility to different places in a university campus must be good enough to avoid undue delays so that the operations are not affected. Similarly, accessibility to medical service within/outside of the university campus is very crucial in case of any emergency. Highly accessible medical services exaggerate the chances of minimum loss. Optimum measures are mandatory to be taken to enhance the accessibility.

1.2 PROBLEM STATEMENT

For using in-campus provided shuttle service and accessing medical facilities inside/outside the campus one may be required to walk to reach up the nearest shuttle stop/station and then wait there for so long. This whole system disturbs student's and staff's tight schedule and causes undue delays. All these issues can be eradicated by deploying a regulatory system which provides the adequate services based on user preferred locations and places with large number in-going/out-going ones. In addition to this, accessibility to the medical facilities is also very crucial at times. It has adequate road network and parking areas but provided transportation facilities are not up to the mark and cannot meet the demand. There has been no estimation of NUST's most

used roads, most visited places, and number of visitors. NUST's present medical facility cannot provide emergency services for sensitive cases, that's why accessibility to other nearby medical facilities must be ensured.

1.3 AIMS & OBJECTIVES

Main aims of the research are to:

- Conduct a survey to assess the accessibility to NUST medical center and further medical facilities nearby NUST located outside campus by students, faculty, and staff.
- Evaluate the accessibility to NUST medical center and nearby medical facilities outside campus using gravity model by incorporating walk and auto mode travel time data.
- Provide useful recommendations to university administration to improve accessibility to NUST medical center and nearby medical facilities outside university campus.

1.4 OVERVIEW OF THE STUDY APPROACH

- To identify the roads with maximum on-road traffic, number of persons daily visiting the prime locations inside the campus and accessibility to campus's medical facility and the ones outside the campus, survey is conducted to collect the required data.
- Google Maps is used to pinpoint potential destinations and calculate trip times. When all relevant information has been gathered, the Gravity model is used to determine the extent to which sites are accessible to one another, on the theory that travel time is inversely proportional to the square of the distance between them. The same is true of the hospitals and clinics.

- Inferred suggestions and measures are communicated to the concerned authorities to regulate the system to maximize the efficiency along with the collected data to cater the continuously increasing demands.

1.5 ORGANIZATION OF THE THESIS

This thesis is organized in four (4) chapters. Brief description of every chapter is given below:

First chapter provides summarized information about different accessibility analysis and travel behavior studies conducted in the world and approaches adopted in them.

Second chapter gives detailed literature review of the accessibility studies and modelling approaches conducted around the globe. It illustrates major findings and results regarding the factors governing transportation accessibility like travel mode choices, demographical factors, spatial position of places etc.

Third chapter is about the methodology adopted in this study for achieving the objectives. It focuses on the selection of methods and instruments used, data about the site and the modelling techniques.

Forth chapter describes the findings of the study, descriptive and mathematical analysis performed on the generated results.

Fifth chapter illustrated the major outcomes of the research work, recommendations, and suggestions in accordance with the obtained data.

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

This chapter is dedicated to the literature review and explains the analysis conducted by various researchers regarding the accessibility, modal choices, travel demands, patterns and other travel behaviors pertaining to university students in different academic spheres around the globe.

Research studies related to travel behavior in a university setting are being conducted across the world and various theories have been developed which mostly complement each other in one way or the other. The choices that the users make relate to different aspects mostly based on the physical and socio-economic factors, age and gender, distance and modal choices, weather conditions and trip purpose, day, time of day, weekday, etc.

These studies differ from other traffic analysis and design studies because the travel patterns of students differ from normal commuters of general population. This dissimilarity, nonetheless, effects the overall travel patterns of the cities because these subpopulations are a part of that region. Several studies have been conducted in the last couple of decades on this issue, some of which are discussed below.

2.2 TRAVEL BEHAVIOR AND ACCESSIBILITY INSIDE UNIVERSITY CAMPUS SETTING

Assad J. Khattak and Xin Wang conducted a study in University of Tennessee. Data from the 2010 fall ODU Student Travel Survey were used for this article. Many people throughout the world count Old Dominion University as their alma mater because of its reputation as a top-tier public doctorate research institution in Virginia. It's located in the metropolitan and cosmopolitan

metropolis of Norfolk, Virginia, on a major campus that spans an expansive 185 acres. The data showed that the percentage of out-of-town trips made by ODU students was significantly higher than that of the rest of the population in Hampton Roads. The percentage of walking trips decreased from 89% for on-campus students to 20% for off-campus students, and the percentage of driving trips climbed from 17% for on-campus students to 78% for off-campus students. Daily excursions were more common among undergraduates, full-time students, and students with jobs. Researchers at Amir Kabir University of Technology developed a Poisson and regression model to examine the demographics, preferences, and behaviour of their student body when it comes to travel. Students' transport modes were evaluated using an activity-based approach, and it was shown that walking is the most common. (Wang & Khattak, 2012).

Khalid Hamad and Lubna Obaid conducted research in Sharjah university. Over two thousand people's commutes to and from the urban university campus of Sharjah University City in the United Arab Emirates were analysed. They studied the patterns of transportation on a large college campus and identified demographic distinctions in the way people got around (e.g., students, faculty, staff, and visitors). Different perceptions and motives towards several transportation issues on campus were also explored.

The Identification of several findings that could be valuable for the university officials and planners were also highlighted. The researchers also recommended several measures to promote sustainable transport on campus, especially under a harsh weather environment.

Due to being in a country with a high per capita income, they discovered that most respondents drove alone. In addition, there were gender differences in mode choice; female students were less likely to use non-motorized transportation but more likely to take the bus than male students. However, when comparing male and female respondents, men are more likely to

choose active modes of transportation. Users of public transportation services reported that they do not consider taking the bus a sustainable means of transportation, but rather a necessity due to financial constraints. (Hamad, Htun, & Obaid, 2021).

In 2010, researchers at McMaster University set out to find out which commutes people would be prepared to take based on whether or not they were enjoyable. Questions were asked in the survey about people's travel habits, socioeconomic background, and perspectives on the relationship between transportation and land use and environmental sustainability. Conclusions showed that commuters who engaged in physical activity were more content than those who used private vehicles or public transportation. Frequent usage of a certain mode of transportation is attributable to factors such as the social environment, the availability of local activities, the quality of facilities, the productive use of the commute, and the intrinsic value discovered within the commute journey. (Paez & Whalen, 2010).

The historic Babarsari district of Yogyakarta, Indonesia, is where the study was carried out. The study's findings confirmed that factors like income and location do affect people's propensity to travel. No matter how far their homes were from the institution, the majority of respondents still opted to drive to class. People's varying socioeconomic statuses were thought to influence their mode of transportation preferences. In addition, students' travel preferences were affected by factors such as the proximity of their schools to other educational institutions, the regional density, and the availability of public transportation.(Devi, Roychansyah, & Herwangi, 2019).

Rahul Das, S. Vishal Kumar, Bhanu Prakash D., and S. S. V. Subbarao conducted research to analyze travel behavior of university students at VIT University, Vellore, Tamil Nadu. Students were categorized into two groups (on-campus and off-campus residents), they were requested to

provide their daily travel information along with their personal information. The results show a significant difference in travel patterns of students living on-campus and off-campus. The data also shows a contrast in mode usage, travel time and travel cost of the students, especially among on-campus and off-campus dwellers (Das, Kumar, Prakash, Dharmik, & Subbarao, 2016).

The study at McGill University Canada (University Transportation system) Report by Shaw et al described the concerns of the university students regarding the campus transportation system. The students were not satisfied by the transportation service in university. The students were asked about their problems regarding the service by using survey forms, emails, messages, and random interviews. The report stated that the main barrier regarding the inefficiency of available shuttle service in university was “long commute time” and “inaccessibility to stops and services.” The analysis showed that there was a problem of inappropriate routing which adds to the travel time and causes accessibility issues to some students and thus the demand was not fulfilled.

For their thesis, "Understanding and Modeling the Activity-Travel Behavior of University Commuters," Naznin Sultana Daisy, Mohammad Hesam Hafezi, and Lei Liu performed research at Dalhousie University, Canada. According to the data, pupils have a shorter commute time from their homes to the school than do the instructors and staff. Zero-inflated negative binomial models point out that if housing tenure is less than a year, it is more likely that the traveler will make more AT trips but fewer automobile trips. It also indicates that individuals living far from the campus will produce fewer transit trips than those who live nearer. Most college and university students, including those pursuing advanced degrees, like strolling around campus. The automobile is the preferred form of transportation for both faculty and guests. (Daisy, Hafezi, Liu, & Millward, 2018).

2.3 MODE CHOICE AND ACCESSIBILITY IN UNIVERSITY CAMPUS SETTING

McMaster University in Hamilton, Canada was used as a case study for the mode choice analysis conducted by Kate E. Whalen, Antonio Páeza, and Juan A. Carrasco. The study's most important findings indicate that students, in comparison to the overall population, are more likely to choose active forms of transportation. For this purpose, a multinomial logit discrete choice model is utilised to isolate the variables that predict modal preferences. The likelihood of utilising motorised modes increases with the density of the roadway network, whereas it decreases with the density of the sidewalk network. The benefits of both vehicle and bicycle trip time were quantified. (Whalen, Paez, & Carrasco, 2013).

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

When commuting, students frequently choose for foot and bike traffic. To better understand what influences college students to choose one form of transportation over another, researchers at McMaster University undertook a study. To achieve this goal, a utility-based model was created, and it was found that monetary considerations, personal preferences, and built-environment considerations (such as the number of streets and sidewalks) all play a role in determining which modes of transportation people ultimately choose to use. It turns out that the

more time spent in transit, the more the benefits of taking a vehicle or a bike decrease. It was also established that a person's decision to cycle to work is entirely up to them and not influenced by anyone else. (Das, Kumar, Prakash, Dharmik, & Subbarao, 2016).

Wang et al. studied the travel behavior of university students and located that traveling distance from university played a crucial role within the mode selection. Higher percentage of scholars who lived near or on campus walked to the university whereas percentage using automobile increased for commuters living far from the campus. Both student age and number of vehicles available showed positive associations with automobile trips, but negative associations with non-motorized trips (Wang F. , 2012).

Limamond et. al studied the travel mode choice and behavior of scholars during 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 were compared. There was not much difference within the travel characteristics of the sub-group which were male car-owners, male car non-owners, female car-owners, and feminine car non-owners. However, there was a difference within the mode selection. Vehicle owners chose to use their personal vehicles and instead of the other mode. Also, students chose to car-pool with a vehicle owner as against using another mode (Limanond, Butsingkorn, & Chermkhunthod, 2011).

Travel demand modeling is a mathematical relationship between travel demand and traveler and system characteristics. ("Activity Based Travel Demand Modeling of Thiruvananthapuram Urban Area ...") Furthermore, the study of special trip generators within a population is important as their travel choices are different as opposed to the public. 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. A total of 428 surveys were conducted among students of Undergraduate and Postgraduate level. Mode choice models were developed for hostellers and Day Scholars to determine the factors affecting its 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. Hostellers 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. NUST Van is the other mode most utilized by students living out of NUST (Sheikh, 2018).

A study was administered at McMaster University to review the factors affecting polymodal travel. An ordered probity model was developed, and it had been found that mode choice is contingent upon demographic, attitudinal and spatial/land use variables. Car users have low modality whereas walking mode users have high modality (Lavery, Paez, & Kanaroglou, 2013).

Poisson and regression model were generated for travel characteristics and mode choice of students at 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 (Dibaj, Golroo, & Habibian, 2017).

The effect 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 at Elementary, high school and university level, it was found that students use the commuting methods as paid for by their parents. However,

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 (Ubillos & Sainz, 2004).

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. The results of a survey in which participants were asked to rank the importance of various criteria, such as journey time, cost, and convenience, corroborated this finding. Without any financial incentive or modification to the travel environment, passengers are willing to share rides. (De Guzman & DIAZ, 2005).

2.4 ACCESSIBILITY TO MEDICAL SERVICES IN GENERAL

The study area was Florida, USA for this article. Multiple transportation modes are considered for the accessibility to the healthcare services. This study used the framework of 2 Step Floating Catchment Area Method (2SFCAM) for single-mode and multi-mode. The comparison between the single-mode and multi-mode 2SFCAMs showed that muti-mode 2SFCAM gives more realistic idea about accessibility whereas single-mode 2SFCAM overestimates and underestimates the accessibility in urban and rural areas respectively (Mao & Nekorchuk, 2013)

This study interrogated whether the spatial accessibility to healthcare services (HS) in residential and workplace neighborhoods has any effect on the use of healthcare services. The information compiled from numerous government sources was analysed using a binomial regression model. There was no correlation between the proximity of a person's home to a healthcare provider and their likelihood of using those services, the study found. Four categories

of HS, including gynaecologists, psychiatrists, primary care physicians, and cardiologists, were most likely to not exhibit this association. (Brondeel, Weill, Thomas, & Chaix, 2014).

2.5 SPATIAL ACCESSIBILITY TO MEDICAL SERVICES

The aim of this study was the development of urban accessibility measure to identify low accessibility areas so that alternate projects can be prioritized and vice versa. There are different types of accessibility measures that are described in this report that includes cumulative measure, gravity measure, utility measure and time-space measure. One of the applications of accessibility measures is to characterize the potential impacts of transportation projects. The results showed that different situation require different types of accessibility measures (Bhat, et al., 2000).

Accessibility is considered as one of the important criteria for the evaluation of performance of transportation system and land-use in a region. There are three types of accessibility measures that are described in this study that includes cumulative measure, gravity measure and utility measure. To measure the accessibility metrics four types of data were used in Sugar Access Method in GIS. Future projects should also include the accessibility measures for the improvement of projects (Khan & Motuba, 2020).

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter illustrates the methodology applied in conducting the research. The sampling procedure and the means of data collection are also discussed comprehensively. It also contains the methods of data analysis and the limitations of this research. Eventually, the framework for this research is explained.

The research delves deeply into modern occurrences in many fields, including data science, economics, psychology, and management, among others. The focus of this study is not on creating ideal decision models, but rather on elucidating the nature of observed phenomena. When looking into the dynamics of traffic studies and modal choice on a college campus, this method is ideal.

University traffic mostly comprises of student activities and movements to and from the departments and residential blocks primarily. The outside traffic consisting of day scholars and staff also interacts with the major highway traffic of the city. It influences the accessibility and mobility especially during morning and recess hours.

This chapter incorporates all the phenomenon that has an influence on accessibility to the major places of the campus. The prime focus of our study were the accessibility and travel frequency to the medical facilities, especially the NUST Medical Center. It also explains the

comparison of in campus medical services to those outside the campus regarding accessibility as well as the frequency of travel to them and preferred choices.

3.2 UNIVERSITY BASIC INFORMATION

Since its founding, National University of Sciences and Technology (NUST) has been one of the most prestigious educational institutions in Pakistan, thanks to its reputation for innovation and academic strength in subjects like engineering, mathematics, and technology. The H-12 campus is over 707 acres in size and features on-site dorms for both male and female students. There are a total of 7,197 students registered at the university, including 6,259 undergraduates and 938 postgraduates, and a total of 817 teaching and research faculty and staff.

The university is located near the Sri Nagar Highway which is a major freeway in the Capitol Territory. It is accessible from two major locations; Gate 1 and 2, and a few minor locations; gate 4 and 9. The university is located near some major traffic attracting universities which i.e., International Islamic University, (IIUI), FAST NUCES as well as the new Islamabad International Airport.

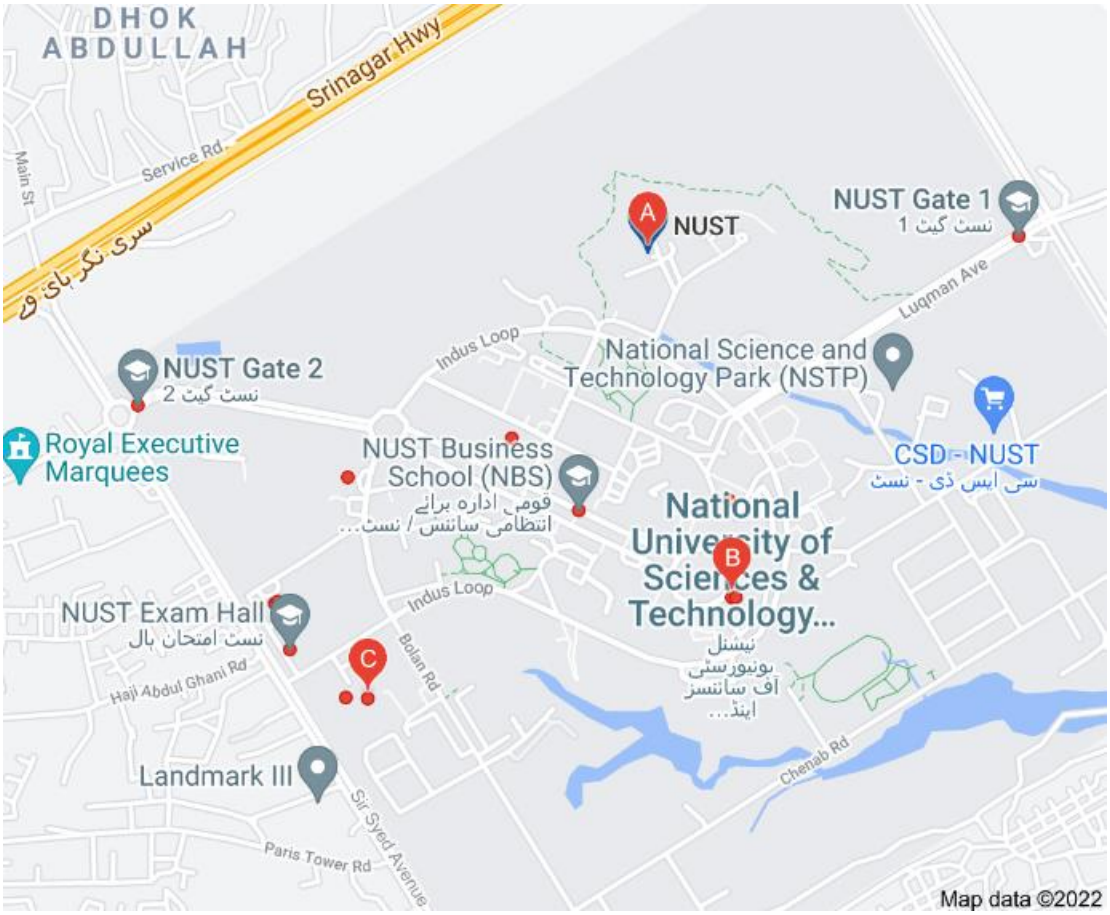

Figure 1: Map of Area under observation (NUST H-12 ISLAMABAD)

Students use different modes to travel to and from the university as well as within the campus. The outside traffic is mostly used by day scholar students and staff members on day-to-day basis and has certain peak hours, most notably during the morning hours and at 5 pm in the evening. The major modes of travel for this type of traffic are motor bikes, private cars and cabs including Uber/Careem rides. NUST also offers its own transportation services for day scholars mostly comprising of minibuses and vans. As far as inter campus movement is concerned, various modes of travel ranging from on foot movement and cycles to cars and buses are used. NUST also runs an effective and efficient shuttle service accessing all major locations to facilitate student and staff.

3.3 SURVEY

NUST Transportation Accessibility Analysis was conducted, and survey instrument selected for this study was Revealed Preference (RP) type for collection of student travel data. The survey questionnaire was divided into different parts.

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

The second part asked questions from hostellers. These questions inquired their preferred mode of travel, accessibility and efficiency of shuttle service and accessibility of different locations in the campus. The next part was related to the questions about the accessibility of medical services inside and outside of the university.

3.4 DATA COLLECTION

Google survey form was used to collect data from students belonging to different departments and hostels of the university. More than five hundred responses were collected to gather more reliable information and remain conservative. Both the hostellers and day scholars were accommodated to produce an all-inclusive report. A good number of male and female students filled the form which is representative to their actual numbers in the campus. The participants belonged all the departments of the university. Most number of responses came from NICE, the reason being its high number of students and origin of study. The detailed analysis of the results is discussed in next chapters.

Some of the main points acquired from the survey has been mentioned below.

- A total of 530 students participated in the survey out of which 301 were male and 229 were female.
- More than 90% of the participants were between the age of 18 and 24.
- 314 resided inside the campus while 216 lived outside.

3.5 MODELLING SPATIAL ACCESSIBILITY MEASURES

Accessibility depends on a lot of major and minor factors which may have varied effect on user preferences and modal choices. An important component among them is the land use component or the spatial distribution of various travel routes and destinations.The goal of accessibility modelling is to quantify how easy or difficult it is for a person or an entire region to access a certain facility, service, or resource by integrating ideas about destinations, mobility, distance, time, convenience, and impedances.

When measuring accessibility, there are three widely used techniques. These are:

1. Cumulative opportunity
2. Gravity measure
3. Utility measure

3.5.1 CUMULATIVE OPPORTUNITY

The opportunities that can be attained within a given budget (in terms of money, time, comfort, etc.) is the focus of the opportunity-based approach. Finding the nearest opportunities and calculating their distances from the origin or counting the number of opportunities available within a given distance/travel time is quite easy. The opportunities that can be attained within a given budget (in terms of money, time, comfort, etc.) is the focus of the opportunity-based approach. Finding the nearest opportunities and calculating their distances from the origin or

counting the number of opportunities available within a given distance/travel time is quite easy. It is the most used form of accessibility measure and can be simply written as:

$$A_i = \sum kE_j \qquad \textit{(Equation 1)}$$

Where,

*A*i is the number of available opportunities in region i,

Ej is the number of opportunities in region j, and

k is a constant having value 1 for region within a specified threshold, and zero otherwise.

3.5.2 GRAVITY MEASURE

To calculate the total cost of transportation from the point of departure to the destination, this model makes use of the distance/time decay function. The gravity model assumes that the magnitude of the interaction between activities/opportunities is proportional to the size of those activities, while the cost of travel and the distance between them are inversely related to the magnitude of the interaction.

The general measure of gravity model takes the form,

$$A_i = \sum_j \frac{S_i}{d_{ij}^{\beta}} \qquad \textit{(Equation 2)}$$

where Ai is the spatial accessibility for location i, Sj is service capacity at location j, d is the impedance, for example, distance or travel time, between the points i and j. β is the gravity decay coefficient, it is also sometimes referred to as the travel friction coefficient.

S

3.5.3 UTILITY MEASURE

A random utility function is the basis for the third type of accessibility metric. Using the principles of random utility theory, this model takes into account how a person's propensity to select a specific vacation spot varies depending on how valuable that spot is in comparison to others. It can be expressed as:

$$A_i = ln \sum exp(v_j - \beta d_{ij}) \qquad \textit{(Equation 3)}$$

Where Ai is the accessibility measure for individual i, vj is the advantage of choosing destination j, β is a distance-based sensitivity parameter, and dij is the distance between the individual i and destination j.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter extensively explains the findings of the survey form through an analytical approach to draw a conclusion. Various graphs and figures show the relation of demographical factors to accessibility. It finds out the major factors which affect the accessibility to medical facilities inside or outside a university area setting. It also includes the findings of gravity model which is used to calculate accessibility indexes for different medical facilities and shows the data of hospitals with respect to their rated accessibility.

4.2 SURVEY BASED RESULTS

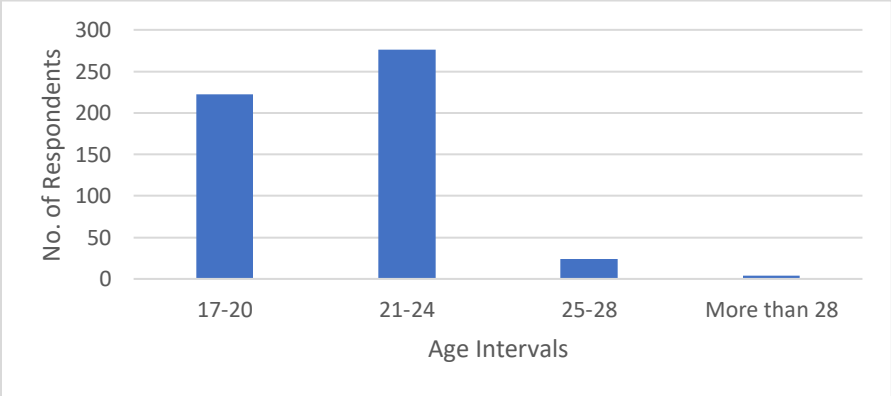

Figure 2: Age wise Distribution of the Survey Respondents

Figure 3 shows the frequency of survey respondents with respect to different age groups. Most people in NUST are either teenagers or belong to early twenties group as NUST offers a lot of undergraduate programs. Other than that, there are postgraduate students and staff members, but they are very less in number, and they usually have a self-owned vehicle, so they are not much affected by accessibility constraints.

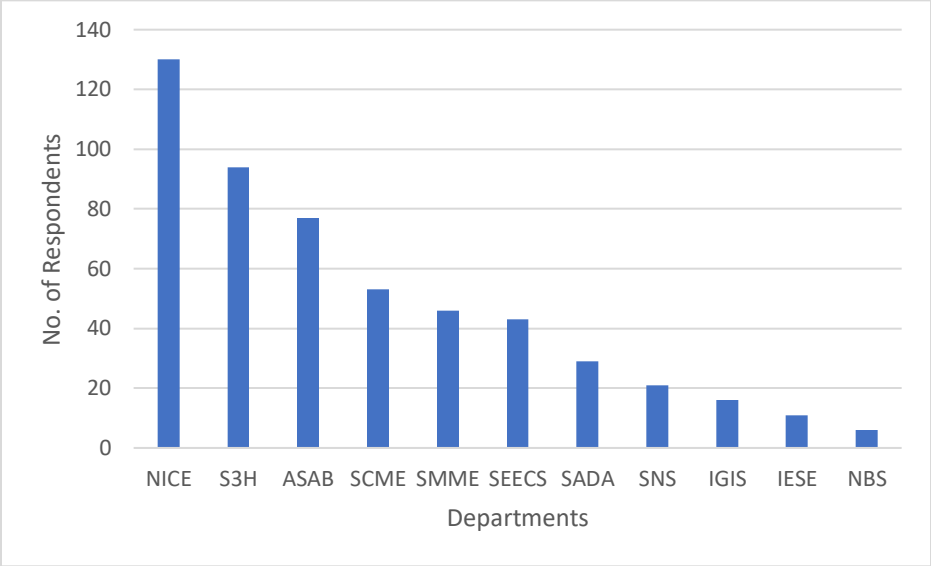

Figure 3: Department wise Distribution of the Survey Respondents

By analyzing figure 4 it can be extracted that we got most of the responses from the NICE and least number of responses from NBS. This is because students and staff in NICE have more tendency to understand the purpose of our survey as they have some knowledge of transportation and other departments may not be aware of the importance of our study. Also, responses were collected from all departments of university. Total number of students and staff members in a department has also affected the number of gathered responses.

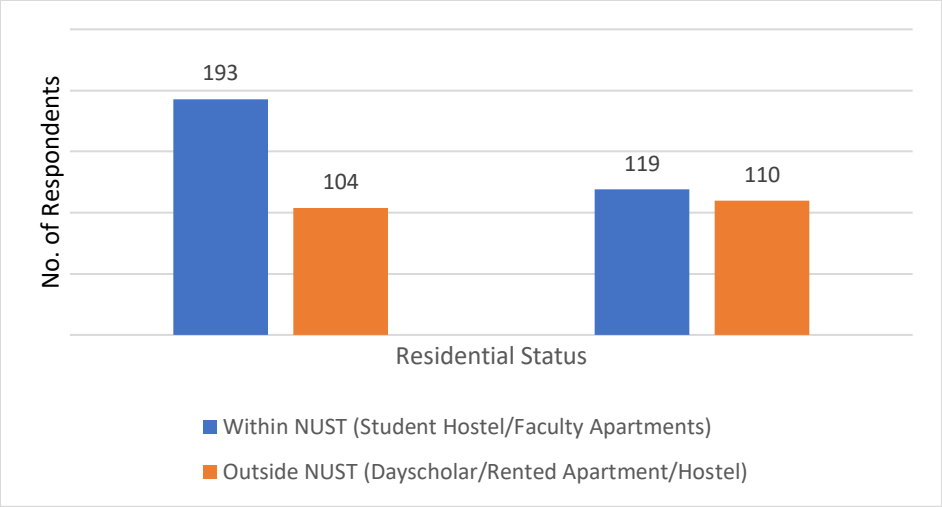

Figure 4: Gender Based Residential Distribution of the Survey Respondents

By the help of figure 5, we can see the number of survey respondents residing inside and outside the NUST. These stats help in studying the effects of demographical factors on accessibility. Left side graphs show male respondents and right side shows female respondents.

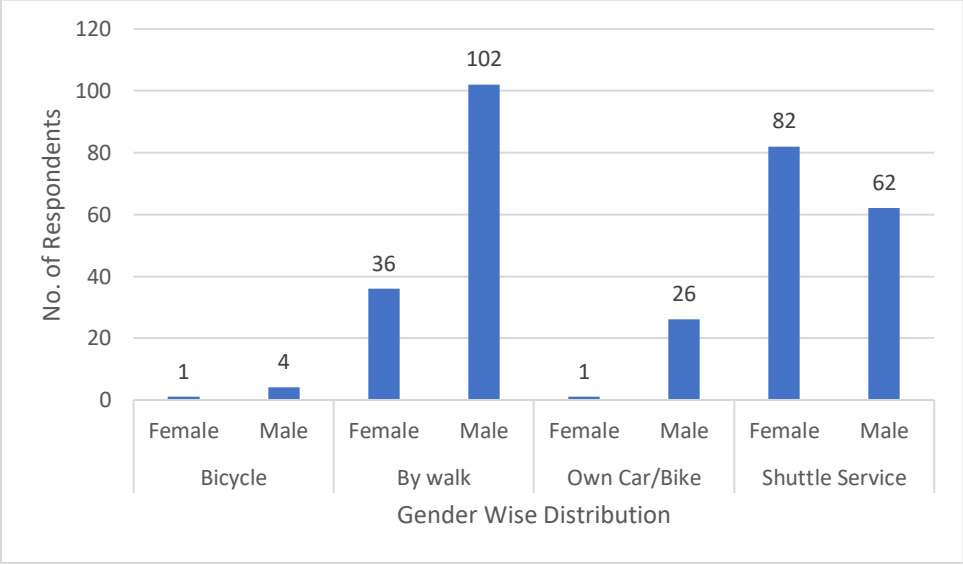

Figure 5: Travel Mode Distribution relative to Gender

Figure 6 shows the preferred mode of travel of males and females. Result shows that most of the males prefer to walk on other travel modes while most of the females prefer shuttle service.

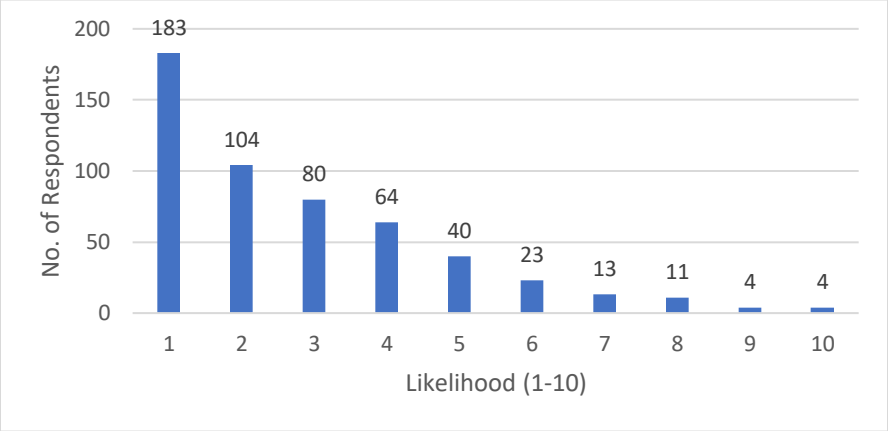

Figure 6: Likelihood of Visiting NUST Medical Centre

The above graph shows the rate at which our respondents visit NUST Medical Center NMC. From the results we can say that the greatest number of people visit NMC very less whereas few people visit NMC very often and moderate number of people visit NMC on average basis. Graph shows a downtrend, showing that very less people tend to visit NMC.

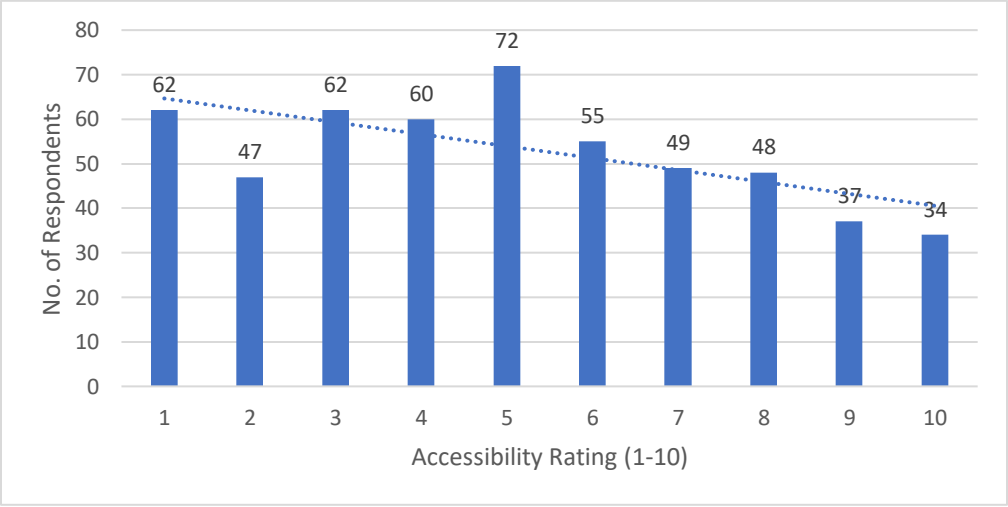

Figure 7: Accessibility to NUST Medical Centre

The above graph represents the rate of accessibility of NUST Medical Center NMC. Rating one represents lowest accessibility and rating ten represents highest accessibility. The results show that according to most respondents NMC has moderate accessibility neither very high nor very low. This data will help us in giving recommendations to improve the rate of accessibility to NMC.

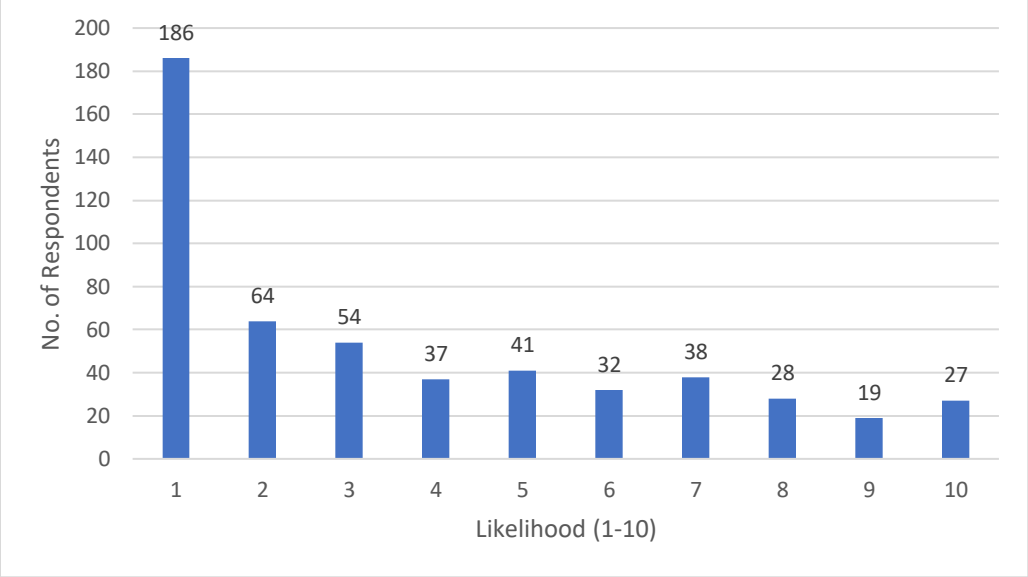

Figure 8: Likelihood of Visiting Medical Facilities Outside NUST

The above graph tells us how often people of NUST use medical facilities outside NUST. The results show that the greatest number of people do not avail medical facilities outside NUST due to inaccessibility which tells us the importance of improving accessibility to outside medical facilities outside NUST.

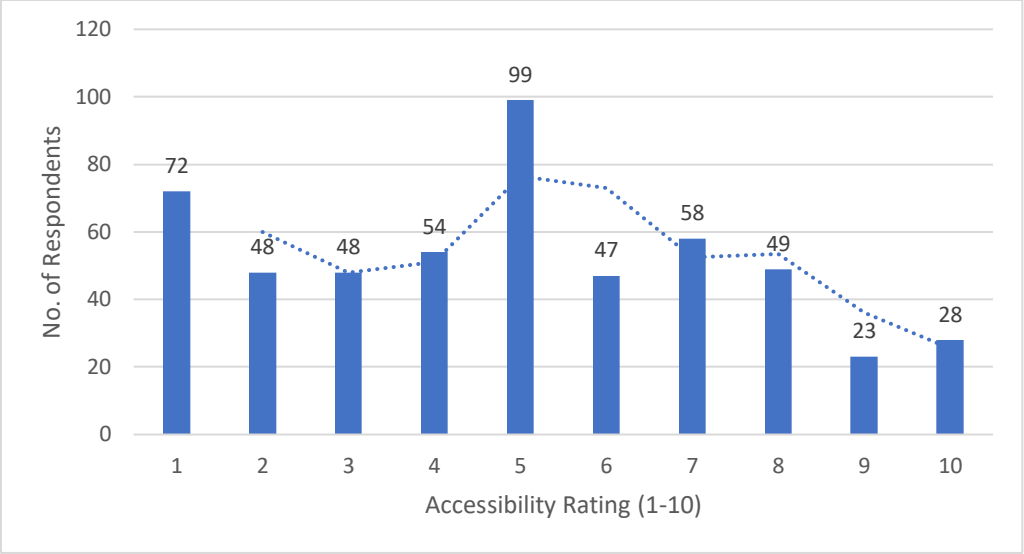

Figure 9: Accessibility to Medical Facilities Outside NUST

The above graph shows the rate of accessibility to medical services in terms of travel time. The results tell us that mostly it will take average time to access the outside medical facility. This shows that we should recommend such solutions which can minimize this time of travel.

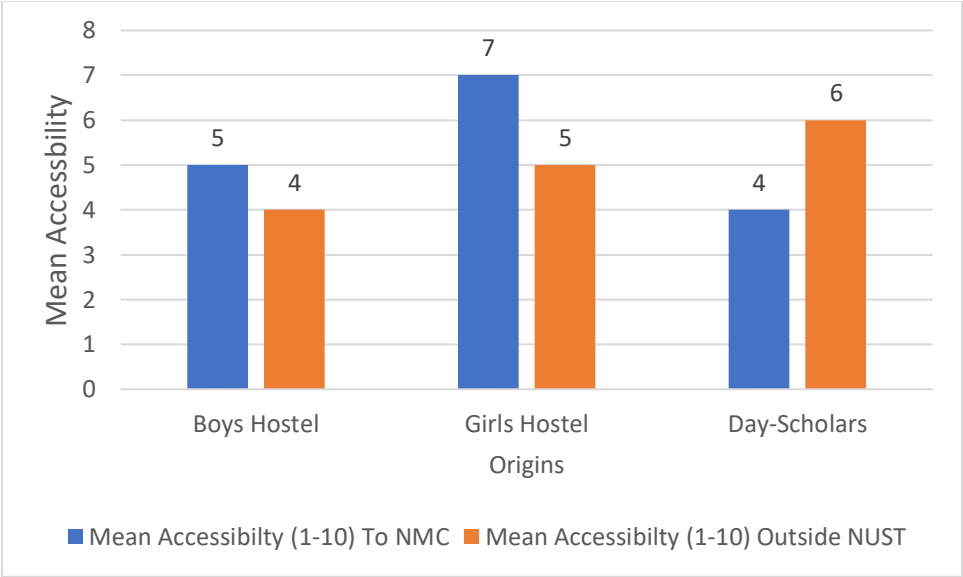

Figure 10: Mean Accessibility to NMC & Medical Facilities Outside NUST

Above figure shows mean accessibility to Nust medical center and other medical facilities outside Nust. Accessibility to NMC from girls' hostel is much better than from boys' hostel. Graph also shows that the accessibility of outside medical facilities is better for day-scholars then the people residing inside campus.

4.3 RESULTS BASED ON GRAVITY MEASURE

To calculate Accessibility indexes, we used gravity measure technique and following results were obtained.

Table 4.1 Accessibility indexes within NUST (from different origins to NMC)

INSIDE NUST				
Origin	**Destination**	**Walk Travel Time**	**β**	**Accessibility Index**
RUMI Hostels	NMC	16	8.33	9.32568E-11
UG Boys		19	8.33	2.22835E-11
Girls Hostels		7	2	0.020408163
SNS, SMME		17	8.33	5.62808E-11
NICE, USPCASE, EXAM CENTER		18	8.33	3.49607E-11
SADA, ASAB, IGIS, IESE		14	5	1.85934E-06
SCME		15	5	1.31687E-06
NBS		10	5	0.00001

For evaluation of transportation accessibility to NMC, gravity measure was used to get a numerical representation for each location. Decay factor values were obtained from Summary of travel trends NHTS 2017 (A. Fucci & McGuckin, 2018). Inside NUST, preferred mode of travel is walk, so with respect to travel time, accessibility to NMC decreases exponentially. It is obvious from human nature that an individual can travel by walk for only ten to fifteen minutes and after that he would rate the accessibility to be poor. Figure 4.10 depicts the same phenomenon for the decreasing values of accessibility indexes. To develop a relation that can be used to enhance inside

NUST accessibility, we used the travel-mode data, which states that inside campus accessibility can be increased by increasing the number of preferred travel opportunities. Extensive suggestions and recommendations are provided in later part of the thesis.

Table 4.2 Accessibility indexes outside NUST (from NMC to hospitals outside NUST)

Outside NUST					
0-8 mins					
Origin	**Destination**	**Auto Travel Time**	**β**	**Accessibility Index**	**Cumulative Accessibility**
NMC	PAEC Hospital	8	0.5	0.353553391	0.707106781
	IMC	8	0.5	0.353553391	
9-15 mins					
Origin	**Destination**	**Auto Travel Time**	**β**	**Accessibility Index**	**Cumulative Accessibility**
NMC	New Capital Hospital	10	0.7	0.199526231	1.789869626
	Capital International Hospital	11	0.7	0.186648765	
	Quaid-e-Azam Hospital	11	0.7	0.186648765	
	The City Hospital	13	0.7	0.166050296	
	Railway General Hospital	15	0.7	0.150222892	
	KRL Hospital	11	0.7	0.186648765	
	Clinics & Diagnostics	9	0.7	0.214798005	
	Noor General Hospital	12	0.7	0.175619658	
	Life Care International Hospital	13	0.7	0.166050296	
	Zobia Hospital	14	0.7	0.157655953	
16-20 mins					
Origin	**Destination**	**Auto Travel Time**	**β**	**Accessibility Index**	**Cumulative Accessibility**
NMC	Social Security Hospital	16	0.9	0.082469244	1.256200834
	Kawari Road General Hospital	19	0.9	0.070651561	
	Friends Hospital	17	0.9	0.078090099	
	Mariam Memorial Hospital	20	0.9	0.067464142	
	Anwar Hospital	20	0.9	0.067464142	
	Shifa International Hospital	17	0.9	0.078090099	
	Shifa Medical Centre	17	0.9	0.078090099	
	PIMS	19	0.9	0.070651561	

	Islamabad International Hospital	19	0.9	0.070651561	
	Maroof International Hospital	17	0.9	0.078090099	
	SARF Hospital	18	0.9	0.07417452	
	PAF Unit 2	19	0.9	0.070651561	
	Max Health Hospital	17	0.9	0.078090099	
	NIRM	16	0.9	0.082469244	
	Ali Medical Centre	20	0.9	0.067464142	
	Noori Hospital	18	0.9	0.07417452	
	Medical City International Hospital	20	0.9	0.067464142	
21-30 mins					
Origin	**Destination**	**Auto Travel Time**	**β**	**Accessibility Index**	**Cumulative Accessibility**
NMC	Polyclinic Hospital	22	1.3	0.017982518	0.251702789
	CDA Hospital	22	1.3	0.017982518	
	PAF Unit 1	21	1.3	0.019103587	
	PNS Hafeez Naval Hospital	24	1.3	0.016059255	
	Azeema Sheikh Hospital	25	1.3	0.015229232	
	PAK EMIRATES Hospital	23	1.3	0.016972812	
	CMH Rawalpinidi	30	1.3	0.012015514	
	MH Rawalpindi	23	1.3	0.016972812	
	Benazir Bhutto Shaheed Hospital	25	1.3	0.015229232	
	Hearts Hospital	30	1.3	0.012015514	
	Margalla General Hospital	22	1.3	0.017982518	
	Holy Family Hospital	27	1.3	0.013779298	
	Bilal Hospital	29	1.3	0.012556905	
	Al-Suffah Hospital	22	1.3	0.017982518	
	Al-Khidmat Razi Hospital	27	1.3	0.013779298	
	Abdul Sattar Family Hospital	24	1.3	0.016059255	
31-45 mins					
Origin	**Destination**	**Auto Travel Time**	**β**	**Accessibility Index**	**Cumulative Accessibility**
NMC	RWP Institute of Cardiology	32	1.7	0.002762136	0.014149208
	Al-Shifa Hospital	45	1.7	0.001547172	
	Fauji Foundation Hospital	40	1.7	0.001890158	
	Attock Hospital	41	1.7	0.001812456	
	OPD Complex	44	1.7	0.001607424	
	NIH	35	1.7	0.002371834	
	HBS General Hospital	37	1.7	0.002158028	

Table 4.3 Decay factor values (β)

Auto Travel Time Threshold	Beta Values
0 to 8 Mins	0.5
9 to 15 Mins	0.7
16 to 20 Minutes	1
21 to 30 Minutes	1.3
31 to 45 Minutes	1.7

Above table 4.2 shows the cumulative accessibility indexes for different medical amenities from Nust medical center. Data shows that the cumulative accessibility of time threshold of 9-15 and 16-20 mins is greatest which means hospitals within these time limit thresholds are accessible. Other time limit thresholds like 21-30 and 31-45 mins have accessibility index very less which shows they are not considered as accessible time limit thresholds in case of emergency.

But if we take a deeper look at the table, the number of public hospitals (Govt.) is greatest in 21-30 min time limit threshold and then in 31-45 min. Accessible time limit threshold have only one gov. sector hospital (KRL HOSPITAL). The comparison of time limit thresholds and accessibility indexes can also be seen in the following graph

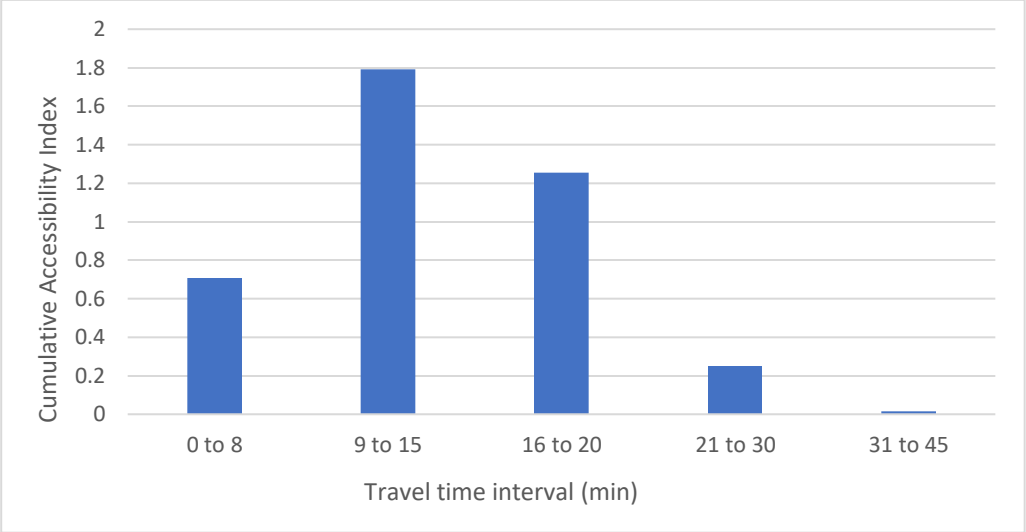

Figure 11: Cumulative Accessibility Indexes for Different Travel-time Threshold

Results from gravity measure shows that the medical facilities from NMC are not in accessible time limit threshold and it should be made accessible so that in any emergency, any casualty or loss can be avoided.

Chapter 5

CONCLUSIONS

In a university area setting, accessibility primarily depends on travel mode choice, which in case of NUST is found to be shuttle service for majority of female students and by-walk for male students. Accessibility to NUST Medical Centre from prime locations came out to be moderate according to survey results. For improving intra-NUST accessibility, preferred travel mode opportunities need to be upgraded. Accessibility to medical services outside NUST is also average with most users giving in a 5/10 rating. Gravity model shows that cumulative accessibility score for services within 9-15 minutes from NUST came out to be maximum. But major public sector medical facilities do not lie in this travel time threshold.

LIMITATIONS

Like every other research work, this study has limitations too especially after being the first of its kind. In this section, we will discuss the limitations of this thesis. The most prominent ones are mentioned below.

- The first among these is that the survey conducted for the study of accessibility to medical services within and outside of the campus was not entirely accurate. The respondents of the survey were mostly students and faculty/staff responses were very few.
- Some of the forms were not filled out accurately. These inaccuracies included incomplete responses and half-filled information. There were also confusion and misunderstanding on what was asked on a few occasions.
- Nust Medical Center is put in the same category as other hospitals despite having significantly lesser facilities. One of the main focuses of this study was to compare the amenities inside and outside of the university. Hence, the importance of NMC was exaggerated because it is the only facility available in NUST.
- This model cannot be applied to find accessibility to medical services for any other larger area university campus without making amendments. The gravity model and time-distance-based analysis applied in this research only yield results to find accessibility for residents of Nust only because these variables differ from place to place. This study, however, can be used as a piece of important literature review because it is the first of its kind and no other work related to this topic is available.

RECOMMENDATIONS

- The accessibility study for NUST can also be done for other emergency services like fire brigade, ambulances etc.
- Statistical models can be developed based on survey data to investigate different factors that can affect the accessibility to medical facilities inside NUST.
- Accessibility to medical facilities outside campus should be evaluated at different times of the day to capture the travel time variation effect.
- Detailed data from hospitals should be incorporated in the gravity measure to obtain more robust accessibility indexes.

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Appendix

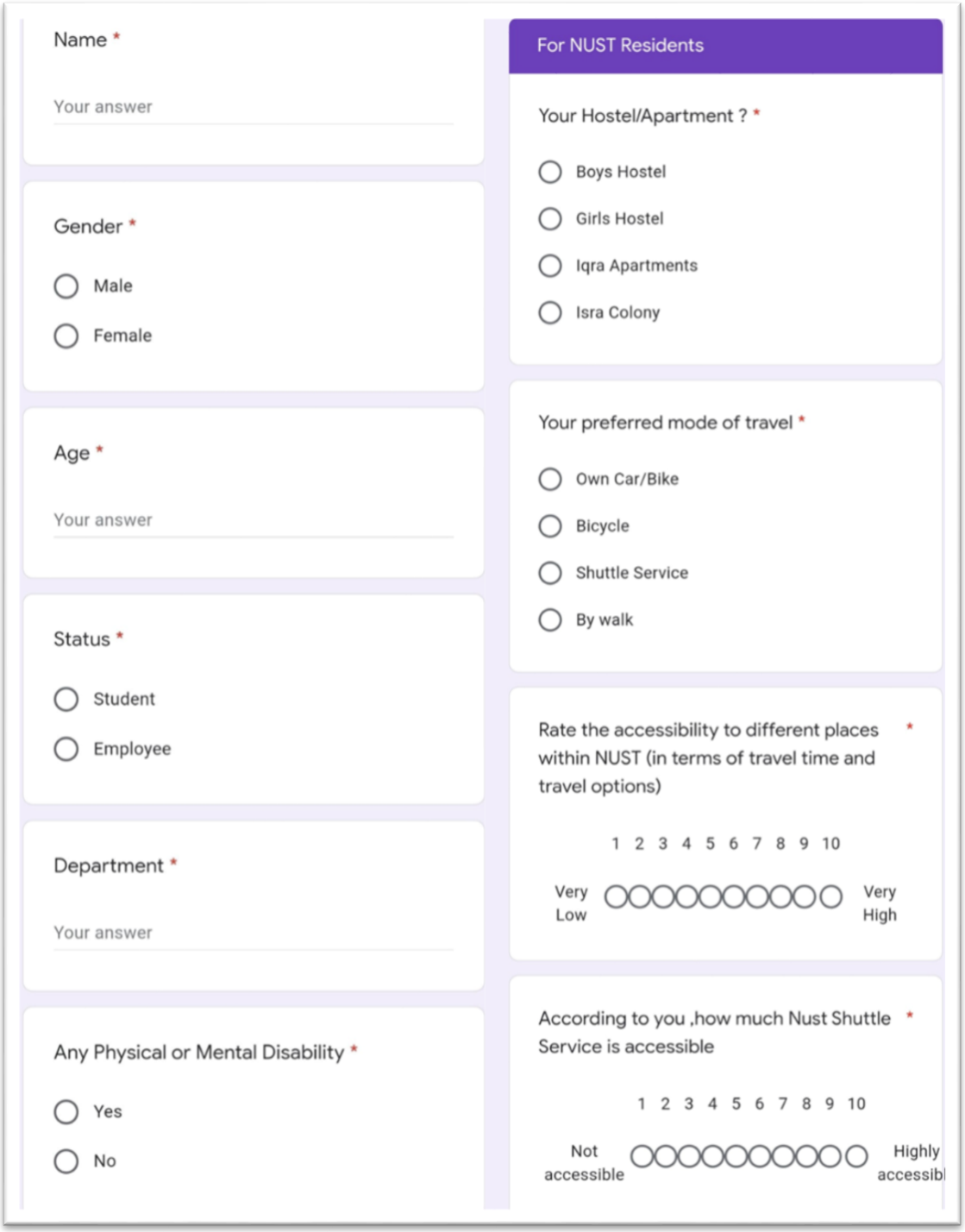

Figure 1: Survey Form I

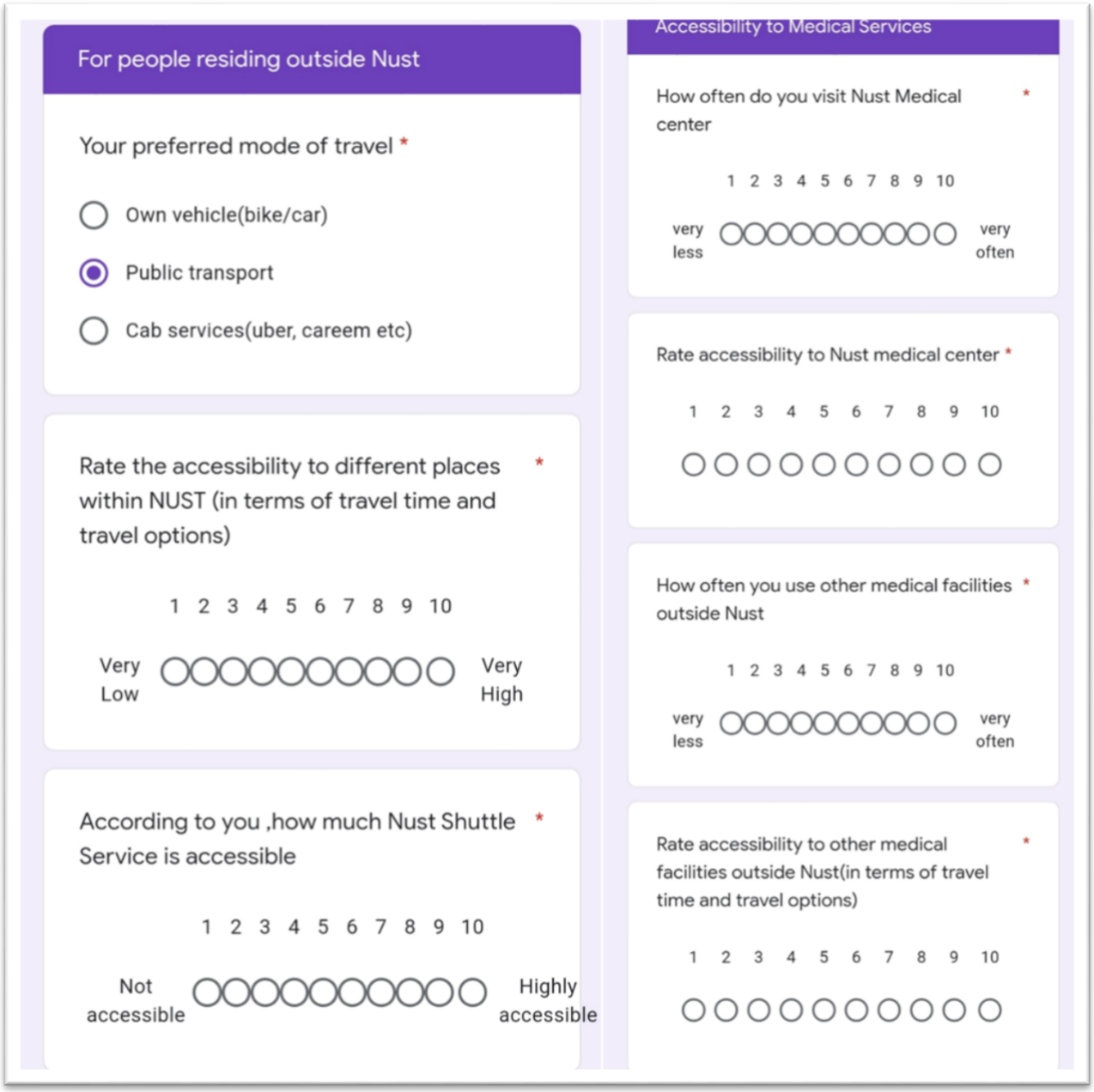

Figure 2: Survey Form II