An-Najah National University
Faculty of Graduate Studies

Transportation Mode Choice Model for Palestinian Universities Students: A Case Study on An-Najah New Campus

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Dedication

All Thanks for who provided me with their support to achieve my work successfully.

I dedicate my simple work for the dearest people to me my father, my mother, my dear husband and my little Laila.

Acknowledgment

My special thanks to Professor Sameer Abu-Eisheh for the continuous support accomplishing this thesis; for his patience, motivation, and immense knowledge. His guidance helped me in all the time of writing of this thesis.

There are a number of people without whom this thesis might not have been written, and to whom I am greatly indebted.

To my mother and father who has been a source of encouragement and inspiration to me throughout my life, a very special thank you for providing a 'writing space' and for nurturing me through the months of writing.

To my dear husband, for his practical and emotional support as I added the roles of wife and then mother, to the competing demands of work, study and personal development.

الإقرار

أنا الموقعة أدناه، مقدمة الرسالة التي تحمل العنوان:

Transportation Mode Choice Model for Palestinian Universities Students: A Case Study on An-Najah New Campus

نموذج لاختيار وسيلة المواصلات لطلبة الجامعات الفلسطينية: جامعة النجاح الوطنية- الحرم الجديد/ كحالة دراسية

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The work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

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Date: 31/5/2016 **التاريخ:**

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Transportation Mode Choice Model for Palestinian Universities Students: A Case Study on An-Najah New Campus

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Abstract

The aim of this research is to develop a transportation mode choice model to predict the utility function for transportation modes used in Palestinian universities, considering the New Campus of An–Najah National University, which is the largest university in Palestine, for this study case.

Analyses were conducted for the current situation of mode choice concerning main used transportations modes. The developed model covers the main three modes of transportation, the first mode is “Private car”, which includes the personal car, carpool and share a ride users, the second mode is “Shared taxi” as it is the most used mode among all other modes of transportation, and the third mode is “Bus”, which is fairly used, and it is important for future policy considerations, in order to encourage its use to assist in solving the mounting traffic problems.

A survey of primary information on mode choice was conducted, through questionnaires, distributed on a sample of university students.

The results indicated that the developed model exhibits a good fit, as the adjusted goodness-of-fit measure statistics rho-squares (ρ^2) for the model is 0.504.

The variables that mostly affected the mode choice are gender, car ownership, per capita family income, shared taxi travel cost, and bus travel time. As expected, those who own private cars prefer going to the university by their cars more than using public transportation modes. The results also show that the use of the private cars increases with the increase of the monthly family income divided by the family size (i.e., with the per capita income).

Moreover, as bus travel time and shared taxi travel cost increase; the use of the related utilities decrease, and that females choose buses and shared taxis more than males. Also, students prefer to choose private cars over buses and shared taxis as they believe the private cars are safer and more comfortable.

Future studies could be done by developing a mode choice model for employees, and for students traveling from university back to home, and use such studies findings for wider policy level actions, and to further development of the transportation planning processes in the Palestinian universities. Referring to the research results, many transportation alternative solutions could be done to encourage using public transportation; bus lanes or BRT (bus rapid transit) systems could be used to decrease travel time for bus.

Chapter One

Introduction

Chapter One
Introduction

1.1 General Background

Transportation planning plays a fundamental role in the state, region or community's vision for its future. It is considered a process designed to foster involvement by all users of the system, such as the traveling public, transportation operators, the relevant public institutions, the related business community, environmental organizations, and the general public.

Transportation planning process (as shown in Figure 1. 1) includes a number of steps starting with determining the regional vision and goals, alternating and evaluating the main strategies and ending with developing a system performance.

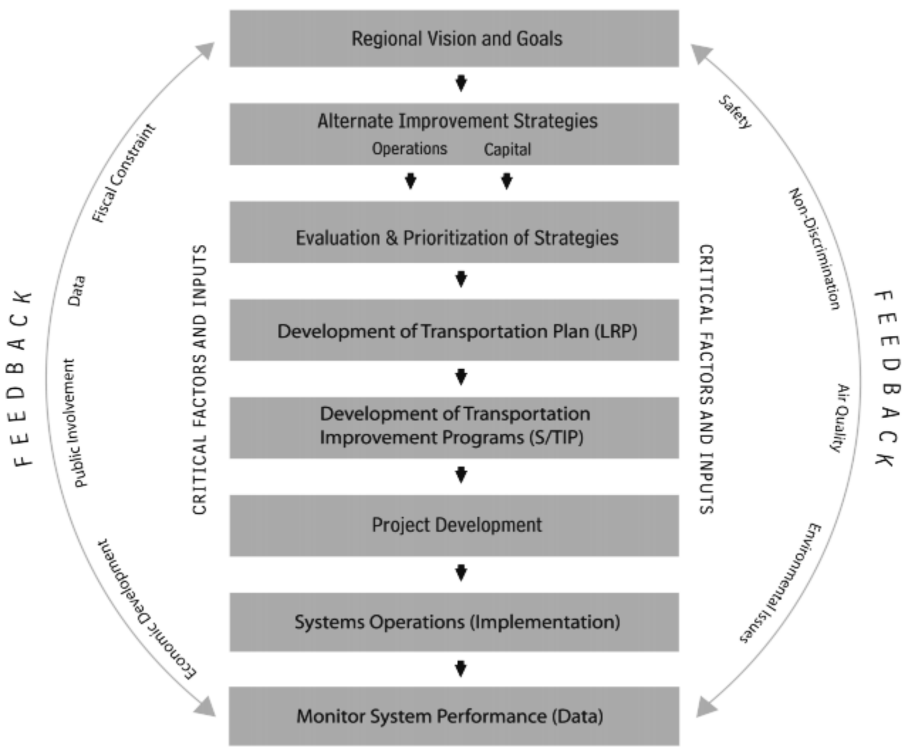

Figure (1.1): Transportation Planning Process

Source: FHWA (2007)

Typical daily decision-making process of individuals regarding the use of transport system involves mainly four types of decisions: trip generation, trip distribution, mode choice and route assignment. Modeling and forecasting of such decisions is of great importance in the transportation planning process.

Mode choice analysis is considered as the third step in the four-step transportation forecasting model following trip generation and trip distribution but before route assignment. Mode choice analysis allows the modeler to replicate what mode of transport would be used, and what is the resulting modal share.

Modeling are divided into aggregate and disaggregate behavioral modeling approaches, where the aggregate approach shares of all or a segment of decision makers choosing each alternative as a function of the characteristics of the alternatives, while the disaggregate approach concentrates on the individual choice responses as a function of the characteristics of alternatives available.

Mode choice is usually modeled using disaggregate (discrete) choice models as it better reflects how decision makers choose a specific alternative among a set of alternatives. However, conventional microeconomics makes strong assumptions concerning the decision maker’s ability to use perfectly all the information available and relevant to the decision and to make a completely rational, consistent decision given this information. A major relaxation of some of these assumptions is possibly through the introduction of the concept of random utility. These models recognize that, in practice, people do not always choose the "objectively best" course of action, nor do they necessarily exhibit consistent choices over time. That is, random utility theory still assumes that an individual will choose that alternative which appears to maximize his or her utility at the time at which the choice is being made. However, utility is assumed to consist of two components: the systematic, observable utility which is identical to the conventional microeconomic utility function; and a random term which is intended to capture such effects as variations in perceptions and tastes of individual trip makers as shown in Equation (3.3) (Domencich and McFadden, 1975).

1.2 Research Statement

This thesis highlights the mode choice part of the individual daily decision as there is lack of studies in mode choice modeling in Palestine in general, and for large trip attractors such as shopping malls, universities and schools, at specific.

The study will consider mode choice for An–Najah National University, which is the largest university in Palestine. For this case study, analysis will be conducted for the current situation of mode choice concerning main used transportations modes by students. This is considered to be important to understand the factors influencing choice of mode, and therefore, to conduct better planning for transportation mode related scenarios to serve the university especially as related to scenarios that encourage public transportation.

The continuous increase of travelers compared to the lack of proper transportation planning, especially in the public transportation sector, and the limitations of modes of transportation used, cause many problems, such as congestion and delay, and cause decrease in the roadway and network performance.

Using discrete choice models allows representing the choice of mode of transport based on an individual decision of what mode of transport is mostly used, which shows a clearer image of how do students make their own choice and focuses on the transportation issues.

The study can be used to understand the relationship between mode choice and the congestion problem in the city of Nablus including the considerable dependence on shared taxis. The results of the study can assist in exploring alternatives related to improvement in the provision of public transportations to relief congestion.

1.3 Research Objectives

The main objectives of the study are:

- Analyzing the current situation of main modes choice of transportation by university students.
- Identifying the factors that affect mode choice.

- Developing disaggregate passenger mode choice models in a multi-modal environment of the study area.
- Drawing conclusions regarding the use of public transportation and based on which lay foundation for proper recommendations.

1.4 Case Study

Nablus City is considered the second largest city in the West Bank after Hebron in terms of population; while An-Najah National University in Nablus is considered the largest university in Palestine and has the largest number of students.

In order to study the ability of applying transportation mode choice model for Palestinian universities; the case study area is selected to be the new campus of An-Najah National University as it is a good representitive generator considering its location on an arterial roadway and the large number of students.The study has considered a random sample size of students coming from their current residency to the new campus.

1.5 Research Outline

This thesis contains six chapters, which are summarized as follows:

- Chapter one presents the introduction, background, objectives, and study area.Chapter two reviews the relevant literature related to mode choice modeling, including for universities.
- Chapter three discusses the methodology.

- Chapter four displayes the case study and data collection.
- Chapter five presents the model development and analysis of the outcomes.

Finaly, chapter six provides summary, conclusions and recommendations of this study.

Chapter Two

Literature Review

Chapter Two
Literature Review

2.1 Introduction

A definition of essential concepts is presented within this chapter, combined with a literature review of relevant researches related to the issues in focus of this thesis. This includes consideration of the follows:

1. Urban transportation planning
2. Aggregate and disaggregate models
3. Mode choice modeling
4. Factors affecting mode choice modeling
5. Previous similar studies
6. Summary

2.2 Urban Transportation Planning

Transportation Planning is essentially the confluence of many different disciplines coming together in the first stages of the development of plans, policies and legislative activities, funding, and project development. The four steps of classical urban transportation planning system model are: trip generation, trip distribution, mode choice, and route assignment.

Hanson (1995) explains that transportation planning is undertaken at many levels from strategic planning to project level planning at different geographic scales in any urban area.

According to Meyer and Miller (2000) there are many transportation planning processes at any given time in an urban area, each defined at a different level of complexity and purpose; while transit planners examine alternative service configurations, traffic engineers identify congestion-reducing alternatives for the highway network, regional planners look at urban development patterns and the provision of public services; individual employers consider alternative employee transportation programs; and social service agencies examine transportation options to improve delivery of their services to targeted population group such as elderly and disabled.

Rosenbaum and Koenig (1997) illustrated that the urban transportation planning system model is divided into four stages as shown in Figure 2.1 and they are:

- Trip Generation which estimates the number of trips generated and attracted by a given spatial unit (particular traffic analysis zone).
- Trip Distribution which indicates a flow matrix between spatial units.
- Modal Split distributes trips between transportation modes.
- Traffic Assignment: The assignment, or loading, of vehicle trips to specific links in the highway network and person trips to links in the transit network occurs in this step.

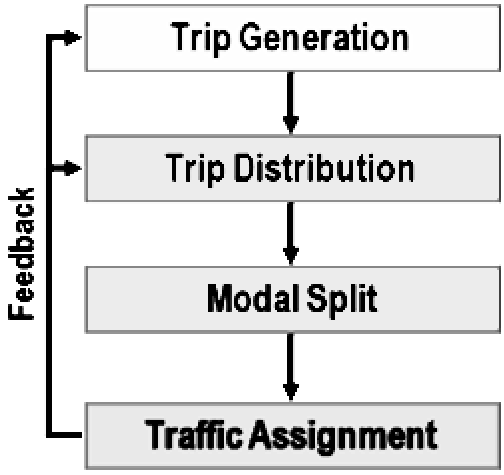

Figure (2.1): The Classical Four Stages Transportation Model

Source: Rosenbaum and Koenig (1997)

The Urban Transport Model System often referred as the 4-step model is commonly used to predict the flows on the links of a particular transportation network as a function of the land-use activity system that generates the travel (Hanson, 1995).

2.3 Aggregate and Disaggregate Models

There are two basic ways of modeling mode choice; aggregate (or group) and disaggregate (individual) behavior. One approach directly models the aggregate share of all or a segment of decision makers choosing each alternative as a function of the characteristics of the alternatives and socio-demographic attributes of the group (Koppelman and Bhat, 2006). This approach is commonly referred to as the aggregate approach. Aggregate modeling primary focuses on the mode choices made by average individuals for trips. Therefore it uses aggregated data which obscures much of the information in the data.

The second approach is to recognize that aggregate behavior is the result of numerous individual decisions and to model individual choice responses as a function of the characteristics of alternatives available to and socio-demographic attributes of each individual (Koppelman and Bhat, 2006). This second approach is referred to as the disaggregate approach. Therefore, the individual will select the mode having the maximum attraction, due to various attributes which is known as utility maximization (Ben-Akiva and Lerman, 1985).

The disaggregate approach has several important advantages over the aggregate approach to modeling the decision making behavior of a group of individual (Ben-Akiva and Lerman, 1985), which include:

- First, the disaggregate approach explains why an individual makes a particular choice given his or her circumstances and is, therefore, better able to reflect changes in choice behavior due to changes in individual characteristics and attributes of alternatives.

- Second, the disaggregate approach, because of its causal nature, is likely to be more transferable to a different point in time and to a different geographic context, a critical requirement for prediction.

- Third, discrete choice models are being increasingly used to understand behavior so that the behavior may be changed in a proactive manner through carefully designed strategies that modify the attributes of alternatives which are important to individual decision makers. The disaggregate approach is more suited for proactive policy analysis since it is causal, less tied to the estimation data and more likely to include a range of relevant policy variables.

- Fourth, the disaggregate approach is more efficient than the aggregate approach in terms of model reliability per unit cost of data collection. Disaggregate data provide substantial variation in the behavior of interest and in the determinants of that behavior, enabling the efficient estimation of model parameters.

- Finally, disaggregate models, if properly specified, will obtain un-biased parameter estimates, while aggregate model estimates are known to produce biased (i.e., incorrect) parameter estimates.

According to Bhat et al. (1998), the aggregate approach, on the other hand, rests primarily on statistical associations among relevant variables at a level other than that of the decision maker. As a result, it is unable to provide accurate and reliable estimates of the change in choice behavior due to changes in service or in the population. Moreover, aggregation leads to considerable loss in variability, thus requiring much more data to obtain the same level of model precision.

2.4 Mode Choice Modeling

Mode choice analysis is considered as the third step in the four-step transportation forecasting model.

Many urban areas are plagued by a continuing increase in traffic congestion resulting in motorist frustration, longer travel times, lost productivity, increased accidents and automobile insurance rates, more fuel consumption, increased freight transportation costs, and deterioration in air quality. Awareness of these serious consequences of traffic congestion, urban areas are examining and implementing Transportation Congestion Management (TCM) and Transportation System Management (TSM) policies. Urban travel mode choice models used to evaluate the effectiveness of TCM policies in shifting single-occupancy vehicle users to high-occupancy vehicle modes (Lawton, 1989).

Ben-Akiva and Lerman, (1985) defined the mode choice model as one which represents the decisions that consumers make when confronted with alternative modal choices. These decisions are made on the basis of the terms upon which the different travel modes are offered, includes the travel times, costs and other level-of-service attributes of the competing alternative traveling modes, in addition to relevant socio-economic and land use characteristics.

Transport modes cover the private automobile, public transport (including bus, light rail, tram, metro, shared taxi, and taxi), walking and cycling, and at the other end of the scale they can also cover air, sea, and freight transportation.

The size of the choice set determined assists in the selection of an appropriate mode choice model in order to forecast the travel behavior of the study region. A mode choice model is divided into binary and multinomial choice models depending on the number traveling modes; if the choice set consists of two traveling modes, or two sets of traveling modes, a binary modal split model can be applied. Contrarily, multinomial modal split models can be selected for larger choices sets as shown in Figure 2.2 (Khan, 2007).

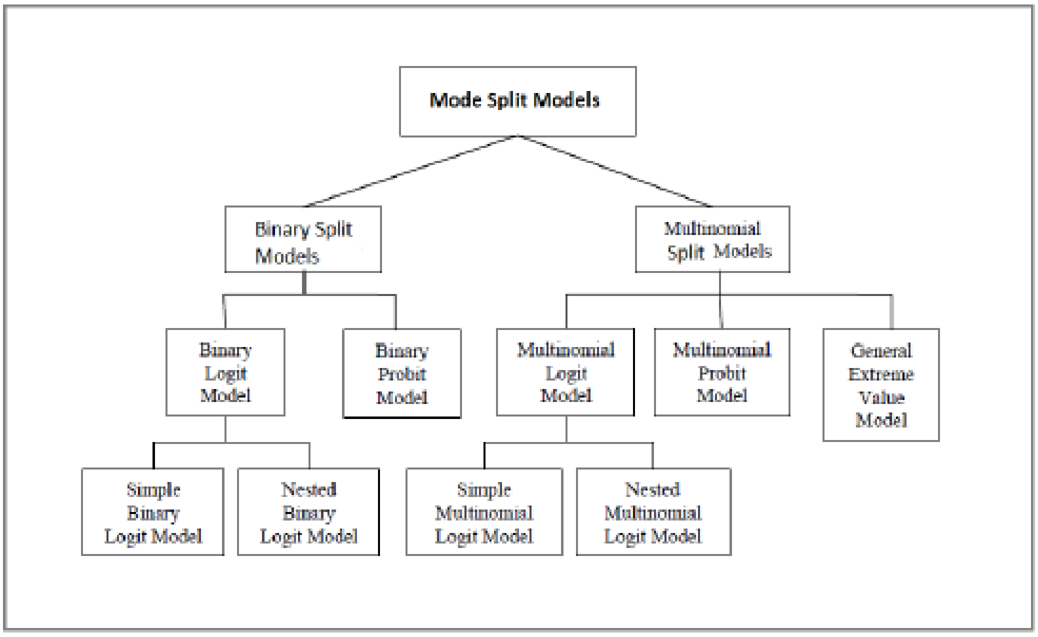

Figure (2.2): Classification of mode choice models
Source: Khan (2007)

2.4.1 Discrete choice model

The models that tend to present the travel behavior of the individuals when provided with a discrete set of travelling alternatives are commonly known as discrete choice models.

However, according to Koppelman and Bhat (2006) discrete choice models can be used to analyze and predict a decision maker's choice of one alternative from a finite set of mutually exclusive and collectively exhaustive alternatives. Such models have numerous applications since many behavioral responses are discrete or qualitative in nature; that is, they correspond to choices of one or another of a set of alternatives.

An individual is visualized as selecting a mode which maximizes his or her utility (Ben-Akiva and Lerman, 1985). The utility of travelling mode is defined as an attraction associated to select the mode having maximum attraction, due to various attributes such as in-vehicle travel time, access time to the transit point, waiting time for the mode to arrive at the access point, interchange time, traveling fares, parking fees, etc. This hypothesis is known as utility maximization and all the travel demand models (Ortuzar and Willmusen, 2001).

There are various forms of mode choice model (e.g., probit or logit or general extreme value), but by far the most common form is the logit model, the main reasons for choosing them are their simple model formulation and estimation techniques. Other mode choice models such as probit and general extreme value models cost more and more complex at mathematical structure and computational estimation. Therefore, the logit models continue to remain dominant in the transportation modeling area (Khan, 2007).

2.4.2 Logit Models

Logit models are the most commonly used modal split models in the area of transportation planning, since they process the ability to model complex travel behaviors of any population with simple mathematical framework of logit models, based on the theory of utility maximization, which assumes that an individual's choice is determined by the indirect utilities of each alternative and the individual can choose the one that maximizes his/her utility level.

It was concluded that logit models associate the most particular modeling framework, out of all modal choice models, although they are based on the Independence of Irrelevant Alternatives (IIA) property which assumes that all the travelling modes used in the choice set are independent of each other. This condition is, however, relaxed with the use of a tree structure that combines the correlated modes into one nest (Ben-Akiva and Lerman, 1985).

Logit model is divided into two types; binary and multinomial logit model. The binary logit model is capable of modeling with two discrete choices only, i.e., the individual has only two possible alternatives for selection, while the multinomial logit model is capable of modeling more than two discrete choices.

The multinomial logit model is widely used in a variety of transport-related choice contexts. Compared with the other choice models, the multinomial logit model is particularly attractive in many modeling scenarios due to the nature that it is linked to the decision-making behavior via maximizing (or minimizing) the utility (Li, 2011).

Multinomial logit models are categorized into simple and nested logit models, based on the characteristic of the available travelling alternatives in the choice set.

Simple Multinomial Logit Models (MNL) assume that all of the alternatives are independent and each should be analyzed separately. Figure 2.3 shows an example of simple multinomial logit model.

The derivation of the nested logit model is based on the assumption that some of the alternatives share common components in their random error terms. That is, the random term of the nested alternatives can be decomposed into a portion associated with each alternative and a portion associated with groups of alternatives as shown in Figure 2.4.

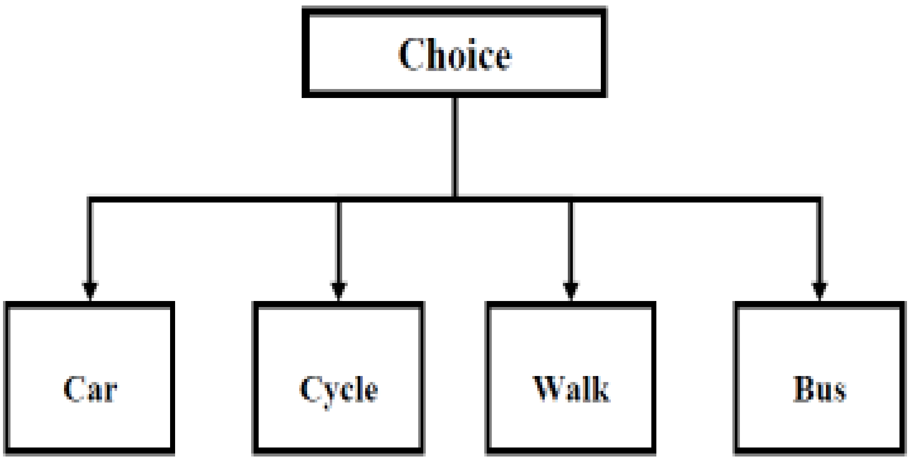

Figure (2.3): An example of simple multinomial logit model

Source: Khan (2007)

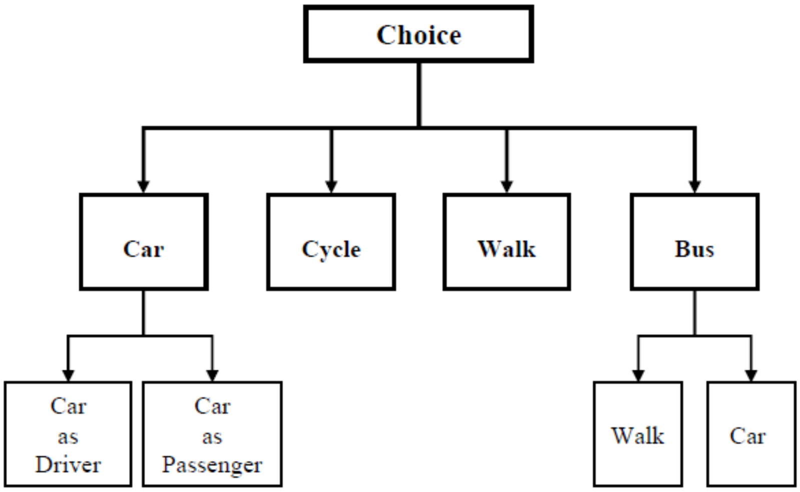

Figure (2.4): An example of nested multinomial logit model

Source: Khan (2007)

2.5 Factors Affecting Mode Choice Modeling

The choice of transportation mode is probably one of the most important traditional models in transport planning. This is because of the public role played by public transport in policy making.

According to Páez and Whalen (2010), traditional theories found in the economics, planning, and engineering literatures deal with the idea that transportation is a derived demand with the only purpose of getting an individual from an origin to a destination, or from an activity to an activity. Therefore, the travel time and the travel cost spent on traveling are always disutilities, a cost to be paid in order to reach spatially dispersed activity locations.

Earlier research had clearly shown that individual and household socio-demographics exert a strong influence on travel mode choice decisions. Specifically, gender, income, car ownership and employment status affect travel mode decisions (Bhat and Sardesai, 2006). However, may not be true for all, it has been argued that there may be many who pay this cost gladly, in fact finding a measure of enjoyment and utility in the act of traveling (Páez and Whalen, 2010).

Public transport system is high passenger occupancy vehicles, which are usually provided by government and other governmental and non-governmental agencies at users' costs in the form of fares. However, in some countries private enterprise provides public transportation services. Formal public transport system is deemed significant because of the following reasons (Aworemi et al. 2008):

1. The growth of private car use tends to intensify congestion costs, environmental hazards.
2. The energy costs, which are socially and politically unacceptable.
3. Due to reasons of age, disability, or poverty, a large proportion of the population may never own private vehicles, and hence there is need to provide public transport for them.

In practical modeling work, the difference between the socio-economic characteristics of similar group of individuals is usually ignored (Ortuzar and Willumisen, 2001). Although this approach makes the whole process simple overall, there is still a possibility of occurrence of severe differences among various groups of people. This can be handled by segmenting the entire set of individuals into separate utility functions for each group of more similar individuals so that individual characteristics could be omitted from the utility function (Kilburn and Klerman, 1999).

2.6 Previous Studies

Many studies have been conducted around the world in the area of mode choice modeling. The studies aimed at developing discrete choice models that fit with the study area and settings. Some of these studies are briefly discussed, in chronological order, in this section.

2.6.1 General Mode Choice Models

Al Ahmadi (2006) developed behavioral mode-choice models for Saudi Arabia and validated them with an independent sample for work, Aumra and social trips. These models indicated that in-vehicle travel time, out of pocket cost, number of family members travelling together, monthly income, travel distance, nationality of traveler, and number of cars owned by family, played the major role in decisions related to intercity mode choice. These models will be helpful in travel demand analysis for Saudi Airlines, Ministry of Transportation, as well as, bus and train operators.

Khan (2007) estimated various nested logit models for different trip length and trip purpose using data from Stated Preference (SP) survey. A Computer Assisted Personal Interviewing (CAPI) instruments was designed using motorized and non-motorized travelling modes in the SP choice set. The study found from the final model estimation that the travel behavior forecasted for regional trip makers is considered different from that for local trip makers. The regional travelers for work were found not to perceive the non-motorized modes as valid alternatives to car, obviously due to longer trip length. He also noticed that a large part of the targeted group are using private cars and not likely to switch to public transportation even if a more efficient transit infrastructure is implemented.

Adjaka (2009) analyzed factors that influence parents' decision in choosing transportation modes for school children in the District of Columbia. The objective of this research was to revive the tradition of walking and bicycling safely to school for the health benefit of students, for the improvement of air quality around schools, and for a decrease in traffic congestion during peak hours. Multinomial logistic regression was used to predict the share between choice modes. Factors that were found to be significant in predicting mode choice included distance home-to-school, student's grade, school's encouragement of walking and biking, and walking/biking fun for schoolchildren.

Al Raee (2012) developed a mode choice model for work trips in Gaza city and therefore investigated the factors that affect the employed people's choice for transport modes. The results of his research showed that the factors that the total travel time, total cost divided by personal income, ownership of means of transport, distance, age, and average family monthly income are the main factors that affect the choice of transportation modes. The results also indicated that the travel time, fare divided by personal income, frequency of service, age, average family monthly income and distance are the factors that affect the work mode choice model. The developed models can be used for predicting the future modal split by inputting predicted future value of exploratory variables.

2.6.2 Mode Choice Models in Universities

Limanond et al. (2010) examined travel patterns of 130 students who study and live on campus in a rural university of Thailand. It was found that students of both genders appeared to have similar travel patterns in all aspects. Whether they own a private vehicle does not appear to impact daily trip generation nor the total distance traveled of the students, but it does have an effect on the travel modes used by students. Those students who own a private vehicle mostly rely on driving the vehicle, while those who do not own a vehicle rely on three modes of travel: primarily being a passenger in a friend’s private vehicle, and to a lesser extent, driving a friend’s vehicle, and taking a bus (the only form of public transport on the campus). The results indicate a high social interdependency among university students, which makes the development of a model to simulate travel behavior of university students a complicated task.

Almasri (2011) analyzed the factors that affect travel choice of shared taxi versus bus for Palestinian university student trips in Gaza Strip. The results indicated the factors that are significantly affecting the mode choice of students: family income divided by family size, weighted travel time, out of vehicle travel time divided by distance and cost divided by natural logarithm of income. On the other hand, Almasri found that the age and gender variables are statistically insignificant and these were dropped from the modeling attempts. The study results can be used to assist decision-makers in developing policies. That encourages more students to use buses, thus leading to mitigate traffic congestion. Using the developed model, one can estimate future modal splits by inputting predicted future values of the explanatory variables.

Eluru et al. (2012) employ a unique survey as part of the McGill University Sustainability project. The survey collected information on commute patterns of students, faculty and staff from McGill University in Canada. The study explained that travel mode choice results clearly highlight the role of travel time, number of transfers, walking time, and initial waiting time on the propensity to choose transit. Further, the transit route choice results provide interesting insights. The results indicated that individuals find travel time on the bus mode the most onerous while they are similarly sensitive to travel time on metro and train. They indicated that public transportation agencies should investigate the reasons for this apparent discomfort and propose remedial measures to alter this.

Danaf et al. (2014) developed a discrete mode choice model to predict the utility function for the choice among car, bus, and shared taxi for students of the American University of Beirut (AUB) and the general population of the Greater Beirut Area. It was found that travel time, cost, income, auto ownership, gender, and residence location are the main factors affecting mode choice. It was suggested that the increase of parking fees and the decrease of bus travel time through the provision of shuttle services or taxi sharing could be promising strategies for mode switching from car to public transport for AUB students.

2.7 Summary

Aggregate and disaggregate models are the two methods of modeling mainly considered in mode choice modeling, aggregate modeling approach refers to the group or the approach that directly models the aggregate share of all or a segment of decision makers choosing each alternative as a function of the characteristics of the alternatives, while the disaggregate approach is recognized as that aggregate behavior is the result of numerous individual decisions and to model individual choice responses as a function of the characteristics of alternatives.

Discrete or disaggregate choice models could be defined as the models that tend to present the travel behavior of the individuals when provided with a discrete set of travelling alternatives.

Discrete mode choice models are divided into binary and multinomial choice models depending on the number traveling modes; if the choice set consists of two traveling modes, or two sets of traveling modes, a binary modal split model can be applied. Contrarily, multinomial modal split models can be selected for larger choices sets.

The multinomial logit model is widely used in a variety of transport-related choice contexts. Compared with the other choice models, the multinomial logit model is particularly attractive in many modeling scenarios due to the nature that it is linked to the decision-making behavior via the maximizing the utility or minimizing the disutility.

Earlier researches have clearly shown that the factors that have a strong influence on travel mode choice decisions are as following:

1. Trip Variables such as trip purpose, trip length, and time in which the trip occurs.

2. Socio-economic Variables such as the income, car ownership, age, gender and employment status.

Travel System Variables such as the relative travel cost among all modes, the service level for each mode (comfort, safety and the ease of switching between modes), and the travel time a mode needs for the distance from the origin to the destination.

Chapter Three

Thesis Methodology

Chapter Three
Thesis Methodology

3.1 Introduction

This chapter describes the steps followed in order to achieve the objectives of the study. To analyze the individual's daily decisions regarding the transportation mode choice choices, taking An–Najah National University new campus students' choice of mode as the case study, the following is the methodology adapted in this study which is composed of:

1. Gathering general information.
2. Designing survey sample.
3. Designing the questionnaire.
4. Testing the questionnaire, considering the outcome of the conducted pilot sample.
5. Determining method of survey.
6. Developing mode choice using multinomial logistic regression.
7. Conducting data analysis and calibration of the model.
8. Model validation.
9. Drawing conclusions.

3.2 General Information Gathering

Accurate data collection is essential to maintaining the integrity of research, regardless of the field of study. The proper selection of research related data reduces occurrence of errors.

In this study, general information gathering was conducted first including existing information and field observation surveys.

The study made use of key documents about the location of An-Najah New Campus and the surrounded area, and the total number of students (graduate and undergraduate). In addition, the study considers available transportation modes used for travel to the campus.

Data were collected by contacting Palestinian Ministry of Transportation, Palestinian Central Bureau of Statistics, An-Najah National University, and Nablus Municipality through interviews, and via email and telephone, visits and by exploring their websites.

To specify the population of case study, statistics from An-Najah National University (Human Resources and the Computer Center) were collected.

It was found that the total number of students at An-Najah New campus is 13,462 for the academic year 2013/2014.

3.3 Designing Survey Sample

The sample size is an important feature of any empirical study in which the goal is to make inferences about a population from a sample.

Larger sample sizes generally lead to increased precision when estimating unknown parameters but it would be too expensive and a waste of time and effort, where a smaller sample size would save time and effort over accuracy. Therefore, between these two extremes lies the most efficient sample size for the given the study objective.

The sample size was selected randomly and calculated using the relevant statistical formula and distributed on the faculties.

The statistical formula used could be found in most statistical textbooks and it is:

$$n = \frac{\left(Z\alpha/_{2}\right)^{2}(\pi)(1-\pi)}{E^{2}+\frac{\left(Z\alpha/_{2}\right)^{2}(\pi)(1-\pi)}{N}} \tag{3.1}$$

Where:

n: is the sample size

Z: is the normal distribution factor from statistical tables

α: is the 1-confidence level

π: response distribution factor

E: acceptable margin of error

N: size of population

3.4 Designing the Questionnaire

Questionnaires are widely used to collect information about people's level of knowledge, attitude, personalities, beliefs, or preferences. Well-designed questionnaires are highly structured to allow the same types of information to be collected from a large number of people in the same way and for data to be analyzed quantitatively and systematically (Leung, 2001).

Questionnaires are best used for collecting factual data and appropriate questionnaire design is essential to ensure that responses are obtained valid to the raised questions.

In designing the questionnaire, two main objectives were considered:

1. Maximizing the response rate through proper administration of the questionnaire had been considered carefully by explaining the purpose of the survey, and reminding those who have not responded.

2. Obtaining accurate relevant information for the survey by testing the drafted questionnaire on a small sample of people and modifying the final questionnaire based on their notes and queries.

The questionnaire consists of 5 pages, which starts with an introduction explaining briefly the purpose of the survey and the importance of the respondents' participation. The other pages contain 22 questions constructed from two parts, with each part dealing with a specific subject. The following illustrates the questions included in each of the parts:

- The first part of the survey included demographic, social and economic information of the respondent. Those include questions on gender, age, marital status, family size, number of kids, career, faculty, family income, educational level and permanent and temporary residence.

- The second part contains of questions related to the modes of transportation those include questions on car ownership, mode of transportation used from home to university and vice versa, travel time and cost and an evaluation of the mode used in terms of comfort, speed, cost and safety.

3.5 Pilot Questionnaire

A pilot questionnaire is a questionnaire performed in preparation for a larger study in order to refine or modify the research methodology.

A pilot study is important to realize that sometimes people misunderstand some questions or don't answer them in the way that is expected. The pilot study allows re-writing the questions before the distribution of final copy of questionnaires.

The survey was pretested to 70 students to obtain their feedback in detail. What were they unsure about? Did they have questions? Did they take a point of view not covered in the answers or question? This was reflected as slight modification of the questionnaire based on the small sample's response and comments.

3.6 Methods of Survey

Conducting the actual survey is considered as the next step when the questionnaire is ready. There are various types of survey methods, and each has its own advantages and disadvantages.

Choosing the proper survey method is affected by the characteristics of the targeted group, expected response rate and population. The most common methods of survey are discussed below.

3.6.1 Face-to-face Survey (Personal Interview Survey)

Face-to-face surveys, where an interviewer presents the items orally, offer advantages in terms of data quality more than any other survey delivery mode, as it allows researchers a high degree of control over the data collection process and environment (Doyle, 2005).

One of the main reasons why researchers achieve good response rates through this method is the face-to-face nature of the personal interview survey, but on the other hand, it is considered a time consuming method as the gathering of data from the respondents can take a longer time. This method is also time-consuming when there is a need to travel and meet the respondents is also either single or different locations.

3.6.2 Paper-and-pencil survey

In the paper-and-pencil method, the items are presented on paper has many advantages including high response rate, more precise data. However, it is more expensive than other types of surveys and more time-consuming, because there is a need to travel and distribute the questionnaires and get them back from respondents at different locations.

3.6.3 Mail-Back Surveys

Mail surveys are sent to a pre-selected sample of people, with instructions on how to fill out the survey and return it enclosed (Zechmeister and Jeanne, 2011).

This method is considered helpful due to their comparatively low data collection costs and ease of administration. Specifically, the costs for mail surveys tend to be lower than those for telephone surveys, and mail surveys are a good strategy for obtaining feedback from respondents who are dissatisfied with a service or who have strong concerns. There is no problem of interviewer bias as the survey is taken in private with the assurance of anonymity so respondent avoids discomfort talking about private subjects as family income and age. However, the disadvantages of mail-back surveys are low response rate.

3.6.4 Electronic Survey

Electronic surveys including online surveys or email surveys. Email survey is considered to be an effort consuming method in designing and sending the questionnaire to specific people with various email accounts and it generates less precise data in comparison with other methods of survey.

An online survey is a questionnaire that the target audience can complete over the Internet. Online surveys are usually created as web forms with a database to store the answers and statistical software to provide analyses. The advantage of this method is that respondents input their own data, and it is automatically stored electronically. Analysis thus becomes easier and can be streamlined, and is available immediately.

Using electronic survey method has so many other advantages as it costs less than other survey methods and it is not restricted with time; the respondent could choose the proper time to fill the questionnaire. Also there is no interviewer in this method, which encourages respondents to share personal information, as they are not disclosing it directly to another person.

The absence of the interviewer is considered one of the disadvantages of this method as he/she is not there to explore the answers of the respondents when some questions need explanation.

Another disadvantage is the inability to reach challenging population. This method is not applicable when some respondents do not have access to the Internet.

It is obvious that the benefits may outweigh the drawbacks for researchers in most situations, especially for shorter, simpler projects.

3.6.5 Selecting Survey Method

Two methods of surveys were used in this research. Most of the questionnaires were filled using paper and pencil method as it is considered an accurate method with high response rate. Electronic survey was used for most of the graduate students whether online or email survey methods as they are not always available in the university.

3.6 Develop Mode Choice Using Multinomial Logistic Regression

In statistics, multinomial logistic regression is a classification method that generalizes logistic regression to multi-class problems, considering more than two possible discrete outcomes (Greene, 1993).

The multinomial logit model assumes that data are case specific; that is, each independent variable has a single value for each case. The multinomial logit model also assumes that the dependent variable cannot be perfectly predicted from the independent variables for any case.

The utility of a travelling mode is defined as an attraction associated by an individual for a specific trip. Therefore, the individual will select the mode having the maximum attraction, due to various attributes such as travel time and cost, gender, age, etc. This hypothesis is known as utility maximization (Ben-Akiva and Lerman, 1985).

The utility is generally represented in a linear function of the attributes of the journey weighted by coefficients that affect choosing this transportation mode. A mathematical representation of a utility function of a mode m is shown in Equation 3.2 as:

$$U_{mi} = \beta_{mi1}x_{mi1} + \beta_2 x_{mi2} + \cdots + \beta_k x_{mik} \qquad (3.2)$$

Where:

U_{mi} : is the net utility function for mode *m* for individual *i.*

$x_{mi1}, \ldots x_{mik}$: are k number of attributes of mode m for individual i.

$\beta_1, \ldots \beta_k$: are k number of coefficients (or weighted attached to each attribute) which need to be inferred from the survey data.

The choice behavior can be modeled using the random utility model which treats the utility as a random variable, comprising of two distinctly separable components: a measurable conditioning component and an error component. Therefore,

$$U_{mi} = V_{mi} + E_{mi} \qquad (3.3)$$

Where:

V_{mi} : is the systematic component (observed) of utility of mode *m* for individual *I*.

E_{mi} : is the error component (unobserved) of utility of mode *m* for individual *i* due to the effect of unobserved variables.

The mathematical framework of logit models is based on the theory of utility maximization as discussed before. Briefly presenting the framework, the probability of an individual i selecting a mode n, out of M number of total available modes, is given in Equation 3.3 as:

$$P_{in} = \frac{\exp(V_{in})}{\sum_{m \varepsilon M} \exp(V_{im})} \qquad (3.4)$$

Where:

V_{in} : is the utility function of mode *n* for individual *i*.

V_{im} : is the utility function of any mode *m* in the choice set for an individual *i*.

P_{in} : is the probability of individual *i* selecting mode *n*.

M : is the total number of available travelling mode in the choice set for individual *i*.

The multinomial logit model uses mathematical frameworks, as Equations 3.2 3.3 and 3.4 is usually estimated using maximum likelihood method.

The maximum likelihood method estimates the values of the parameters for which the observed sample is most likely to have occurred (Ben-Akiva and Lemman, 1985). Maximum likelihood method calculates the set of parameters that are "most likely" to have resulted in the choices observed in the data.

Given the mode choice data, most the softwares estimate the coefficients that best explain the observed choices in the sense of making them most likely to have occurred, is mode using relevant softwares.

This method is the most common procedure used for determining the estimators in logit models.

3.7 Data Analysis and Calibration of The Model

After filing the questionnaire all filled data were entered into a computerized program (TransCAD) and using multinomial logistic method which measures the relationship between the categorical dependent variable and one or more independent variables by estimating probabilities using a logistic function, which is the cumulative logistic distribution.

Data were analyzed and calibrated to create the mode choice model considering each of the selected transportation modes, as well as all possible factors that affect this mathematical model using the logistic regression instead of the ordinary multiple regression, as the assumptions required for ordinary regression are not met, such as:

- The assumption of linear regression model that the values of y which are normally distributed cannot be achieved since in this research y only takes the values of 0 and 1.
- The predicted values, using ordinary regression, will become greater than 1 and less than 0, if moving far enough on the x-axis. Such values are theoretically inadmissible for probabilities.

TransCAD software program had been used to analyze the data in this study as it is a comprehensive, flexible, and capable travel demand modeling software. TransCAD supports all important styles of travel demand modeling including sketch planning methods, four-step demand models, activity models, and other advanced disaggregate modeling techniques, and comes with an extensive set of traffic assignment models assembled for use by planners and traffic engineers.(Caliper Corporation, 2008)

TransCAD is the only package designed to facilitate the implementation of best practices for travel forecasting and to provide a mechanism for advancing the state of the art in transportation modeling. Modeling with TransCAD is not limited to urban or regional demand forecasting, but is directly applicable for modeling passenger and freight flows at the state, national, and international level. TransCAD has applications for all types of transportation data and for all modes of transportation, and is ideal for building transportation information and decision support systems.

One of TransCAD applications which is used in this study is Discrete Choice Models, which uses disaggregate household or individual level data to estimate the probability with which any household or individual will make trips. The outcome can then be aggregated to predict the number of trips produced, the mode choice, and the route traveled.

TransCAD provides procedures for calibrating and applying mode choice models based on multinomial and nested logit models, and may be pursued at either a disaggregate or aggregate zonal level.

Multinomial logit model analysis is used in this study and the estimation of the parameters in the multinomial logit model is performed in TransCAD by the method of maximum likelihood.

3.8 Statistical Tests

Three tests are considered as the most common statistical tests used in multinomial logit analysis. A brief description of these tests is presented below.

3.8.1 T-test of Parameter Value

The t-test simply provides the significance level for rejecting the null hypothesis of having the true parameter value equals zero (rejecting that the parameter has no influence on the utility).

A t-test value of ±1.96 means that the parameter is different than zero at a confidence level of about 95%. At a t-test value of ±1.5 the confidence level drops to 85%, which is the lower limit usually recommended to consider a parameter significant.

3.8.2 Sign of Parameter Value

The sign of parameter allows judging if the variable conforms to a priori notion or theory about its overall behavior with respect to the utility. Under current practice, it is recommended to keep relevant policy variables with a correct sign even if these fail the t-test. The reason is that the estimated parameters are the best approximation available for their real values, and the lack of significance may very well be the result of lack of enough data. On the other hand, variables with wrong signs should always be dropped from the model, even of the parameters pass the t-test.

3.8.3 Adjusted ρ^2

The asymptotic ρ^2 (rho-squared) is similer concept to that of the cooficient of determination (R^2) obtained for linear regression models through least-squares, in that it provides a value between 0 and 1 as a measure of goodness-of-fit, where 0 indicates a bad fit while 1 indicates a perfect fit; values of 0.4 may in fact be excellent fits (Gonzalez-Ayala, 1999).

The differnece between ρ^2 and R^2 is that ρ^2 is obtained for logistic regression models and R^2 is obtained for linear regression models, and usually the value of ρ^2tends to be smaller than the value of R^2.

Goodness of fit index (ρ^2) that measures the fraction of an initial likelihood value explained by the model, which can be calculated due to McFadden as:

$$\rho^2 = 1 - \frac{LL(\beta)}{LL(0)} \qquad (3.5)$$

Where:

ρ^2 : is the goodness of fit index (roh-squared)

$LL(\beta)$: is the log of likelihood function value at its maximum.

$LL(0)$: is the log of likelihood function value when all parameters are zero.

3.9 Model Validation

Model validation is defined as the process of determining the degree to which a model is an accurate representation of the real world from the perspective of the intended uses of the model (Trucanoa et al., 2006).

Ideally, disaggregate validation is performed using a sample of travel observations which is independent of that used for model estimation. If a separate data set is not available, disaggregate validation can be performed using the same data set used for model estimation. Models can be applied to segments of the data set using the model estimation program to identify biases (FHWA, 1997).

This method was conducted in many studies, taking the study of the new Sydney Strategic model as an example, which presented the results of the validation of the models for the new Sydney Strategic model, following on from the estimation of the mode and destination choice models for travel to work. The validation of the model was carried out through examination of validation tables, which were used to compare the observed and the predicted choice variables across a number of model dimensions. (Hague Consulting Group and Institute of Transport Studies, 2001).

After the calibration process is completed and the models have been compared, validation of mode choice model is checked. Approximately $1/4^{th}$ of the data sets were used for this purpose.

The null hypothesis formulated for the purpose is as follows:

H_0: There is no difference between the observed and predicted behavior (i.e., there is no difference between the parameter vectors obtained from calibration data and the validation data).

$$H_0 \colon \beta_i = \beta_j \tag{3.6}$$

Where:

$\beta_i = \beta_j$: are the estimated parameter vectors of the model obtained from calibration and validation data.

3.10 Conclusion

The conclusion of a research is an important feature of any empirical study as it is a belief based on the researcher's reasoning on the study results. It discusses the issues, and reaches a final judgment, which attempts to carry the reader to a new level of perception about the study.

The main purposes of conclusion are tieing together and integrating the issues raised in the discussion sections, answering the thesis research questions, and providing the direction for future researches (Holewa and Mathison, 2006).

After checking the model validation, a set of conclusions and recommendations were developed and discussed based on the above results.

Chapter Four

Case Study and Data Collection

Chapter Four
Case Study and Data Collection

4.1 Case Study

For transportation research purposes, a study area is generally regarded as a geographical region in which transport planning needs to be done, for reasons such as estimating and forecasting the travel behavior of the population (Khan, 2007).

Nablus city is located in the heart of Palestine and has been considered as the economic capital of Palestine. According to the recent estimates of the Palestinian Central Bureau of Statistics for the year 2014, the total population of Nablus City population including the refugee camps is 241,490 inhabitants, while that for Nablus Governorate is estimated at 372,620 inhabitants.

One of the key attractions in Nablus City is An-Najah National University which hosts about 21,832 students (2013/2014). Studying the transportation mode choice of the new campus of An-Najah National University had a great importance since An Najah National University is considered the largest in Palestine and due to the large number of employees and students in the campus.

4.1.1 Area and Location

In the year 2000, the University began constructing the New Campus on 130 dunums of land in Beit Wazan/Al-Juneid Area in Nablus. The New

Campus houses the Faculties of Engineering and Information Technology, Science, Medicine and Health Sciences, Educational Sciences and Teachers' Training (Department of Physical Education), Fine Arts, Law, Economics and Social Sciences (Department of Media), and the Faculty of Graduate Studies.

The New Campus is also home to the Prince Turki Bin Abdul Aziz Theatre, the Hikmat Al-Masri Amphitheater, the Korean-Palestinian IT Institute of Excellence as well as a number of other facilities and laboratories. The New Campus features a state-of-the art library, a cutting-edge media center, a new swimming pool, a sports complex and a mosque as shown in Figure 4.1.

Studying the transportation mode choice of the new campus is really important as it is located in Beit Wazan/Al-Jnaid Area along Rafedia Street which is considered as an arterial roadway that connects the western parts of the city with the CBD area, as well as the south western entrance to the city as shown in Figure 4.2 and Figure 4.3.

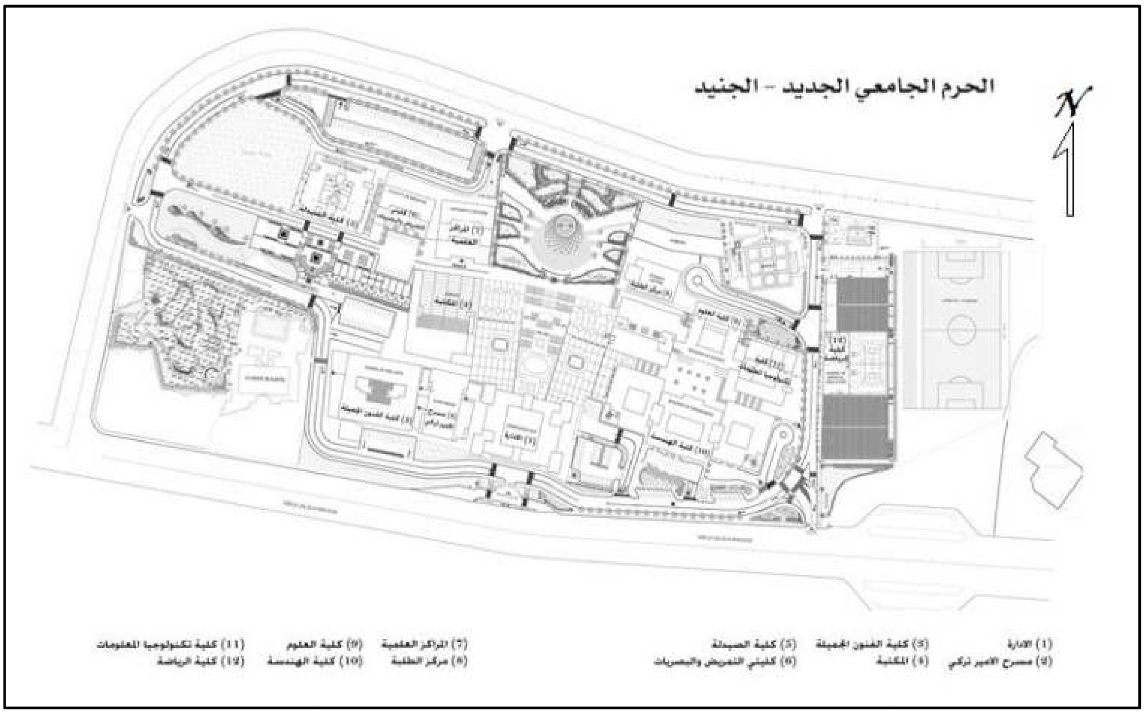

Figure (4.1): An-Najah New Campus

Source: www.najah.edu

Figure (4.2): An-Najah New Campus location

Source: Google Earth

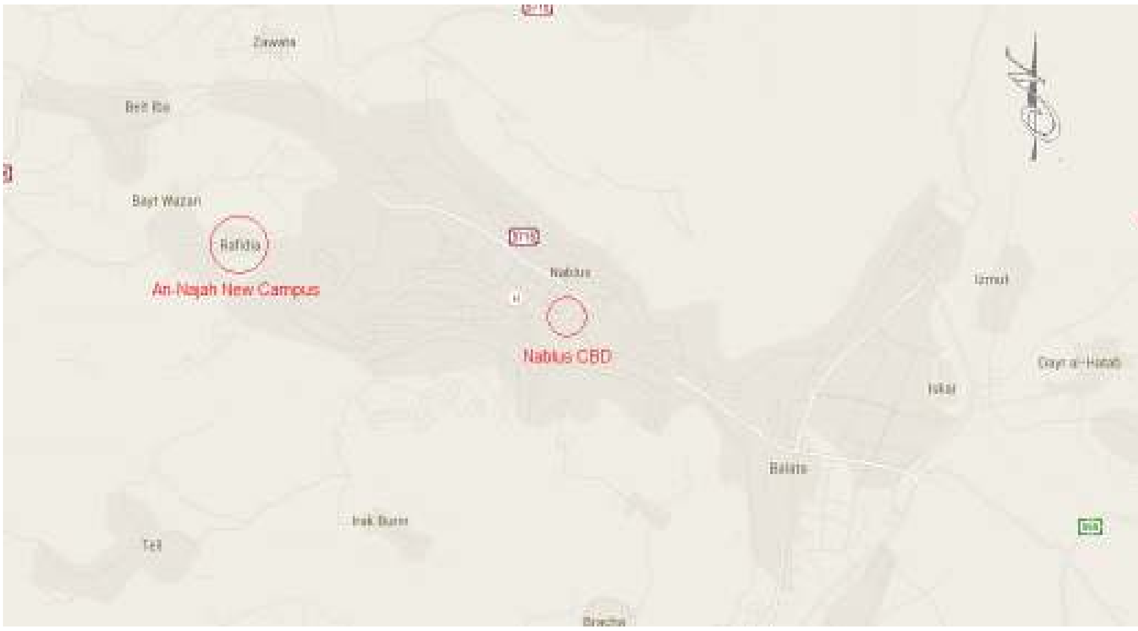

Figure (4.3): Nablus Map showing An-Najah New Campus Location

Source: Google Map

4.1.2 The Study Community

Through offering high quality education over the past four decades, An-Najah National University is promoting the development of qualified and competitive human resources. During the academic year (2013/2014) there were 21,832 students involved at the university while there were 1,495 employees. In the New Campus there were 13,642 students and 711 employees.

The sample size of students indicates the variety of places of residencies, including all West Bank cities with Jerusalem and within the Greenline, and even from outside Palestine.

The large number of students and the accelerating increase in the targeted group encouraged the study of their transportation mode choice behavior based on their Socio-economic characteristics and other transportation related factors, in order to understand the current transportation situation, especially as related to mode choice and therefore, to facilitate deriving relevant policies and putting future plans in this regard.

4.2 Data Collection

This section presents the sample size calculation and the instrument design of the survey conducted in the case study, with the aim of estimating the passenger mode choice travel behavior for the university students. Moreover, it illustrates the implementation strategy adopted for conducting the surveys in the new campus of An-Najah National University and the statistical analyses performed on the survey data.

The sample was generated using the methods of stratified random sampling, as discussed in Section 3.6, survey (questionnaire) methods used were: Paper-and-pencil survey and electronic survey methods.

For data collection, the focus was on students who travel from home to university. The number of students at An-Najah University in the academic year of 2013/2014 is 21832 students and the number of student at the new campus based on An-Najah statistics 2013/2014 is shown in Table 4.1.

Table (4.1): Number of student in An-Najah New Campus (2013/2014)

Faculty	Male	Female	Total
Faculty of Engineering and Information Technology	2814	2134	**4948**
Faculty of Science	388	1663	**2051**
Faculty of Medicine and Health Sciences	649	1386	**2035**
Faculty of Educational Sciences and Teachers' Training	266	150	**416**
Faculty of Fine Arts	305	432	**737**
Faculty of Law	640	781	**1421**
Faculty of Economics and Social Sciences	164	359	**523**
Faculty of Graduate Studies	677	834	**1511**
Total	**5903**	**7739**	**13642**

4.2.1 The Sample Size

In this thesis the sample size was calculated by Equation (3.1) presented in Section 3.3 was used to calculate the sample size considering:

- The confidence level: 95%
- The acceptable margin of error: 5%
- Response distribution factor: the most conservative π =50%
- The sample size is >30

A manual statistical formula had been used to calculate the sample size as in Equation (3.1) as follows:

The sample size of the students:

$$n = \frac{(1.96)^2(0.5)(1-0.5)}{0.05^2+\frac{(1.96)^2(0.5)(1-0.5)}{13642}} = 374$$

The sample size was selected randomly and distributed according to the percentage of students in each faculty as shown in Table 4.2

Table (4.2): The percentage of each specialization and career of the sample size

Career(employee) / Faculty(student)	Total Number	% Percentage	Sample Size
Faculty of Engineering and Information Technology	4948	36.3	136
Faculty of Science	2051	15	56
Faculty of Medicine and Health Sciences	2035	14.9	56
Faculty of Educational Sciences and Teachers' Training	416	3.05	11
Faculty of Fine Arts	737	5.4	21
Faculty of Law	1421	10.4	39
Faculty of Economics and Social Sciences	523	3.8	14
Faculty of Graduate Studies	1511	11.1	42
Total	**13,642**	**100**	**375***

* 375 students in table are different from the number (374) from equation above since fractions couldn't be used on students.

4.2.2 Pilot study

A pilot study was distributed before collecting the final data from the whole sample. The objective of the pilot study was to test for the questionnaire, which involved testing the wording of the questions; identifying confusing questions and testing the technique for collecting the data. For conducting the pilot study, the preliminary questionnaire was prepared and distributed to 70 students representing 19% of the sample size.

The final copy of the questionnaire (as shown in Appendix A) included 22 questions divided into 2 groups as following:

- The first group was about socioeconomic characteristics of students and employees. It included questions about gender, age, marital status, size of the household, career, specializations, and place of current and permanent residence. It incorporated also questions about average monthly income and car ownership.

- The second group contained questions about the transportation modes and the last transportation mode used to come to and to leave the university. There were questions about the travel time and cost of the journey, the personal evaluation of comfort, speed, cost and safety from one to four regarding for 1=”excellent” to 4=”poor”.

The set of choice alternatives consisted of 7 transportation mode alternatives: 1="Personal car"; 2=”Car sharing”, 3="drop a ride", 4="Bus’", 5= ‘Shared taxi", 6= "Ordered Taxi” and 7=”Walking”.

Chapter Five

Data Analysis and Model Estimation Results

Chapter Five
Data Analysis and Model Estimation Results

5.1 Introduction

This chapter presents various statistical analyses performed on the survey sample. First, descriptive statistical analysis is conducted by categorizing the collected data by users, presenting the findings in the form of tables and pie charts, using excel software, in order to infer the basic characterestics related to traffic behaviour of the mode users (students) of the new campus of An-Najah National University.

Next, TransCAD software has been used to analyze the data. The multinomial logit model method (definition in Section 3.8) has been used in this research which assumes that all of the alternatives are independent and each should be analyzed separately. Relevant statistical tests' results are presented and discussed below.

5.2 Descriptive Analysis

The data used in this research were obtained from the questionnaires collected from sample of students of An-Najah National University new campus. Details regarding the survey instrument, its administration, and data management are discussed in this section.

This research focuses on the last transportation mode used from home to the new campus. All targeted students responded to the survey. Before presenting the descriptive stoical analysis of the sample, it is to be stated that first, all the seven modes mentioned in Section 4.2.2 were considered to be equally competitive for the respondents. Many trials were made to the input data of all alternatives using TransCAD software, results were always inconvenient due to the statistical tests discussed in Section 3.9 (sign of parameters, t-test of parameter value and ρ^2). However, it was observed that low respondents choose walking (26 observations) and taxi (26 observations) as their last mode of transportation to the new campus., and that the observations with missing income values were also discarded (66 observations) as the income per capita turned to be a strong variable, where all these sum to 118 observations.

The whole sample size after discarding missing income observations, walkers and taxi users is 257. This has no effect on the 95% confidence level considered in the calculation of the sample size, as the considered response distribution factor of 50% results in the need of valid 188 responses which is more than the net considered observations of 257 after omitting the discarded data of 118 observations as illustrated above.

The three alternatives that have been chosen to reach a good convenient model to represent the choice set are as follows:

1. The “Private Car” mode which includes personal car, carpool and share a ride as these three alternatives presents the private mode sector (55 out of 257),

2. The “Shared Taxi” mode, as it was the most riding mode by students (169 out of 257), and

3. The “Bus” mode, as this alternative is very important solving the main traffic problem “traffic congestion” (33 out of 257).

To explore students’ mode choice, a variety of methods were employed, including descriptive statistical analysis using Excel and TransCAD softwares. These analyses provided stand-alone insight into students’ characteristics related to travel behavior.

5.2.1 General Analysis of Data

General descriptive analysis was used to get an overall picture of the survey’s results. The distribution of travelers for various travel and socio-economic characteristics are obtained and are presented in the following sub-sections.

5.2.1.1 Mode Choice Model

The distribution of last transportation mode choice for students from their current residency to the new campus is illustrated in Table 5.1 and Figure 5.1 below. The results show that about two third of students in the sample chose shared taxi as their last mode to campus, while 21% of students chose the private car mode, and only 13% of students chose the bus mode.

Table (5.1): Transportation mode distribution

Transportation mode	Mode Users	Percentage
Private car	55	21.4%
Shared taxi	169	65.8%
Bus	33	12.8%
Total	257	100%

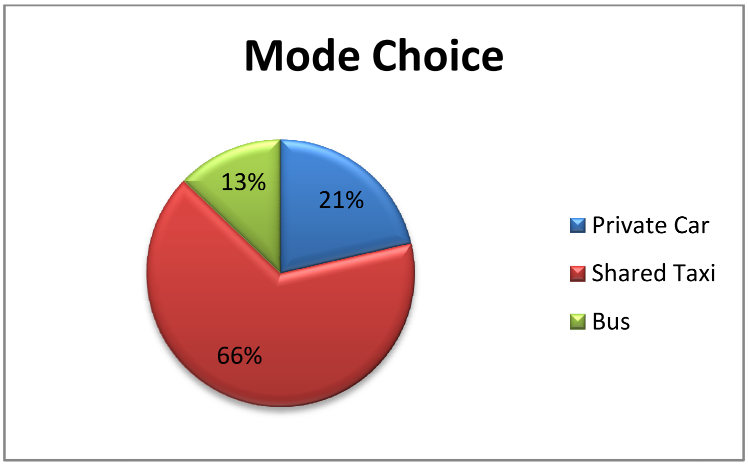

Figure (5.1): Mode Choice Summary (n =257)

5.2.1.2 Gender of Respondents

The distribution of gender of travelers can be seen Figure 5.2. About 51% of the respondents are males and 49% are females.

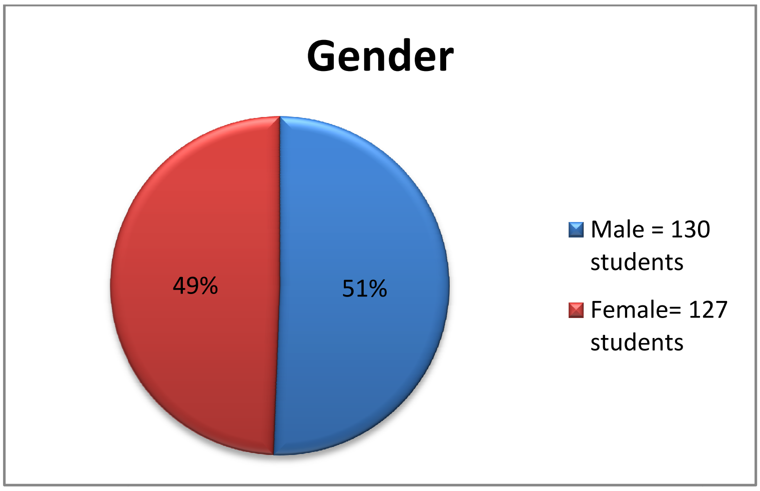

Figure (5.2): Gender of Students Sample (n=257)

5.2.1.3 Age of Respondents

The distribution of age of students can be seen Figure 5.3. Almost two thirds of respondents' age (65%) lies between (17-21 years).

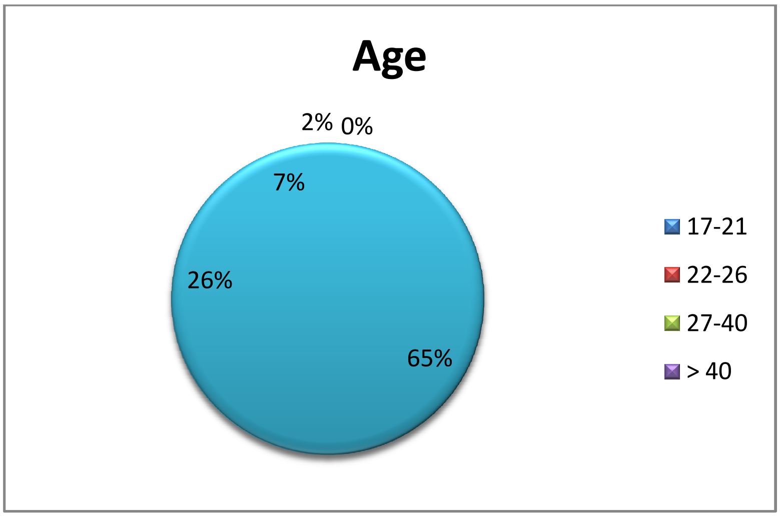

Figure (5.3): Age of Students Sample (n=257)

5.2.1.4 Distance from Respondents' Current Residency to the New Campus

The variable is residential distance students' travel from their current residency to the new campus, shown in Figure 5.4 below.

It is clear that about one third of the respondents live near the new campus (0-5 km away from the campus). This indicates the high percentage of students coming from outside Nablus.

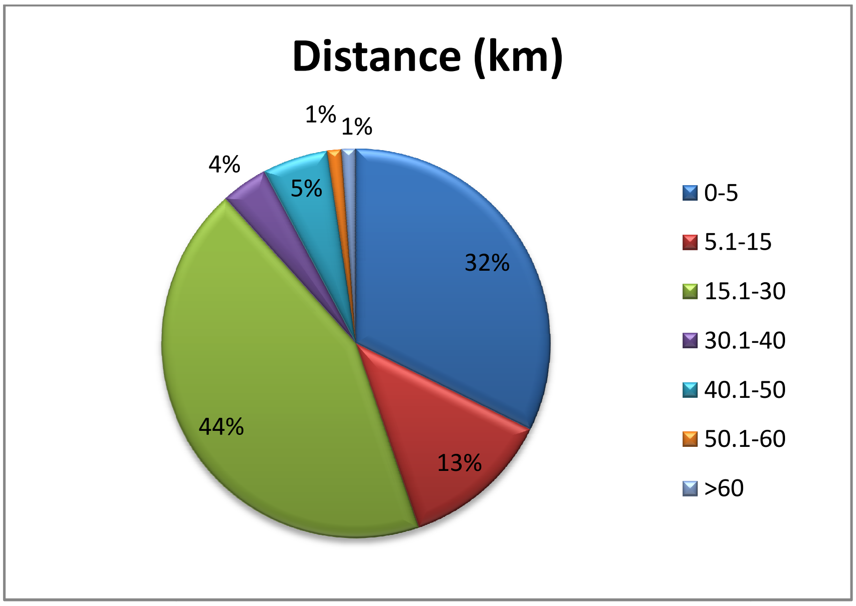

Figure (5.4): Distance of students' current residency (n=257)

5.2.1.5 Family Size of Respondents

Figure 5.5 shows the family size of students. Obviously, about 62% of students' families are between 6-8 members.

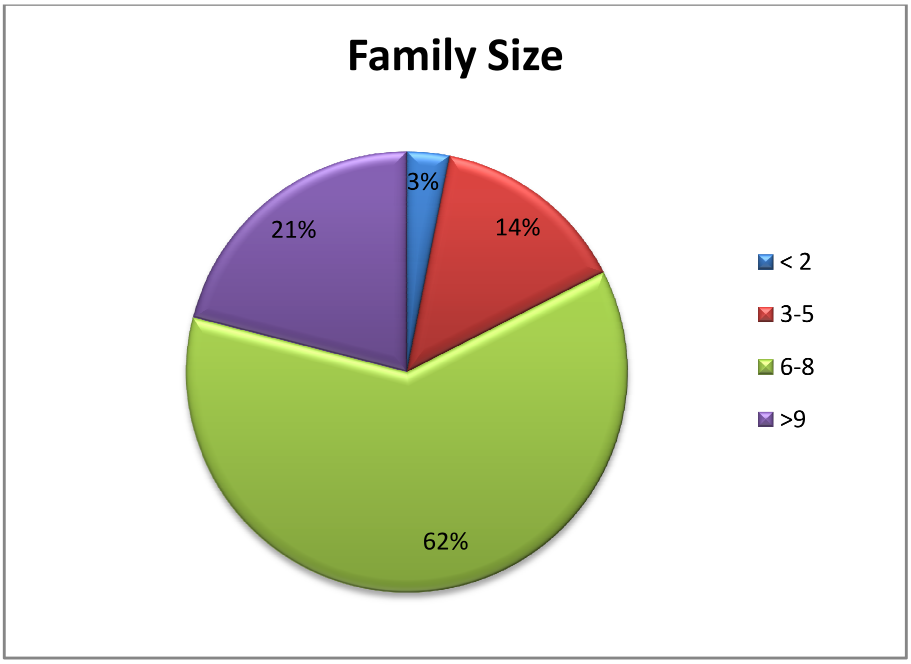

Figure (5.5): Family Size of Respondents (n=257)

5.2.1.6 Car Ownership of Respondents

Figure 5.6 presents the distribution of car ownership of students. As can be seen, only 11% of the students have a private car, while 89% of the respondents don't own a private car.

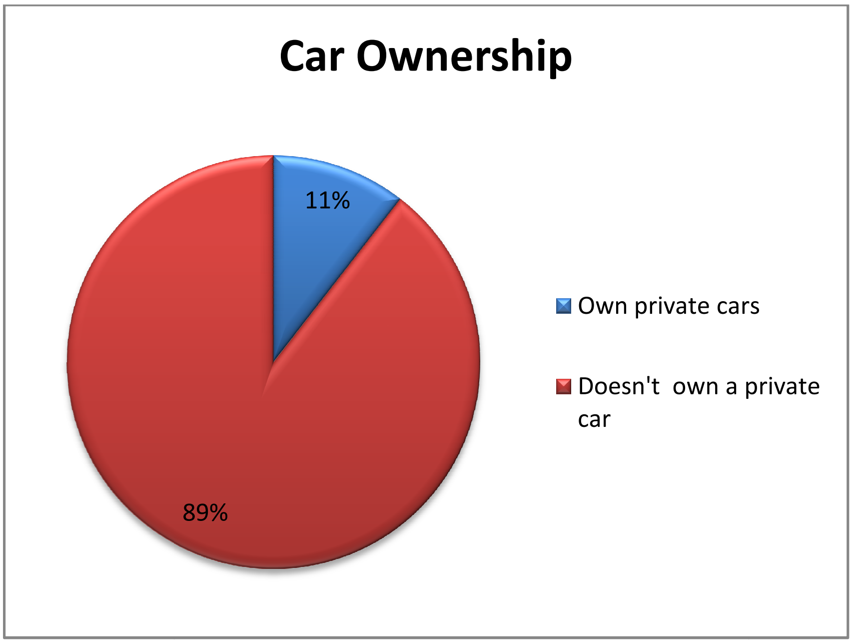

Figure (5.6): Car Ownership of Respondents (n=257)

5.2.1.7 Family Monthly Income of Respondents

The distribution of respondents' average family monthly income can be seen in Figure 5.7. The results reported in the figure below show the majority of students' families have a monthly income between 350-700 JD which represents about 42% of the whole sample.

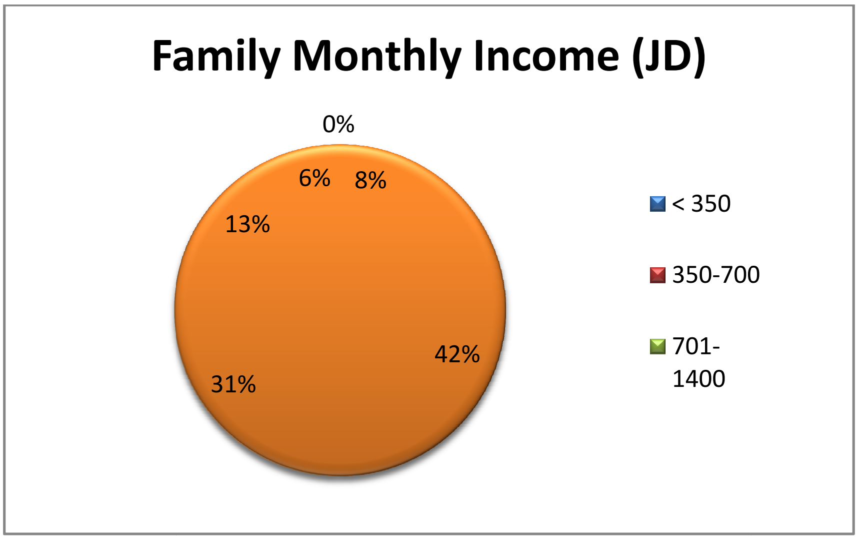

Figure (5.7): Family Monthly Income of Respondents (n=257)

5.2.1.8 Students' Faculty

The distribution of students' faculty can be seen in Figure 5.8. It is clear that the largest percentage of students is the engineering and the information technology students, and the lowest percentage is students of educational sciences and teachers' training.

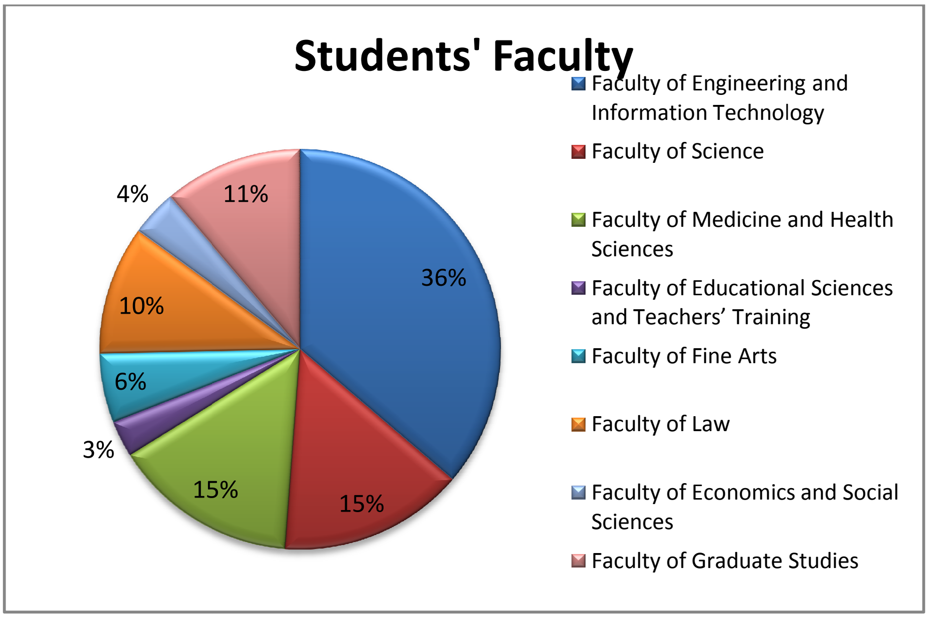

Figure (5.8) Students' Faculty (n=257)

5.3 Estimation of Mode Choice Model

Estimation and calibration of the multinomial model is the process by which the multinomial model is filtered to the data through the use of the maximum likelihood principles and methodology.

The inclusion potential of variables is tested and the parameters of the utility functions are computed, all under a trial and error procedure. The initial functions can be further adjusted until an optimum fit is achieved. The variables considered in the trials to find the model with the best fit are illustrated in Table 5.2.

Table (5.2): Description of the variables considered in the trials

Parameter	Variable	Description	Variable indications
$\boldsymbol{\beta_{0st}}$	ASC_{st}	Alternative specific constant of shared taxi	
$\boldsymbol{\beta_{0b}}$	ASC_b	Alternative specific constant of bus	
$\boldsymbol{\beta_1}$	*GEN*	Gender	"0" for male "1" for female
$\boldsymbol{\beta_2}$	*CO*	Car Ownership	"0" doesn't own a car "1" owns a car
$\boldsymbol{\beta_3}$	*FS*	Family Size	
$\boldsymbol{\beta_{4pc}}$	TT_{pc}	Private car travel time	
$\boldsymbol{\beta_{4st}}$	TT_{st}	Shared taxi travel time	
$\boldsymbol{\beta_{4b}}$	TT_b	Bus travel time	
$\boldsymbol{\beta_{5pc}}$	TC_{pc}	Private car travel cost	
$\boldsymbol{\beta_{5st}}$	TC_{st}	Shared taxi travel cost	
$\boldsymbol{\beta_{5b}}$	TC_b	Bus travel cost	
$\boldsymbol{\beta_6}$	*D*	Distance (km)	From home to university in kilometer
$\boldsymbol{\beta_7}$	*SAF*	Safety indication	"1" very bad "2" bad "3" good "4" very good
$\boldsymbol{\beta_8}$	*COM*	Comfort indication	"1" very bad "2" bad "3" good "4" very good
$\boldsymbol{\beta_9}$	*FINC/HH*	Per capita family income (JD)	

Thus, referring to Table 5.2, the utility functions for the first model (Model 1) initially suggested for the three modes have the following form:

The utility function of the Private Cars:

$U_{pc}= \beta_2(CO) +\beta_{4pc}\ (TT_{pc}) + \beta_{5pc}\ (TC_{pc}) + \beta_6\ (D) + \beta_7\ (SAF) + \beta_8\ (COM) + \beta_9\ (FINC/HH)$ (5.1)

The utility function of the Shared Taxis:

$U_{st} = \beta_{0st} (ASC_{st}) + \beta_1 (GEN) + \beta_3 (FS) + \beta_{4st} (TT_{st}) + \beta_{5st} (TC_{st}) + \beta_6 (D)$ (5.2)

The utility function of the Buses:

$U_b = \beta_{0b} (ASC_b) + \beta_1 (GEN) + \beta_{4b} (TT_b) + \beta_{5b} (TC_b) + \beta_6 (D)$ (5.3)

This model includes all variables proposed to be the most affecting the model, whether they were generic or mode specific variables. Table 5.3 shows the initial trial for the multinomial logit model (Model 1). The table contains the parameter constants, the socio-economic variables, the mode variables, the altitudinal variables, and the model statistics.

Table (5.3): Estimation results for Model 1

Parameter	Coefficient estimate	St. error	t-test
Constants			
ASC_{st}	0.747850	1.621742	0.461140
ASC_b	-1.808832	1.585347	-1.140969
Socio-economic Variables			
GEN (Shared taxi and bus)	0.355059	0.448698	0.791310
CO (private car)	4.843343	1.242554	3.897892
FS (shared taxi)	0.006592	0.079779	0.082633
FINC/HH (Private car)	0.000467	0.001264	0.369568
D (all)	3.213241	19.665438	0.163395
Mode Variables			
TT_{pc}	0.222646	0.218680	1.018134
TT_{st}	0.245667	0.204726	1.199981
TT_b	0.152288	0.165254	0.921538
TC_{pc}	-0.028869	0.085167	-0.338973
TC_{st}	-0.224042	0.068497	-3.270824
TC_b	0.009191	0.092390	0.099480
Attitudinal Variables			
SAF (Private car)	0.508126	0.209681	2.423331
COM (Private car)	0.579679	0.226333	2.561181
Model Statistics			
Log-likelihood at zero	-356.277651		
Log-likelihood at end	-155.082100		
-2 (LL(zero) - LL(end))	402.391102		
Asymptotic rho squared	0.564716		
Adjusted rho squared	0.522614		
Sample Size	257		
Valid Cases	257		

The first step in the three statistical tests is checking the signs of the coefficients. It is clear from Table 5.3 that the sign of the travel time parameters of all modes is positive, which means that the utility of mode increases as the mode become slower which is inconvenient. Rationally, students avoid slow modes that will delay them from catching their classes on time.

However, the positive sign of bus travel cost means that the utility of the bus increases as it becomes more expensive which is not realistic. Both car ownership and shared taxi travel cost have large absolute t-statistic values (3.89 and 3.27) respectively, larger or almost equal to the critical t-value (3.290) even at 99.9% confidence level, which led to reject the hypothesis that these variables have no effect on modal utilities at a confidence level higher than 99.9%. Thus, these variables should be retained in the model.

The t-statistics of the bus utility function for most of the variables are even less than 1.645 in absolute value (90% confidence). Therefore, travel time from all modes and travel cost of the bus could be removed from the utility functions. Model 1 is therefore rejected due to the signs of some coefficients despite the fact that rho-squares (ρ^2) statistics for the model is 0.522, which represent a good fit. This leads to Model 2 as presented in table 5.4.

Table (5.4): Estimation results for Model 2

Parameter	Coefficient estimate	St. error	t-test
Constants			
ASC_{st}	0.803174	1.558150	0.515466
ASC_b	-2.116755	1.479045	-1.431164
Socio-economic Variables			
GEN (Shared taxi and bus)	0.423518	0.436137	0.971067
CO (private car)	4.577427	1.225698	3.734546
FS (shared taxi)	0.009231	0.077293	0.119432
FINC/HH (Private car)	0.000446	0.001233	0.361438
D (all)	3.572506	25.022251	0.142773
Mode Variables			
TC_{pc}	-0.015637	0.018023	-0.867586
TC_{st}	-0.127328	032564	-3.910050
Attitudinal Variables			
SAF (Private car)	0.486873	0.206157	2.361667
COM (Private car)	0.587963	0.223584	2.629721
Model Statistics			
Log-likelihood at zero	-356.277651		
Log-likelihood at end	-159.992891		
-2 (LL(zero) - LL(end))	392.569519		
Asymptotic rho squared	0.550932		
Adjusted rho squared	0.520057		
Sample Size	257		
Valid Cases	257		

In Model 2, the first step is checking the signs of coefficients. The positive sign of car ownership variable indicates that students who own a car prefer to use it more than using public transportations which is convenient.

Moreover, as the family size increases, the students choose the shared taxi, which could be explained in conjunction with family income;

as the family size increases, the per-capita income decreases and the students tend to choose cheaper mode. This also explains the positive sign of per-capita income; as it increases, students choose private car over shared taxis and buses.

Another key variable is the travel cost of private car and shared taxi variables, which have negative signs. This indicates that students avoid choosing private cars and shared taxis as these become more expensive.

Finally, for the attitude related variables, the model shows that students prefer using private cars as it is safer and more comfortable (giving more privacy to users). However, considering the statistical test of parameter value and rejecting all parameters with values lower than value of 1.5 (with confidence level drops to 85%). Model 2 is rejected although rho-squares (ρ^2) statistics for the model is 0.52, which represent a good fit. Therefore, family size, per-capita income, distance, and private car travel cost variables are removed. Consequently, a new model, Model 3, is built and presented in Table 5.5.

Table (5.5): Estimation results for Model 3

Parameter	Coefficient estimate	St. error	t-test
Constants			
ASC_{st}	4.692028	0.590108	7.951138
ASC_b	1.923354	0.527293	3.647601
Socio-economic Variables			
GEN (Shared taxi and bus)	0.726318	0.432369	1.679857
CO (private car)	2.406640	0.617106	3.899883
Mode Variables			
TC_{st}	-0.109539	0.028610	-3.828778
Attitudinal Variables			
SAF (Private car*)*	0.670780	0.206980	3.240798
COM (Private car)	0.989552	0.208585	4.744129
Model Statistics			
Log-likelihood at zero	-356.277651		
Log-likelihood at end	-171.207129		
-2 (LL(zero) - LL(end))	370.141045		
Asymptotic rho squared	0.519456		
Adjusted rho squared	0.499808		
Sample Size	257		
Valid Cases	257		

As shown in Table 5.5, the sign of gender variable is positive for the shared taxi and bus alternatives which indicate that females prefer to use public transportation more than males, and the t-test of this variable is 1.68. The t-statistics on this variable is larger than 1.645 in absolute value (90% confidence).

The car ownership variable for private car users has a positive sign indicating that students who own a car prefer to use it more than using public transportations. The coefficient of this variable is 2.4 and has a good influence on the private car utility function.

Moreover, the shared taxi travel cost variable is (-0.109) which means that as the cost if the shared taxi increases, students prefer not to choose shared taxis. The safety and comfort variables of the private car have positive signs (0.67 and 0.989) respectively, which mean that students choose private cars more as these are believed to be safer and more comfortable than public transportation modes.

Although all variables have reasonable signs and a large t-test value (larger than the value of 1.5), and the adjusted goodness-of-fit measures rho-squares ρ^2 statistics for the model is 0.499 which represents a good fit, many trials were made to improve this model by adding more variables to enhance it (using a trial and error method).

Finally, Model 4 shown in Table 5.6 presents the most satisfactory model among all trails (whether those are presented in the study or not).

Table (5.6): Estimation results for Model 4

Parameter	Coefficient estimate	St. error	t-test
Constants			
ASC_{st}	5.331704	0.706472	7.546947
ASC_b	2.886227	0.794630	3.632166
Socio-economic Variables			
GEN (Shared taxi and bus)	0.582302	0.443221	1.313794
CO (private car)	2.208527	0.634819	3.478987
FINC/HH (Private car)	0.002399	0.001201	1.997057
Mode TT and TC			
TT_b	-0.015597	0.013499	-1.155444
TC_{st}	-0.132055	0.034018	-3.881932
Attitudinal Variables			
SAF (Private car)	0.659709	0.208806	3.159428
COM (Private car)	0.925868	0.213752	4.331494
Model Statistics			
Log-likelihood at zero	-356.277651		
Log-likelihood at end	-167.534602		
-2 (LL(zero) - LL(end))	377.486097		
Asymptotic rho squared	0.529764		
Adjusted rho squared	0.504503		
Sample Size	257		
Valid Cases	257		

Table 5.6 shows that the signs of the coefficients for the mode-specific constants are positive for both shared taxi and bus and the magnitude is statically significant. This implies that there are un-captured effects of modes, which indicate that these results in preference of students for bus over private cars, and shared taxi over both bus and private car with an estimated coefficient values equal to 5.33 and 2.88, respectively, with absolute t-statistic values for these variables equal to 7.546 and 3.632, respectively, which are larger than the critical t-value (3.290 at 99.9%

confidence level). This leads to reject the hypothesis that these variables have no effect on modal utilities at a confidence level higher than 99.9%. Thus, these variables should be retained in the model.

Socio-economic variables indicate that females prefer to choose public transportation modes (shared taxi and bus) more than private cars with an estimated coefficient value equals 0.582. This could be due to reasons such as relative difficulties in driving during the peak hours to the university and in finding a parking near the new campus. The absolute t-statistic value for this variable equals 1.313, which is larger than the value 1.28 at 80% confidence level. This value is relatively small due to the relatively small sample size.

The results also show that private cars' owners prefer to choose their cars to go to the university more than the shared taxis or buses with an estimated coefficient value equals 2.208, and an absolute t-statistic value for this variable equals 3.478, larger than the critical t-value (3.290 at 99.9% confidence level), which leads us to reject the hypothesis that this variable has no effect on modal utilities at a confidence level higher than 99.9%. Thus, this variable should be retained in the model.

Moreover; the use of the private cars increases with the increase the monthly family income divided by the family size (i.e. per capita income), with an estimated coefficient value equals 0.002, and an absolute t-statistic value for this variable equals 1.997, larger than the critical t-value (1.96 at 95% confidence level), thus, this variable should be retained in the model.

As expected, the estimated coefficient of the bus travel time variable is negative (-0.015). This implies that the utility of the bus decreases as it becomes slower, and it has an absolute t-statistic value equal to (1.15); larger than the value (1.036) at 70 % Confidence level. Although this value is not relatively high, but the bus travel time parameter is still considered to be important and this variable should be retained in the model.

The estimated coefficient of the shared taxi travel cost variable is negative (-0.132). This implies that the utility of the shared taxi decreases as it becomes more expensive, and it has an absolute t-statistic value equal to (-3.88); larger than the critical t-value (3.290 at 99.9% confidence level), which leads to reject the hypothesis that this variable has no effect on modal utilities at a confidence level higher than 99.9%. Thus, this variable should be retained in the model.

Finally, the analysis of the outcome related to the attitude-related variables indicate that students have more utility to choose private cars more than shared taxis and buses due to:

- Safety, as students believe that it's safer to use a private car than shared taxis and buses as there is general inception of the fast and lack of adherence to safety and traffic regulations by public transportation drivers. The estimated coefficient of the safety rate of the private cars is 0.659, with an absolute t-statistic value equals to 3.159, which is larger than the t-value (3.09 at 98% confidence level). Thus, this variable should be retained in the model.

- Comfort, as students believe that choosing private cars makes them feel more comfortable. On the other hand, it gives users more privacy that public transportation (buses and shared taxis). The estimated coefficient of the comfortable variable of the private cars is 0.925, with an absolute t-statistic value equals to 4.331, which is larger than the critical t-value (3.290 at 99.9% confidence level). This leads to reject the hypothesis that this variable has no effect on modal utilities at a confidence level higher than 99.9%. Thus, this variable should be retained in the model.

The adjusted goodness-of-fit measures rho-squares ρ^2 statistics for the model is 0.504 which represent a good fit as any value $\geqq 0.4$ is considered a good fit (as discussed in Section 3.9.3).

At last, the following equations used as the functional forms of the utility functions for the multinomial logit model based on Model 4 in Table 5.6:

The utility function of the Private Car:

U_{pc}= 2.208527(CO) + 0.002399($FINC/HH$) + 0.659709(SAF) + 0.925868(COM) (5.4)

The utility function of the Shared Taxi:

U_{st}=5.331704 + 0.582302(GEN) - 0.132055(TC_{st}) (5.5)

The utility function of the Bus:

U_b=2.886227 + 0.582302(GEN) - 0.015597(TT_b) (5.6)

5.4 Model Validation

Model validation is considered as a very important process to evaluate the performance of the calibrated model and its ability to predict modal split. The validation process may be carried out by using the calibrated model to predict model-split for data that was not used in the calibration or selecting a random sample from the same data used to develop the calibrated model.

Two different phases were used to test the validation of the model. The first phase is the test of reasonableness validation process which was tested during the calibration process depending on the expected sign of estimators. All models with a wrong sign of estimators would not consider as a valid model. Based on this criterion, it is clear that Model 4, which was chosen as the most satisfactory model in the study, is considered as a valid model.

The second phase for the validation process is concerned with calculating the prediction capability of the calibrated model (Model 4). To calculate the prediction ratio, about $1/4^{th}$ of the data (70 observations) were randomly selected and the utility for each trip maker was calculated then the probability of each alternative (mode) was estimated considering Equation 3.2. The alternative with the highest probability is predicted to be the chosen mode for that particular individual. The number of travelers correctly predicted was summed up to each alternative and compared to yield the prediction value. The calculated prediction value was 0.743 which means that the model is capable to predict about 74.3% of the choices of the trip makers' correctly (as shown in Appendix C).

Chapter Six

Summary, Conclusions and Recommendations

Chapter Six
Summary, Conclusions and Recommendations

This chapter discusses the summary, conclusions and recommendation of the study.

6.1 Summary

Transportation planning involves mainly four types of decisions: trip generation, trip distribution, mode choice and route assignment. Mode choice analysis allows replicating what mode of transport is chosen, and what is the resulting modal share.

In order to study transportation mode choice model at the Palestinian universities, the new campus of An-Najah National University is selected to be the case study.

The most appropriate mode choice model was developed, which considered the last transportation mode students use in traveling from home to the new campus of An-Najah National University. The main three transportation modes considered were the Private Car, the Shared Taxi, and the Bus.

Disaggregate mode choice modeling approach, considering the multinomial logit model was utilized to estimate various versions of the model, where the most powerful model is recommended.

6.2 Conclusions

Relevant conclusions can be drawn as follows:

1. The best fit model applied to students traveling from home to university showed that socio-economic variables affected choosing mode are gender, car ownership, per capita household income, and the attitudinal variables of comfort and safety.

2. The model shows that students who own a private car prefer to use it compared with using shared taxis or buses.

3. It was also noticed that the probability of choosing the private car mode increases with the increase of the monthly family income divided by the family size.

4. Students, who choose the private cars, consider in their decision that it is safer and more comfortable than buses or shared taxis.

5. On the other hand, females prefer using buses and shared taxis more than males. This could be due to reasons such as relative difficulties in driving during the peak hours to the university and in finding a parking near the new campus.

6. The positive signs and the values of the constants' coefficients for both shared taxi and bus indicates a preference of students for bus over private cars, and shared taxi over bus and private car.

7. The adjusted goodness-of-fit measures rho-squares ρ^2 statistics for the preferred model is 0.504 which represents a good fit.

6.3 Recommendations

The following recommendations can be drawn from the results of this research:

1. Officials and planners are encouraged to use the results of mode choice model within the four-steps of urban transportation planning process in planning for transportation for the Palestinian Universities.

2. As this study focused on students' last mode of choice from their homes to the new campus, it is recommended also to develop a mode choice model for students traveling from university to home to focus on the considerable congestion problem which the students face due to the lack of enough shared taxis at the end of their classes.

3. The prevailing of the foreseen congestion problems lead to propose that future studies should be conducted on how to encourage users to travel by buses instead of shared taxis, as a part of suggesting alternative transportation solutions, such as bus lanes or a BRT (bus rapid transit) systems, which could be used to decrease travel time for bus, feasibility studies to reduce the public transportation fees "especially on students" to encourage them to choose public transportation over private cars.

4. It is also recommended to develop a mode choice model for employees (academic and administrative) traveling from home to university and

vice versa to understand their choices and for testing potential private car shared ride programs, compared with drive alone.

5. Researchers are encouraged to do stated preference studies to examine the potential of new modes. For example, questions such as "what if there were a tram connecting the CBD area of Nablus to the new campus of An-Najah National University", as this may help to solve the congestion problems in addition to those of lack of safety and lack of comfort problems, which make users hesitate about using shared taxis and buses.

6. Similar studies could be done in the public transport by using updated data based on the variables changes (household income, shared taxi travel cost and car ownership variables, etc.) and then comparing the results with the results of this study in order to examine whether there is stability in the effect of the variables on mode choice. This will ensure the use of such models with more confidence towards the development of transportation planning in Palestine.

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Appendices

Appendix (A): Questionnaire Form

جامعة النجاح الوطنية

كلية الدراسات العليا

استبيان حول عمل نموذج لاختيار وسيلة المواصلات لطلبة الجامعات الفلسطينية: جامعة النجاح الوطنية- الحرم الجديد/ كحالة دراسية

عزيزي الطالب في جامعة النجاح الوطنية- الحرم الجديد، تحية طيبة:

تقوم الباحثة دينا مروان عبد الحق و تحت اشراف الأستاذ الدكتور سمير أبو عيشة بإعداد رسالة ماجستير بعنوان:

Transportation Mode Choice Model for Palestinian Universities Students: A Case Study on An-Najah New Campus:

(نموذج لاختيار وسيلة المواصلات لطلبة الجامعات الفلسطينية: جامعة النجاح الوطنية- الحرم الجديد/ كحالة دراسية)

حيث تهدف هذه الدراسة الى عمل نموذج رياضي لجميع وسائل المواصلات المستخدمة من قبل طلاب الحرم الجديد في الجامعة لبحث فرص تحسين مستوى أداء هذه الوسائل والحد من المشكلات التي يواجهها قطاع النقل العام والخاص فيما يتعلق بالانتقال من وإلى الجامعة بشكل عام، وفي منطقة الحرم الجديد بشكل خاص. ومن المؤمل أن تؤدي الدراسة إلى توصيات ومقترحات عملية سعيا لتحقيق مصلحة الطلاب بشكل خاص وبما ينعكس على مدينة نابلس عامة.

يرجى التكرم بتعبئة الاستبيان والإجابة عن الأسئلة المرفقة للمساعدة في جمع البيانات الخاصة بالأطروحة، علما بأن المعلومات الواردة في البيانات لأغراض البحث العلمي فقط مع مراعاة السرية التامة.

مع وافر الاحترام ،،،

1) الجنس

(   ) ذكر   (   ) أنثى

2) العمر:

(   )

3) الحالة الاجتماعية:

(   ) متزوج   (   ) أعزب

(   ) مطلق   (   ) أرمل

4) عدد أفراد الأسرة:

(   )

5) عدد الأبناء (في حال وجود أبناء):

(   )

6) المهنة

(   ) طالب بكالوريوس

(   ) طالب دكتوراه

(   ) طالب ماجستير

7) ما هي الكلية التي تدرس بها:

(   ) كلية الهندسة وتكنولوجيا المعلومات   (   ) كلية العلوم

(   ) كلية الطب وعلوم الصحة   (   ) كلية العلوم التربوية وإعداد المعلمين

(   ) كلية الفنون الجميلة   (   ) كلية القانون

(   ) كلية الاقتصاد والعلوم الاجتماعية (الاعلام)   (   ) كلية الدراسات العليا

8) إذا كنت طالب بكالوريوس في أي سنة أنت حاليا:

(   )

9) مستوى التعليم: (اخر درجة علمية حصلت عليها)

( ) دون الثانوية العامة	( ) ثانوية عامة
( ) معهد متوسط	( ) بكالوريوس
( ) دبلوم عالي	( ) ماجستير
( ) دكتوراه	

10) مكان سكن العائلة الدائم:

المدينة:________________ القرية: ________________

المخيم: ________________

11) عنوان السكن الحالي:

المدينة:________________ القرية: ________________

المخيم: ________________

12) هل تمتلك سيارة خاصة:

( ) نعم ( ) لا

13) كيف تصل يوميا الى الجامعة من مقر سكنك (في حال استخدام أكثر من وسيلة واحدة للمواصلات في نفس الرحلة يمكنك الاشارة الى أكثر من خيار):

( ) سيارتك الخاصة

( ) راكبا في سيارة خاصة (رحلة مع زملاء في الدراسة العمل)

( ) رحلة توصيل (بسيارة خاصة من قبل صديق/قريب)

( ) باص	( ) سيرفس
( ) سيارة طلب (تكسي)	( ) سيرا على الأقدام

14) حدد آخر وسيلة مواصلات تستخدمها للوصول الى الجامعة يوميا:

(   ) سيارتك الخاصة

(   ) راكبا في سيارة خاصة (رحلة مع زملاء في الدراسة العمل)

(   ) رحلة توصيل (بسيارة خاصة من قبل صديق/قريب)

(   ) باص (   ) سيرفس

(   ) سيارة طلب (تكسي) (   ) سيرا على الأقدام

15) تكلفة المواصلات اليومية الى الجامعة (ذهابا من مكان السكن الى الجامعة) (شيكل):________

16) كم دقيقة تستغرقك رحلة القدوم من مكان السكن الى الجامعة (من لحظة مغادرة المنزل حتى دخول بوابة الجامعة): __________

17) كيف تعود يوميا من الجامعة الى مقر سكنك (في حال استخدام أكثر من وسيلة واحدة للمواصلات في نفس الرحلة يمكنك الاشارة الى أكثر من خيار):

(   ) سيارتك الخاصة

(   ) راكبا في سيارة خاصة (رحلة مع زملاء في الدراسة العمل)

(   ) رحلة توصيل (بسيارة خاصة من قبل صديق/قريب)

(   ) باص (   ) سيرفس

(   ) سيارة طلب (تكسي) (   ) سيرا على الأقدام

18) حدد أول وسيلة المواصلات تستخدمها عند خروجك من بوابة الجامعة يوميا:

(   ) سيارتك الخاصة

(   ) راكبا في سيارة خاصة (رحلة مع زملاء في الدراسة العمل)

(   ) رحلة توصيل (بسيارة خاصة من قبل صديق/قريب)

(   ) باص (   ) سيرفس

(   ) سيارة طلب (تكسي) (   ) سيرا على الأقدام

19) **تكلفة المواصلات اليومية الى مكان السكن الحالي (عائدا من الجامعـــة الـــى المســـكن) (شيكل):________**

20) **كم دقيقة تستغرقك رحلة العودة الى مكان السكن ا(من لحظة مغادرة الجامعة حتى دخول المسكن): ______________**

21) **ما هو تقييمك لوسيلة المواصلات التي تستخدمها حاليا من حيث:**

	سئ	مقبول	جيد	جيد جدا	ممتاز
الراحة					
السرعة					
التكلفة					
الأمان					

22) **كم يبلغ معدل دخل العائلة الشهري**

(   ) دينار

شكرا لحسن تعاونكم.

Appendix (B): TransCAD results

Starting Procedure Multinomial Logit Estimation on November 30, 2015 (04:20 PM)

Variable 'FamSize' dropped since all cells are 0.0

Variable '[Private TT]' dropped since all cells are 0.0

Variable '[service TT]' dropped since all cells are 0.0

Variable '[Public TC]' dropped since all cells are 0.0

Variable '[private TC]' dropped since all cells are 0.0

Variable '[Bus TC]' dropped since all cells are 0.0

Variable 'Distance' dropped since all cells are 0.0

Variable 'Cost' dropped since all cells are 0.0

Variable 'Speed' dropped since all cells are 0.0

Total Cases: 283

Cases with bad or missing choice value: 26

Valid Cases: 257

Choice Distribution

0	55 21.4
1	169 65.8
2	33 12.8
3	0 0.0

Maximum likelihood reached at iteration 14

Parameter	Estimate	Std. Err.	T-Test
[Service Cons]	5.331704	0.706472	7.546947
[Bus Cons]	2.886227	0.794630	3.632166
Gender	0.582302	0.443221	1.313794

CarOwnership	2.208527	0.634819	3.478987
[Bus TT]	-0.015597	0.013499	-1.155444
[Service TC]	-0.132055	0.034018	-3.881932
Safety	0.659709	0.208806	3.159428
Comfort	0.925868	0.213752	4.331494
[Income/FamSize]	0.002399	0.001201	1.997057

Log-likelihood at zero: -356.277651

Log-likelihood at end: -167.534602

-2 (LL(zero) - LL(end)): 377.486097

Asymptotic rho squared: 0.529764

Adjusted rho squared: 0.504503

Total Running Time 402470:20:13.963.

Appendix (C): Validation Calculations

NO.	Gender	Car Ownership	Comfort	Safety	Bus TT	Shared Taxi TC	income/hh	Actual Utility Choice	Private Car utility fcn	Shared Taxi Utility fcn	Bus Utility fcn	Maximum Utility fcn	correct predection
1	0.00	0.00	3.00	2.00	20.00	5.00	642.86	Shared Taxi	5.639236286	4.671429	2.574287	Shared Taxi	Y
2	0.00	0.00	2.00	3.00	20.00	5.00	200.00	Shared Taxi	4.310663	4.671429	2.574287	Shared Taxi	Y
3	0.00	0.00	2.00	2.00	42.00	10.50	30.00	Shared Taxi	3.243124	3.9451265	2.231153	Shared Taxi	Y
4	0.00	0.00	3.00	2.00	22.00	7.00	214.29	Shared Taxi	4.611093429	4.407319	2.543093	Shared Taxi	Y
5	0.00	0.00	1.00	1.00	20.00	5.00	50.00	Shared Taxi	1.705527	4.671429	2.574287	Shared Taxi	Y
6	1.00	0.00	2.00	2.00	38.00	11.50	250.00	Shared Taxi	3.770904	4.3953735	2.875843	Shared Taxi	Y
7	1.00	0.00	2.00	2.00	20.00	5.00	80.00	Shared Taxi	3.363074	5.253731	3.156589	Shared Taxi	Y
8	0.00	0.00	1.00	1.00	20.00	5.00	166.67	Shared Taxi	1.985410333	4.671429	2.574287	Shared Taxi	Y
9	1.00	0.00	1.00	1.00	20.00	5.00	1166.67	Shared Taxi	4.384410333	5.253731	3.156589	Shared Taxi	Y
10	1.00	0.00	1.00	1.00	20.00	5.00	750.00	Shared Taxi	3.384827	5.253731	3.156589	Shared Taxi	Y
11	1.00	1.00	5.00	5.00	33.00	17.50	40.00	Private Car	10.232372	3.6030435	2.953828	Private Car	Y
12	0.00	0.00	2.00	3.00	41.00	26.00	77.78	Private Car	4.017451889	1.898274	2.24675	Bus	N
13	1.00	0.00	2.00	2.00	62.00	13.50	28.57	Bus	3.239696857	4.1312635	2.501515	Shared Taxi	N
14	1.00	0.00	3.00	3.00	20.00	5.00	57.14	Private Car	4.893816714	5.253731	3.156589	Shared Taxi	N
15	0.00	0.00	3.00	3.00	44.00	11.00	71.43	Shared Taxi	4.928088143	3.879099	2.199959	Shared Taxi	Y
16	1.00	0.00	1.00	4.00	27.00	10.00	85.71	Shared Taxi	3.770332571	4.593456	3.04741	Shared Taxi	Y
17	1.00	0.00	1.00	1.00	27.00	10.00	166.67	Bus	1.985410333	4.593456	3.04741	Shared Taxi	N
18	1.00	0.00	2.00	2.00	45.00	9.50	125.00	Shared Taxi	3.471029	4.6594835	2.766664	Shared Taxi	Y
19	1.00	0.00	2.00	2.00	39.00	11.50	166.67	Bus	3.570987333	4.3953735	2.860246	Shared Taxi	N
20	1.00	0.00	2.00	2.00	21.00	6.50	100.00	Bus	3.411054	5.0556485	3.140992	Shared Taxi	N
21	1.00	0.00	4.00	2.00	45.00	10.00	80.00	Shared Taxi	5.21481	4.593456	2.766664	Shared Taxi	Y
22	1.00	0.00	3.00	3.00	17.00	6.50	225.00	Shared Taxi	5.296506	5.0556485	3.20338	Shared Taxi	Y
23	1.00	0.00	3.00	2.00	44.00	10.00	50.00	Shared Taxi	4.216972	4.593456	2.782261	Shared Taxi	Y
24	1.00	0.00	1.00	2.00	44.00	12.50	166.67	Shared Taxi	2.645119333	4.2633185	2.782261	Shared Taxi	Y
25	1.00	0.00	3.00	2.00	21.00	6.50	44.44	Shared Taxi	4.203644222	5.0556485	3.140992	Shared Taxi	Y
26	1.00	0.00	3.00	4.00	35.00	9.50	200.00	Shared Taxi	5.89624	4.6594835	2.922634	Shared Taxi	Y
27	1.00	0.00	2.00	3.00	35.00	9.50	112.50	Shared Taxi	4.1007505	4.6594835	2.922634	Shared Taxi	Y
28	0.00	0.00	2.00	2.00	18.00	7.00	300.00	Shared Taxi	3.890854	4.407319	2.605481	Shared Taxi	Y
29	0.00	0.00	5.00	5.00	42.00	12.50	233.33	Private Car	8.487651667	3.6810165	2.231153	Private Car	Y
30	1.00	0.00	2.00	3.00	22.00	7.00	83.33	Shared Taxi	4.030779667	4.989621	3.125395	Shared Taxi	Y
31	0.00	0.00	1.00	4.00	20.00	5.00	111.11	Bus	3.831259556	4.671429	2.574287	Shared Taxi	N
32	0.00	1.00	5.00	5.00	20.00	5.00	833.33	Private Car	12.13557867	4.671429	2.574287	Private Car	Y
33	1.00	0.00	5.00	5.00	31.00	9.00	71.43	Private Car	8.099242143	4.725511	2.985022	Private Car	Y
34	0.00	0.00	2.00	2.00	42.00	12.50	114.29	Bus	3.445325429	3.6810165	2.231153	Shared Taxi	N
35	0.00	0.00	2.00	1.00	33.00	11.50	100.00	Shared Taxi	2.751345	3.8130715	2.371526	Shared Taxi	Y
36	0.00	0.00	1.00	1.00	42.00	10.50	100.00	Shared Taxi	1.825477	3.9451265	2.231153	Shared Taxi	Y
37	1.00	0.00	3.00	2.00	31.00	9.00	100.00	Shared Taxi	4.336922	4.725511	2.985022	Shared Taxi	Y
38	1.00	0.00	3.00	1.00	44.00	11.00	57.14	Shared Taxi	3.574398714	4.461401	2.782261	Shared Taxi	Y
39	1.00	0.00	2.00	2.00	44.00	11.00	114.29	Bus	3.445325429	4.461401	2.782261	Shared Taxi	N
40	0.00	0.00	2.00	1.00	20.00	5.00	50.00	Shared Taxi	2.631395	4.671429	2.574287	Shared Taxi	Y
41	0.00	0.00	4.00	4.00	17.00	6.50	160.00	Shared Taxi	6.726148	4.4733465	2.621078	Private Car	N
42	0.00	0.00	3.00	4.00	20.00	5.00	50.00	Bus	5.53639	4.671429	2.574287	Shared Taxi	N
43	0.00	0.00	3.00	4.00	20.00	5.00	50.00	Bus	5.53639	4.671429	2.574287	Shared Taxi	N
44	0.00	0.00	2.00	1.00	41.00	12.50	214.29	Shared Taxi	3.025516429	3.6810165	2.24675	Shared Taxi	Y
45	0.00	0.00	3.00	4.00	53.00	17.00	375.00	Shared Taxi	6.316065	3.086769	2.059586	Private Car	N
46	0.00	0.00	1.00	2.00	20.00	5.00	55.56	Shared Taxi	2.378563778	4.671429	2.574287	Shared Taxi	Y
47	0.00	0.00	2.00	2.00	35.00	9.00	214.29	Private Car	3.685225429	4.143209	2.340332	Shared Taxi	N
48	0.00	1.00	1.00	1.00	34.00	9.00	2142.86	Private Car	8.934818286	4.143209	2.355929	Private Car	Y
49	0.00	0.00	2.00	3.00	21.00	6.50	555.56	Shared Taxi	5.163640778	4.4733465	2.55869	Shared Taxi	Y
50	0.00	0.00	1.00	1.00	34.00	9.00	37.50	Shared Taxi	1.6755395	4.143209	2.355929	Shared Taxi	Y
51	1.00	0.00	2.00	3.00	26.00	8.00	111.11	Bus	4.097418556	4.857566	3.063007	Shared Taxi	N
52	0.00	0.00	2.00	5.00	38.00	18.50	114.29	Private Car	5.424452429	2.8886865	2.293541	Private Car	Y
53	0.00	0.00	3.00	2.00	38.00	11.50	70.00	Shared Taxi	4.264952	3.8130715	2.293541	Shared Taxi	Y
54	0.00	0.00	2.00	4.00	38.00	18.50	116.67	Private Car	4.770455333	2.8886865	2.293541	Shared Taxi	N
55	0.00	0.00	1.00	5.00	44.00	10.00	75.00	Shared Taxi	4.404338	4.011154	2.199959	Shared Taxi	Y
56	0.00	0.00	1.00	1.00	42.00	12.50	40.00	Shared Taxi	1.681537	3.6810165	2.231153	Shared Taxi	Y
57	1.00	0.00	1.00	3.00	72.00	18.50	200.00	Shared Taxi	3.384795	3.4709885	2.345545	Shared Taxi	Y
58	0.00	0.00	1.00	1.00	44.00	11.00	571.43	Shared Taxi	2.956434143	3.879099	2.199959	Shared Taxi	Y
59	1.00	0.00	2.00	2.00	20.00	5.00	71.43	Shared Taxi	3.342511143	5.253731	3.156589	Shared Taxi	Y
60	1.00	1.00	5.00	5.00	20.00	5.00	375.00	Private Car	11.036037	5.253731	3.156589	Private Car	Y
61	0.00	1.00	4.00	4.00	20.00	5.00	600.00	Private Car	9.990235	4.671429	2.574287	Private Car	Y
62	0.00	1.00	3.00	3.00	20.00	5.00	500.00	Private Car	8.164758	4.671429	2.574287	Private Car	Y
63	0.00	0.00	4.00	3.00	72.00	18.50	125.00	Shared Taxi	5.982474	2.8886865	1.763243	Private Car	N
64	1.00	1.00	5.00	5.00	33.00	11.50	80.00	Private Car	10.328332	4.3953735	2.953828	Private Car	Y
65	1.00	0.00	2.00	2.00	20.00	5.00	112.50	Shared Taxi	3.4410415	5.253731	3.156589	Shared Taxi	Y
66	0.00	0.00	3.00	3.00	20.00	5.00	125.00	Shared Taxi	5.056606	4.671429	2.574287	Shared Taxi	Y
67	0.00	1.00	2.00	1.00	45.00	10.00	66.67	Shared Taxi	4.879905333	4.011154	2.184362	Shared Taxi	Y
68	0.00	1.00	5.00	4.00	20.00	5.00	194.44	Private Car	9.943175222	4.671429	2.574287	Private Car	Y
69	0.00	0.00	2.00	2.00	20.00	5.00	57.14	Shared Taxi	3.308239714	4.671429	2.574287	Shared Taxi	Y
70	1.00	0.00	3.00	3.00	20.00	5.00	66.67	Shared Taxi	4.916664333	5.253731	3.156589	Shared Taxi	Y

جامعة النجاح الوطنية
كلية الدراسات العليا

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إعداد
دينا مروان نظمي عبد الحق

إشراف
أ. د. سمير أبو عيشة

قدمت هذه الأطروحة استكمالا لمتطلبات الحصول على درجة الماجستير في هندسة الطرق والمواصلات بكلية الدراسات العليا في جامعة النجاح الوطنية في نابلس، فلسطين.
2016م

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الملخص

يتمثل الهدف الرئيسي لهذه الدراسة في بناء نموذج رياضي لاختيار وسائل النقل التي يستخدمها طلاب الجامعات الفلسطينية لرحلة الدراسة من البيت الى الجامعة. ولهذا الغرض فقد تم بناء نموذج واقعي لاختيار وسائل النقل لرحلات الدراسة لطلاب جامعة النجاح الوطنية (الحرم الجديد) في مدينة نابلس، وقد تم اختيار جامعة النجاح كنموذج دراسي كونها تعد الجامعة الأكبر في فلسطين.

تم تحليل الوضع القائم لأهم وسائل المواصلات المستخدمة وهي كما يلي: "السيارات الخاصة" وتشمل السيارات الشخصية والرحلات المشتركة مع الزملاء ورحلات التوصيل من قبل الأهل و"سيارات الأجرة المشتركة" حيث قد تم اختيارها كونها الأكثر استخداما ضمن العينة الممثلة، و"الباص" والذي يستخدم بشكل محدد ولكن اعتباره ضمن الخيارات قد يسهم في ايجاد حلول مستقبلية لتشجيع الطلاب لاختياره، وذلك للتخفيف من المشاكل المرورية خاصة الازدحام المروري.

وقد تم جمع البيانات والمعلومات من خلال استبيان تم توزيعه على عينة مختارة من الطلاب. وتدل النتائج الاحصائية على أن النموذج الذي تم اختيارة هو نموذج جيد حيث أن معامل ρ^2 يساوي 0.504. ولقد أوضحت نتائج الدراسة المتعلقة بنموذج اختيار وسائل النقل أن أهم العوامل التي تؤثر في اختيار وسيلة النقل المستخدمة للوصول الى الجامعة هي: الجنس و امتلاك سيارة خاصة، ومعدل دخل الفرد في الاسرة وأجرة سيارة الأجرة المشتركة، والزمن الذي يستغرقه الباص في الوصول الى الجامعة. وكما هو متوقع فقد أوضحت النتائج أن العينة

التي تمتلك سيارة خاصة تفضل استخدامها للوصول للجامعة على استخدام وسائل المواصـــلات العامة، كما أنه كلما ارتفع معدل دخل الفرد ازداد استخدامه للسيارة الخاصة.

كما أوضحت الدراسة ايضا أنه كلما ازدادت أجرة سيارة الأجــرة المشــتركة وزمــن وصول الباص الى الجامعة، قلت نسبة اقبال الطلاب على استخدام سيارة الأجــرة المشــتركة والباص. وأن نسبة الطالبات الاناث اللواتي يستخدمن وسائل المواصلات العامة كانت أكبر من النسبة المثيلة لطلاب الذكور. وأخيرا، فقد لوحظ من النموذج ازدياد اقبال الطلاب على استخدام السيارات الخاصة لاعتبارها أكثر أمانا وراحة.

ويمكن اعتماد هذه الدراسة في اعداد دراسات مستقبلية كتطبيق النموذج على مــوظفي الجامعة الاداريين أو الأكاديميين، سواء كانو قادمين أو مغادرين الحرم الجديد للجامعة، وعلــى الطلاب المغادرين، وتوسيع مستوى الدراسة لتطوير عملية التخطيط على مستوى جامعة النجاح والجامعات الفلسطينية عامة.

وتشير نتائج البحث الى أن هناك العديد من الحلول المقترحة مســتقبليا والتــي يمكــن فحصها من خلال النموذج، وذلك لتشجيع الطلاب على استخدام وسائل المواصــلات العامــة، ومنها على سبيل المثال: تخصيص مسرب خاص للباصات حيث يسهم ذلك في تخفيــف وقــت الرحلات للباصات بشكل ملموس، وتخفيض اجرة سيارات الأجرة المشتركة.