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تقييم الطلب على المواصلات العامة و مرونة الإقبال عليها بين محافظات قطاع غزة

Public Transportation Demand and Elasticity Appraisal between Gaza Strip Governorates

by

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A Thesis Submitted in Partial Fulfillment of Requirements for the Degree of Master in Civil Engineering – Infrastructure

1434 هـ - 2012 م

DEDICATION

I dedicate this work to my father, my wife, my daughters and my sons who bravely and patiently endured my absence. I also devote the work to my mother who did not live to witness the eventful day.

ACKNOWLEDGEMENT

I feel obliged to extend my sincere thanks and appreciation to my instructors in the Faculty of Engineering of the Islamic university, who were helpful and brace.

Special thanks to my supervisor Dr. Essam H. Almasri who saved no effort in supporting me to complete this work in spite of the difficult circumstances.

My thanks to the discussion committee instructors Dr. Alaeddinne D. EL Jamassi and Dr. Sari W. Abusharar who honored me in their valuable discussion from which I benefit much.

Finally, thanks to all official organizations which provided me with valuable information and figures. I mention, in particular, Ministry of Transport, Palestinian Central Bureau of Statistics and Department of Licensing in Gaza.

" نَرْفَعُ دَرَجَٰتٍ مَّن نَّشَآءُ ۗ وَفَوْقَ كُلِّ ذِى عِلْمٍ عَلِيمٌ "

سُورَةُ يُوسُفَ 7

صَدَقَ اللهُ العَظِيمُ

ملخص الدراسة

يلعب قطاع المواصلات دورا مهما في الدول الصناعية والنامية على حد سواء. وعلى الرغم من اختلاف درجات التقدم والتكنولوجيا فإن نقل الناس والبضائع حاجة ضرورية جدا لا يمكن الاستغناء عنها وعلى ذلك فإن قطاع المواصلات يجب أن يعامل كوحدة متكاملة وكعنصر رئيسي ويجب أن يؤخذ بعين الاعتبار في أي خطة تطويرية في المستقبل.

إن قطاع المواصلات العامة في قطاع غزة يعاني بشكل عام من الفوضى وقلة التنظيم وغياب الجهة موضع التنفيذ على الأرض في مجالات عديدة. الهدف من هذه الدراسة هو التعرف على العلاقة بين الطلب على المواصلات العامة والعوامل المؤثرة على ذلك وهذا يفيد في تقييم المواصلات العامة في الوضع الحالي وفي المستقبل.

كما تهدف هذه الدراسة إلى إيجاد معادلة رياضية لتقييم الطلب على المواصلات العامة بين محافظات قطاع غزة حاليا وفي المستقبل، وكذلك تقييم واختبار بعض العوامل التي تؤثر على مرونة الطلب في استخدام الباصات مثل سعر تذكرة الباص والزمن الكلي لرحلة الباص.

إن منطقة الدراسة هي محافظات قطاع غزة: شمال غزة، غزة، المنطقة الوسطى، خانيونس، ورفح. ولقد تم حصر جميع خطوط الباصات بين هذه المحافظات وهي تتكون من أربعة عشر خطا. لقد تم الحصول على البيانات المطلوبة من خلال استبيان، مراجعة الدراسات السابقة المحلية والدولية ذات العلاقة، الجهاز المركزي للإحصاء الفلسطيني، وزارة النقل، وزارة التعليم العالي.

توصلت الدراسة إلى صيغة رياضية تصف العوامل التي تحدد عدد الركاب، وقد صنفت إلى عوامل خارجية وعوامل داخلية. العوامل الخارجية شملت نسبة العمالة، نسبة الطلبة الجامعيين، الإنفاق الشهري للأسرة، وعدد المركبات الخاصة في كل من محافظة المنشأ و الوجهة، بينما العوامل الداخلية فقد شملت طول الرحلة، الوقت المستغرق للسفر، وسعر التذكرة. وقد كانت قيمة معامل الارتباط R^2 تساوي 0.997 وهي قيمة مرتفعة.

لقد تمت عملية المسح الميداني لعينة من المجتمع الكلي لرواد الباصات وسيارات الأجرة، حيث شملت هذه العينة 400 من ركاب الباصات وسيارات الأجرة. تضمن الإستبيان أسئلة عن صفات الركاب، صفات الرحلة، وتفضيل تغيير وسيلة المواصلات نتيجة تغير في سعر تذكرة الباص أو وقت الرحلة الكلي.

أظهرت نتائج التحليل للإستبيان أن معامل المرونة لركاب الباص نتيجة تغير سعر تذكرة الباص و التغير في وقت رحلة الباص الكلي يساوي 2.23 - ، 0.29 - على التوالي، في حين كان معامل المرونة لركاب سيارات الأجرة يساوي 0.23 ، 0.22 على التوالي. أظهرت الدراسة بأن الطلبة والموظفين هم أكثر حساسية للتغير في سعر تذكرة الباص أو في زمن الرحلة. حيث أنهم يقومون برحلات يومية محاولين توفير المال.

نتائج هذه الدراسة يمكن أن تستخدم في تقييم وسائل النقل العامة بين محافظات قطاع غزة حاليا وفي المستقبل.

ABSTRACT

Transportation sector plays an essential and important role in industrial and developing countries. In spite of the variation in the level of progress and technology, the transfer of people and goods is a necessary requirement. Therefore, the transport sector must be managed as one body and main element and must be taken into consideration in any development plan in the future. The public transportation sector in Gaza Strip suffers in general from deregulation and the absence of enforcement on the ground in many aspects. For that reason, this study aims to find out the relationship between the public transport demand and the factors affecting it. This will help in appraising of existing and future public transportation.

The major objectives of this research are to develop a ridership demand model and evaluate and test some factors that have significant impact on elasticities of passenger demand. The study area was Gaza strip Governorates; North Gaza, Gaza, Middle Area, Khanyounis and Rafah. Fourteen external bus routes were studied. The related data needed was obtained based on a field survey, reviewing related studies at the local and international levels, the Palestinian Central Bureau of Statistics (PCBS), Ministry of Transport (MOT) and Ministry of Higher Education (MOHE).

A mathematical equation for bus ridership demand was developed. The statistical analysis of the model was run using multiple linear regression software. The independent variables in the model were classified into external and internal ones. The external variables included employment percent, students percent, monthly expenditure of family and the number of private cars in both origin and destination governorates. The internal variables included trip length, travel time and bus fare. The correlation coefficient of the recommended model (R^2) was 0.997.

Public transportation ridership behavior information was collected by using a questionnaire for bus riders and shared taxi riders. The sampling size was 400. The questionnaire includes questions regarding personal characteristics of the riders, about the trip and concerning changing mode preference for a change in bus fare or total trip time. The results of analysis of the questionnaire showed that the elasticity of the bus

ridership demand towards the bus fare change and total trip time change were estimated to be – 2.23 & - 0.29 respectively. The shared taxi elasticity of the riders towards the bus fare change and total trip time change were estimated to be 0.23 & 0.22 respectively. The results revealed that students and employees were the most sensitive to mode change. This is because they make daily trips and try to save money. The results of this research can be used in assessing the existing and future public transportation.

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LIST OF ABBREVIATIONS

PCBS	Palestinian Central Bureau of Statistics
PIC	Palestinian Information Centre
PNA	Palestinian National Authority
USA	United States of America
UK	United Kingdom
TRRL	Transport and Road Research Laboratory
PTC	Public Transport Council
TDM	Travel Demand Management
JD	Jordanian Dinar
NIS	New Israeli Sheqel
No.	Number
m	Meter
Km	Kilometer
Min.	Minute
hr	Hour
R^2	Coefficient of determination
R	Correlation coefficient of a population
r	Correlation coefficient of a sample
LOS	Level of service
Orig.	Origin

Dest.	Destination
Pop.	Population
E	Elasticity
Employ.	Employment
Expend.	Expenditure
Eq.	Equation
MSAs	Metropolitan Statistical Areas
MSA	Metropolitan Statistical Area
CBD	Central Business District
TOD	Transit Oriented Development
GIS	Geographic Information System
TCRP	Transit Cooperative Research Program
WRT	with respect to
CAMA	Computer Assisted Mass Appraisal
MOT	Ministry of Transport
MOHE	Ministry of Higher Education
N. Gaza	North Gaza
Khan Y.	Khan Younis
M. area	Middle Area

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CHAPTER 1: INTRODUCTION

1.1 Background

Public Transportation is part of our transportation network and plays an important role in the society by transporting large number of people to jobs, schools, and community activities. Public transportation assists in reducing congestion and in protecting the environment on local roads through shifting people to use high occupancy vehicles.

" Public transportation has long been recognized as a public service necessary to meet the most basic mobility needs for the elderly, disabled, and many low-income individuals." (Shoup, 2008). " As we look to the future, there is no reasonable way that more roads and automobiles alone can accommodate all the anticipated growth. Public transportation is, and has to be, a major part of the solution." (Oberstar, 2007).

"Enhancing capacities and improving service quality are key to increasing the number of trips on public transit. Overall success is further ensured through reasonable fare structures and policies and practical fare initiatives" (Chen and Lin,2005).

The governments in developing countries have to found appropriate policy initiatives using scientific and research base to increase the share of public transport. Such interventions should be based on researches that identify factors influencing the demand for public transport and quantify the impact of environmental and policy variables.

Examples of these factors are the following: population density; levels of private vehicles ownership; topography; free network extent; parking availability and cost; transit network extent and service frequency; transit fares; and transit system safety and cleanliness. Understanding the relative influences of these factors is central to public policy debates over transportation system investments and the pricing and the deployment of transit services.

1.2 Towards Better Public Transportation

1.2.1 Public Transportation in Gaza Strip

Along with the increase of the population and the development of the industries, Gaza Strip governorates are extending gradually. The interactions between people in the

governorates are more frequent than the past days. Therefore, the public transportation is an important means to connect people to each other. The essential purpose to develop the public transportation is to assist citizens to make a trip easily and ensure the normal operation of the essential social organizations and their activities. Public transport consists of all shared ride transport service systems in which the passengers do not travel in their own vehicles such as bus services and shared taxi services. There are two public transportation modes in Gaza Strip Governorates namely, buses and share-taxis. The fleet is owned and operated by the private sector; individuals or firms. No major developments in public transportation have been observed during the past few years. There were no funds assigned by the Palestinian National Authority (PNA) for the improvement of the public transport amenities. As public transport is owned and operated by the private sector, the PNA depends on the private sector initiatives to develop the sector. Due to the lack of the PNA power on the ground due to the continuous Israeli military occupations in Gaza strip Governorates, there has been fragile control of the PNA on public transport. The following reasons explain the decision of PNA to hang the development of public transport:

1- Public transportation agencies are privately owned.

2- PNA focused on physical infrastructure rather than on operation projects.

3- Some of public transportation development projects need public awareness.

1.2.2 The Coexistence of the Public Transport and Private Car

Beside the public transport services between Governorates (bus and shared taxi), the existing of private cars in Gaza Strip can not be ignored and it is impossible to create a zero private car city. In fact, the coexistence of public transport and private car is possible. For instance, people can take bus to go and back from work to a void congestion whereas they could use their own cars for vacation purposes such as shopping. Through this way, the number of private cars in the future can be reduced regularly starting from reducing the use of private cars at present. The rising amount of car utilization within urban centers will create the problem of congestion and hence will become a threat to economic growth, noise, poor air quality and even global warming.

1.3 Problem Statement

After the establishment of the Palestinian National Authority in 1993, the transportation system in Gaza Strip was extensively improved and a dramatic unprecedented increase in the possession of the vehicles were noticed. In consequence of that, new infrastructure projects especially road networks, were constructed. However, the construction was with little scientific-based planning. This led to shortage in public transport system on several divisions such as economic, social, cultural and service sectors.

The Palestinian National Authority did not direct any funds towards the development of public transportation facilities. Modes of public transportation in Gaza Strip may be limited to buses and shared taxis. The problem facing the public transport sector with regard to buses is that they are few and their stops needed for loading and unloading are rare. Furthermore, there are no clearly indicated bus lines and no timetables which cause long waiting times for passengers. Regarding shared taxis, the problem is that they are a lot but their loading and unloading areas are inadequate that causes obvious traffic congestion in different areas.

As a result of that, the public transportation services in Gaza Strip require to determine future needs and demand of riders. Therefore, there is a need for evaluating existing public transportation and studying the factors that affect current and future public transportation demand. This will help to suggest policies in managing public transport that lead to choose the feasible and logical solutions.

There had been extensive studies in the area of ridership demand analysis and modeling for public transport in many developed countries. Few of them were in developing countries such as Al-Sahili and Sadeq (2003) who analyzed the ridership demand for intercity public transport in West Bank. However, this study is extremely significant in Gaza Strip.

1.4 Research Objectives

The goal of this research is to develop a ridership demand model for public transportation in Gaza Strip Governorates. The particular objectives of this research are:

- To assess the existing and future public transportation using the technique of ridership demand modeling.
- To evaluate and test the factors that affect the elasticity of ridership demand.

1.5 Research Scope and Limitations

The research area is Gaza Strip Governorates during the period from 1970 –2010. Figure 1.1 illustrates the location of Gaza Strip in Palestine map and figure 1.2 shows the location of Gaza Strip governorates respectively.

Figure 1.1: Map of Palestine (P I C, 2010)

Figure 1.2: Map of Gaza Strip Governorates (P I C, 2010)

1.6 Methodology

This study comprises five main stages of work as follows:

Stage 1: Literature review

The basic concern through out the review stage is to identify some of the broad parameters likely to be relevant in studying intercity public transportation demand and elasticity. A systematic literature review is to be conducted which will cover textbooks,

institutional publications, periodicals, academic journals, seminar and conference papers.

Stage 2: General information and pilot study

General information will be gathered such as population, activity status, auto-ownership and expenditure and consumption levels. Other data about average trips and riders will also be obtained through interviews with managers of all bus companies. A pilot study which will take the form of a small – scale trial survey will be used before conducting the final questionnaire. This initial questionnaire will be used to validate the appropriateness of the main study questionnaire.

Stage 3: Final questionnaire

The final public transportation questionnaire will be prepared to obtain input data from riders regarding issues such as the change in bus fare, waiting time and the service level that are not simple to control. This phase involves designing the final survey form and conducting the survey from start to finish. It includes selection of factors that might affect the elasticity of public transport ridership demand, implementation of the survey and finally the collection and analysis of data.

Stage 4: Ridership demand modeling

In this stage, a statistical correlation matrix among the different variables is established. Then, the type of function between the dependent and independent variables such as linear, exponential or logarithmic functions will be investigated. The process includes estimating, calibrating and validation of public transport ridership demand model.

Stage 5: Conclusion

This stage summarizes the major findings and conclusions from the study.

1.7 Research Structure

This thesis includes six chapters:

Chapter One presents the introduction chapter which includes background, problem definition, objectives, scope of the study, significance of the study and brief research methodology.

Chapter Two reviews briefly the literature related to demand forecasting concept, elasticity concept, factors affecting ridership demand, and models of rider ship demand.

Chapter Three describes the methodology and approach for the analysis and evaluation of the results. It also depicts the explanation of theoretical foundation of the proposed ridership demand model.

Chapter Four illustrates the survey including design of initial survey form, administration survey and descriptive analysis of the results. The results from the initial survey will be used to develop the final questionnaire that will be used for development of ridership demand model.

Chapter Five describes development of ridership demand model for Gaza Strip. It begins with the estimation procedure, calibration and validation of the model.

Chapter Six includes conclusions and recommendations in addition to some thoughts of future researches.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Many developed countries have studied extensively ridership demand analysis and modeling for public transportation. The conducted studies addressed different points of view. The demand for Bus service generally increases when bus service quality attractively raises achieving viable and reasonable standard. To increase the bus service demand, the bus service elements and characteristics have to be changed. These changes can play a role in the elasticity of bus services demand.

Public transit ridership is one of the most frequency studied phenomena in transportation. It is influenced by a variety of factors, both internal and external to the transit system. Internal factors are those that transit system administrators have control over. Examples of these are the level of service provided, fare structures and levels, route design, service frequency and schedules, and service area size. Transit operators can adjust the level of service provided and the fare charged in an effort to attract paying customers in the most cost-effective manner possible. External factors, in contrast, are those beyond the control of administrators such as population and employment growth, fuel prices, health of the economy, car ownership levels and parking costs. Changes in these external factors can powerfully increase ridership. For example, the increase in the absolute number of potential transit users can increase transit ridership in regional population growth. Downtown employment growth can be correlated strongly with both the transit patronage and the level of transit service. In contrast, increasing unemployment rates and overall reductions in consumer spending can significantly decrease both transit ridership and revenue (Taylor and McCullough, 1998).

This chapter seeks to find the most important internal and external factors that influence transit use. This research presents a number of studies in developed and developing countries that will assist in developing analytical model for Gaza strip governorates. These studies were classified into two sections. The first section briefly explains the ridership demand forecasting studies. Elasticity of passenger demand studies is presented in the second section.

2.2 Ridership Demand Forecasting Studies

2.2.1 The Demand Forecasting Concept

The demand function expresses the number of trips demanded during a given period of time in terms of a set of explanatory variables such as the monetary costs of the journey, and the time spent traveling. The time spent traveling might be divided into various components such as waiting, walking and in - vehicle time. Similar variables for competing, modes of transport, and income which are considered in demand forecasting were modes of transport and income. A general formulation of a demand function is:

$$y = f(x_1, x_2, \ldots, x_n) \qquad 2\text{-}1$$

where y *is the dependent variable (level of demand) and* x_i $(i = 1, 2, \ldots, n)$ *are the explanatory variables* (Sadeq, 2001).

There is no general rule or consensus among researchers in the field as to either the functional form of the demand equation or the variables which should be used to obtain the best explanation of the demand. These questions have to be resolved by empirical analysis. For example, by testing various forms and specifications against observed behavior using statistical techniques. Correlation and regression analyses are used in this group of studies to examine the relationships between transit ridership and potentially influenced factors. These statistical analyses can identify the factors thought to affect ridership and attempt to measure the level of influence in a comparative fashion. Multiple regression analysis is commonly used for these studies to analyze the combined effects of a variety of factors on transit use.

Sadeq and Alsuhaili (2003) collected socioeconomic and intercity service data for six governorates in the northern and central districts of the West Bank (Nablus, Salfit, Jenin, Tulkarim, Qalqilia and Ramalla). They obtained ridership demand model using the multiple linear regression analysis. They also stated that the factors influencing ridership for the study were population in both origin and destination cities, employees and students, and bus fare. The general form of the relationship, which describes rider-ship demand that was used in this research, is as follows:

$$Y = a_0 + a_1 x_1 + a_2 x_2 + a_3 x_3 + \ldots + a_r x_r \qquad 2\text{-}2$$

Using the multiple linear regression analysis, the following relationship was obtained:

$$Y = 1084.8 + 26.8\,D_1 + 25.7\,D_2 - 813\,D_3 + 80.3\,D_4 + 68.3\,D_5 \qquad 2\text{-}3$$

where: D_1 = Origin city population, D_2 = Destination city population, D_3 = Bus fare, D_4 = Origin city percentage of students, D_5 = Origin city percentage of people older than 15 years who are employed. The correlation coefficient, R2, for the above equation was 0.82 and The t-test and significance level statistics indicated that the variables had a good significance.

Thompson et al.(2003) conducted a study related to transit system to investigate the relationship between service orientation and transit system performance. They used comparative case studies of transit systems in decentralized metropolitan areas that have pursued multi destination versus radial service approaches. Data was gathered on transit system profiles and transit performance from 1983 to 1998 for transit systems in Miieapoli, Columbus, Pittsburgh, Sacramento, and Seattle. The performance measures include: cost per passenger mile, passenger miles per capita, peak to base ratio, and vehicle miles per capita. Comparing systems that met definitions of multi destination versus radial service orientation, they found that multi destination systems were more effective (higher ridership), and more equitable (lower peak-to-base ratio) than radial systems.

An Urban Mass Transportation Administration report conducted by Sale (1976) analyzed the techniques used to increase ridership for the factors influencing transit ridership growth by more than 5 percent on transit systems in seven U.S. cities between 1971 to 1975. He found that the most ridership factors are in large part attributable to service expansion – especially the route expansion in rapidly growing metropolitan areas. He also noted three other important gains with respect to transit mode share in the short term: strong public and political support, resulting in the availability of substantial and stable financial resources; stable or declining fare levels; and higher motor vehicle fuel prices due to the energy crises.

Bae et al. (2002) carried out a study to undertake a review of existing literature on Transit Oriented Development (TOD) and to use Orenco Station in Portland as a study site against which to apply the literature's principles of successful TOD. Orenco Station

is different from many TODs in that much of the development is some distance away from the rail station (very little is within a quarter mile), an artifact of the pre-existing landownership situation. They stated that successful TODs have definite key requirements: the need for supportive land polices around rail or bus stations and terminals; the promotion of high density residential development near stations; some commercial and mixed use development, and pedestrian design elements. Established in an area of market gardens, they also noted that Orenco Station had few amenities to claim as a locational advantage.

Cervero (1993) made basically a review of various studies that concentrated on transit ridership. He examined the characteristics of rail station - adjacent housing and commercial projects thought to affect transit ridership. He also found that proximity to transit lines and stations has effects on transit use changes. He illustrated that the share of trips by rail and bus turns down by approximately 0.65 percent for every 100 – foot increase in distance of a residential site from a Metrorail station. The increase in distance between stations and offices declines rider-ship gradually. The findings mean that the decrease in the average distance from residences and workplaces to transit stations and stops will increase service network densities and this would significantly increase transit use.

Cervero (2006) examined what he termed the" ridership bonus" among people living beyond relaxed walking distance of the stations in California by comparing their behavior to people who live near rail stations. A data base on travel behavior and other attributes of 1000 people living in 26 housing projects within 1/2 mile of urban rail stations in California are applied. Binomial logit models for predicting transit mode choice for residents' commute trips are calculated approximately as a function of travel times, regional accessibility, workplace job and parking policies, neighborhood design, auto ownership levels, and a variable measuring transit lifestyle preference. Finally, Cervero estimated a pair of nested logit models for location choice and mode choice as a function of an array of location, neighborhood, household, transportation, and individual attributes. He found that residential self selection (lifestyle), destination area streets, and employer – based parking policies, connectively are among the key factors that influence residents' decisions to ride transit. He also called for an array of market

based strategies and regulatory (zoning) to take benefit of these findings and promote more " transit-based" housing.

Based on the aggregate data for the period from 1956 to 1984 in Honolulu, Hawaii, Mcleod et al. (1991) estimated multivariate time – series regression models of transit ridership. These models include five independent variables (civil jobs, inflation adjusted fares, the size of the transit fleet, inflation adjusted per capita incomes, and a variable accounting for service disruptions due to strikes) and two dependent variables (linked trips and revenue trips). Although both internal and external factors influence ridership, other factors such as gasoline prices, and the number of registered passenger vehicles thought to be important.

California Department of Transportation (2003) performed a study to develop strategies to attract transit ridership by determining customer expectations and needs regarding transit. Data is collected by means of a combination of literature review, a survey of 3,302 California residents and focus groups to identify expectations and needs. Then, Geographic Information System (GIS) analysis is used to identify locations in the state with the best potential to attract riders. The authors found that the following external factors: parking availability, land use patterns and aging population are significant influences on transit ridership. They observed that non – riders are not very likely to commit to using transit even when these high expectations are met. They also observed that both riders and non riders have similar high expectation about comfort, safety, convenience, and service reliability. They identified the states four largest metropolitan areas as the regions with the highest potential to attract new riders.

Aftabuzzaman et al. (2010) presented a comparative appraisal of international research. He assessed the congestion alleviation impacts of public transportation by exploring previous research, valuing congestion relief effects and examining secondary evidence. Many city and transport variables such as population, trip rate, mode share, average trip distance, city size and density, land use, development patterns, topography, the roadway network and public transport system, existing levels of congestion, socio-economic status of users and non-users, overall travel pattern and telecommuting, and peak spreading were used for the performance of public transport to relieve traffic congestion. They showed changes in mode split connected with changes in public

transportation. In general, the analysis presented a simplifying method for investigating the effect of public transportation on traffic congestion. They established a framework for approximating the monetary value of a congestion decreasing effects of public transport and presented a congestion relief valuation model to approximate the congestion relief benefits of public transportation building on the available transport data. Six parameters for this model were selected to demonstrate a practical method with easily available data for most cities. A simple model was proposed of the following form:

$$DCB_{PT} = P \times TR \times PT_{share} \times D \times MS \times DB \qquad 2\text{-}4$$

where DCB_{PT} = Annual decongestion benefit of public transport in a city, P = population, TR = average trip rate (trips per person per annum), PT_{share} = Public transport mode share, D = average trip distance, MS = Percentage of mode shift (additional auto travel for removal of PT), DB = Unit value of decongestion benefits.

A number of cities are tested by this model to estimate the monetary value of the congestion relief effect of public transportation. The cities from developing Asian and African countries were not included in this study since the nature of transit provision and car ownership of these cities varies substantially from those of the selected cities from the developed countries.

2.3 Elasticity of Passenger Demand Studies

2.3.1 Expected Ridership Response

The definition of price elasticity of demand is the ratio of the relative change in the quantity demanded to the relative change in price (Swardo et al., 2010).
Mathematically, elasticity, E, is defined as:

$$\mathbf{E} = \triangle \mathbf{Y} \ / \ \triangle \mathbf{X} \qquad 2\text{-}5$$

where $\triangle$ Y is the relative percentage for change in demand and $\triangle$ X is the relative percentage for change in price.

This section explains how price changes affect transit ridership. Price sensitivity is measured using elasticities. The degree of price sensitivity refers to the absolute

elasticity value, that is, regardless of whether it is positive or negative. For example, if the elasticity of transit ridership with respect to (abbreviated WRT) transit fares is –0.5, this means that each 1.0 percent increase in transit fares causes a 0.5 percent reduction in ridership, so a 10 percent fare increase will cause ridership to decline by about 5 percent. Similarly, if the elasticity of transit ridership with respect to transit service hours is 1.5, a 10 percent increase in service hours would cause a 15 percent increase in ridership. Economists used several terms to classify the relative magnitude of elasticity values. Unit elasticity refers to an elasticity with an absolute value of 1.0. Elasticity values less than 1.0 in absolute value are called inelastic. Elasticity values greater than 1.0 in absolute value are called elastic. For example, both a 0.5 and –0.5 values are considered inelastic, because their absolute values are less than 1.0, while both 1.5 and –1.5 values are considered elastic, because their absolute values are greater than 1.0. There is also a distinction between short-run and long-run price elasticities. In the long-run, consumers (or firms) are better able to adjust to price signals than in the short run. Hence long run demand functions tend to be more elastic than short run demand. There are various definitions of short, medium and long – run, but most authors take short – run to be 1 or 2 years, and long – run to be around 12 to 15 years, while medium run is usually around 5 to 7 years. Direct and cross elasticity are distinguished by to which the change will take effect. The effect of change is able to influence whether on the demand for the same product or for another product. The elasticity at which the change in price of a product affects directly to the change in demand of the product is called a direct elasticity. On the other hand, the price elasticity reflecting the price change in one product affects the demand for another product is called cross elasticity (Swardo et al. 2010). Price elasticities have many applications in transportation planning. They can be used to predict the ridership and revenue effects of changes in transit fares; they are used in modeling to predict how changes in transit service will affect vehicle traffic volumes and pollution emissions; and they can help evaluate the impacts and benefits of mobility management strategies such as new transit services, road tolls and parking fees. Cross – sectional statistical analyses are premised on the idea that there are structural relationships between factors influencing transit use.

Gomez-Ibanez (1996) managed to estimate the impacts on ridership of both internal (fare and service level) and external (income, demographic, and others) factors in

regression models. He investigated the changes in ridership and increased in deficits for the Massachusetts Bay transportation Authority in Boston in the late 20th century. The model produced predicts ridership change based on two external factors (employment and income) and three internal factors (fare, revenue vehicle miles, and a dummy variable for a 1980 – 81 service budget crisis). The model predicted an 11.9 percent increase in ridership between 1970 and 1990. The study showed that, at least in Boston, transit ridership is strongly affected by external factors beyond the transit system's control. He found that each percentage decrease in central city jobs reduced the Massachusetts Bay Transportation Authority ridership in Boston by 1.24 to 1.75 percent and each percentage increase in real per capita income reduced ridership in Boston by 0.7 percent. The impacts of fare and service policies are, by contrast, relatively small. A 1 percent reduction in fares increased ridership by 0.22 to 0.23 percent and a 1 percent increase in service increased ridership by 0.30 to 0.36 percent.

Using a diversity of sources, the Transit Cooperative Research Program (TCRP, 1996) analyzed the relationships between urban form and transit ridership. The study found that residential densities have a significant impact on rail transit ridership, as does the size and density of the central business district. They also found that increasing downtown employment from 50,000 to 300,000 for a 3 – square mile of the central business district could increase ridership along the 25 – mile light rail line surrounded by low – density residences from 18,000 to 85,000 daily boarding. The central business district is not found to be significant beyond a certain size. The TCRP lessons also showed that employment center size, transit service characteristics, corridor – level urban structure, and a variety of public policies are interrelated with the effects of density. Finally, the types and mix of land uses, and the use of non motorized modes affect transit demand. However, it was no easy to sort out the impacts of urban design and land use mix since they are so strongly correlated with density.

Spillar et al. (1998) studied the relation between transit ridership and urban residential densities and income in five U.S. cities (Portland, Seattle, Salt Lake City, San Diego, and Denever) using 1980 Census data. The data included total population counts within a given geographic area, average area in acres of each zone, and average annual income levels in that area. They used the data from the Census and examined only work –

related trips. The study found that transit use per person grows with increasing density up to range between 20 and 30 people per acre. In higher – income areas, the influence of density on transit use is less than that in low- income neighborhoods, although the sample size analyzed was rather small.

Since there is a relation between car ownership, car use, and transit use, a change in one variable influences other factors, however, the magnitude of effect may not be symmetrical in term of direction. Using surveys and trips diaries given to nearly 4,000 people in the Netherlands, Kitamura (1989) examined the relationships between car ownership, car use, and transit use. He found that the change in car use is due to a change in car ownership, which affects transit use, and conversely, the significant changes in transit use are usually related to changes in car ownership or car use. Transit patronage for the work trip can be increased by adopting strategies to price parking. Increasing parking costs has significant effects on mode share, which affects relative attractiveness of traveling by transit compared to driving an automobile.

Transit Research Program(1998) reported about a quantitative analysis of mode choice. The study found the following: (1)Transit share is likely to be influenced more than either transit frequency or transit accessibility by people who pay to park. (2)Transit accessibility has less significant effects on transit mode share than transit frequency. (3) Transit share has been affected greatly by the combination of pay – to – park probability and transit frequency. The study revealed that when the pay – to – park probability doubles from 0.05 to 1.0, and when transit frequency doubles from 1.0 transit revenue hours per capita to 2.0, transit share increases nearly 300 percent, from 6.5 to 24.5 percent. The study also estimated that transit use increases from 8.6 to only 9.3 percent when the increasing access to a transit stop from 30 percent of the population to 60 percent .

Cervero (1990) reported that riders are more easily attracted by service improvement than fare decreases. A study by Syed (2000) supported Cervero's findings. Using survey data on 47 variables for each of 2,000 transit riders, Syed conducted a factor analysis of the determinants of increasing transit ridership at the Ottawa Carleton Transportation Commission. This analysis focused on the most important factors judged by the users of the system. He found that bus information on street service, customer service, station

safety, reduced fares, safety en – route, cleanliness, and general transit operator attitudes were the most important factors in determining ridership. Syed combined the original factors from the survey into a smaller number of categories. For example, On – Street Service is lumped into one category that includes such aspects as on – time performance, frequency of service, and system expansion. So, it may be difficult for transit agencies to implement any of the measures evaluated in the study with certainty of the probable outcome.

Kain and Liu (1996) analyzed the factors that determined the level of ridership using the data for 184 systems over a 30 – year period from 1960 to 1990. Two different econometric analyses are performed. First, they estimated regression models for changes in ridership for the periods 1960 – 70, 1970 – 80, and 1980 – 90. They used variables such as fare levels, the rail share in revenue miles, Revenue miles of service supplied, whether the system was privately or publicly operated, and a vector of control variables such as population and employment, area fraction of careless households in the area and density. A few of the control variables included in each regression model because many factors are highly correlated. All models of ridership varies between 1980 and 1990 had R2= 0.75 or higher. Second, cross-sectional regression models were estimated for ridership for four different years – 1960 – 1970, 1980, and 1990 – using transit fares, service types, service levels, private or public ownership, and a vector of exogenous or control variables. The models used for 1990 had at least R2= 0.95. Kain and Liu concluded that the mean revenue mile elasticities range between 0.70 and 0.89 and the mean fare elasticities during 1990 and 1980 and 1970 – 1980 periods and the 1990 and 1980 cross section models range between -0.34 & 0.44. This means that transit agencies will increase ridership less by reducing fares than by increasing service. In this study, the selection of explanatory variables in two groups (policy and control variables) from the large variety of possible factors is not clear since the study focuses more on the effects of four specific policy variables (transit fares, service levels, service type, and public or private ownership).

The Federal Transit Administration collects detailed transit operator data in the National Transit Data base allows comparative analysis of transit systems. Using nationally reported data for 1988 through 1997, Hartgen and Kinnamon (1999) developed

comparative statistics for the nation's largest urban bus transit operators. The following four measures of resources: vehicles, population base, coverage area and fare revenue are normalized and compared with seven outcome measures (ridership, vehicle hours of service, vehicle mile of service, operating costs per passenger mile, operating expenses per mile, operating costs per passenger, and operating expenses per hour). Based on overall performance against U.S. averages, systems are ranked within six peer groups according to population served and modes of service. The authors found that the overall performance of bus transit agencies steadily declined during the study period; only two of the 12 measures of performance improved from 1988 to 1997. The 10 top – ranked systems for 1997 were Champaign–Urbana, IL, Santa Monica, CA, Tucson, AZ, Milwaukee, WI, Santa Barbara, CA, Long Beach, CA, Las Vegas, NV, Durham, NC, Shrevepart, LA, and New port News, VA. Hartgen and Kinnamon concluded that low fares, low unit costs, and low subsidies, with concentrated service that optimizes service utilization influence the cost – effective performance.

Hendrickson (1986), in a study of 25 large metropolitan U.S. areas, which made up 60 percent of all transit ridership examined the significance of the share of employment in the central business district and the share of work trips by public transit using 1980 Census data. He reported that the percentage of work trips taken on public transit declined from 12.2 percent in 1970 to 10.5 percent in 1980, while the percentage of employees who worked in central business district dropped from 8.5 percent in 1970 to 7.8 percent in 1980. He used ordinary least squares regression model with the following factors: Percentage of work force in the central business district, absolute number of work transit trips, absolute number of workers, and percentage of work trips taken on transit and explains 96 percent of the variation of public transit use, showing a strong relation between central business district employment and transit use. The land use patterns of the city (other than the central business district), the growth rate of an area, and any other economic factors are not considered in the model. For 1980, 90 percent of the variation is explained by the percentage of jobs based in the central business district rather than overall metropolitan employment. He also noted that the supply of transit to the central business district might actually encourage downtown employment but that central business district employment did not necessarily promote transit usage.

Kohn (2000) examined the data from 1992 and 1998 for 85 Canadian urban transit agencies to determine explanatory variables to predict ridership. He examined average fares, revenue vehicle hours, demographic, hours of service, fare structure, vehicle statistics, energy consumptions, employment, passenger statistics, revenues and expenditures. He concluded that the two main variables were average fares and revenue vehicle hours. These variables were included in his model which did not control for other variables because two variables explain almost all variation in the ridership level (R2= 0.97). The study did not specifically account for the fact that the service levels are, at least in part, a function of the level of transit demand. For example, increasing service and lowering fares is the way to increase ridership. Statistical results of the model are shown in table 2.1.

Table 2.1: Statistical Results of Kohn's Model (Kohn, 2000)

Independent Variable	Coefficient	Standard Error	t statistics
Intercept	5,099,953	2,232,952	2.28
Average Fare	- 7,976,442	2,024,021	- 3.94
Revenue Vehicle Hours	40.58	0.41	119.85
R 2 = 0.97	F Ratio = 7190 (99 % Significant)		

Morral et al. (1996) examined the effects of downtown parking supply on transit use in eight Canadian cities and 14 U.S. cities. They found that the number of central business district parking spaces per downtown employee had a significant effect on the percentage of central business district workers that commute to work on transit. Their models are non linear regression models as follows:

Canadian Cities:

Percent transit modal split= $109.7e^{(-2.49x)}$ **(**$R_2 = 0.92$) 2-6

Canadian and U.S. Cities:

Percent transit modal split= $3.6 - 32.97\ ln(x)$ $(R_2 = 0.59)$ 2-7

where x= downtown parking stalls per central business district employee.

Schaller (1999) examined the effects of increasing the taxicab fare on trip demand and service availability by using a unique data set from New York city in the U.S.A. He estimated the elasticity of trip demand with respect to fare as 0.28; and the elasticity of service availability with respect to total supply of service near 1.0. The results obtained have the following benefits: First, as fare increases, industry revenues increase but at a lesser rate than the ratio increase in fare. Second, service availability that is examined during fare policy debates should be a central consideration in fare setting. Finally, the number of taxicab can be increased without harmful effects to the revenue group of current operators. Fare elasticities are estimated in the first equation in which the dependent variable is taxicab fare revenue per mile.

Equation 1: <u>Revenue per mile</u>: The initial specification for revenue and demand is: Revenue per mile = f (economic activity; taxi fare; bus/subway fare, supply) After testing, the supply variable is dropped from the final equation because it is not a significantly related to revenue per mile.

<u>Fare Revenue</u>: The first equation takes the following form:

$$log(ADJ.REVM) = \beta_0 + \beta_1 * log(E\&D) + \beta_2 * log(LAYOFFS) + \beta_3 * log(TAXIFARE)$$

$$+\beta_4 * log(BUSFARE) + \beta_5 * log(MILES) + \beta_6 * SUMMER \qquad 2\text{-}8$$

where *ADJ.REVM* = Adjusted Revenue per Mile, *E & D* = Economic Activity, *LAYOFFS* = A second economic variable that is added in the demand equation, *TAXI – FARE* = Real Taxicab Fare, *BUS FARE* = Real Bus / Subway Fare, *MILES* = Total Taxicab Mileage, *SUMMER* = A dummy variable for July, β_0, β_1, β_2, β_3, β_4, β_5 & β_6 are constants. The impact of the fare and industry size on cab availability is estimated in a second equation in which the dependent variable is total taxi industry mileage operated without passengers.

Equation 2: <u>Service availability</u>: The specification for service availability is:

Availability = f(economic activity; taxi fare; bus/subway fare; supply), After testing, the bus/subway fare is dropped from the equation.

Service Availability: The availability equation takes the following form:

$$log(AVAIL) = \beta_0 + \beta_1 * log(E\&D) + \beta_2 * log(LAYOFFS) + \beta_3 * log(TAXIFARE) + \beta_4 * log(BUSFARE) + \beta_5 * log(MILES) + \beta_6 * SUMMER \quad 2\text{-}9$$

where *AVAIL* = Service Availability, *E & D* = Economic Activity, *LAYOFFS* = A second economic variable that is added in the demand equation, *TAXI FARE* = Real Taxicab Fare, *BUS FARE* = Real Bus / Subway Fare, *MILES* = Total Taxicab Mileage, *SUMMER*= A dummy variable for July and β_0, β_1, β_2, β_3, β_4, β_5 & β_6 are constants.

Shoup (2008) developed a direct ridership forecasting model for heavy rail transit in the Washington, D.C. region by using data from the computer Assisted Mass Appraisal (CAMA) system, socioeconomic factors and data on average weekday metro rail boarding from the Washington Metropolitan Transit Authority. Thirty land-use and other factors were hypothesized to affect ridership at the individual station-level. Of these, seven variables were determined to have a sizable predictive quality: (1) Commercial Floor Space (2) Commuter Rail Connection (3) Number of Residential/Condo Units (4) Number of WMATA Parking Spaces (5) Distance on Transit to Metro Center (6) Number of Feeder Bus Routes at Station (7) Median Household Income within ½ mile of Station. The data in this study were analyzed using a cross sectional, linear regression since of its ability to simultaneously assess the influence of a large number of factors. Based on the results of the sketch modeling efforts at the national and individual system levels, the results suggest that the type of development density around transit stations is very significant to predict transit ridership. Besides, in this model, a great significance has given to transit oriented development that consists of high commercial intensities. On the other hand, a location within a central business district and population density were less significant than other models would suggest.

A study by Dargay and Hanly (1999) stated the effects of UK transit bus fare changes over several years to derive the elasticity values summarized in table 2.2. They used a dynamic econometric model (separate short- and long-run effects) of per capita income, per capita bus patronage, bus fares, and service levels. They found that demand is slightly more sensitive to rising fares (-0.4 in the short run and –0.7 in the long run) than

to falling fares (-0.3 in the short run and –0.6 in the long run), and that demand tends to be more price sensitive at higher fare levels. Dargay and Hanly found that the cross-elasticity of bus patronage to automobile operating costs increases to 0.3 to 0.4 over the long run, and is negligible in the short run and the long-run elasticity of car ownership with respect to transit fares is 0.4, while the elasticity of car use with respect to transit fares is 0.3.

Another study compared transit elasticities in France and the UK between 1975 and 1995 (Dargay et al. 2002). It indicated that transit ridership declines with income (although not in Paris, where wealthy people are more likely to ride transit than in most other regions) and with higher fares, and increased with raised transit service kilometers. They also found that transit elasticities have increased during this period as illustrated in table 2.3.

Table 2.2: Bus Fare Elasticities (Dargay and Hanly, 1999)

Elasticity Type	Short - Run	Long- Run
Non – urban	- 0.2 to – 0.3	- 0.8 to –1.0
Urban	- 0.2 to – 0.3	- 0.4 to – 0.6

Table 2.3: Transit Elasticities (Dargay et al., 2002)

	England		France	
	Log - Log	Semi- Log	Log - Log	Semi- Log
Income				
Short run	-0.67	-0.69	-0.05	-0.04
Long run	- 0.90	-0.95	-0.09	-0.07
Fare				
Short run	- 0.51	- 0.54	-0.32	- 0.30
Long run	- 0.69	- 0.75	- 0.61	- 0.59
Transit VKM				
Short run	0.57	0.54	0.29	0.29
Long run	0.77	0.74	0.57	0.57
Annual fare elasticity growth rate		1.59 %		0.66 %

In their research, Paulley et al.(2006) performed Meta – analysis of 104 studies in Britain and elsewhere to measure the transit – service regarding Bus fares, Fare – bus or rail and effect is on car share. They noticed fare elasticities based on regression model estimated with 902 fare elasticities from 104 studies in Britain between 1951 and 2002. They also found that elasticity between bus ridership and fare is – 0.4 in the short – run, – 0.55 in the medium – run, and – 1.0 in the long – run. For Metro fares, elasticity between Metro ridership and fares is -0.3 in the short – run, -0.6 in the long –run. Also,

for transit – service measure (Fares – bus or rail – Effect is on car share) elasticity between share of trips by car and bus fares is + 0.057. Elasticity between share of trips by car and rail fares is + 0.054. They also estimated elasticities for the following transit – service measures (Vehicle kilometers of service – bus, Vehicle kilometer of service – rail, Decrease in time spent on vehicle – bus and Decrease in time spent on vehicle - rail) based on results from prior studies.(studies not specified).They found that elasticity between bus ridership and vehicle kilometers of service is +0.38 in the short – run and + 0.66 in the long-run and elasticity between rail ridership and vehicle kilometers of service is +0.75 in the short-run. Elasticity between bus ridership and in – vehicle travel time range from -0.4 to -0.9.

Finally, Taylors et al. (2009) managed to estimate elasticities based on cross – sectional analysis of transit use in 265 urbanized areas. They used a two stage least-squares regression that accounts for the interrelation of supply and demand. For fares - all transit, elasticity between total ridership and fare is -0.51. Elasticity between total ridership and vehicle hours (all transit) is + 1.1 and between per capita ridership and vehicle hours is + 1.2. For transit – service measure (service frequency – all transit), elasticity between total ridership and service frequency is + 0.5 and between per capita ridership and vehicle hours is + 0.48.

Conclusions

The review of previous studies of transit ridership has identified several common factors (both internal and external) to transit systems that influence ridership growth. Most studies in the literature look at either internal variables or external variables with varying results. Among internal factors, reducing fares of public transport and increasing the quality of service (in terms of service frequency and service coverage) both found to have significant effects on ridership. Among the external factors studied, residential and employment density are critical determinants of transit use, while the effects of land use mix and urban design are relatively small. Demographic factors, such as personal income, auto ownership, suburbanization of residential and job locations also have been found to significantly affect ridership. Hartgen and Kinnamon (1999) proved that low fares, low unit costs, with concentrated service that optimizes service utilization are the most cost-effective in increasing ridership. Several analytical models

(mathematical formulas) were identified in the literature, that are developed on the surrounding communities characteristics and transit agencies. The majority of studies in the literature review depended on the ridership as an approach to dealing with the travel demand forecasting. Although a wide array of factors clearly influence transit patronage, the most significant factors influencing transit use are external to transit systems.

The aggregate data on inter district public transport should be used to calibrate a total demand model with influence factors. Thus, it is important to use such influence factors to predict the public transportation demand between Gaza Strip governorates. This study will develop a model to assess the existing and future public transportation (buses) in Gaza Strip. Also, the variables such as bus fare and total trip time taken by the bus that affect the elasticity of passenger demand will be investigated.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the methodology which is used in this research. The public transport demand forecasting is described and the methods of analysis used to formulate the empirical relationships are presented. This research aims to provide a comprehensive study and sufficient background to appraise the intercity public transport to appreciate the validity, reliability, and usefulness of the results given in later chapters.

3.2 Bus Ridership Demand Modeling between Governorates

3.2.1 Multiple Linear Regression Analysis

What Does Regression Mean?

A statistical measure that attempts to determine the strength of the relationship between one dependent variable (usually denoted by *Y*) and a series of other changing variables (known as independent variables). The two basic types of regression are linear regression and multiple regression. Linear regression uses one independent variable to explain and/or predict the outcome of *Y*, while multiple regression uses two or more independent variables to predict the outcome. The general form of each type of regression is:

Linear Regression: $Y = a + bx + u$ 3-1

Multiple Regression: $Y = a + b_1x_1 + b_2x_2 + b_3x_3 + \ldots\ldots + b_kx_k + u$ 3-2

where Y is the variable that we are trying to predict, x is the variable that we are using to predict Y, a is the intercept, b is the slope, u is the residual.

Multiple linear regression is a statistical analysis technique that tests how well a dependent variable can be predicted on the basis of multiple independent variables. The theories of statistical analysis and least square regression are used to predict public transport demand form (Sadeq, 2001). Various standard tests of validity are considered for such models to determine the reasonableness of the results. The purpose of a multiple regression is to find an equation that best predicts the *Y* variable as a linear

function of the *X* variables. There is no general rule or consensus among researchers for using the functional form of the demand equations or the variables to obtain the best explanation of the demand. In order to predict the dependent variable as accurately as possible, it is usually necessary to include multiple independent variables in the model. Based on multiple linear regression analysis, the expected model deals with the socioeconomic characteristics and the internal factors of the public transport mode (such as trip length, bus fare, travel time and frequency) taking into account the living conditions and needs of the individuals who live in Gaza Strip.

3.2.2 The Multiple Regression Model

Multiple regression analysis is used to estimate models in order to describe the distribution of a response variable with the help of a number of predictors. A function of the analysis is used to search for predictor variables that help to explain significant variation in the response variable. If a number of significant predictors can be identified, then a decision-maker can manage risks and maximize the odds of favorable outcomes. In this study, eq. 3-2 is used for the multiple regression model where b_1 , b_2 , b_3 , ... b_k are called regression coefficients of predictors, $x_1, x_2, x_3, \ldots\ldots\ldots x_k$ are the relevant independent variables such as employment percent (orign & dest.), students percent (orign & dest.), monthly expenditure (orign & dest.), no. of private cars (orign & dest.), trip length (km), travel time (min.) and bus fare (sheqel). Y is the dependent variable.

3.2.3 Selecting Variables in the Multiple Regression

Every time you add a variable to a multiple regression, the coefficient of determination denoted by R^2 increases. The best fitting model is therefore the one that includes all of the *x* variables with the objective of getting the best final equation. However, whether the purpose of a multiple regression is prediction or understanding functional relationships, it is often useful to decide which are important and unimportant variables. After adding each *x* variable, the effects of removing any of the other *x* variables is tested. This continues until adding new *x* variables does not significantly increase R^2 and removing *x* variables does not significantly decrease it. The chosen variables were added based on their correlation with the dependent variable.

3.2.4 Correlation Coefficient

Correlation is a statistical technique that can show whether and how strongly pairs of variables are related. Examining the correlation coefficient means how well the regression equation truly represents the set of data. Correlations are useful because they can indicate a predictive relationship that can be exploited in practice. There are several correlation coefficients measuring the degree of correlation. Correlation coefficients measure the strength of association between two variables. The most common correlation coefficient, called the Pearson product-moment correlation coefficient**,** measures the strength of the linear association between variables. Generally, the correlation coefficient of a sample is denoted by r, and the correlation coefficient of a population is denoted by R.

3.2.5 How to Interpret a Correlation Coefficient

The sign and the absolute value of a correlation coefficient depict the direction and the magnitude of the relationship between two variables. The value of a correlation coefficient ranges between -1 and 1 as described below:

- The greater the absolute value of a correlation coefficient, the stronger the linear relationship.
- The strongest linear relationship is indicated by a correlation coefficient of -1 or +1.
- The weakest linear relationship is indicated by a correlation coefficient equal to 0.
- A positive correlation means that if one variable gets bigger, the other variable tends to get bigger.
- A negative correlation means that if one variable gets bigger, the other variable tends to get smaller.

3.3 Demand Elasticity and Preparing a Sample Survey

3.3.1 The Concept of Elasticity

Travel demand elasticity is a major tool that measures the rider responsiveness sensitivity for any change of one or more variables, such as transportation mode, route and trip itself (Sadeq, 2001). Elasticity is defined as the percent of change in quality demanded in comparison to the percent of change in the tested variables. Elasticity can be estimated from several sources and using different types of formulas. The following equation was set for a price change:

Elasticity = $\{ (Y - Y_0) / Y_0 \} / \{ (X - X_0) / X_0 \}$ (Al-Sahili and Sadeq, 2004) 3- 3

where,

E is elasticity of the ridership demand, $Y - Y_0$ is $\triangle Y$ change in ridership demand, Y_0 is original ridership demand, $X - X_0$ is $\triangle X$ change in transit fare and X_0 is original transit fare. When a product is highly elastic, a small change in price will cause a large change in consumption, and when a product has a low elasticity, or inelastic, a change in price will have little effect on the consumption of the product. According to fare change, for example, the above equation measures the proportions by which the additional bus rider or service taxi rider demands increase, decrease, or remain unchanged. The ridership demand elasticity is measured in accordance with change in both bus waiting time at terminal and bus fare. Due to the difficulty in applying changes in the internal variables such as travel time of the bus trip and service level during the period of this research, and because the decision makers are not awarded to execute such policy nowadays, elasticity of the bus ridership demand is based on a public transport questionnaire. Thus, the questionnaire is prepared carefully to provide a standardized data-gathering procedure from riders. Using a well-constructed questionnaire can minimize the effects of potential human errors (for example, altering the pattern of question asking, calling at inconvenient times, and biasing by "explaining").

3.3.2 Sample Survey

Sampling provides a means of gaining information about the population without the need to examine the population in its entirety. A sample is a representative part of a whole group. Thus a sample survey involves examining only a portion of the total group in which you are interested, and from it, inferring information about the group as a whole. One of the decisions to be made in surveying is whether or not to sample. By sampling only a small portion of a large population, it is possible to collect data in far less time than would be required to survey the entire group. Not only is data collection quicker, but data processing and analysis also require less time because fewer pieces of data need to be handled. By limiting the group to be surveyed, less time, hence less cost, are involved in collecting, formatting, and analyzing the data. The disadvantages of sampling are few, but important. The main disadvantages stem from risk, lack of representativeness, and insufficient sample size, each of which can cause errors. Inattention to any of these potential flaws will invalidate survey results. It is important to realize that using a sample from a population to infer something about the entire population involves a risk. The risk results from dealing with partial information. If risk is not acceptable in seeking the solution to a problem or the answer to a question, then a complete survey or census, rather than a sample survey, must be conducted. Determining the representativeness of the sample is the surveyor's greatest problem when sampling. Without a representative sample, a survey will, at best, produce results that are misleading and potentially dangerous. The final major problem in sampling is to determine the size of the sample. The size of the sample you need for a valid survey depends on many variables including the risk you are willing to accept and the characteristics of the population itself. In this study, the sample survey will be conducted during normal conditions at different times of the day in three locations at bus stations, at shared taxi stations and on board to get a representative part of an entire group.

3.3.2.1 The Purpose of Survey Study

The first step in producing a survey is the most important. It defines the purpose and determines where you are going. A clear statement of purpose is necessary not only as a justification/explanation of the project, but also as a guideline to determine if future

actions in the project are in support of the original purpose. Without knowledge of the exact nature of the problem objective, you cannot decide exactly what kind of data to collect or what to do with it once you have it. Usually a staff officer is given a problem or objective; it seldom originates with him. But this does not relieve the individual of responsibility for insuring that: (1) the problem is well stated, (2) the surveyor understands exactly what the problem is, (3) the stated problem is the real problem. The survey should be designed to answer only the stated problem. Adding additional interesting objectives will lengthen and complicate the survey while clouding the real issue. The purpose of the questionnaire is to define the elasticity of the ridership towards the reduction of bus waiting time, the change in bus fare and making statistical analysis about the personal characteristics of commuters.

3.3.2.2 Target Population

It is incumbent on the researcher to clearly define the target population. There are no strict rules to follow, and the researcher must rely on logic and judgment. The population is defined in keeping with the objectives of the study. Usually, the population is too large for the researcher to attempt to survey all of its members. A small, but carefully chosen sample can be used to represent the population. The sample reflects the characteristics of the population from which it is drawn. In this study, bus and shared taxi commuters are considered for the population and the sample survey was conducted at the main stations and on board to obtain true results about their trips.

3.3.2.3 Data to Be Collected

The purpose of the data collection is to ensure that proper data are collected in the right amounts from the sampled units and to avoid collecting data that are irrelevant to the purpose of the survey. It is important to remember that for any questionnaire to be really effective it has to be designed well. Questions should be framed in a simple language and care should be taken to avoid grammatical and spelling mistakes. Questions should have clarity and must convey the same meaning to all kinds of readers, so it is best to use direct questions rather than ambiguous ones. As a general rule, with only a few exceptions, long questionnaires get less response than short questionnaires. In fact, the shorter is the better. One of the most effective methods of maximizing response is to

shorten the questionnaire since the unusually large number of questions can bore the respondents and may erode the quality of data gathered. The intended manner of conducting the questionnaire is to get data about mode preference that reflect the impact of increasing the bus fare on mode choice. Also, to illustrate the relation between shared taxi riders and switching for a bus when the bus fare or bus waiting time decreases and to obtain some information regarding the personal characteristics of riders such as trip purpose, gender, age, employment, income and auto ownership.

3.3.2.4 Selecting An Appropriate Sampling Method

Sampling methods are classified as either probability or non probability. The advantage of probability sampling is that sampling error can be calculated. Sampling error is the degree to which a sample might differ from the population. In non probability sampling, the degree to which the sample differs from the population remains unknown. So, in this research probability samples are described. There are many methods available for use with varying degrees of complexity. Certain methods suit circumstances better than others. In this research, the sampling method used is the stratified sampling since the study population is divided into groups. Bus and shared taxi are the main two groups and the bus routes and the shared taxi routes between Governorates are the subgroups.

3.3.2.5 Confidence Level and Precision

Risk, as it relates to sample size determination, is specified by two interrelated factors: (1) the confidence level (2) the precision (or reliability) range. To minimize risk, you should have a high confidence (say 95 percent) that the true value you seek (the actual value in the population) lies somewhere within a small interval (say + or - 5 percent) around your sample value (your precision) (Renckly, 2002).

3.3.2.6 Sample Size Determination

Once you determine your desired degree of precision and your confidence level, you can use the suitable formula to determine sample size depending on how you plan to report the results of your study. The question of how large a sample to take arises early in the planning of any survey. This is an important question that should be treated lightly. To take a large sample than is needed to achieve the desired results is wasteful of resources whereas very small samples often lead to that are no practical use of

making good decision. The main objective is to obtain both a desirable accuracy and a desirable confidence level with minimum cost. Renckly (2002) recommended in similar sampling surveys that the following formula can be used to find the sample size. So, the sample size for the bus and shared taxi ridership can be calculated as follows:

$$n = NZ^2 * 0.25/(d^2 * (N-1)) + (Z^2 * 0.25) \quad \text{3-4}$$

where, n is the sample size required, N is the total population size (known or estimated), d is the precision level (usually 0.05 or 0.10), z is the number of standard deviation units of the sampling distribution corresponding to the desired confidence level (see Annex 4 in page 139).

3.3.2.7 Developing the Public Transportation Questionnaire:

The survey is intended to examine the elasticity of bus ridership towards the changes of some internal variables such as: (1) bus fare, (2) waiting time and (3) service level. These factors necessitate coordination with decision makers and it is hard to alter these variables during the period of research. Thus, the public transportation questionnaire was organized to attain input data from riders concerning these issues. One form was used for both bus and shared taxi riders. The questionnaire form is presented in Annex 2. There are selected locations that the survey was distributed at in Gaza Strip Governorates. It represents various population sectors considering people numbers and the geographic distribution of the communities as much as possible at bus main station, at shared taxi main station and on board. The following is a detailed description of the bus questionnaire content.

Part One: contained general information about the respondent such as age, job, gender, education attainment and income.

Part Two & Three: comprised of questions for both bus riders and shared taxis riders respectively such as trip purpose, number of similar weekly trips, the current preference to riding a bus, cost of the trip. Also, it included questions about the reason for riding the shared taxi and the motivation of shared taxi riders to switch to a bus in the following situations: (1) increase in shared taxi fare. (2) decrease in bus waiting time at main stations.

3.3.2.8 Pretest the Questionnaire

It is advisable to conduct a pilot study to find mistakes in order to improve the questionnaire. Before beginning such a full research project, researchers need to know that their study is valid and the study's design will be able to capture the data they are looking for. They need to know that the research they plan to do will be the most accurate and reliable research possible. The best way to do this is to perform a pilot study. Both sampling methods and sampling size can be improved by providing information or suggestions in a small – scale trial survey. In this research, 25 questionnaires were conducted in a small –scale trial survey for the bus and shared taxi riders and statistical analysis was applied for this pilot study.

CHAPTER 4: DATA COLLECTION

4.1 Introduction

In order to develop bus demand model and ridership demand elasticities between Governorates, data on a total of eight public bus operators in Gaza Strip was collected for this analysis. The data necessities for calibrating such models rely on adequate available data and surveys especially adapted to the needs of such models. However, data collection is a very vital and serious process and requires establishing a data base that must be sufficient, reliable, and logical to get sensible results. Transport researchers can benefit from the considerable diversity of data available in developed countries which considered to be a treasure house of information. All Governorate pairs that have bus services in Gaza Strip were included. It considered Gaza Governorate as a core of this research. The Governorates included in this study were; North Gaza, Gaza, Middle Area, Khan Younis and Rafah. They represent the core of commercial, educational and institutional activities in their related governorate.

4.2 Sources of Data

The data assembled in this research can be organized into five categories as follows:

(1) Palestinian Central Bureau of Statistics (PCBS), (2) Ministry of Transport (MOT), (3) Ministry of Higher Education (MOHE), (4) Reports of variety of public transport agencies and bus companies, (5) Questionnaire for the bus and taxis riders.

4.2.1 Palestinian Central Bureau of Statistics

The Palestinian Central Bureau of Statistics (PCBS) published in 2010 the final report that described the population demographics and their activities in Gaza Strip and the West Bank. These published reports, which were used in this study are as follows:

- Population Report, Gaza Strip, 2010
- Labor Force Survey; Main Finding, 2009 and 2010
- Expenditure and Consumption Levels, Annual Report, 2010

This study considered the year 2010 as the base year and all the assembled data were based on that year. The three external variables (population, expenditure and employment) which were used in the ridership modeling were obtained from the PCBS. Tables 4.1, 4.2 and 4.3 illustrate the three external variables used in the ridership model.

Table 4.1: Total Population and Percentage by Governorate (PCBS, 2010)

Governorate	Year 2009		Year 2010	
	Number	*Percent	Number	*Percent
North Gaza	286,246	19.25	297,269	19.36
Gaza	519,027	34.91	534,558	34.82
Middle Area	215,808	14.51	222,866	14.52
Khan younis	283,286	19.06	291,737	19.00
Rafah	182,449	12.27	188,690	12.30
Gaza Strip Population	1486816	100.00	1535120	100.00

*Percent: The percent of the governorate population out of the total population in Gaza Strip

Table 4.2: Average Family Expenditure in J. D. (PCBS, 2010)

Governorate	Average Monthly Expenditure (J. D.)	
	2009	2010
North Gaza	606	725
Gaza	575	756
Middle Area	565	693
Khan Younis	528	655
Rafah	606	726
Average	**576**	**711**

Table 4.3: Percentage Distribution of Employment by Governorate (PCBS, 2010)

Governorate	[1]Inside Employ. %	[2]Outside Employ. %	Total %	Inside Employment				[6]Employ. %
				[3]Full Employ. %	[4]Limited Employ. %	[5]Unemploy. %	Total %	
North Gaza	33.90	66.10	100.00	62.60	1.60	35.80	100.00	21.76
Gaza	35.10	64.90	100.00	64.90	0.60	34.50	100.00	22.99
Middle Area	38.20	61.80	100.00	55.10	5.90	39.00	100.00	23.30
Khan Younis	38.40	61.60	100.00	40.00	15.30	44.70	100.00	21.24
Rafah	38.70	61.30	100.00	54.70	8.90	36.40	100.00	24.61

[1]Inside Employment: People 15 years or older who have the ability to be employed.

[2]Outside Employment: People 15 years or older who can not be employed such as people older than 60 years or ill people.

[3]Full Employment: People 15 years or older who have constant and permanent jobs.

[4]Limited Employment: People 15 years or older who have daily, but not constant jobs such as labors or farmers.

[5]Unemployment: People 15 years or older who do not have a job now.

[6]Employment Percent = ([3]Full Employ. + [4]Limited Employ.) * [1]Inside Employ. / 100

4.2.2 Ministry of Transport

The fourth external variable (private cars) was attained from Ministry of Transport (MOT). Table 4.4 indicates the fourth factor used in the ridership model.

Table 4.4: Licensed Auto Ownership by Governorate (MOT, 2010)

Governorate	Private Vehicles in Year 2010
North Gaza	9600
Gaza	32000
Middle Area	3600
Khan Younis	18400
Rafah	2400
Total	**66000**

4.2.3 Ministry of Higher Education

The fifth external factor (students percent) was achieved from MOHE. Tables 4.5 illustrates the fifth external variable used in the ridership model.

Table 4.5: Students Percent by Governorate (MOHE, 2010)

Governorate	Student Percent Year 2010
North Gaza	14.35
Gaza	38.13
Middle Area	15.10
Khan Younis	19.52
Rafah	12.90

4.2.4 Reports of Various Public Transportation Agencies and Bus Companies

Interviews were conducted with managers of all bus companies that have bus services between Governorates to obtain the data reports of the existing bus trips in Gaza Strip, in North Gaza, Gaza, Middle Area, Khan Younis and Rafah. Table 4.6 indicates total weekly bus riders between pairs of Governorates.

Tables 4.7, 4.8, 4.9, 4.10 and 4.11 indicate the daily bus trips from the origin governorate to the destination governorate, in terms of bus companies, number of buses, number of trips, number of ridership and other notes. These tables were classified according to the origin governorate; North Gaza, Gaza, Middle area, Khan younis and Rafah respectively. The average of riders per day is calculated by multiplying no. of trips by no. of riders per trip. The no. of riders per trip is equal to or less than fifty riders in tables 4.7 through 4.11 according to bus companies' operators (2010). The average no. of riders per week is calculated by multiplying average of riders per day by six day. Friday is a holiday.

Table 4.6: Total Weekly Bus Riders Between Pairs of Governorates

To / From	N.Gaza	Gaza	M. Area	Khan Y.	Rafah
N. Gaza	x	7800	-	-	-
Gaza	7800	×	4140	4380	8640
M. Area	-	4740	×	1800	1200
Khan Y.	-	4620	2100	×	5700
Rafah	-	10020	1200	5700	×

Source: Bus companies' operators (2010)

Table 4.7: Bus Services Originated at North Gaza Governorate

Bus Route Between Governorates		Bus Company	No. of Buses	No. of Trips Per Day	Average of Riders Per Day	Average of Riders Per Week
Origin Govern.	Destination Govern.					
North Gaza	Gaza	El-Salam Co.	4	4	200	**7800**
		Abu Lubda Co.	3	3	150	
		Abu Olba Co.	3	3	150	
		Sweety Tours Co.	2	2	100	
		Sobeh Co.	2	2	100	
		Mady Co.	2	2	100	
		Hamdona Co.	3	6	300	
		Md.Abu Olba Co.	1	1	50	
		Others	3	3	150	
		Total	**23**	**26**	**1300**	

Source: Bus Companies' Operators (2010)

Table 4.8: Bus Services Originated at Gaza Governorate

Bus Route Between Governorates		Bus Company	No. of Buses	No. of Trips Per Day	Average of Riders Per Day	Average of Riders Per Week
Origin Govern.	Destination Govern.					
Gaza	North Gaza	El-Salam Co.	4	4	200	**7800**
		Abu Lubda Co.	3	3	150	
		Abu Olba Co.	3	3	150	
		Sweety Tours Co.	2	2	100	
		Sobeh Co.	2	2	100	
		Mady Co.	2	2	100	
		Hamdona Co.	3	6	300	
		Md. Abu Olba Co.	1	1	50	
		Others	3	3	150	
		Total	**23**	**26**	**1300**	
	Middle Area	Gaza Co.	2	3	100	**4140**
		Md. Abu Olba Co.	2	2	100	
		Sweety Tours Co.	1	1	40	
		Elia Al Taiba Co.	4	5	200	
		Central Co.	2	3	100	
		Nuseirat Co.	3	3	150	
		Total	**14**	**17**	**690**	
	Khan Yunis	Gaza Co.	5	5	230	**4380**
		Abu Olba Co.	2	3	100	
		Sweety Tours Co.	1	1	50	
		Kardash Co.	3	4	150	
		Central Co.	1	1	50	
		Al Rawames Co.	3	3	150	
		Total	**15**	**17**	**730**	
	Rafah	Al Nairab Co.	15	20	800	**8640**
		Md. Abu olba Co.	2	3	120	
		Abu Olba Co.	1	2	100	
		Sweety Tours Co.	2	3	90	
		Elia Al Taiba Co.	1	2	80	
		Tawfiq Qeshta Co.	2	4	160	
		Mady Co.	1	2	90	
		Total	**24**	**36**	**1440**	

Source: Bus Companies' Operators (2010)

Table 4.9: Bus Services Originated at Middle Area Governorate

Bus Route Between Governorates		Bus Company	No. of Buses	No. of Trips Per Day	Average of Riders Per Day	Average of Riders Per Week
Origin Govern.	**Destination Govern.**					
Middle Area	Gaza	Gaza Co.	2	2	80	**4740**
		Md. Abu Olba Co.	2	2	100	
		Abu Olba Co.	3	3	120	
		Sweety Tours Co.	1	1	40	
		Elia Al Taiba Co.	4	4	200	
		Central Co.	2	2	100	
		Nuseirat Co.	3	3	150	
		Total	**17**	**17**	**790**	
	Khan Yunis	Sweety Tours Co.	1	1	50	**1800**
		Al Etehad Co.	1	1	50	
		Elia Al Taiba Co..	1	1	50	
		Central Co.	3	4	150	
		Total	**6**	**7**	**300**	
	Rafah	Al Etehad Co.	2	2	100	**1200**
		Other Companies	3	3	100	
		Total	**5**	**5**	**200**	

Source: Bus Companies' Operators (2010)

Table 4.10: Bus Services Originated at Khan Younis Governorate

Bus Route Between Governorates		Bus Company	No. of Buses	No. of Trips Per Day	Average of Riders Per Day	Average of Riders Per Week
Origin Govern.	**Destination Govern.**					
Khan Younis	Gaza	Gaza Co.	6	6	250	**4620**
		Abu Olba Co.	3	3	120	
		Sweety Tours Co.	1	1	50	
		Kardash Co.	3	3	150	
		Central Co.	1	1	50	
		Al Rawames Co.	3	3	150	
		Total	**17**	**17**	**770**	
	Middle Area	Al Nairab Co.	1	1	50	**2100**
		Sweety Tours Co.	1	1	50	
		Al Etehad Co.	1	1	50	
		Elia Al Taiba Co.	1	1	50	
		Central Co.	3	3	150	
		Total	**7**	**7**	**350**	
	Rafah	Al Nairab Co.	5	10	500	**5700**
		Tawfiq Qeshta Co.	6	6	300	
		Other Companies	3	3	150	
		Total	**14**	**19**	**950**	

Source: Bus Companies' Operators (2010)

Table 4.11: Bus Services Originated at Rafah Governorate

Bus Route Between Governorates		Bus Company	No. of Buses	No. of Trips Per Day	Average of Riders Per Day	Average of Riders Per Week
Origin Govern.	**Destination Govern.**					
Rafah	Gaza	Al Nairab Co.	15	20	1000	**10020**
		Gaza Co.	3	3	80	
		Md.Abu Olba Co.	2	2	100	
		Abu Olba Co.	5	5	200	
		Sweety Tours Co.	2	2	90	
		Elia Al Taiba Co.	1	1	50	
		Tawfiq Qeshta Co.	2	2	100	
		Mady Co.	1	1	50	
		Total	**31**	**36**	**1670**	
	Middle Area	Al Etehad Co.	2	2	100	**1200**
		Other companies	3	3	100	
		Total	**5**	**5**	**200**	
	Khan Younis	Al Nairab Co.	5	10	500	**5700**
		Tawfiq Qeshta Co.	6	6	300	
		Other companies	3	3	150	
		Total	**14**	**19**	**950**	

Source: Bus Companies' Operators (2010)

Tables 4.12 through 4.15 illustrate bus trips attributes between pairs of governorates in terms of the bus trip length, travel time, bus fare and the average weekly bus trips respectively.

Table 4.12: Trip length in Kilometer Between the Origin and Destination Governorates

To / From	N. Gaza	Gaza	M. Area	Khan Y.	Rafah
N. Gaza	x	9	24	37	44
Gaza	9	×	15	28	35
M. Area	24	15	×	13	20
Khan Y.	37	28	13	×	7
Rafah	44	35	20	7	×

x : No intercity bus service

Source: Bus Companies' Operators (2010)

Table 4.13:Travel Time in Minutes Between Origin and Destination Governorates

To / From	N.Gaza	Gaza	M. Area	Khan Y.	Rafah
N. Gaza	x	35	-	-	-
Gaza	35	×	30	50	75
M. Area	-	30	×	20	45
Khan Y.	-	50	20	×	25
Rafah	-	75	45	25	×

x: No intercity bus service

Source: Bus Companies' Operators (2010)

Table 4.14: Bus Fare in (NIS) Between the Origin and Destination Governorates

To / From	N.Gaza	Gaza	M.Area	Khan Y.	Rafah
N. Gaza	x	2	-	-	-
Gaza	2	x	2	3	4
M. Area	-	2	x	2	3.5
Khan Y.	-	3	2	x	2
Rafah	-	4	3.5	2	x

x: No intercity bus service

Source: Bus Companies' Operators (2010)

Table 4.15: Average Weekly Bus Trips Between Governorates

To / From	N.Gaza	Gaza	M.Area	Khan Y.	Rafah
N. Gaza	x	156	-	-	-
Gaza	156	x	102	102	216
M. Area	-	102	x	42	30
Khan Y.	-	102	42	x	114
Rafah	-	216	30	114	x

x: No bus service between Governorates

Source: Bus Companies' Operators (2010)

Tables 4.16, 4.17, 4.18, 4.19 and 4.20 indicate the daily shared taxi trips from the origin governorate to the destination governorate, in terms of number of shared taxi, number of trips, number of ridership and other notes. These tables were divided according to the origin governorate; North Gaza, Gaza, Middle area, Khan Younis and Rafah respectively. The average of riders per day for tables 4.16 through 4.20 is calculated by multiplying no. of shared taxis by no. of trips per day by seven riders. The average of riders per week is calculated by multiplying the average of riders per day by six days. Friday is a holiday.

Table 4.16: Shared Taxis Services Originated at North Gaza Governorate

Shared Taxi Route Between Governorates		Shared Taxi Garage	No. of Shared Taxis	No. of Trips Per Day	Average of Riders Per Day	Average of Riders Per Week
Origin Govern.	**Destination Govern.**					
North Gaza	Gaza	North Gaza Garage	15	7	735	**4410**
		Total	**15**	**7**	**735**	

Source: Shared Taxi Operators (2010)

Table 4.17: Shared Taxis Services Originated at Gaza Governorate

Shared Taxi Route Between Governorates		Shared Taxi Garage	No. of Shared Taxis	No. of Trips Per Day	Average of Riders Per Day	Average of Riders Per Week
Origin Govern.	**Destination Govern.**					
Gaza	North Gaza	North Gaza Garage	15	7	735	**4410**
		Total	**15**	**7**	**735**	
	Middle Area	Al - Kateeba	200	4	5600	**72660**
		Al- Shefa	200	4	5600	
		Al-Zahra	65	2	910	
		Total	**465**	**10**	**12110**	
	Khan Younis	Al - Kateeba	200	3	4200	**42000**
		Al- Shefa	80	4	2240	
		Al-Zahra	40	2	560	
		Total	**320**	**9**	**7000**	
	Rafah	Al - Kateeba	75	2	1050	**13860**
		Al- Shefa	30	4	840	
		Al-Zahra	30	2	420	
		Total	**135**	**8**	**2310**	

Source: Shared Taxi Operators (2010)

Table 4.18: Shared Taxis Services Originated at Middle Area Governorate

Shared Taxi Route Between Governorates		Shared Taxi Garage	No. of Shared Taxis	No. of Trips Per Day	Average of Riders Per Day	Average of Riders Per Week
Origin Govern.	Destination Govern.					
Middle Area	Gaza	Deir Al Balah	100	3	2100	**111300**
		Maghazi	100	5	3500	
		Nuseirat	220	5	7700	
		Al-Bureij	150	5	5250	
		Total	**570**	**18**	**18550**	
	Khan Younis	Deir Al Balah	10	3	210	**6300**
		Maghazi	10	3	210	
		Nuseirat	15	4	420	
		Al-Bureij	10	3	210	
		Total	**45**	**13**	**1050**	
	Rafah	Deir Al Balah	10	3	210	**4788**
		Maghazi	10	3	210	
		Nuseirat	10	3	210	
		Al-Bureij	8	3	168	
		Total	**38**	**12**	**798**	

Source: Shared Taxi Operators (2010)

Table 4.19: Shared Taxis Services Originated at Khan Younis Governorate

Shared Taxi Route Between Governorates		Shared Taxi Garage	No. of Shared Taxis	No. of Trips Per Day	Average of Riders Per Day	Average of Riders Per Week
Origin Govern.	**Destination Govern.**					
Khan Younis	Gaza	Jalal	100	2	1400	**22680**
		Bani Suhaila	70	2	980	
		Others	100	2	1400	
		Total	**270**	**6**	**3780**	
	Middle Area	Jalal	10	2	140	**2940**
		Bani Suhaila	15	2	210	
		Others	10	2	140	
		Total	**35**	**6**	**490**	
	Rafah	Jalal	10	2	140	**2520**
		Bani Suhaila	10	2	140	
		Others	10	2	140	
		Total	**30**	**6**	**420**	

Source: Shared Taxi Operators (2010)

Table 4.20: Shared Taxis Services Originated at Rafah Governorate

Shared Taxi Route Between Governorates		Shared Taxi Garage	No. of Shared Taxis	No. of Trips Per Day	Average of Riders Per Day	Average of Riders Per Week
Origin Govern.	**Destination Govern.**					
Rafah	Gaza	Eastern Garage	200	2	2800	**19320**
		Others	30	2	420	
		Total	**230**	**4**	**3220**	
	Middle Area	Eastern Garage	30	2	420	**4200**
		Others	20	2	280	
		Total	**50**	**4**	**700**	
	Khan Younis	Eastern Garage	10	2	140	**4200**
		Others	20	4	560	
		Total	**30**	**6**	**700**	

Source: Shared Taxi Operators (2010)

4.2.5 Questionnaire Distribution

The average daily bus riders and shared taxi riders between Governorates for this study were 12,330 and 52,598 respectively. The sample size for the bus and shared taxi ridership was calculated using eq. 3-4 in page 33. The total average daily population (N) for bus riders is **12,330** and with a 95% confidence level and ± 5 percent precision level (d =0.05, Z = 1.96 from Annex 4 in page 139) (Renckly, 2002). The sample size for bus riders is as follows:

$$n = 12330 * 1.96^2 * .25 / (.05^2 * 12329)) + (1.96^2 * .25) = 372.58$$

So, a representative sample of **373** (372.58 rounded up) would be sufficient to satisfy the risk level.

The total average daily population (N) for shared taxi riders is **52,598** and with a 95% confidence level and ± 5 percent precision level (d = 0.05, Z = 1.96 from Annex 4).

Then, the sample size for shared taxi riders is as follows:

$$n = 52598 * 1.96^2 * .25 / (.05^2 * 52597)) + (1.96^2 * .25) = 381.38$$

So, a representative sample of **382** (381.38 rounded up) would be sufficient to satisfy the risk level.

The questionnaire is developed to contain three parts: general information, questions for bus riders and finally, questions for shared taxi riders. A sum of 420 forms were distributed for bus and shared taxi riders. The number of valid samples was 400. The number of non valid forms was rejected since some answers were confusing, or they were not completing. Data were gathered through a questionnaire that was developed and distributed at selected locations representative of the population that are affected by the current transport system.

The questionnaire was distributed in the period of (01/05/2012 to 07/06/2012). The number of questionnaires to be distributed between Governorates was based on the proportional distribution of trip passengers. The distribution of the questionnaires was done according to each pair of governorates as shown in table 4.21.

Table 4.21: Sample Size Distribution for Bus Trip Routes Between Governorates

Trip Route	Sample Size	Number of Valid Forms
North Gaza / Gaza	60	54
Gaza / North Gaza	60	54
Gaza / Rafah	61	60
Rafah / Gaza	70	67
Khan Younis / Gaza	34	32
Gaza / Khan Younis	31	30
Middle Area / Gaza	33	33
Gaza / Middle Area	29	28
Middle Area / Rafah	8	8
Rafah / Middle Area	8	8
Middle Area / Khan Younis	12	12
Khan Younis / Middle Area	14	14
Total	**420**	**400**

CHAPTER 5: STATISTICAL ANALYSIS AND MODELING

5.1 INTRODUCTION

This chapter is discussing the statistical analysis of the ridership demand modeling and the elasticities of the ridership related to different variables. This statistical analysis consists of three parts. The first part explains the independent variables that are potentially affecting ridership demand across Gaza strip major governorates; North Gaza, Gaza, Middle Area, Khan Yunis, and Rafah. The second part of this analysis illustrates a ridership demand in the future. The third part explains a sample of riders in order to find the type of functions that characterizes the relation between the number of riders and other independent variables. The main factors that significantly affect the number of riders in the present time and future would be identified. The characterizations and the common features of the riders and their ridership demand along with their major obstacles facing them during their travelling would be realized.

5.2 Statistical Analysis of Ridership Demand

All collected data were joined into one main table as shown in Table 5.1. The data consists of employment, average weekly ridership, the number of private cars, population, average monthly expenditure per family, trip length, travel time, bus fare and average number of bus trip between the origin and destination governorates.

5.2.1 Trip length

According to the map of Gaza Strip, the longest trip length was between Rafah to Gaza governorates (35 Km), while the shortest length was between Rafah and Khan Younis governorates (12 Km). More trips are expected to be made to the neighboring communities than that of long trips. Therefore, trip length is considered one of the factors that influence the ridership demand. Figure 5.1 shows the trip length between each pair of governorates.

5.2.2 Bus Fare

It is expected to make more trips due to low fare compared with higher fare to the far places. Figure 5.2 shows the bus fare between governorates.

Table 5.1: Characteristics of the Study Area

Origin Governorate (External Variables)						Destination Governorate (External Variables)					
Origin Governorate	*Population	Employment Percent	Monthly Expenditure	Student Percent	No. of Private Cars	Destination Governorate	Population	Employment Percent	Monthly Expenditure	Student Percent	No. of Private Cars
North Gaza	297269	21.76	725	14.35	9600	Gaza	534558	22.99	756	38.13	32000
Gaza	534558	22.99	756	38.13	32000	North Gaza	297269	21.76	725	14.35	9600
						Middle Area	222866	23.3	693	15.10	3600
						Khan Younis	291737	21.24	655	19.50	18400
						Rafah	188690	24.61	726	12.90	2400
Middle Area	222866	23.3	693	15.10	3600	Gaza	534558	22.99	756	38.13	32000
						Khan Younis	291737	21.24	655	19.50	18400
						Rafah	188690	24.61	726	12.90	2400
Khan Younis	291737	21.24	655	19.50	18400	Gaza	534558	22.99	756	38.13	32000
						Middle Area	222866	23.3	693	15.10	3600
						Rafah	188690	24.61	726	12.90	2400
Rafah	188690	24.61	726	12.90	2400	Gaza	534558	22.99	756	38.13	32000
						Middle Area	222866	23.3	693	15.10	3600
						Khan Y.	291737	21.24	655	19.50	18400

* (2010)

Table 5.1: Characteristics of the Study Area (continued)

Destination Governorate (Internal Variables)						
Origin Governorate	Destination Governorate	Trip Length (km)	Travel Time (min.)	Bus Fare (Sheqel)	Weekly No. of Trips	No. of Ridership
North Gaza	Gaza	9	35	2	156	7800
Gaza	North Gaza	9	35	2	156	7800
	Middle Area	15	30	2	102	4140
	Khan Younis	28	50	3	102	4380
	Rafah	35	75	4	216	8640
Middle Area	Gaza	15	30	2	102	4740
	Khan Younis	13	20	2	42	1800
	Rafah	20	45	3.5	30	1200
Khan Younis	Gaza	28	50	3	102	4620
	Middle Area	13	20	2	42	2100
	Rafah	7	25	2	114	5700
Rafah	Gaza	35	75	4	216	10020
	Middle Area	20	45	3.5	30	1200
	Khan Younis	7	25	2	114	5700

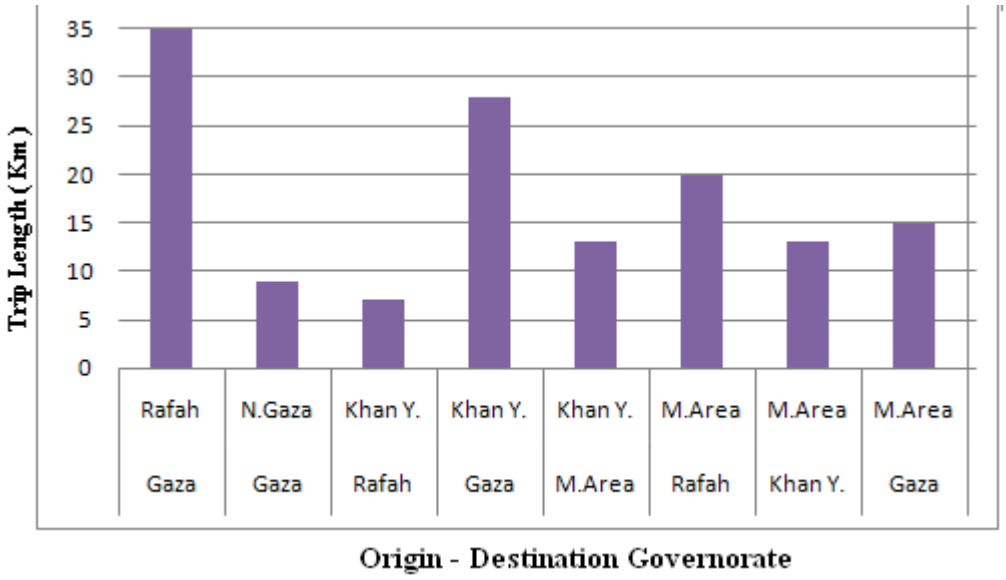

Figure 5.1: Trip length Between Each Pair of Governorates

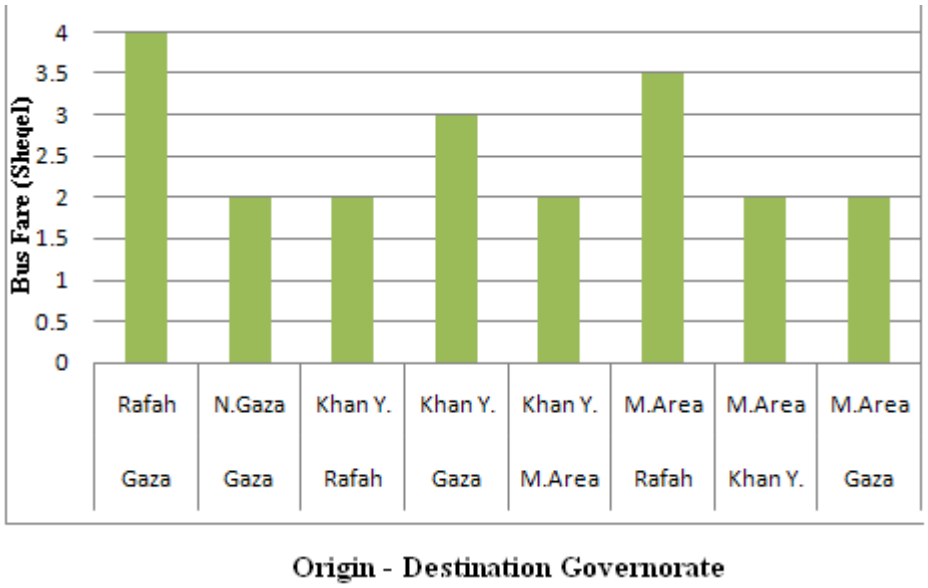

Figure 5.2: Bus Fare Between Governorates

5.2.3 Students Percent

Students are expected to make more trips to their universities and institutes. So, students are considered one of the variables that may affect ridership demand. Figure 5.3 illustrates students percent between governorates.

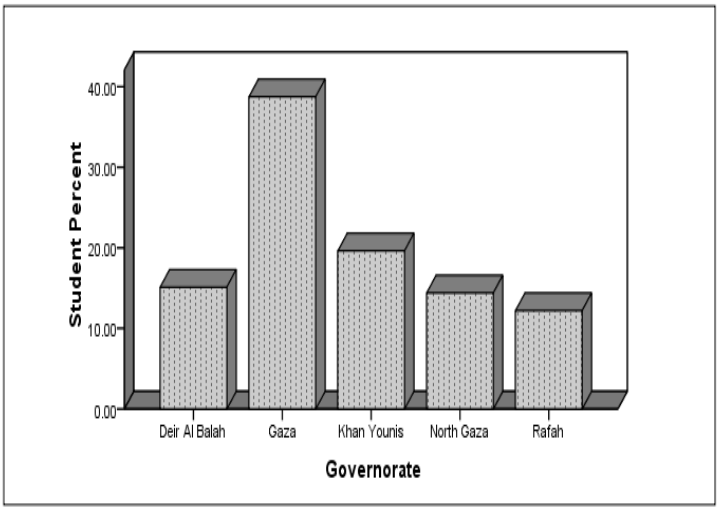

Figure 5.3: Students Percent Between Governorates

5.2.4 Average Weekly Ridership

Based on bus companies operator's report, the highest average weekly ridership was between Rafah to Gaza cities (10020 riders), while the least average weekly ridership was between Rafah to Middle Area (1200 riders). Figure 5.4 shows the ridership demand between each pair of governorates .

5.2.5 Bus Travel Time

Ridership is also affected by travel time by making more short time trips to the neighboring community than the far one. Based on bus companies operator's report, the shortest bus trip was between Middle Area and Khan Younis governorates (about 20 minutes). Also, the longest travel time was between Rafah and Gaza governorates (about 75 minutes). Figure 5.5 shows the ridership demand between each pair of governorates of this study.

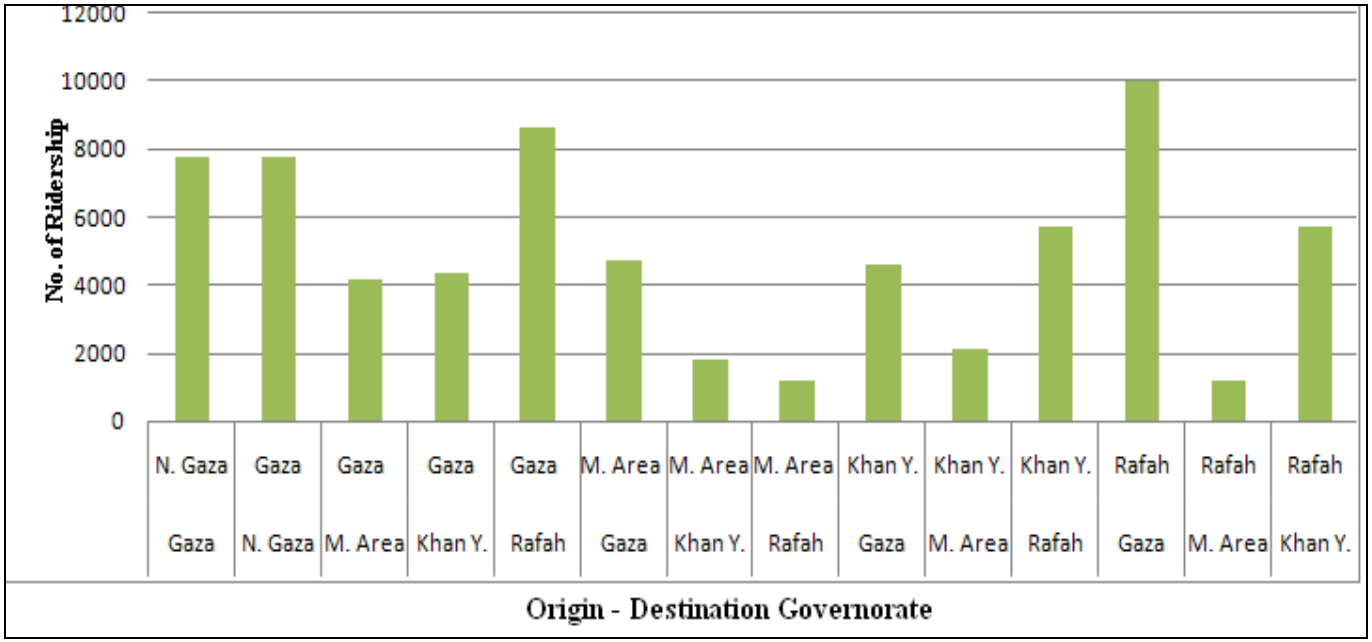

Figure 5.4: Bus Ridership Between Governorates

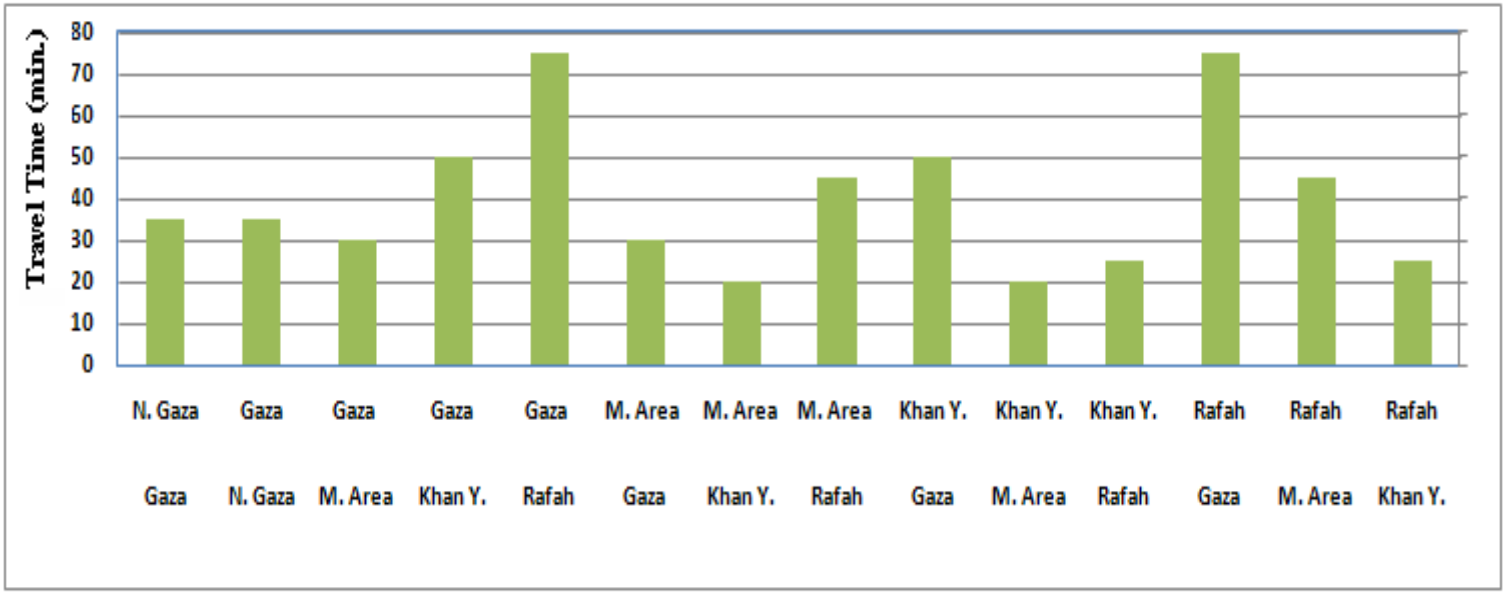

Figure 5.5: Bus Travel Time Between Governorates

5.2.6 Population

Based on PCBS source, the distribution of population by governorate of this study shows that Gaza governorate has the largest population (534558) while Rafah governorate has the smallest population (188690). Increasing the origin population will increase the bus ridership demand. Therefore, the population variable was studied since it may influence ridership demand. Figure 5.6 illustrates population per governorate.

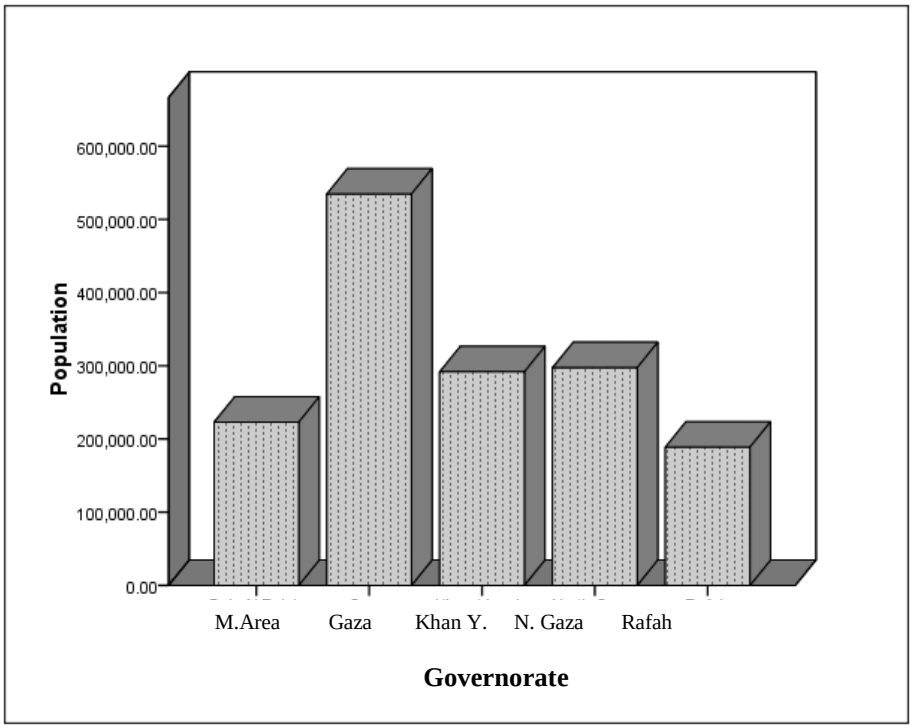

Figure 5.6: Population Distribution Per Governorate

5.2.7 Employment

The employment is considered one of the factors that may affect ridership demand. So, small level employment governorate will be attracted to that of high employment level. As shown in Figure 5.7, there is no variance of the percentage of employment status between the different governorates. Based on PCBS source, Rafah governorate has the highest employment percentage (24.61%), while Khan Younis governorate has the lowest employment percentage (21.24%).

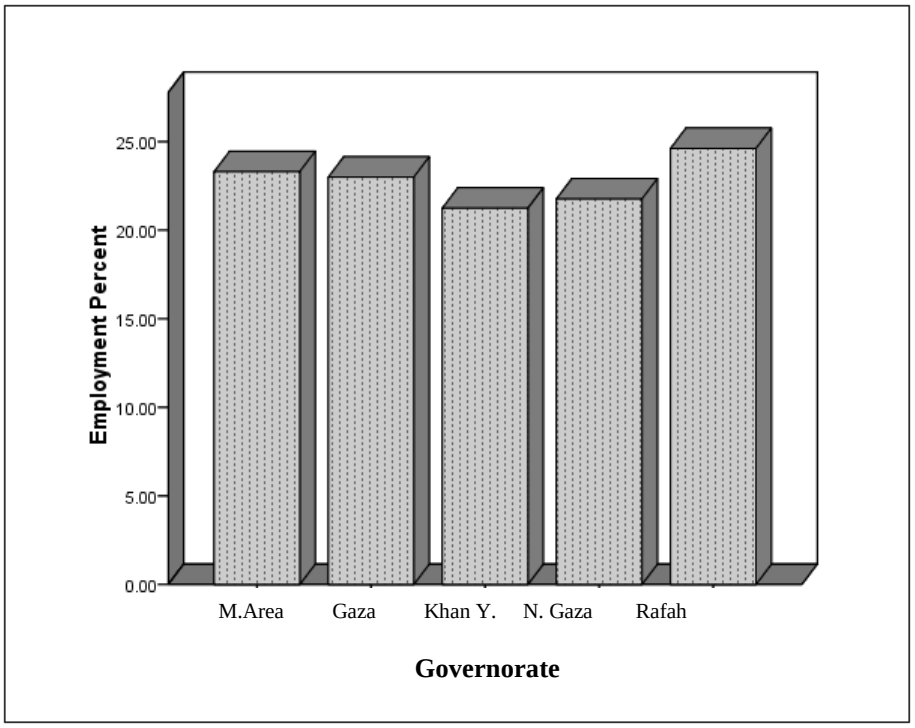

Figure 5.7: Percent Employment Per Governorate

5.2.8 Expenditure

Ridership is influenced by the average monthly expenditure per family. Low expenditure communities are expected to ride buses more than shared taxis. As shown in Figure 5.8, there is no variance of the percentage of average monthly expenditure of family between the different governorates. Based on PCBS source, Gaza governorate has the highest average monthly expenditure (756 NIS per month), while Rafah governorate has the lowest average monthly expenditure (726 NIS per month).

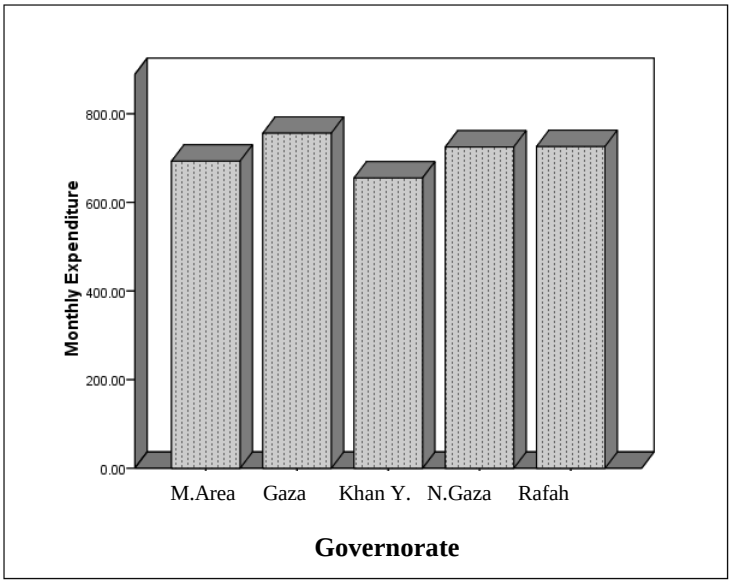

Figure 5.8: Average Family Expenditure Per Governorate

5.2.9 Private Cars

Private cars are expected to make more trips. So, ridership is influenced by private cars. Based on the MOT source, Gaza governorate has the highest total numbers of private cars (32000 cars), while Rafah governorate has the lowest total numbers of private cars (2400 cars). Figure 5.9 illustrates the number of private cars per governorate.

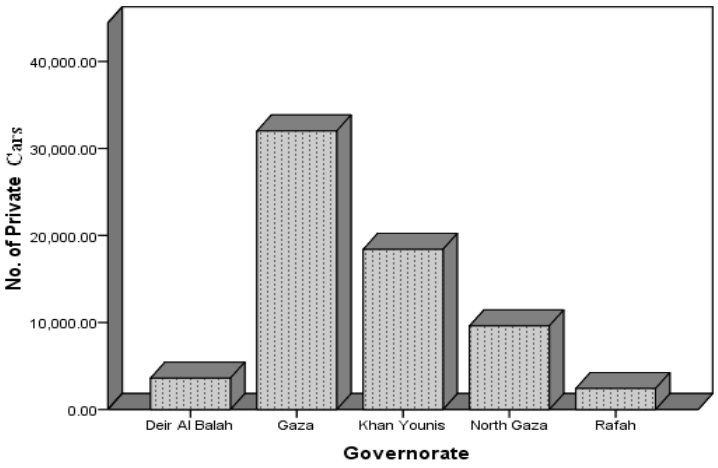

Figure 5.9: Total Number of Private Cars Per Governorate

5.3 Constructing a Ridership Predicting Model

The multiple regression function will be estimated. For this approach, two main methods for estimating such a model were used as below:

1-Stepwise Method: Variables are entered into the model based on a mathematical criteria. Through Stepwise method of regression, stepwise regression includes regression models in which the choice of predictive variables is carried out by an automatic procedure. Usually, this takes the form of a sequence of F-tests but other techniques are possible, such as t-tests and adjusted R-square. In this study, 14 independent variable (predictors) were used. Using stepwise method will reduce the number of variables to be included in the final model, as shown in Table 5.2. The method just selected the most important four variables to be included in the model, since including these variables in the model increase the value of R, R Square, and Adjusted R Square.

Table 5.2: R and R Square Changes

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.865	.749	.707	1504.74623
2	.954	.910	.875	984.46207
3	.970	.941	.905	726.18307
4	.940	.908	.901	995.68289

Table 5.3 illustrates the ANOVA test that includes an F test and the significance of the four important variables which is another criteria for measuring and selecting the best variables to be included in the model. Table 5.4 illustrates the names and coefficients of the four variables suggested by stepwise method to create and construct the optimum regression model that predicts the ridership demand. As we can see in table 5.4, the model includes four important variables; Monthly Expenditure (orig.), Monthly Expenditure (dest.), Travel Time, and Bus Fare. It also contains the coefficients of the variables or Beta values plus the constant value or the intercept in order to construct the optimum regression model.

Table 5.3: ANOVA Test

	Model	Sum of Squares	Mean Square	F	Sig.
1	Regression	4.055E7	4.055E7	17.909	.005[a]
	Residual	1.359E7	2264261.231		
	Total	5.414E7			
2	Regression	4.929E7	2.465E7	25.429	.002[b]
	Residual	4845827.812	969165.562		
	Total	5.414E7			
3	Regression	5.303E7	1.768E7	63.968	.001[c]
	Residual	1105370.007	276342.502		
	Total	5.414E7			
4	Regression	5.724E7	2.703E7	115.968	.000[c]
	Residual	908289.126	233081.539		
	Total	5.414E7			

Table 5.4: The Names and Coefficients of the Four Variables Suggested by Stepwise Method

		Coefficients				
Model		Un Standardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-19706.439-	6230.675		-3.163-	.019
	Monthly Expenditure(orig.)	19.964	9.443	.865	4.232	.005
2	(Constant)	-19738.719-	4076.358		-4.842-	.005
	Monthly Expenditure(orig.)	17.770	6.221	.818	6.071	.002
	Monthly Expenditure(des)	26.953	10.045	.405	3.003	.030
3	(Constant)	-16970.945-	2682.490		-5.208-	.006
	Monthly Expenditure(orig.)	12.250	3.325	.828	11.505	.000
	Monthly Expenditure(des)	26.423	10.042	.781	6.245	.003
	Travel Time (min.)	251.591	17.981	.460	-3.679-	.021
4	(Constant)	-16268.350-	2682.490		-5.208-	.006
	Monthly Expenditure(orig.)	10.387	3.325	.828	11.505	.000
	Monthly Expenditure(dest)	24.653	8.042	.781	6.245	.003
	Travel Time (min.)	251.591	17.981	.460	-3.679-	.021
	Bus Fare (sheqel)	-5112.129-	1542.068	.952	4.735	.018

Hence, the final and optimum ridership model is suggested to be as follows:

$$Y = - \quad 16268.350 + 10.387x_1 + 24.653x_2 + 251.591x_3 - 5112.129\, x_4$$

where, x_1 is Monthly Expenditure (orig.), x_2 is Monthly Expenditure (dest.), x_3 is Travel Time, and x_4 is the Bus Fare. Table 5.5 shows the comparison between the observed and the predicted ridership demand using the above model. Also, Figure 5.10 illustrates the Normal Probability Plot, which is a graphical representation of discovering or testing the regression main assumption. It says the residuals should be normally distributed, and violation of this assumption indicates that the model is out of condition. Since the points should not be far away from the line, hence the more closeness of the points to the line, the more indication that the residuals are normally distributed. In Figure 5.10, the points are so close to the line. This is an indicator that the residuals of the model is normally distributed and hence there is no violation of that assumption by the model. Therefore, the model fits data for prediction of the ridership demand.

Table 5.5: **Comparison Between the Observed and Predicted Ridership Demand**

* Source: Bus Companies' Operators (2010)

Origin Governorate	Destination Governorate	* Observed No. of Ridership	Predicted No. of Ridership
North Gaza	Gaza	7800	8481
Gaza	North Gaza	7800	8039
	Middle Area	4140	5992
	Khan Younis	4380	4975
	Rafah	8640	7903
Middle Area	Gaza	4740	3368
	Khan Younis	1800	1885
	Rafah	1200	2257
Khan Younis	Gaza	4620	6415
	Middle Area	2100	2427
	Rafah	5700	4498
Rafah	Gaza	10020	8331
	Middle Area	1200	1786
	Khan Younis	5700	3485

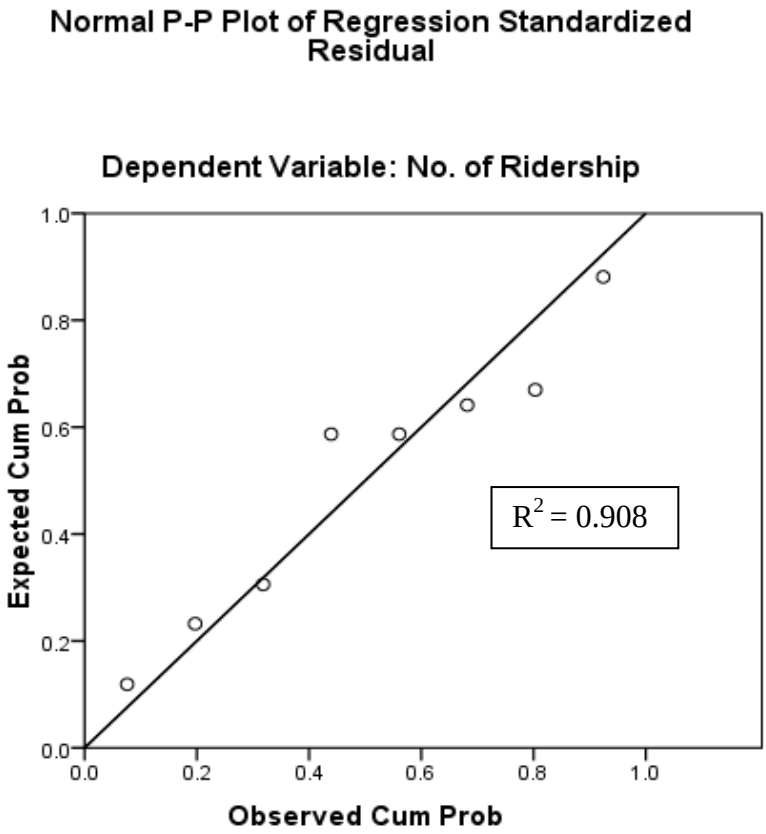

Figure 5.10: **Normal P-P plot of regression standardized residual**

2-Enter Method: All independent variables or predictors are entered simultaneously into the equation in one step, also called "forced entry". Table 5.6 shows the changes of R square, while using Enter method of regression. R square is equal to (0.997) and it is increased relatively compared with that used in stepwise method (which was equal to 0.908).

Table 5.6: The Changes of R Square

Model Summary					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Sig. F Change
1	.999	.997	.981	389.42265	.016

Table 5.7 shows that the model is significant because the p-value is less than 0.05.

Table 5.7: Multiple Regression Results

ANOVA					
Model		**Sum of Squares**	**Mean Square**	**F**	**Sig.**
1	Regression	1.037E8	9424624.675	62.147	.016
	Residual	303300.000	151650.000		
	Total	1.040E8			

Table 5.8 illustrates that the majority of the independent variables are significant to enter the model at the .05 level. However, when examining the multiple regression, there are only two variables that may be excluded from the model, which are: Monthly Expenditure (dest.) and Travel Time (min.) because they are shown to be insignificant.

Table 5.8: The Significance in Analysis of Variance Between Predictors Entered in the Model

Coefficients						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	-136171.177-	15153.421		-8.986-	.012
	Employment Percent(orig.)	5499.554	625.619	2.340	8.791	.013
	Student Percent(orig.)	-975.986-	143.863	-3.860-	-6.784-	.021
	monthly Expenditure(orig.)	-59.591-	12.325	-.813-	-4.835-	.040
	No. of Private cars(orig.)	.875	.130	3.920	6.749	.021
	Employment Percent(dest.)	5095.943	634.195	2.169	8.035	.015
	Students Percent(dest.)	-927.186-	113.454	-3.667-	-8.172-	.015
	Monthly Expenditure(dest.)	-48.666-	13.806	-.664-	-3.525-	.072
	No.of Private cars(dest.)	.829	.101	3.714	8.172	.015
	Trip length (km)	1057.208	165.182	3.359	6.400	.024
	Travel Time (min.)	4.286	55.632	.029	.077	.946
	Bus Fare (sheqel)	-11160.000-	1101.454	-3.231-	-10.132-	.010

In table 5.8 the names and the coefficients of all variables to build and construct the optimum regression model predict the ridership demand. The model includes the following variables in origin and destination: Bus Fare (shekel), Students Percent (des), monthly Expenditure, No. of Private cars, Employment Percent, Trip length (km), Travel time (min.). The model also contains the coefficients of the variables (Beta

values) plus the constant value (the intercept) in order to construct the optimum regression model. Using Enter method, the final and optimum ridership model is suggested to be as follows:

$$Y = -136171.177 + 5499.554x_1 - 975.986x_2 + \ldots - 1116.000x_{11}$$

where the $x_1, x_2, \ldots\ldots x_{11}$ represent all the significant variables mentioned above respectively, in addition to the intercept.

Table 5.9 shows the comparison between the observed and the predicted ridership demand using the above model. Also, Figure 5.11 illustrates the Normal Probability Plot, similar to that used at stepwise method. It is a graphical representation of discovering or testing the regression main assumption. It says that the residuals should be normally distributed, and violation of this assumption indicates that the model is unfit. Since the points should not be far away from the line, hence the more closeness of the points to the line, the more indication that the residuals are normally distributed.

By comparing between Figure 5.10 & Figure 5.11, the points are so close to the line than that have shown at stepwise method. This is an indicator that the residuals of the model is normally distributed. Hence there is no violation of that assumption by our model. Therefore, using Enter method, the model seems to fit our data accurately more than stepwise method for prediction of the ridership demand. The principle of parsimony calls for keeping the model as simple as possible. It begins with calibration by estimating very few parameters that together represent most of the features of interest. Just having the penalty of more variables to be included in the model, there is a sensitivity to violate the principle of parsimony. It is a principle urging one to select from among competing hypotheses that which makes the fewest assumptions.

Table 5.9: Comparison Between the Observed and the Predicted Ridership Demand

Origin Governorate	Destination Governorate	Observed No. of Ridership	Predicted No. of Ridership
North Gaza	Gaza	7800	7789
Gaza	North Gaza	7800	7789
	Middle Area	4140	4131
	Khan Younis	4380	4134
	Rafah	8640	8863
Middle Area	Gaza	4740	4731
	Khan Younis	1800	1922
	Rafah	1200	1071
Khan Younis	Gaza	4620	4839
	Middle Area	2100	1967
	Rafah	5700	5590
Rafah	Gaza	10020	9779
	Middle Area	1200	1326
	Khan Younis	5700	5799

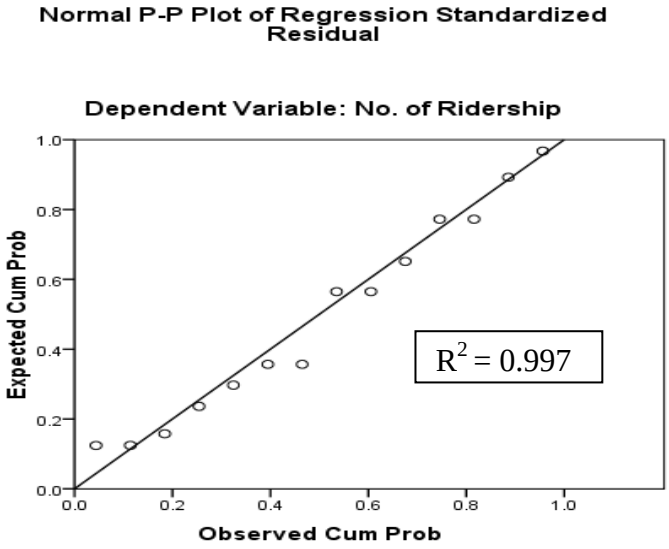

Figure 5.11: Normal P-P Plot of Regression Standardized Residual

5.4 Statistical Analysis of Ridership Questionnaire

A sample of riders is conducted to identify the main factors that significantly affect the number of riders in the present time and future. The characterizations and the common features of the riders and their ridership demand along with their major obstacles and problems facing them during their travelling were also realized. The questionnaire contained three parts; General information, the bus riders, and the shared taxi riders. The riders answers to these parts reflected and indicated their opinions and feelings. The survey was distributed across 400 riders which is the sample size of the study. The following table 5.10 describes the trip lines and number of riders between pairs of governorates using bus and shared taxi.

Table 5.10: Numbers of Riders Across Trip Lines Between Pairs of Governorates

From \ To	N. Gaza	Gaza	Mid. Area	Khan Y.	Rafah
N. Gaza	X	54	NA	NA	NA
Gaza	54	X	28	30	60
Mid. Area	NA	33	X	12	8
Khan Yunis	NA	32	14	X	NA
Rafah	NA	67	8	NA	X

NA indicates that there is no available information.

The following figure illustrates the number of bus / shared taxi riders between governorates.

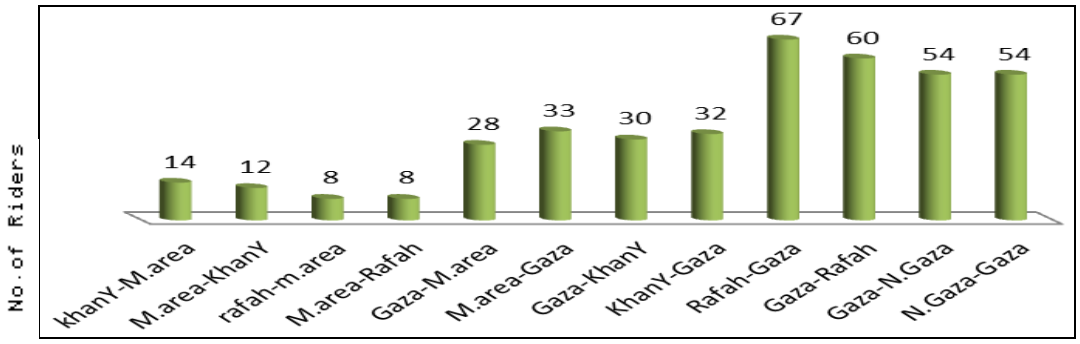

Figure 5.12: Bus / Shared Taxi Ridership Between Governorates

5.4.1 The Riders Age

Figure 5.13, Figure 5.14 & Table 5.11 illustrate the riders distribution according to their age. The majority of riders ages were between 25-34 years with proportion of 40% of the actual sample, followed by those between 15-24 with proportion of 32%, 14% for those between 35-44, 8% for those between 45-65, and those ages less than 65 with proportion of 6% from the actual sample of 400 riders.

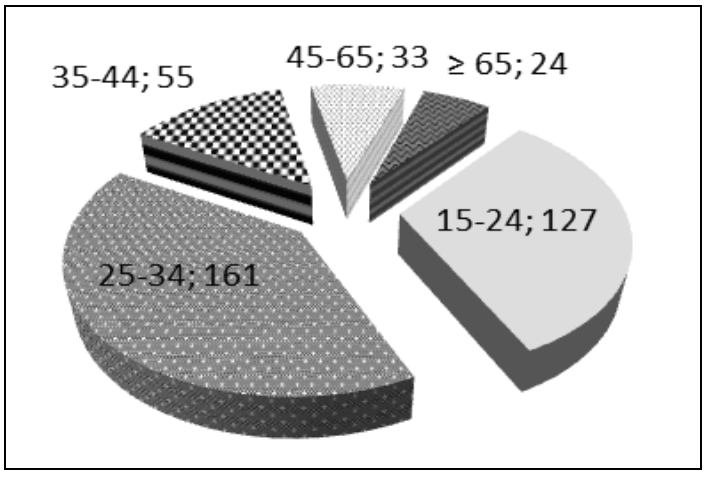

Figure 5.13: The Distribution of Riders According to Their Age

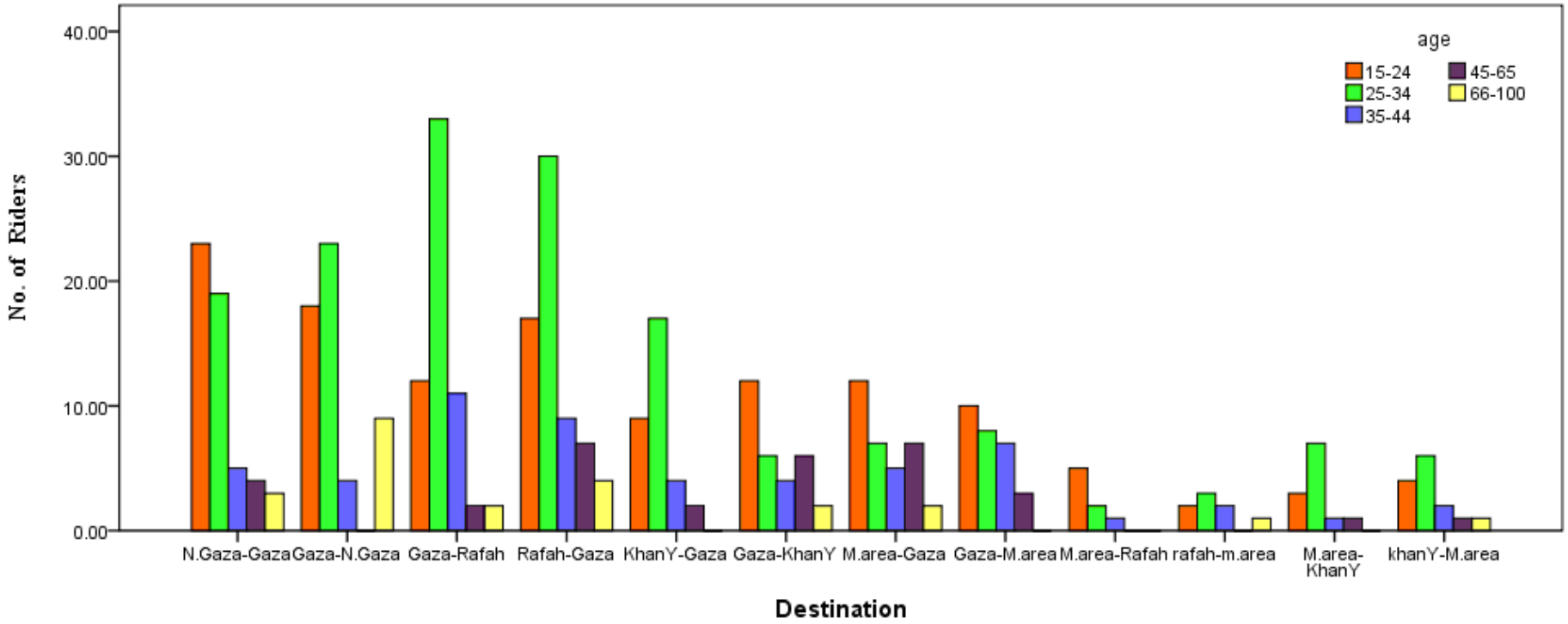

Figure 5.14: The Riders Between Governorates According to Their Age

Table 5.11: The Riders Between Governorates According to Their Age

Age	khanY-M.area	M.area-KhanY	Rafah-M.area	M.area-Rafah	Gaza-M.area	M.area-Gaza	Gaza-KhanY	KhanY-Gaza	Rafah-Gaza	Gaza-Rafah	Gaza-N.Gaza	N.Gaza-Gaza	Total
15-24	4	3	2	5	10	12	12	9	17	12	18	23	127
25-34	6	7	3	2	8	7	6	17	30	33	23	19	161
35-44	2	1	2	1	7	5	4	4	9	11	4	5	55
45-65	1	1	0	0	3	7	6	2	7	2	0	4	33
≥ 65	1	0	1	0	0	2	2	0	4	2	9	3	24
Total	14	12	8	8	28	33	30	32	67	60	54	54	400

5.4.2 The Riders Job

Figure 5.15, Table 5.12 & Figure 5.16 illustrate the riders job distribution, the majority of riders were students with proportion of 60% of the actual sample, followed by employees 24%, labors 12% and others with proportion of 4% from the actual sample of 400 riders.

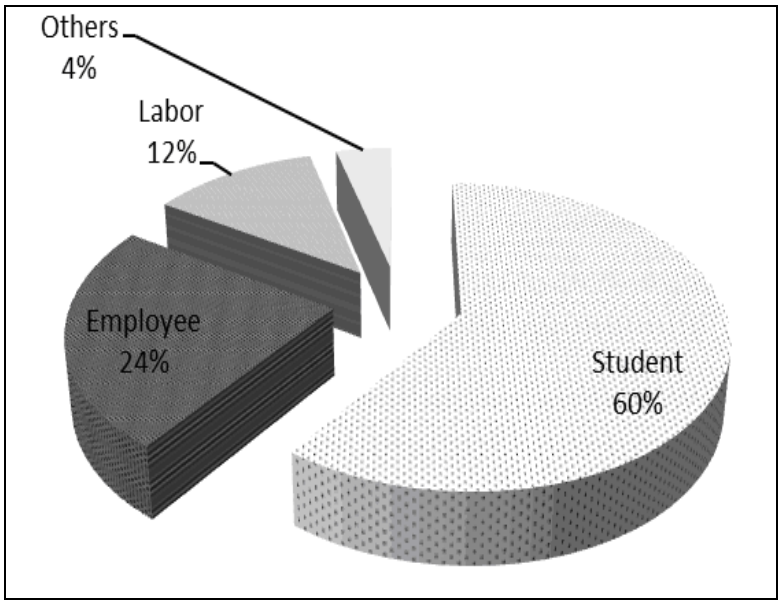

Figure 5.15: The Distribution of Riders According to Their Job

Table 5.12: The Riders Between Governorates According to Their Job

Job	N.Gaza-Gaza	Gaza-N.Gaza	Gaza-Rafah	Rafah-Gaza	KhanY-Gaza	Gaza-KhanY	M.area-Gaza	Gaza-M.area	M.area-Rafah	Rafah-M..area	M.area-KhanY	khanY-M.area	Total
Student	31	39	35	32	24	27	17	19	0	0	8	8	240
Employee	15	8	14	18	2	3	15	4	4	5	4	4	96
Labor	6	4	6	12	5	0	1	5	4	3	0	2	48
Others	2	3	5	5	1	0	0	0	0	0	0	0	16
Total	54	54	60	67	32	30	33	28	8	8	12	14	400

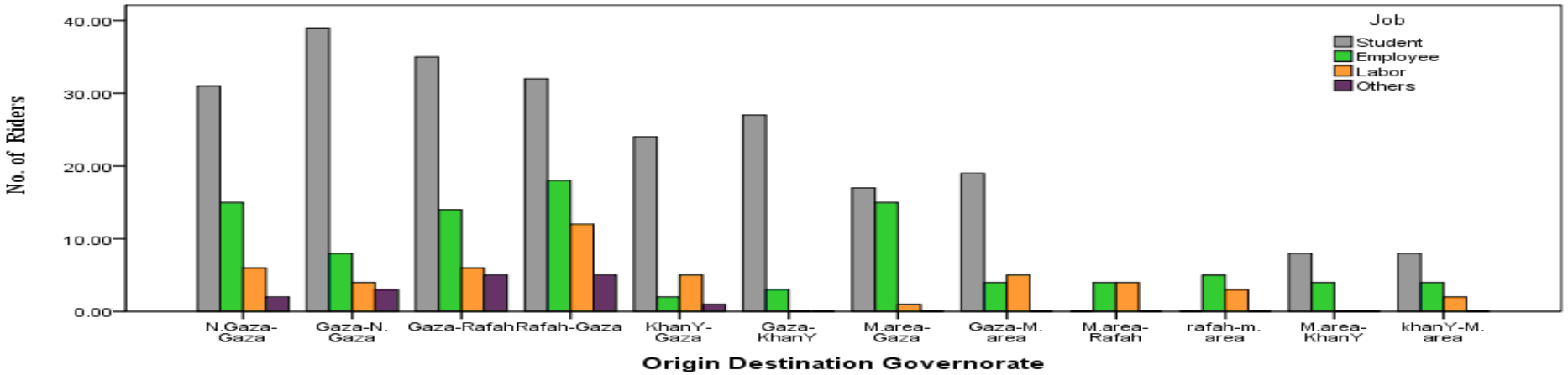

Figure 5.16: The Riders Between Governorates According to Their Job

5.4.3 The Riders Gender

Figure 5.17, Table 5.13 & Figure 5.18 illustrate the riders gender distribution, the majority of riders were from male with proportion of 63% of the actual sample, and 37% were female with proportion of 37% from the actual sample of 400 riders.

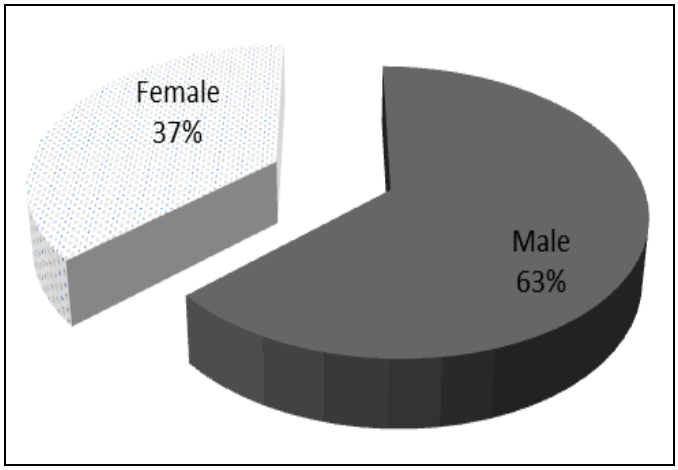

Figure 5.17: The Distribution of Riders According to Their Gender

Table 5.13: The Riders Between Governorates According to Their Gender

Gender	N.Gaza-Gaza	Gaza-N.Gaza	Gaza-Rafah	Rafah-Gaza	KhanY-Gaza	Gaza-KhanY	M.area-Gaza	Gaza-M.area	M.area-Rafah	Rafah-M.area	M.area KhanY	khanY-M.area	Total
Male	34	36	42	45	18	21	22	13	4	5	2	6	248
Female	20	18	18	22	14	9	11	15	4	3	10	8	152
Total	54	54	60	67	32	30	33	28	8	8	12	14	400

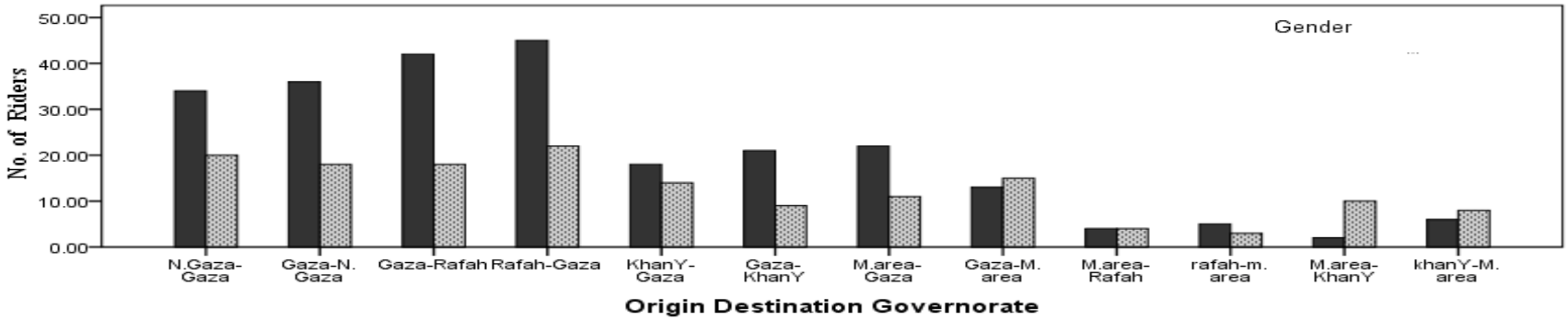

Figure 5.18: The Riders Between Governorates According to Their Gender

5.4.4 The Riders Education

Figure 5.19,Table 5.14 & Figure 5.20 illustrate the riders education distribution. The majority of riders were holding an university degree with proportion of 68% of the actual sample, followed by those holding diploma 20%, the holders of secondary certificate were 7%, while the holders of postgraduate degree were 4%, and those riders having below secondary education were having proportion of 1% from the actual sample of 400 riders

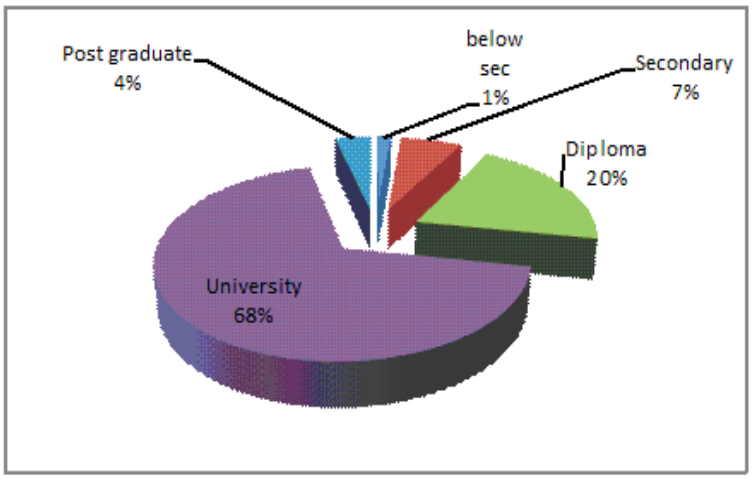

Figure 5.19: The Distribution of Riders According to Their Education Level

Table 5.14: The Riders Between Governorates According to Their Education Level

Education	N.Gaza-Gaza	Gaza-N.Gaza	Gaza-Rafah	Rafah-Gaza	KhanY-Gaza	Gaza-KhanY	M.area-Gaza	Gaza-M.area	M.area-Rafah	Rafah-M.area	M.area-KhanY	khanY-M.area	Total
Below sec	1	0	0	3	0	0	0	0	0	0	0	2	6
Secondary	2	3	2	10	3	1	0	2	1	0	1	1	26
Diploma	7	5	12	10	11	8	9	6	1	2	3	6	80
University	41	45	42	39	18	21	23	20	6	6	7	5	273
Post graduate	3	1	4	5	0	0	1	0	0	0	1	0	15
Total	54	54	60	67	32	30	33	28	8	8	12	14	400

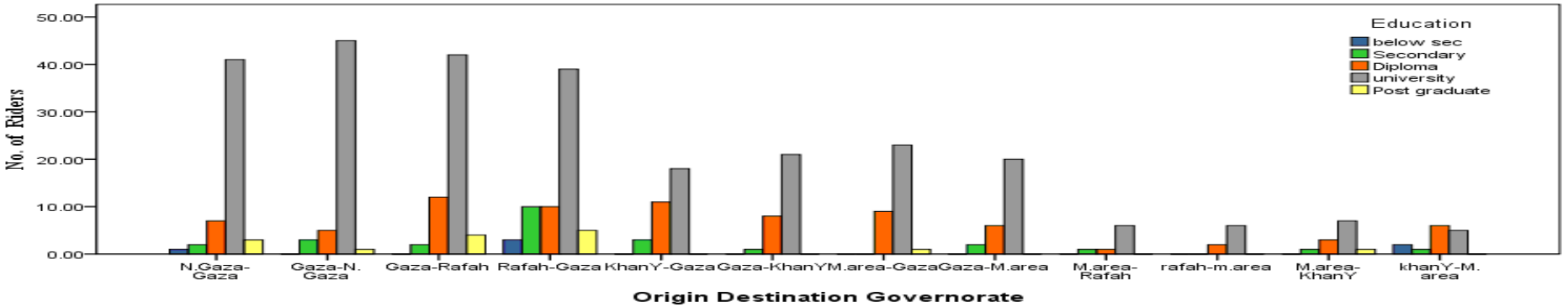

Figure 5.20: The Riders Between Governorates According to Their Education Level

5.4.5 The Riders Income Per Month

Figure 5.21, Table 5.15 & Figure 5.22 illustrate the riders distribution according to their income per month in Shekel. The income per month for 8% of the riders was less than 1000. 34% of the riders were from those that their income per month was from 1000 to 2000. Also, 33% of them were from 2000 to 3000 and for 15% of the riders, the income per month was from 3000 to 4000. The income per month for 8% of the riders was from 4000 to 5000. lastly, 2% proportion of them were those that their income per month was more than 5000 Shekel from the actual sample of 400 riders.

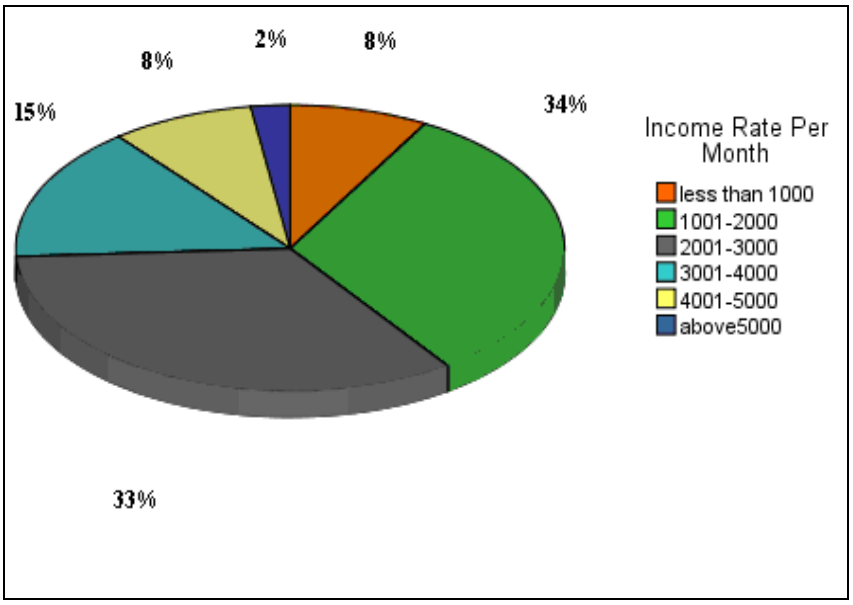

Figure 5.21: The Distribution of Riders According to Their Income Per Month

Table 5.15: The Riders Between Governorates According to Their Income Rate Per Month

Income Rate	N.Gaza-Gaza	Gaza-N.Gaza	Gaza-Rafah	Rafah-Gaza	KhanY-Gaza	Gaza-KhanY	M.area-Gaza	Gaza-M.area	M.area-Rafah	Rafah-M.area	M.area-KhanY	khanY-M.area	Total
‹ 1000	6	2	7	10	2	2	1	2	0	0	0	0	32
1000-2000	17	15	18	21	15	12	15	12	2	1	4	3	135
2000-3000	18	14	16	15	14	14	14	14	3	3	2	5	132
3000-4000	5	15	11	10	1	2	2	0	3	2	4	4	59
4000-5000	4	7	8	9	0	0	1	0	0	1	1	2	33
› 5000	4	1	0	2	0	0	0	0	0	1	1	0	9
Total	54	54	60	67	32	30	33	28	8	8	12	14	400

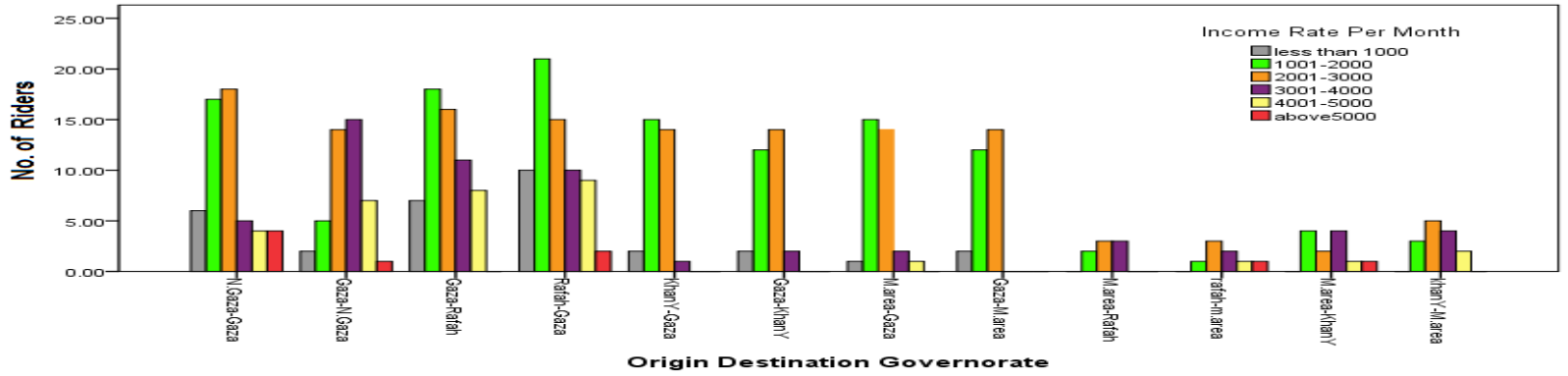

Figure 5.22: The Riders Between Governorates According to Their Income Rate Per Month

5.4.6 The Riders Weekly Trips

Figure 5.23, Table 5.16 & Figure 5.24 illustrate the riders distribution according to their number of weekly trips. The majority of riders were having more than 4 trips per week with proportion of 73% of the actual sample, followed by 2-4 weekly trips with proportion of 16%, 7% for those who have one weekly trip, and others with proportion of 4% from the actual sample of 400 riders.

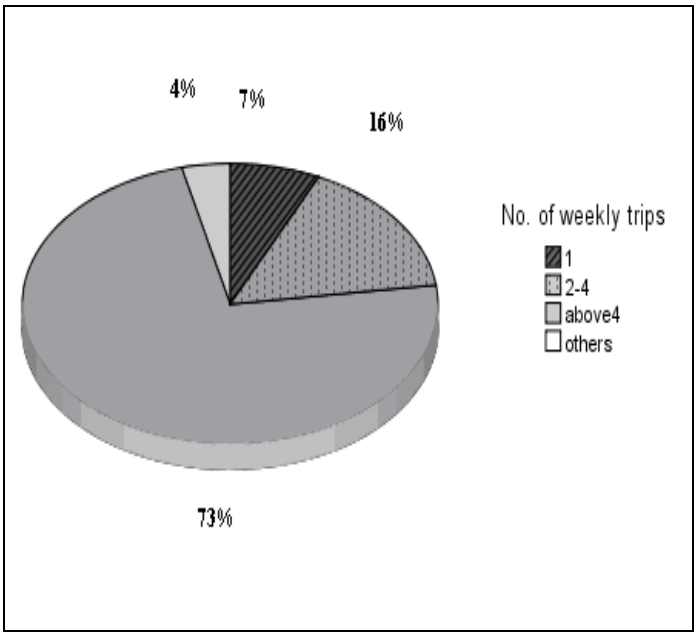

Figure 5.23: The Distribution of Riders According to No. of Weekly Trips

Table 5.16: The Riders Between Governorates According to No. of Weekly Trips

No. of weekly trips	N.Gaza-Gaza	Gaza-N.Gaza	Gaza-Rafah	Rafah-Gaza	KhanY-Gaza	Gaza-KhanY	M.area-Gaza	Gaza-M.area	M.area-Rafah	Rafah-M.area	M.area-KhanY	khanY-M.area	Total
1	2	3	5	6	2	2	1	1	2	1	3	0	28
2-4	4	4	8	11	8	6	4	5	2	3	4	4	63
› 4	45	47	44	48	22	18	28	21	4	3	5	8	293
Others	3	0	3	2	0	4	0	1	0	1	0	2	16
Total	54	54	60	67	32	30	33	28	8	8	12	14	400

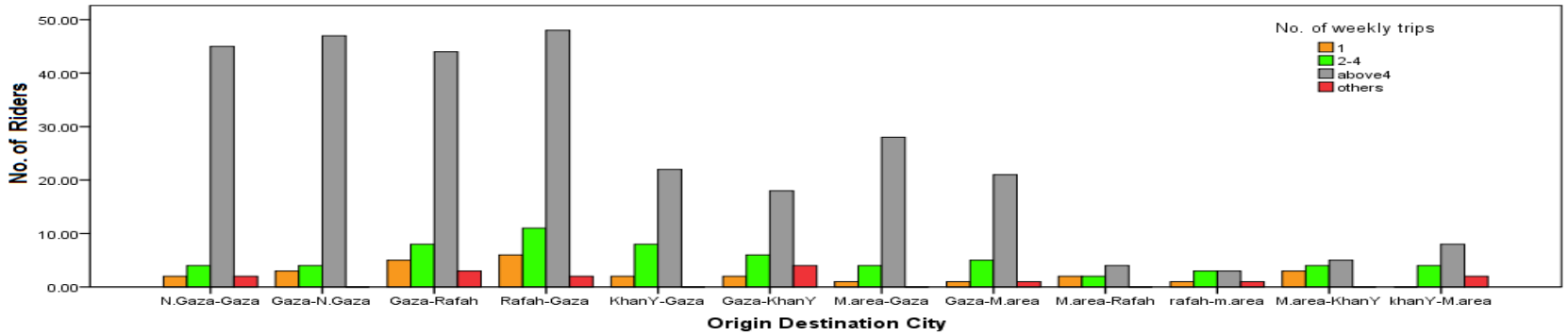

Figure 5.24: The Riders Between Governorates According to No. of Weekly Trips

5.4.7 The Riders Owning Private Cars

Figure 5.25, Table 5.17 & Figure 5.27 illustrate the riders distribution according to their owning private car. The majority of riders do not owning private car with proportion of 88% of the actual sample, and 12% proportion of them were owning private car from the actual sample of 400 riders.

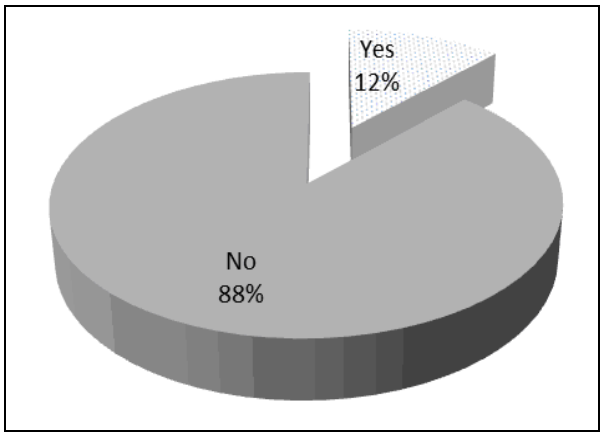

Figure 5.25: The Distribution of Riders According to Owning Private Cars

5.4.8 The Riders Preference

Figure 5.26, Figure 5.28 & Table 5.18 illustrate the riders distribution according to their riding preferences. The majority of riders were preferring bus with proportion of 65% of the actual sample, and those preferring shared taxi were with a proportion of 35% from the actual sample of 400 riders.

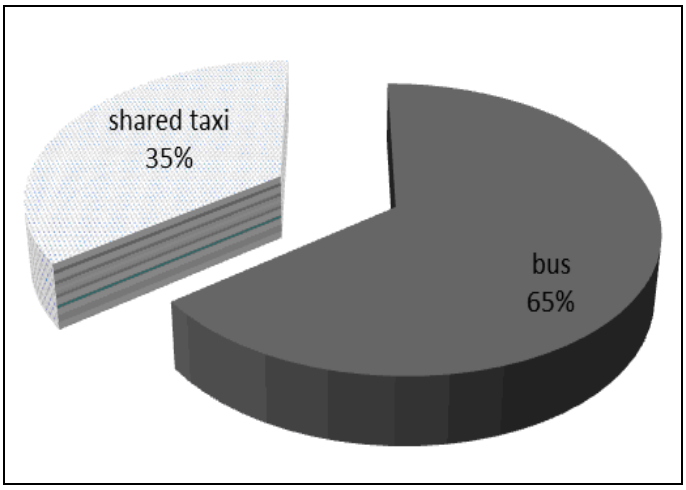

Figure 5.26: The Distribution of Riders According to Their Preference

Table 5.17: The Riders Between Governorates According to Owning Private Car

Owning private car	N.Gaza-Gaza	Gaza-N.Gaza	Gaza-Rafah	Rafah-Gaza	KhanY-Gaza	Gaza-KhanY	M.area-Gaza	Gaza-M.area	M.area-Rafah	Rafah - M.area	M.area-KhanY	khanY-M.area	Total
Yes	3	6	8	2	3	3	5	7	2	4	4	1	48
No	51	48	52	65	29		28	21	6	4	8	13	352
Total	54	54	60	67	32	30	33	28	8	8	12	14	400

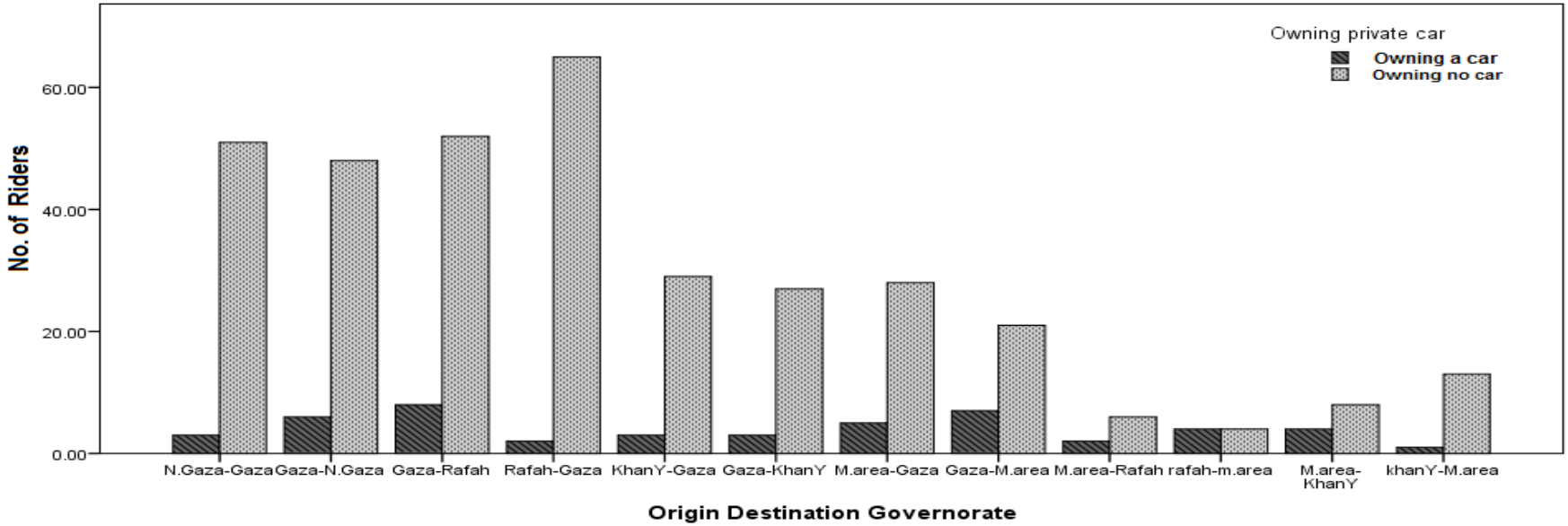

Figure 5.27:The Riders Between Governorates According to Owning Private Car

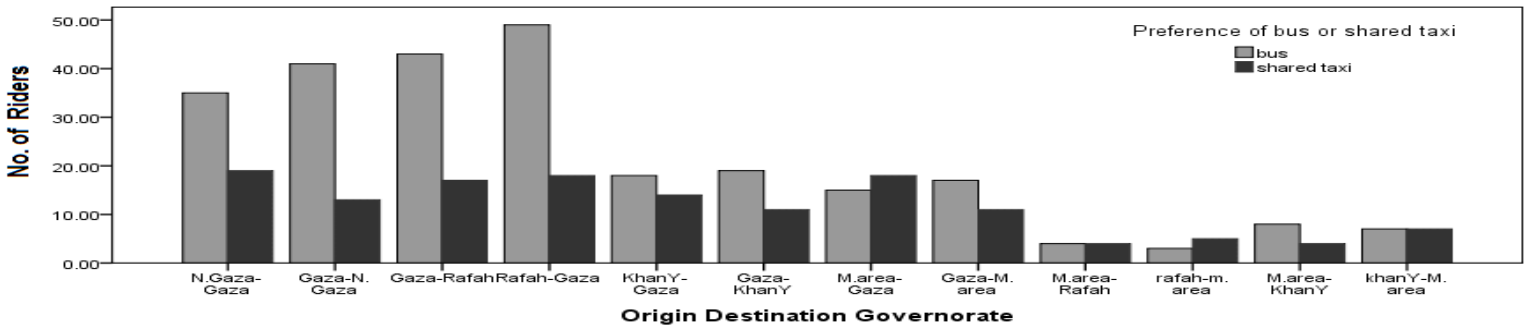

Figure 5.28: The Riders Between Governorates According to Preference of Bus or Shared Taxi

Table 5.18: The Riders Between Governorates According to Preference of Bus or Shared Taxi

Preference of bus or shared taxi	N.Gaza-Gaza	Gaza-N.Gaza	Gaza-Rafah	Rafah-Gaza	KhanY-Gaza	Gaza-KhanY	M.area-Gaza	Gaza-M.area	M.area-Rafah	Rafah-M.area	M.area-KhanY	khanY-M.area	Total
bus	35	41	43	49	18	19	15	17	4	3	8	7	259
shared taxi	19	13	17	18	14	11	18	11	4	5	4	7	141
Total	54	54	60	67	32	30	33	28	8	8	12	14	400

5.4.9 Trip Purpose

Figure 5.29 shows that most of the trip purposes for both bus and shared taxi riders were for education 34.75% & 46.25% respectively and for work 29.00% & 34.50% respectively. The figure showed also that least number of trip purposes for bus riders and taxi riders were for other purposes 2% and for shopping 4% respectively.

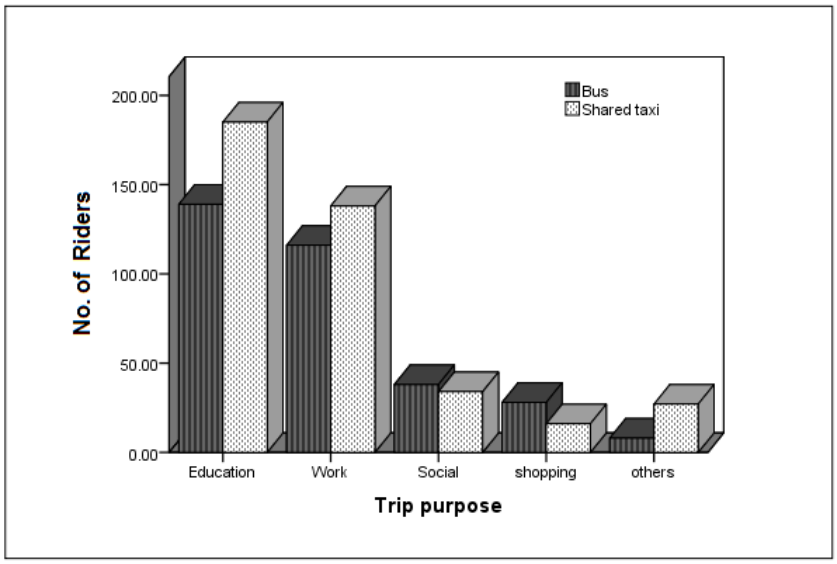

Figure 5.29: Bus and Shared Taxi Riders Trip Purpose Between Governorates

5.4.10 Number of Trips Per Week

Figure 5.30 shows the number of trips per week of the riders of our questionnaire. As we see here, the majority of riders are riding both bus and shared taxi between 2 and 4 times a week, followed by the riders of one time a week. The minority of the riders have different trips a week.

5.4.11 Trip Cost

Figure 5.31 shows the trip cost of riding a bus and a shared taxi. The majority of riders of our questionnaire said that the trip cost of bus and shared taxi is suitable. On the other hand, the figure shows that the majority of the respondents said that the trip cost of the shared taxi is high.

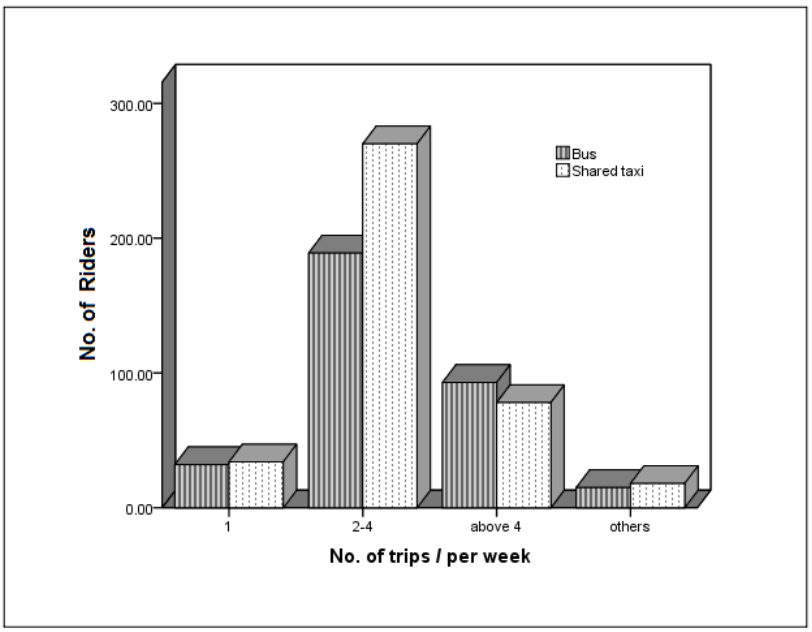

Figure 5.30: The Number of Trips Per Week of Riders Between Governorates

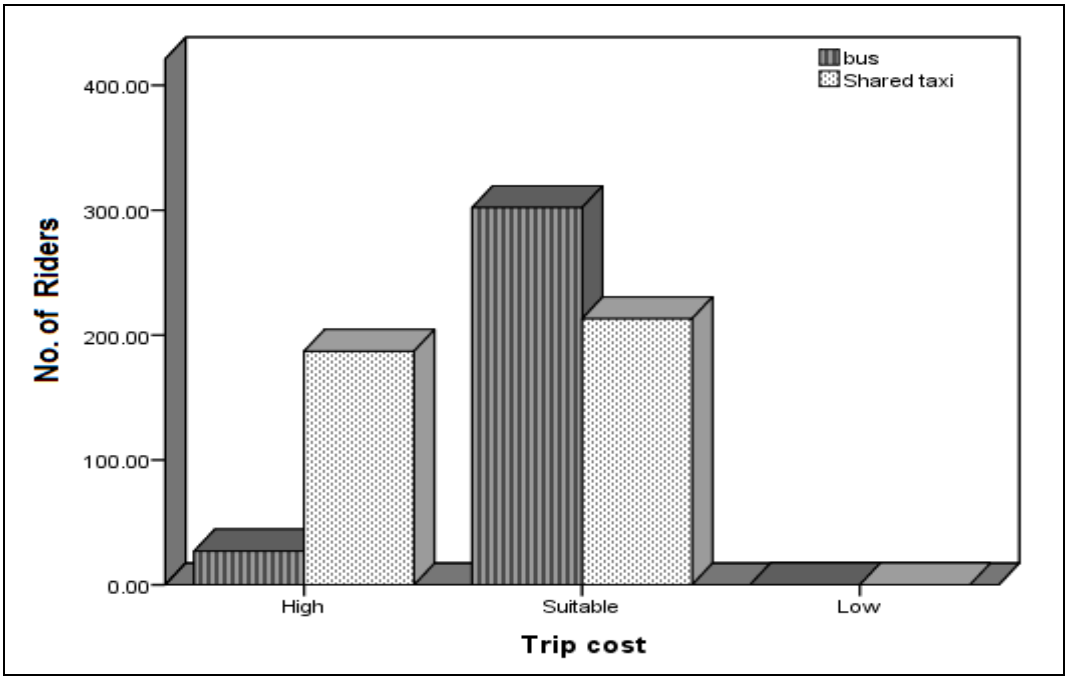

Figure 5.31: Bus and Shared Taxi Trip Cost

5.4.12 Time Taking from the Beginning of the Bus Trip Till the End

Figure 5.32 illustrates the time taking from the beginning of the bus trip till the end. The majority of respondents said that the shared taxi is taking less time from the beginning of trip till the end than the bus.

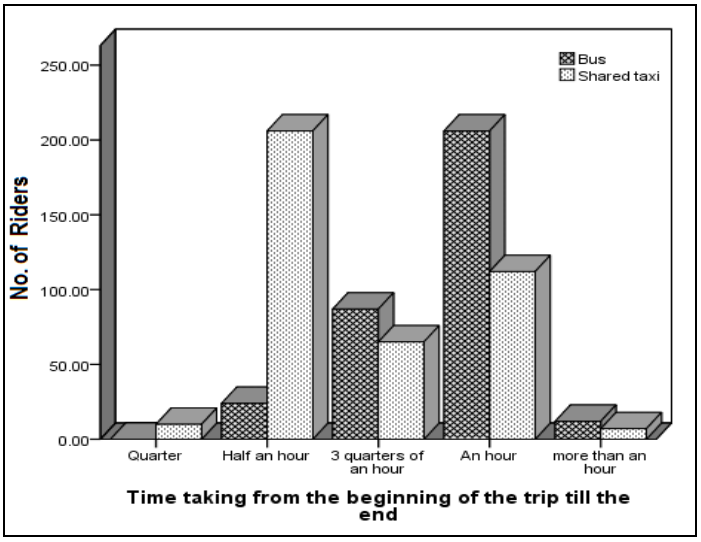

Figure 5.32: Time Taking from the Beginning of Trip Till the End

5.4.13 Waiting Time before Launching the Trip

Figure 5.33 illustrates the waiting time before launching the trip. The majority of respondents said that the shared taxi is taking less time in waiting before launching the trip than the bus.

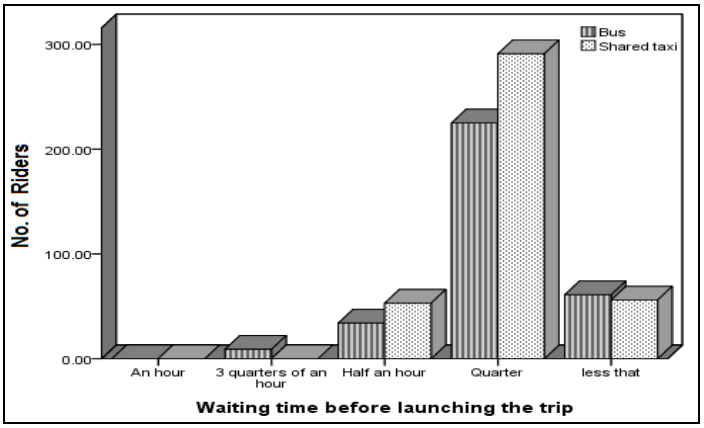

Figure 5.33: Waiting Time before Launching the Trip

5.5 Ridership Demand Elasticity

The main reasons for riding and not riding the buses and shared taxi were described as demonstrated in the following sections.

5.5.1 The Reasons for Riding the Bus

Figure 5.34 illustrates the reasons of riding the bus. The majority of riders said that they are riding the bus because of its cost, safety and comfort, while the minority of them are riding the bus for the reasons of the bus route, bus is the only mode and others.

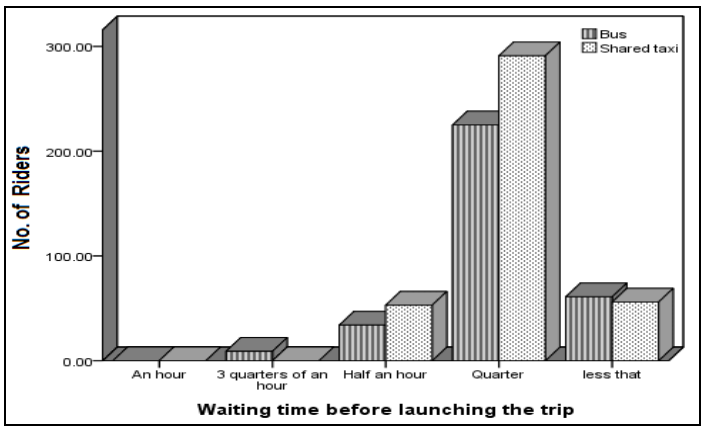

Figure 5.34: Bus Riders Reasons for Riding the Bus

5.5.2 The Reasons for Not Riding the Bus

Figure 5.35 illustrates the reasons of not riding the bus, the majority of respondents said that they are not riding the bus because of its number of stops, while the minority of them are not riding the bus for the reasons of its irregular schedule time, waiting time, and the farness of the bus station. Also, figure 5.36 shows the problems that riders faced while riding the bus such as the number of bus stops, waiting time, slowness and discomfort.

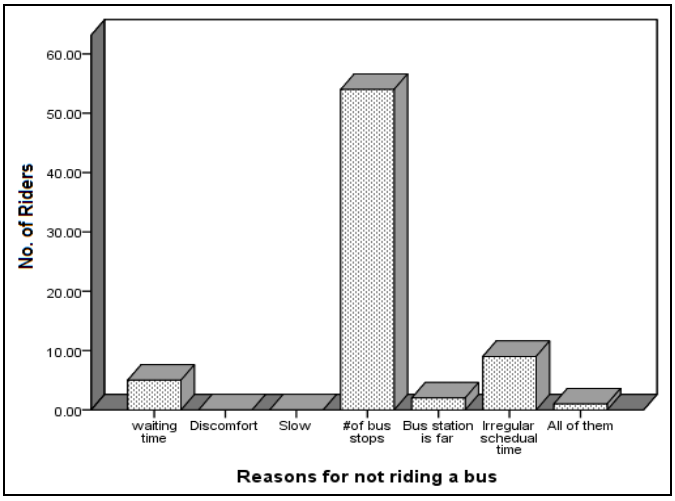

Figure 5.35: Shared Taxi Riders Reasons for not Riding the Bus

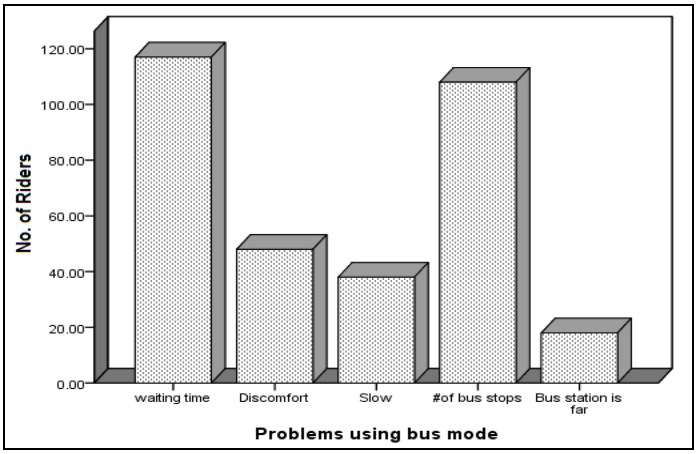

Figure 5.36 : Bus Riders Problems for Using the Bus

5.5.3 Reasons for Choosing a Shared Taxi

Figure 5.37 illustrates the main reasons of riding shared taxi. The majority of respondents said that they are riding shared taxi because of its speed, safety and comfort. It is followed by those who are riding the shared taxi because the shared taxi is the only mode, due to shared taxi route and others.

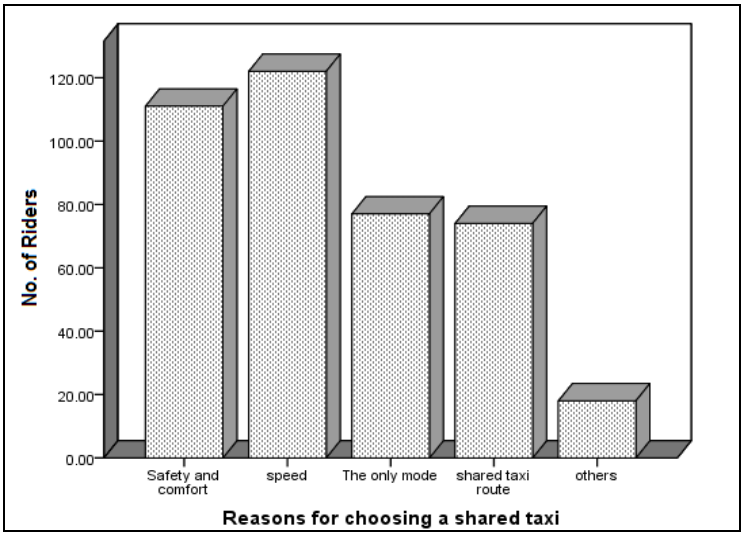

Figure 5.37: Shared Taxi Riders Reasons for Riding the Shared Taxi

5.5.4 Preference of Shared Taxi to Bus

Figure 5.38 illustrate the main reasons of riders preference for the shared taxi to a bus, ranking orderly; number of bus stops, followed by waiting time, discomfort, slowness, and the bus station is far away.

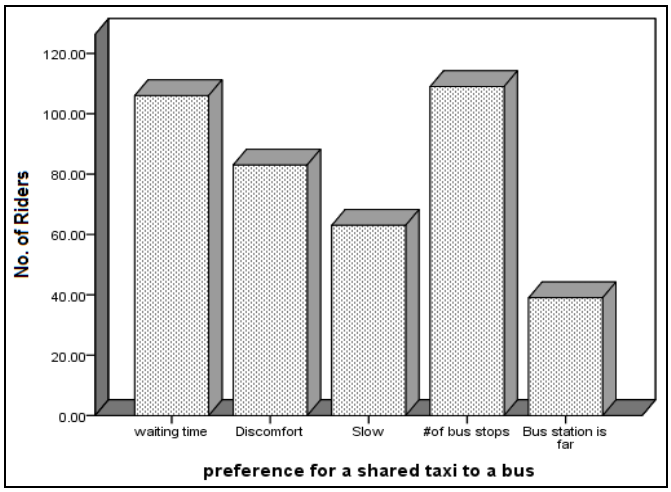

Figure 5.38: Preference for a Shared Taxi Riders to a Bus

5.6 Bus Services Ridership Demand Elasticity

In this section the riders responses towards any change of prices were considered. Figure 5.39 shows the respondents opinion if the cost of the bus fare increased by one third and their opinion when the cost of the bus fare increased by one half. It was shown that the trend of some riders will ride a shared taxi.

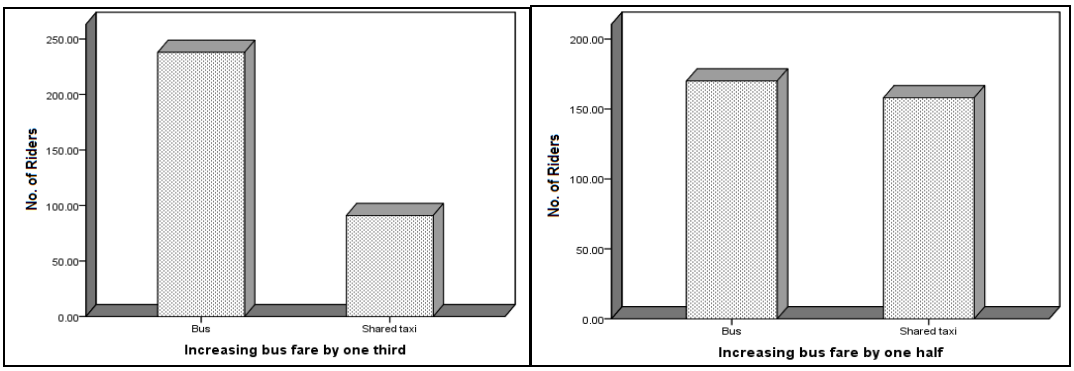

Figure 5.39: The Bus Riders Response Towards the Change of Prices

A mathematical function is constructed to express the response towards the change of price as illustrated in figure 5.40. The best fit line of this equation is as shown below:

$$y = -400\,x + 770$$

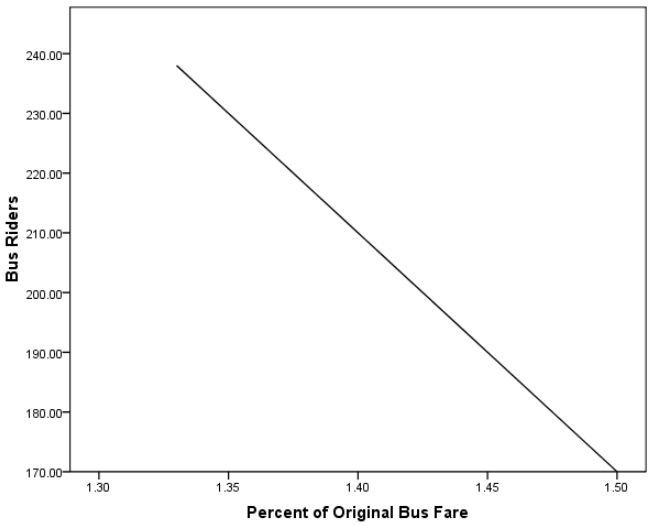

Figure 5.40: Bus Riders Elasticity to Fare Change

The riders response towards any change of total trip time was considered. Figure 5.41 shows the riders opinion of the questionnaire if the total trip time of the bus increased by 10 minutes, and their opinion when the total trip time increased by 20 minutes. It was shown that the trend of some riders will ride a shared taxi.

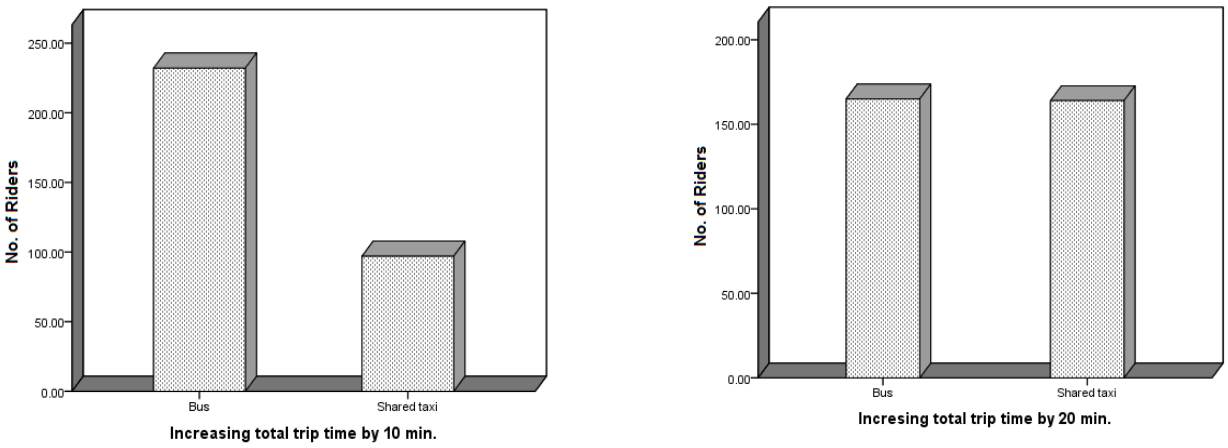

Figure 5.41: The Bus Riders Response Towards the change of Total Trip Time

A mathematical function is assembled to express the response towards the change of the total trip time as illustrated in Figure 5.42. The best fit line of this equation was:

$$y = -6.7\,x + 299$$

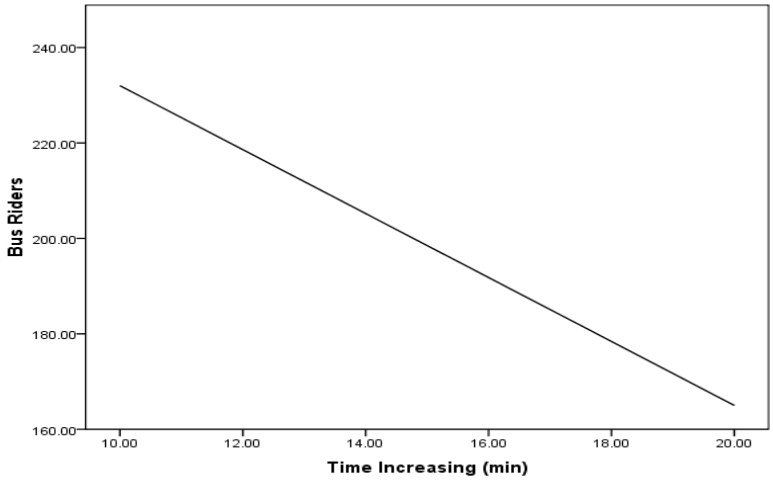

Figure 5.42: Bus Riders Elasticity to Total Trip Time Change

The following section reflects on the riders responses towards any change in the price of the bus fare. Figure 5.43 shows the respondents opinion if the cost of the bus fare decreased by one third, and their opinion when the cost of the bus fare reduced by one half. It shows that the trend of some riders increases in riding the bus and decreases in riding the shared taxi. Although the bus fare decreased by one half, the number of bus riders declined and this happened due to the bus waiting time, the frequent stops along the route and it is uncomfortable.

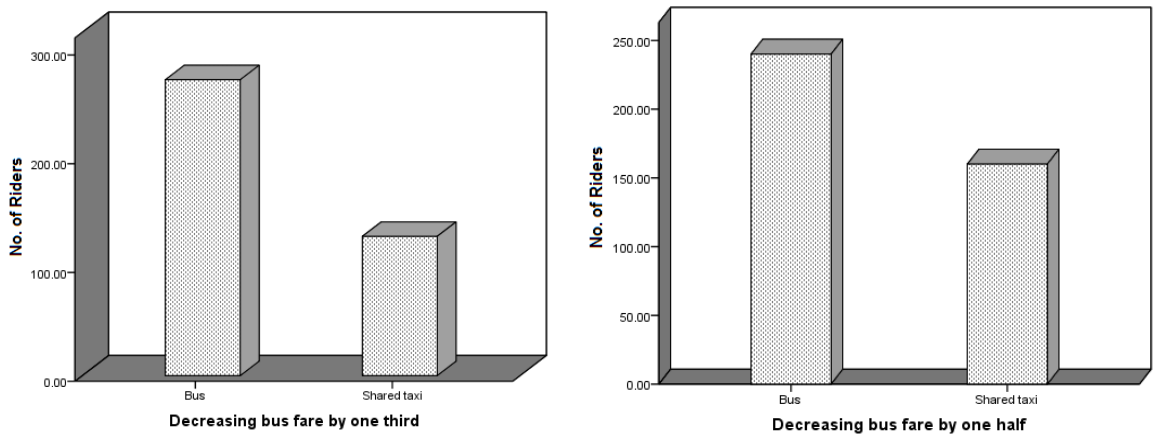

Figure 5.43: The Shared Taxi Riders Response Towards the Change of Prices

A mathematical function is constructed to express the response towards the change in the price as illustrated in Figure 5.44. The best fit line of this equation was:

$$y = 188\,x - 122$$

The riders response towards any change of the total trip time was considered. Figure 5.45 shows the riders opinion of the questionnaire if the total trip time declined by 10 minutes and their opinion when the total trip time decreased by 20 minutes. It shows that the trend of some riders will ride the bus. A function is constructed to state the response towards the change in the total trip time as illustrated in the next Figure 5.46. The best fit line of this equation was:

$$y = 2.7\,x + 94$$

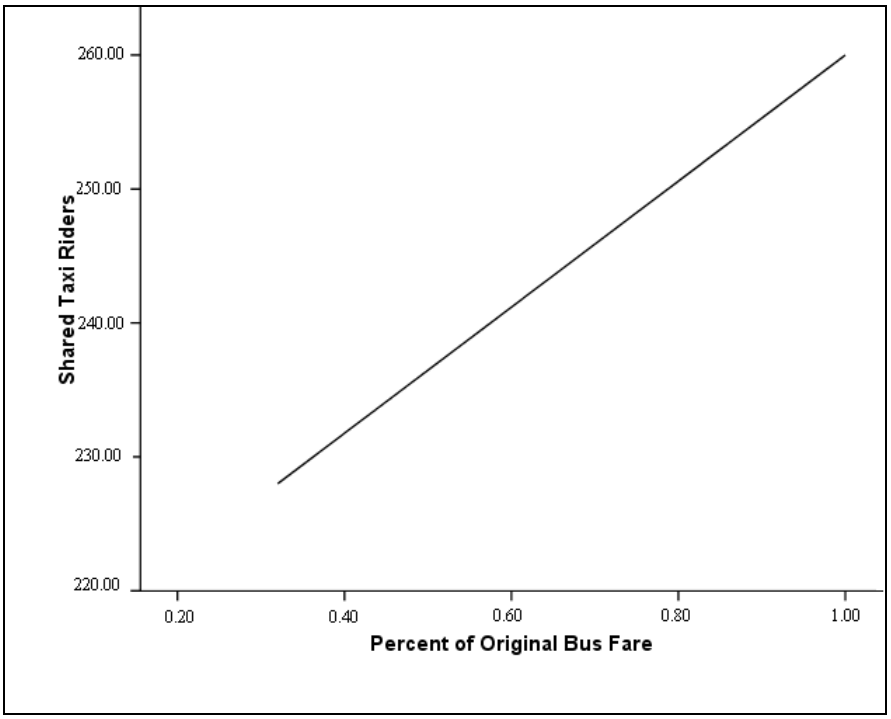

Figure 5.44 : Shared Taxi Riders Elasticity to Fare Change

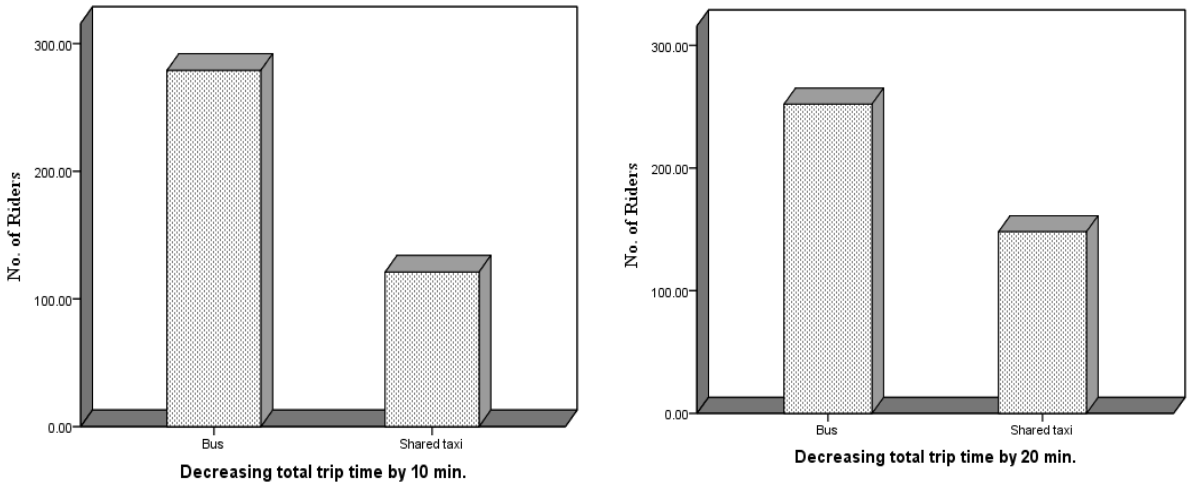

Figure 5.45: Shared Taxi Riders Response Towards the Change of Total Trip Time

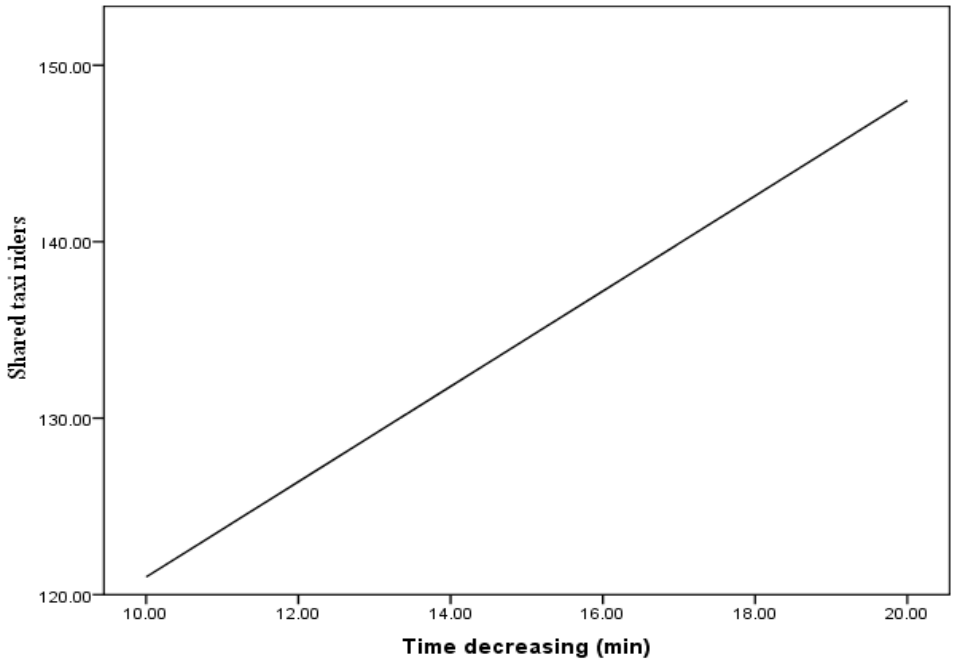

Figure 5.46: Shared Taxi Riders Elasticity to Total Trip Time Change

The bus ridership demand elasticity is determined using eq. 3 – 3 in page 29.

For buses:

(1) If the cost of the bus fare increased by one third and by one half (Y = 238 for X = 1.33 & Y = 170 for X = 1.5) then, Elasticity = - 2.23; it means that the bus commuter riders demand elasticity was - 2.23 for the bus fare change (see Figure 5.40). This means that, for example, for every increase in bus fare by 1 %, the expected decrease in ridership demand is 2.23 %.

(2) If the total time taken by the bus trip increased by 10 min. and by 20 min. (Y = 232 for X = 10 min. & Y = 165 for X = 20 min.) then , Elasticity = - 0.29

For Shared Taxis:

(1) If the cost of the bus fare decreased by one third and by one half (Y= 145 for X = 0.67 & Y = 136.5 for X = 0.5) then, Elasticity = 0.23. The shared taxi riders demand elasticity was

about 0.23 for the bus fare change (see Figure 5.44). It means that for every decrease in bus fare by1%, the expected shared taxi riders to ride the bus out of the total taxi riders is 0.23 %.

(2) If the total trip time by bus decreased by 10 min. and by 20 min. (Y= 121 for X= 10 min. & Y= 148 for X= 20 min.) then, Elasticity = 0.22.

5.7 Recommendations of Bus Riders and Shared Taxi Riders

Based on the questionnaire question of recommendations for Bus riders and Shared taxi riders, the respondents answered that the public transport service applied by the local buss companies is not satisfactory. In general, the fleet is old, the quality of service is partially satisfactory, no clear schedule and frequency.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Based on data collected and analysis, the following conclusions can be drawn:

1- For the travel forecasting process, more precise results could be attained if detailed data on socioeconomic characteristics for each governorate were accessible. So, it is recommended that a follow up work should be prepared, where a more detailed work concentrating on the demand and supply forecasting is carried out.

2- Public transport in Gaza Strip is provided by buses and shared taxis. Public transport service between North Gaza and other Governorates is not available except for Gaza Governorate. Many rural communities do not have any public bus transportation.

3- External and internal variables were used in Multiple Linear Regression Analysis to develop ridership demand model.

4- The independent variables that were used in the simplified model and mostly affected the number of bus ridership demand were employment percent (orign & dest.), students percent (orign & dest.), monthly expenditure (orign & dest.), no. of private cars(orign & dest.), trip length (km), travel time (min.) and bus fare (sheqel). The simplified model could be used to help the MOT in predicting the number of bus ridership required.

5-The suggested ridership demand model had the following relation as below: $\boldsymbol{Y = -136171.177 + 5499.554\ x_1 - 975.986\ x_2 + \ldots - 11160.000\ x_{11}}$ with $R^2 = 0.997$, where the $x_1, x_2, \ldots, x_{11}$ represent all the significant variables mentioned in table 5.8 page 67, in addition to the intercept.

6- The majority of the independent variables entered the model are significant at the .05 level except for monthly expenditure (dest.) and travel time (min.) that are insignificant.

7- The statistical analysis results demonstrated that the relation between the number of bus ridership demand and the independent variables was strong (**Coefficient of determination is equal to 0.997,** page 69**)**.

8- The sampling size of the questionnaire was 400, which stands for a 95 confidence level.

9- It was found that bus waiting time was the first reason for not riding the bus.

10- The questionnaire analysis revealed that many people did not ride the bus because of the frequent stops along the route.

11- The existing bus companies are operating without any coordination between them in the service they provide since public bus service is entirely managed by the private sector.

12- Most of the buses work is directed towards school and university students and workers in a random way. The students and employees were the most sensitive among other riders to mode change based on reducing fare or travel time.

13- It was noticed that some riders did not prefer riding the bus since they found it uncomfortable.

14- Improving the current bus service and its operation such as reducing waiting time, decreasing the no. of bus stops and providing express bus route will achieve passenger's satisfaction and will attract more riders.

15- As shown in page 97, bus riders elasticity for a change in the bus fare and a change in the total time taken by the bus trip was calculated to be – 2.23 and – 0.29 respectively. Also, the elasticity for shared taxi riders was calculated to be 0.23 and 0.22 for a change in the bus fare and a change in the total time taken by the bus trip respectively.

6.2 Recommendations

As a result of this study, the following recommendations are depicted:

1- A comprehensive study through the transport assessor should be performed in order to check and examine the real necessitate for the number of shared taxis based on demand as it is followed internationally.

2- it is recommended to restrict issuing of new licenses for shared taxi and private cars to attract more bus riders since the number of bus riders is little compared with shared taxi riders or private cars riders.

3- The Palestinian Ministry of Transport and Ministry of Public Works and Housing should improve the effectiveness of road network, and this will be achieved by continuous safeguarding and rehabilitation projects. This will generate more trips.

4- Effective measures in the short term to improve the public transport services as part of a comprehensive long term transport plan should be taken by MOT.

5- Providing an express bus service between governorates during the peak period to draw more riders.

6- It is recommended to raise trip frequency and number of buses for crammed routes to accommodate the future passenger demand.

7- MOT should commence and encourage the use of latest technologies regarding fare collection system, such as electronic or magnetic card system to shrink travel time and assist the fare payment process.

8- It is recommended to supply better services with up to date means and stations to receive the increased number of passengers.

9- The study recommendations may help out the MOT in reviewing its set of laws and policies regarding public transport, and can stimulate decision-makers and planners to lay down the proper regulations, plans, and policies.

10- It is recommended to establish the shared taxis and buses main stations outside the central commercial area of the governorate to prevent congestion.

11- Further researches and database building should be done on transportation sector to cover its various aspects in Gaza Strip and West Bank.

REFERENCES

1-Al-Sahili, K. and Sadeq, A.(2004) **"Elasticity of Intercity Buses in the West Bank."** An-Najah University Journal of Research. 18(2), 157-171.Nablus, Palestine.

2-Al-Sahili, K. and Sadeq, A. (2003) **" Ridership Demand Analysis for Palestinian Intercity Public Transport."** Journal of Public Transportation. 6(2), 19-35. Center for Urban Transportation Research, Florida, USA.

3-Bae, Christine and Chang-Hee (2002) **"A Successful Transit Oriented Development Experiment?"** Transportation Quarterly, Vol. 56, No. 3, (9 -18).

4-Brian D. Taylor, Douglas Miller, Hiroyuki Iseki and Camille Fink (2009) **"Nature and/or nurture? Analyzing the determinants of transit ridership across US urbanized area"** Transportation Research Part A, Science Direct, Elsevier Ltd. All rights reserved.

5-Brown, Jeffrey, Daniel Hess, and Donald Shoup (2001) **"Unlimited access**." Transportation 28 (3): 233–267; available at UCLA Institute of Transportation Studies.

6- BRUCE SCHALLER (1999) **" Elasticities for taxicab fares and service availability."** Schaller Consulting, 94 Windsor Place, Brooklyn, New York. (c) Kluwer Academic Publishers, Printed in the Netherlands, Transportation 26(3): 283-297.

7-California Department of Transportation (2003) **"An Analysis of Public Transportation to Attract Non- Traditional Riders in California**." Sacramento, CA: California Department of Transportation.

8-Cambridge Systematics, Inc.(2005)**"Evaluation of Recent Ridership Increases**." Transit Cooperative Research Program Research Results Digest Number 69. Washington, DC: Transportation Research Board, National Research Council.

9-Cervero (1990) **"Transit Pricing Research: A Review and Synthesis."** Transportation, 17: 117-139.

10-Cervero Robert (1993) **"Ridership Impacts of Transit-Focused Development in California."** Working Paper No. 176, Chapter 2. Berkeley, CA: University of California Transportation Center.

11-Cervero Robert (2006) **"Transit- Oriented Development's Ridership Bonus: A Product of Self-Selection and olicies."** Forthcoming in Environment and Planning A.

12-Dargay, Joyce, Mark Hanly, G. Bresson, M. Boulahbal, J. L. Madre, and A. Pirotte. (2002) **"The main determinants of the demand for public transit: A comparative analysis of Great Britain and France"** ESRC Transport Studies Unit, University College London (www.ucl.ac.uk) (March).

13-European Commission Transport Research (1996) **"Effectiveness of Measures Influencing the Levels of Public Transport Use in Urban Areas**." Luxembourg: European Commission Transport Research.

14-Gomez-Ibanez, Jose A**. (1996) "Big City Transit Ridership, Deficits and Politics: Avoiding Reality in Boston."** Journal of the American Planning Association 62, no.1:30-50.

15-Hartgen, David T., and Martin L. Kinnamon (1999) **" Comparative Performance of Major U.S. Bus Transit Systems: 1988-1977 "** Charlotte, NC: Center for Interdisciplinary Transportation Studies, University of North Carolina at Charlotte.

16-Hendrickson, Chris. (1986) **"A Note on Trends in Transit Commuting in the United States Relating to Employment in the Central Business District."** Transportation Research Part A 20, no. 1 : 33- 3.

17-James L.Oberstar (2007) **"Vision for Public and Intercity Transportation" "**Transit and Intercity Bus Panel. Committee on Transportation and Infrastructure.U.S. House of Representatives, April 18–19, Washington, DC.

18-Joyce M Dargay and Mark Hanly (1999) **" BUS FARE ELASTICITIES Report to the Department of the Environment, Transport and the Regions "**ESRC Transport Studies Unit, University College London, Gower Street, London WC1E 6BT.

19-Kain and Zhi Liu. (1996) **"Econometric Analysis of Determinants of Transit Ridership: 1960-1990."** Prepared for Volpe National Transport Systems Center, U.S. Department of Transportation.

20-Kitamura, Ryuichi. (1989) **"A causal analysis of car ownership and transit use."** Transportation 16(2): 155-173.

21-Kohn, Harold M. (2000) **" Factors Affecting Urban Transit Ridership."** Paper presented at the Canadian Transportation Research Forum Conference.

22-Lilly Shoup (2008) "**Ridership and Development Density: Evidence from Washington, D.C. University of Maryland at College Park ."** Master of Community Planning Program URSP 631: Land-use and Transportation Final Paper, 1329 Florida Avenue NW Washington, DC 20009 (202) 906-9193.

23-Lund, Hollie and Richard W. Willson (2005) **" Pasadena Gold Line: Development Strategies, Location Decisions, and Travel Characteristics along a New Rail Line in the Los Angeles Region**." Mineta Transportation Institute, San Jose State University.

24-Ministry of Higher Education, Palestine (2012) **"Statistics of Higher Education**." The Ministry of Higher Education Website: www.mohe.gov.ps, accessed on 20 / 03 / 2012.

25-Ministry of Transport, Palestine (2012) **"Transportation and Communication Statistics in the Palestinian Territories."** The Ministry of Transport Website: www.mot.gov.ps, accessed on 17 / 02 / 2012.

26-Ministry of Transport, (2010) **"Transportation and Communication Statistics in the Palestinian Territories."**Annual Report. Gaza, Palestin26-Ministry of Transport, Singapore (2012).The Public Transport Council Website: www.ptc.gov.sg, accessed on 21/ 01/ 2012.

27-McLeod, Malcolm S., Jr., Kevin Flannelly, Laura Flannelly, and Robert W. Behnke (1991) **"Multivariate Time-Series Model of Transit Ridership Based on Historical, Aggregate Data: The Past, Present, and Future of Honolulu."** Washington, D.C.: Transportation Research Board. Transportation Research Record 1297: 76-84.

28-Md Aftabuzzaman, Graham Currie, Majid Sarvi. Monash University (2010) **"Evaluating the Congestion Relief Impacts of Public Transport in Monetary Terms"** Journal of Public Transportation,Vol.13, No1.

29-Morral, John and Dan Bolger (1996) **"The Relationship Between Downtown Parking Supply and Transit Use."** ITE Journal 66(2): 32-36.

30-Naoum, S. G. (1998) **"Dissertation Research and Writing for Construction Students"**.

31-Palestinian Center Bureau of Statistics (PCBS), (2010) **" Expenditure and Consumption Levels in Gaza Strip."** Annual Report. Ramallah, Palestine.

32-Palestinian Center Bureau of Statistics (PCBS), (2010) **"Labor Force Survey; Main Finding, 2009 and 2010 in Gaza Strip."** Ramallah, Palestine.

33-Palestinian Center Bureau of Statistics (PCBS), (2010)**" Population Report in Gaza Strip."** Ramallah, Palestine.

34-Palestinian Information Center (2012) Website: www.palestine-info.org, accessed on 05/ 01/ 2012.

35-Paulley, N.; Balcombe, R.; Mackett, R.; Titheridge, H.; Preston, J.M.; Wardman, M.R.; Shires, J. D.; White, P. (2006) **"The demand for public transport: The effects of fares, quality of service, income and car ownership"** Transport Policy, 13 (4), pp.295 – 306.

36-Sadeq, A. (2001) **"Assessment of Intercity Public Transport Demand and Elasticity in the West Bank."** Unpublished Master's Thesis, An-Najah National University, Nablus, Palestine.

37-Sale, James. (1976) **" Increasing Transit Ridership: The Experience of Seven Cities."** Washington, D.C.: Urban Mass Transportation Administration, November.

38-Spillar, Robert J., and G. Scott Rutherford (1998) **" The Effects of Population Density and Income on Per Capita Transit Rider ship in Western American Cities."** Paper presented at the 60th Annual Meeting of the Institute of Transportation Engineers.

39-Suwardo, Madzlan Napiah, and Ibrahim Kamaruddin (2010) **" Ridership Factors Change and Bus Service Demand Sensitivity Assessment of the Fixed-Route Bus Service for Short-term Action Plan."** International Journal of Civil & Environmental Engineering IJCEE-IJENS Vol:10 No:02.

40-Syed, Sharfuddin. (2000) **" Factor Analysis for the Study of Determinants of Public Transit Ridership."** Journal of Public Transportation 3(3), 1-17.

41-Taylor, Brian D., and William S. McCullough (1998) **"Lost Riders."** Access 13: 26-31.

42-Thomas K. Renckly (2002) **"Guidelines for planning, organizing, and conducting surveys."** Air University Sampling and Surveying Handbook, Revised (PDF) Edition: May.

43-Thompson, Gregory L., and T.G. Matoff (2003) **" Keeping Upwith the Joneses: Planning for Transit in Decentralizing Regions."** Journal of the American Planning Association 69, no. 3 : 296 - 312.

44-Transit Cooperative Research Program Research Results Digest (1998) **"Continuing Examination of Successful Transit Ridership Initiatives."** Number 29.

45-Transit Cooperative Research Program Research Results Digest (1995)**"Transit Ridership Initiative."** Number 4, February.

46-Transit Cooperative Research Program (1998) **"Strategies to Attract Auto Users to Public Transportation."** Number 40.

47-Transit Cooperative Research Program (1996) **"Transit and Urban Form."** Washington, D.C.: National Academy Press. TCRP Report 16(1): 1-25.

48-Walpole, R.E. & Myers, R. H. (1993) **" Probabilities and Statistics for Engineers and Scientists."** USA. Prentice – Hall, inc.

49-Xumei Chen and Guoxin Lin (2005) **" Evaluation Analysis on an Integrated Fare Initiative in Beijing. "** Journal of Public Transportation, Vol. 8, No. 3.

المراجع العربية:

1- جامعة القدس المفتوحة، مبادئ الإحصاء، 2007

2 - محمد عثمان الخشت، **فن كتابة البحوث العلمية و إعداد الرسائل الجامعية** (القاهرة، مصر الجديدة، مكتبة ابن سينا للنشر والتوزيع والتصدير)

ANNEX 1

Definition of Important Repeated Terms

Public Transportation: It is the service that is provided for the carriage of passengers and their incidental baggage on established routes and fixed schedules at published rate of fare, and available to the general public in urban areas or for short distances in rural areas (Sadeq, 2001).

Public Travel (Mass Transit) Demand: Demand for mass transit is estimated as a part of total trip estimation process for the study area between the origin and destination points. It involves some information about those trips through a fixed route and schedule (Sadeq, 2001).

Ridership: It is the traveler who freely chooses a specific mode of transportation on a specific route to achieve his or her trip purpose between the origin and destination (Sadeq, 2001).

Public Transport Operators: Bus operators that are licensed by Public Transport Council (PTC) to provide basic schedule bus services (Singapore MOT, 2005).

Travel Demand Elasticity: Travel demand elasticity is a major tool that measures the rider response's sensitivity for any change of one or more variable. That means that the rider may change his or her preferable transportation mode, route, and trip it self because of such changes (Sadeq, 2001).

Regression Analysis: Regression analysis is a statistical method. It deals with the formulation of mathematical models that depict the relationships among variables, and the use of these modeled relationships for the purpose of predicting and other statistical inferences. The method of least square is the efficient method for estimating the regression parameters to minimize the overall discrepancy (Sadeq, 2001).

Intercity Bus Service: Intercity bus service is the public participation mode that connects two cities that have a bus service all week days in a fixed route, fixed schedule, and fixed bus fare. Intercity bus service is provided by private companies.

Bus Mode: The bus is a rubber-tired vehicle operating on a surface street and usually subjected to all traffic conditions. Almost all buses are powered by fuel-efficient, time proved diesel engine. Features vary such that no one size or body conformation is best adapted to all application. Standard bus lengths are 35 and 40 ft (12.2m)**,** and widths are 96 or 102 in (2.45 or 2.6m). The seated capacities are, respectively, 41 to 45 and 49 to 53 passengers (Sadeq, 2001).

Bus transportation is highly energy-efficient mode, averaging 300 seat miles per gallon of fuel. Buses are also very safe. Their accident rate of 12 fatalities per 100 billion passenger-mile is more than 100 times than that of automobiles (Sadeq, 2001).

Shared Taxi Modes: The shared taxi is considered as one of the paratransit services. It is a service providing a transition of passengers and their packages from one place to another. The standard shared taxi seated capacities is seven passengers. Services may deviate from routes and / or fixed schedule, and may pick up and drop off passengers at other than regular stops.

ANNEX 2

Questionnaire Form

بسم الله الرحمن الرحيم

الجامعة الإسلامية – غزة

كلية الدراسات العليا

كلية الهندسة

الإستبيان العام

يقوم أحد طلاب كلية الدراسات العليا / كلية الهندسة تخصص البنى التحتية بإعداد رسالة ماجستير بعنوان:

" تقييم الطلب على المواصلات العامة ومرونة الإقبال عليها بين محافظات قطاع غزة "

ومن الوسائل المهمة في الدراسة إجراء استبيان مع المواطنين. يرجى من الأخوة و الأخوات الإجابة على الأسئلة إجابة واضحة بغية مساعدتنا في تحقيق الهدف المرجو من هذه الإستبانة وهو التخطيط الأمثل للنقل العام في محافظات قطاع غزة.

شكرا لكم على تعاونكم

الباحث م. محمود الصبيحي

المسار الأول: المعلومات العامة

(1) العمر: (أ) 15 – 24 □ (ب) 25 – 34 □ (ج) 35 – 44 □ (د) 45 –65 □
(هـ) أكثر من 65 □

(2) المهنة: (أ) طالب □ (ب) موظف □ (ج) عامل □ (د) غير ذلك □

(3) الجنس: (أ) ذكر □ (ب) أنثى □

(4) المؤهل: (أ) دون الثانوي □ (ب) ثانوي □ (ج) دبلوم □
(د) جامعي □ (هـ) دراسات عليا □

(5) متوسط دخل أسرتك في الشهر بالشيكل الإسرائيلي:

(أ) أقل من 1000 □ (ب) 1000 – 2000 □ (ج) 2000 – 3000 □
(د) 3000 – 4000 □ (هـ) 4000 – 5000 □ (و) أكثر من 5000 □

(6) متوسط عدد المرات التي تنتقل فيها إلى نفس المكان أسبوعيا:

(أ) مرة واحدة أسبوعيا □ (ب) 2 – 4 مرات □ (ج) أكثر من 4 مرات □ (د) غير ذلك □

(7) هل تمتلك سيارة خاصة؟ (أ) نعم □ (ب) لا (ج) غير ذلك □

(8) في حال الإجابة بلا هل تفضل استخدام: (أ) الباص □ (ب) سيارة الأجرة العمومية □

المسار الثاني: الباص

(1)هل تستخدم الباص في تنقلاتك؟ (أ) نعم □ (ب) لا □

إذا كانت الإجابة **(نعم)** أجب على باقي الأسئلة **(سؤال 2 حتى سؤال 16)**، وإذا كانت الإجابة **(لا) فأجب فقط عن السؤال التالي وتجاهل الأسئلة من 2 إلى 16**، ما هي أسباب عدم استخدام الباص ؟

(أ) طول مدة الإنتظار في المحطة □ (ب) غير مريح □ (ج) بطيئ □ (د) تكرار توقف الباص □
(هـ) بعد المحطة عن مكان السكن أو العمل □ (و) عدم التقيد بجدول زمني □ (ز) جميع ما سبق □

(2) المدينة / القرية / المخيم / التي تنطلق منها رحلتك بالباص: ----------

(3) المدينة / القرية / المخيم / التي تنتهي عندها رحلتك بالباص: ----------

(4) الغرض من رحلتك بالباص: (أ) تعليمي □ (ب) عمل □ (ج) اجتماعي □ (د) تسوق □
(هـ) غير ذلك □

(5) متوسط عدد المرات التي تنتقل فيها لنفس المكان أسبوعيا مستخدما الباص:

(أ) مرة واحدة أسبوعيا □ (ب) 2 – 4 مرات □ (ج) أكثر من 4 مرات □

(د) غير ذلك □

(6) سبب اختيار هذه الوسيلة من المواصلات:

(أ) الأمان والراحة □ (ب) التكلفة □ (ج) الوسيلة المتوفرة □
(د) ضمن خط سير رحلتي □ (هـ) غير ذلك □

(7) أهم المشاكل التي تعاني منها نتيجة استخدامك الباص كوسيلة مواصلات:

(أ) طول مدة الإنتظار □ (ب) غير مريح □ (ج) بطيئ □ (د) تكرار توقف الباص □

(هـ) بعد محطة الباص عن مكان السكن أو العمل □

(8) عدد المرات التي يتوقف فيها الباص في المحطات أثناء رحلتك:

(أ) 1 – 3 □ (ب) 4 – 6 □ (ج) أكثر من 7 □ (د) لا يتوقف □

(9) تكلفة رحلتك بالباص: (أ) مرتفعة □ (ب) مناسبة □ (ج) منخفضة □

(10) ماذا تفضل في حال زيادة سعر تذكرة الباص بمقدار الثلث وثبات أسعار باقي وسائل المواصلات:

(أ) الباص □ (ب) سيارة الأجرة العمومية □

(11) ماذا تفضل في حال زيادة سعر تذكرة الباص بمقدار النصف وثبات أسعار باقي وسائل المواصلات:

(أ) الباص □ (ب) سيارة الأجرة العمومية □

(12) المدة الزمنية التي تستغرقها في انتظار الباص قبل البدء بالرحلة:

(أ) ساعة □ (ب) ثلاث أرباع ساعة □ (ج) نصف ساعة □ (د) ربع ساعة □

(هـ) أقل من ذلك □

(13) المدة الزمنية التي تستغرقها منذ لحظة انطلاق الباص حتى نهاية رحلتك:

(أ) ربع ساعة □ (ب) نصف ساعة □ (ج) ثلاث أرباع ساعة □ (د) ساعة □ (هـ) أكثر من ساعة □

(14) ماذا تستخدم في حال زاد وقت الرحلة الكلي من لحظة انتظار الباص حتى الوصول إلى رحلتك المنشودة بمقدار 10 دقائق:

(أ) الباص □ (ب) سيارة الأجرة العمومية □

(15) ماذا تستخدم في حال زاد وقت الرحلة الكلي من لحظة انتظار الباص حتى الوصول إلى رحلتك المنشودة بمقدار 20 دقيقة:

(أ) الباص □ (ب) سيارة الأجرة العمومية □

(16) ما هي مقترحاتك للباص (مواصفات الباص) الذي تفضل استخدامه في تنقلاتك؟

(أ).....

(ب).....

(ج).....

(د).....

المسار الثالث: سيارات الأجرة العمومي

(1)هل تستخدم سيارة الأجرة العمومي (المواصلات العامة) في تنقلاتك؟ (أ) نعم □ (ب) لا □

إذا كانت الإجابة **(نعم)** أجب على باقي الأسئلة **(سؤال 2 حتى سؤال 15)**، وإذا كانت الإجابة **(لا) فأجب فقط عن السؤال التالي وتجاهل الأسئلة من 2 إلى 15**، ما هي أسباب عدم استخدام السيارة ؟

(أ) ارتفاع الأجرة □ (ب) عدم الدقة في مواعيد بدء السفر □ (ج) عدم توفر الأمان □

(د) عدم تحلي السائق بالأخلاق الحميدة □ (هـ) يتوقف السائق كثيرا في الطريق □

(و) زيادة عدد حوادث الطرق □ (ز) جميع ما سبق □

(2) المدينة / القرية / المخيم / التي تنطلق منها رحلتك بسيارة الأجرة العمومي: ----------

(3) المدينة / القرية / المخيم / التي تنتهي عندها رحلتك بسيارة الأجرة العمومي: ----------

(4) الغرض من رحلتك بسيارة الأجرة العمومي:

(أ) تعليمي □ (ب)عمل □ (ج) اجتماعي □ (د) تسوق □ (هـ) غير ذلك □

(5) متوسط عدد المرات التي تنتقل فيها لنفس المكان أسبوعيا مستخدما سيارة الأجرة العمومي:

(أ) مرة واحدة أسبوعيا □ (ب) 2 – 4 مرات □ (ج) أكثر من 4 مرا ت □ (د) غير ذلك □

(6) سبب اختيار سيارة الأجرة العمومي:

(أ) الأمان والراحة □ (ب) التكلفة □ (ج) الوسيلة المتوفرة □ (د) ضمن خط سير رحلتي □

(هـ) غير ذلك □

(7) الأسباب التي تجعلك تفضل سيارات الأجرة العمومي على الباص:

(أ) الباص غير مريح □ (ب) مدة انتظار طويلة □ (ج) بطيئ □

(د) وقوف الباص كثيرا □ (هـ) محطة الباص بعيدة عن السكن أو العمل □

(8) تكلفة رحلتك بسيارة الأجرة العمومي: (أ) مرتفعة □ (ب) مناسبة □ (ج) منخفضة □

(9) ماذا تفضل في حال انخفاض سعر تذكرة الباص بمقدار الثلث وثبات أسعار باقي وسائل المواصلات:

(أ) الباص □ (ب) سيارة الأجرة العمومية □

(10) ماذا تفضل في حال انخفاض سعر تذكرة الباص بمقدار النصف وثبات أسعار باقي وسائل المواصلات:

(أ) الباص □ (ب) سيارة الأجرة العمومية □

(11) ما هي المدة الزمنية التي تستغرقها في انتظار سيارة الأجرة العمومي قبل البدء بالرحلة:

(أ) ساعة □ (ب) ثلاث أرباع ساعة □ (ج) نصف ساعة □ (د) ربع ساعة □

(هـ) أقل من ذلك □

(12) ما هي المدة الزمنية التي تستغرقها منذ لحظة انطلاق سيارة الأجرة العمومي حتى نهاية رحلتك:

(أ) ربع ساعة □ (ب) نصف ساعة □ (ج) ثلاث أرباع ساعة □ (د) ساعة □

(هـ) أكثر من ساعة □

(13) ماذا تفضل في حال نقصان وقت الرحلة الكلي من لحظة انتظار الباص حتى الوصول إلى رحلتك المنشودة بمقدار 10 دقائق: (أ) الباص □ (ب) سيارة الأجرة العمومية □

(14) ماذا تفضل في حال نقصان وقت الرحلة الكلي من لحظة انتظار الباص حتى الوصول إلى رحلتك المنشودة بمقدار 20 دقيقة: (أ) الباص □ (ب) سيارة الأجرة العمومية □

(15) ما هي مقترحاتك لسيارة الأجرة العمومية (مواصفات السيارة) التي تفضل استخدامها في تنقلاتك؟

(أ).....

(ب).....

(ج).....

(د).....

ANNEX 3

Questionnaire Results

Statistical Analysis for Bus and Shared Taxi Riders

(Part One: General Information)

Question	Type	N. Gaza Gaza	Gaza N.Gaza	Gaza Rafah	Rafah Gaza	KhanY. Gaza	Gaza Khan Y.
Age	15-24	23	18	12	17	9	12
	25-34	19	23	33	30	17	6
	35-44	5	4	11	9	4	4
	45-65	4	0	2	7	2	6
	> 65	3	9	2	4	0	2
	Total	54	54	60	67	32	30
Job	Student	31	39	35	32	24	27
	Employee	15	8	14	18	2	3
	Labor	6	4	6	12	5	6
	Others	2	3	5	5	1	0
	Total	54	54	60	67	32	30
Gender	Male	34	36	42	45	18	21
	Female	20	18	18	22	14	9
	Total	54	54	60	67	32	30
Education	Below secondary	1	0	0	3	0	0
	Secondary	2	3	2	10	3	1
	Diploma	7	5	12	10	11	8
	University	41	45	42	39	18	21
	Post graduate	3	1	4	5	0	0
	Total	54	54	60	67	32	30

Statistical Analysis for Bus and Shared Taxi Riders (continued)

(Part One: General Information)

Question	Type	N. Gaza Gaza	Gaza N.Gaza	Gaza Rafah	Rafah Gaza	KhanY. Gaza	Gaza KhanY.
Income rate per month	< 1000	6	2	7	10	2	2
	1000 - 2000	17	15	18	21	15	12
	2000 - 3000	18	14	16	15	14	14
	3000 - 4000	5	15	11	10	1	2
	4000 - 5000	4	7	8	9	0	0
	> 5000	4	1	0	2	0	0
	Total	54	54	60	67	32	30
No.of weekly trips	1	2	3	5	6	2	2
	2 - 4	4	4	8	11	8	6
	> 4	45	47	44	48	22	18
	Others	3	0	3	2	0	4
	Total	54	54	60	67	32	30
Owning private car	Yes	3	6	8	2	3	3
	No	51	48	52	65	29	27
	Total	54	54	60	67	32	30
Preference of bus to shared taxi	Bus	35	41	43	49	18	19
	Shared taxi	19	13	17	18	14	11
	Total	54	54	60	67	32	30

Statistical Analysis for Bus and Shared Taxi Riders

(Part One: General Information)

Question	Type	M.area Gaza	Gaza M.area	M.area Rafah	Rafah M.area	M.area KhanY.	KhanY. M.area
Age	15-24	12	10	5	2	3	4
	25-34	7	8	2	3	7	6
	35-44	5	7	1	2	1	2
	45-65	7	3	0	0	1	1
	> 65	2	0	0	1	0	1
	Total	33	28	8	8	12	14
Job	Student	17	19	0	0	8	8
	Employee	15	4	4	5	4	4
	Labor	1	5	4	3	0	2
	Others	0	0	0	0	0	0
	Total	33	28	8	8	12	14
Gender	Male	22	13	4	5	18	21
	Female	11	15	4	3	10	8
	Total	33	28	8	8	12	14
Education	Below secondary	0	0	0	0	0	2
	secondary	0	2	1	0	1	1
	Diploma	9	6	1	2	3	6
	university	23	20	6	6	7	5
	Post graduate	1	0	0	0	1	0
	Total	33	28	8	8	12	14

Statistical Analysis for Bus and Shared Taxi Riders (continued)

(Part One: General Information)

Question	Type	M.area Gaza	Gaza M.area	M.area Rafah	Rafah M.area	M.area KhanY.	KhanY. M.area
Income rate per month	< 1000	1	2	0	0	0	0
	1000 - 2000	15	12	2	1	4	3
	2000 - 3000	14	14	3	3	2	5
	3000 - 4000	2	0	3	2	4	4
	4000 - 5000	1	0	0	1	1	2
	> 5000	0	0	0	1	1	0
	Total	33	28	8	8	12	14
No. of weekly trips	1	1	1	2	1	3	0
	2 - 4	4	5	2	3	4	4
	> 4	28	21	4	3	5	8
	Others	0	1	0	1	0	2
	Total	33	28	8	8	12	14
Owning private car	Yes	5	7	2	4	4	1
	No	28	21	6	4	8	13
	Total	33	28	8	8	12	14
Preference of bus to shared taxi	Bus	15	17	4	3	8	7
	Shared taxi	18	11	4	5	4	7
	Total	33	28	8	8	12	14

Statistical Analysis for Bus and Shared Taxi Riders

(Part Two: A Bus)

Question	Type	N. Gaza Gaza	Gaza N. Gaza	Gaza Rafah	Rafah Gaza	Khan Y.Gaza	Gaza Khan Y.
Riding a bus	Yes	48	51	55	66	21	17
	No	6	3	5	1	11	13
	Total	54	54	60	67	32	30
Reasons for not riding a bus	waiting time	1	0	0	0	0	0
	Discomfort	0	0	0	0	0	0
	Slow	0	0	0	0	0	0
	#of bus stops	3	2	4	1	8	10
	Bus station is far	0	0	0	0	1	1
	Irregular schedual time	1	1	1	0	2	2
	All of them	1	0	0	0	0	0
	Total	6	3	5	1	11	13
Trip purpose	Education	28	10	32	28	10	10
	Work	14	26	18	23	4	2
	Social	5	6	2	7	5	2
	Shopping	1	5	3	8	2	1
	Others	0	4	0	0	0	2
	Total	48	51	55	66	21	17

Statistical Analysis for Bus and Shared Taxi Riders (continued)

(Part Two: A Bus)

Question	Type	N. Gaza Gaza	Gaza N. Gaza	Gaza Rafah	Rafah Gaza	KhanY. Gaza	Gaza Khan Y.
# of trips using a bus	1	4	3	4	6	4	2
	2 - 4	19	27	40	41	11	8
	> 4	24	19	11	14	4	6
	Others	1	2	0	5	2	1
	Total	48	51	55	66	21	17
Reason for riding a bus	Safety &comfort	27	16	17	30	8	7
	Cost	14	28	25	25	10	8
	The only mode	4	5	2	2	1	0
	Bus route	3	2	10	7	2	2
	Others	0	0	1	2	0	0
	Total	48	51	55	66	21	17
Problems using bus mode	Waiting time	20	16	17	17	8	9
	Discomfort	3	6	9	15	8	4
	Slow	4	12	14	2	1	0
	#of bus stops	21	13	15	25	4	3
	Bus station is far	0	4	0	7	0	1
	Total	48	51	55	66	21	17
#of bus stops	1 - 3	12	7	17	15	8	6
	4 - 6	28	36	38	44	11	10
	> 7	8	8	0	7	2	1
	Not stopping	0	0	0	0	0	0
	Total	48	51	55	66	21	17

Statistical Analysis for Bus and Shared Taxi Riders (continued)

(Part Two: A Bus)

Question	Type	N. Gaza Gaza	Gaza N. Gaza	Gaza Rafah	Rafah Gaza	KhanY. Gaza	Gaza Khan Y.
Trip cost using bus mode	High	6	3	2	6	1	0
	Suitable	42	48	53	60	20	17
	Low	0	0	0	0	0	0
	Total	48	51	55	66	21	17
Increasing the bus fare by one third	Bus	43	38	47	48	11	8
	Shared taxi	5	13	8	18	10	9
	Total	48	51	55	66	21	17
Increasing the bus fare by half	Bus	20	28	23	40	11	13
	Shared taxi	28	23	32	26	10	4
	Total	48	51	55	66	21	17
Waiting time for the bus before launching the trip	An hour	0	0	0	0	0	0
	Three quarters of an hour	0	3	1	5	0	0
	Half an hour	7	4	9	5	0	0
	Quarter	28	32	39	45	13	12
	< that	13	12	6	11	8	5
	Total	48	51	55	66	21	17
Time taken from the beginning of the bus trip till the end	Quarter	0	0	0	0	0	0
	Half an hour	0	0	0	0	0	0
	Three quarters of an hour	2	3	0	0	19	16
	An hour	46	46	51	60	2	1
	> an hour	0	2	4	6	0	0
	Total	48	51	55	66	21	17

Statistical Analysis for Bus and Shared Taxi Riders (continued)

(Part Two: A Bus)

Question	Type	N. Gaza Gaza	Gaza N. Gaza	Gaza Rafah	Rafah Gaza	Khan Y. Gaza	Gaza Khan Y.
Increasing the total trip time by 10 min.	Bus	30	36	42	46	17	13
	Shared taxi	18	15	13	20	4	4
	Total	48	51	55	66	21	17
Increasing the total trip time by 20 min.	Bus	16	20	32	38	13	10
	Shared taxi	32	31	23	28	8	7
	Total	48	51	55	66	21	17

Statistical Analysis for Bus and Shared Taxi Riders

(Part Two: A Bus)

Question	Type	M.area Gaza	Gaza M.area	M.area Rafah	Rafah M.area	M.area KhanY.	KhanY. M.area
Riding a bus	Yes	23	26	4	3	7	8
	No	10	2	4	5	5	6
	Total	33	28	8	8	12	14
Reasons for not riding a bus	waiting time	0	0	1	0	1	2
	Discomfort	0	0	0	0	0	0
	Slow	0	0	0	0	0	0
	#of bus stops	9	2	3	5	3	4
	Bus station is far	0	0	0	0	0	0
	Irregular schedual time	1	0	0	0	1	0
	All of them	0	0	0	0	0	0
	Total	10	2	4	5	5	6
Trip purpose	Education	9	4	2	2	2	2
	Work	3	19	2	1	1	3
	Social	5	2	0	0	2	2
	Shopping	5	1	0	0	2	0
	Others	1	0	0	0	0	1
	Total	23	26	4	3	7	8
# of trips using a bus	1	3	5	0	0	1	0
	2-4	9	21	3	2	3	5
	> 4	7	0	1	1	3	3
	Others	4	0	0	0	0	0
	Total	23	26	4	3	7	8

Statistical Analysis for Bus and Shared Taxi Riders (continued)

(Part Two: A Bus)

Question	Type	M. area Gaza	Gaza M. area	M. area Rafah	Rafah M. area	M. area KhanY.	KhanY. M. area
Reason for riding a bus	Safety &comfort	8	12	1	1	1	2
	Cost	11	11	3	2	3	2
	The only mode	2	0	0	0	1	1
	Bus route	2	3	0	0	2	2
	Others	0	0	0	0	0	1
	Total	23	26	4	3	7	8
Problems using bus mode	Waiting time	9	12	3	2	2	2
	Discomfort	2	1	0	0	0	0
	Slow	2	1	0	0	1	1
	#of bus stops	7	12	1	1	2	4
	Bus station is far	3	0	0	0	2	1
	Total	23	26	4	3	7	8
#of bus stops	1-3	6	5	1	0	1	2
	4 -6	13	19	3	2	4	4
	> 7	4	2	0	1	2	2
	Not stopping	0	0	0	0	0	0
	Total	23	26	4	3	7	8

Statistical Analysis for Bus and Shared Taxi Riders (continued)

(Part Two: A Bus)

Question	Type	M. area Gaza	Gaza M. area	M. area Rafah	Rafah M. area	M. area KhanY.	KhanY. M. area
Trip cost using the bus mode	High	3	2	1	0	2	1
	Suitable	20	24	3	3	5	7
	Low	0	0	0	0	0	0
	Total	23	26	4	3	7	8
Increasing the bus fare by one-third	Bus	12	18	2	1	4	6
	Shared taxi	11	8	2	2	3	2
	Total	23	26	4	3	7	8
Increasing the bus fare by half	Bus	10	12	2	2	5	5
	Shared taxi	13	14	2	1	2	3
	Total	23	26	4	3	7	8
Waiting time for the bus before launching the trip	An hour	0	0	0	0	0	0
	Three quarters of an hour	0	0	0	0	0	0
	Half an hour	5	1	1	0	1	1
	Quarter	18	23	2	2	5	6
	< that	0	2	1	1	1	1
	Total	23	26	4	3	7	8

Statistical Analysis for Bus and Shared Taxi Riders (continued)

(Part Two: A Bus)

Question	Type	M.area Gaza	Gaza M.area	M.area Rafah	Rafah M.area	M.area KhanY.	Khan Y. M.area
Time taken from the beginning of the bus trip till the end	Quarter	0	0	0	0	0	0
	Half an hour	20	1	1	0	1	1
	Three quarters of an hour	3	25	3	3	6	7
	An hour	0	0	0	0	0	0
	> an hour	0	0	0	0	0	0
	Total	23	26	4	3	7	8
Increasing total trip time by 10 min.	Bus	14	21	2	2	3	6
	Shared taxi	9	5	2	1	4	2
	Total	23	26	4	3	7	8
Increasing total trip time by 20 min.	Bus	8	12	3	1	5	7
	Shared taxi	15	14	1	2	2	1
	Total	23	26	4	3	7	8

Statistical Analysis for Bus and Shared Taxi Riders

(Part Three: Shared taxi)

Question	Type	N. Gaza Gaza	Gaza N. Gaza	Gaza Rafah	Rafah Gaza	Khan Y.Gaza	Gaza Khan Y.
Riding Shared taxi	Yes	54	54	60	67	32	30
	No	0	0	0	0	0	0
	Total	54	54	60	67	32	30
Reasons for not riding a shared taxi	High fare	0	0	0	0	0	0
	Irregular time	0	0	0	0	0	0
	unsafe	0	0	0	0	0	0
	Bad manner of driver	0	0	0	0	0	0
	# of shared taxi stops	0	0	0	0	0	0
	Increase in road accidents	0	0	0	0	0	0
	All of them	0	0	0	0	0	0
	Total	0	0	0	0	0	0
Trip purpose	Education	21	32	8	27	23	20
	Work	26	10	42	23	5	6
	Social	4	6	2	3	1	2
	Shopping	3	4	2	0	1	2
	Others	0	2	6	14	2	0
	Total	54	54	60	67	32	30

Statistical Analysis for Bus and Shared Taxi Riders (continued)

(**Part Three: Shared taxi**)

Question	Type	N.Gaza Gaza	Gaza N.Gaza	Gaza Rafah	Rafah Gaza	KhanY. Gaza	Gaza KhanY.
# of trips using a shared taxi per week	1	6	4	3	4	3	2
	2-4	35	41	44	51	23	14
	> 4	9	7	11	7	3	12
	Others	4	2	2	5	3	2
	Total	54	54	60	67	32	30
Reason for choosing a shared taxi	Safety &comfort	18	13	21	17	9	7
	Speed	18	15	13	18	10	6
	The only mode	7	14	12	15	7	8
	Shared taxi route	9	8	10	17	6	6
	Others	2	4	4	0	0	3
	Total	54	54	60	67	32	30
Preference for a shared taxi to a bus	Waiting time	15	13	12	18	9	7
	Discomfort	10	9	14	7	2	8
	Slow	8	14	16	6	8	6
	#of bus stops	18	16	10	17	6	9
	Bus station is far	3	2	8	19	7	0
	Total	54	54	60	67	32	30
Trip cost using a shared taxi	High	6	9	34	47	20	17
	Suitable	48	45	26	20	12	13
	Low	0	0	0	0	0	0
	Total	54	54	60	67	32	30

Statistical Analysis for Bus and Shared Taxi Riders (continued)

(**Part Three: Shared taxi**)

Question	Type	N.Gaza Gaza	Gaza N.Gaza	Gaza Rafah	Rafah Gaza	KhanY. Gaza	Gaza KhanY.
Decreasing bus fare by one-third	Bus	20	28	43	47	19	14
	Shared taxi	34	26	17	20	13	16
	Total	54	54	60	67	32	30
Decreasing bus fare by half	Bus	31	35	49	53	18	13
	Shared taxi	23	19	11	14	14	17
	Total	54	54	60	67	32	30
Waiting time for a shared taxi before launching the trip	An hour	0	0	0	0	0	0
	Three quarters of an hour	0	0	0	0	0	0
	Half an hour	8	4	11	8	5	6
	Quarter	41	48	44	51	20	14
	< that	5	2	5	8	7	10
	Total	54	54	60	67	32	30
Time taken from the beginning of the shared taxi till the end	Quarter	0	0	0	0	0	0
	Half an hour	50	48	0	0	10	11
	Three quarters of an hour	4	6	5	3	22	19
	An hour	0	0	55	57	0	0
	>an hour	0	0	0	7	0	0
	Total	54	54	60	67	32	30

Statistical Analysis for Bus and Shared Taxi Riders (continued)

(**Part Three: Shared taxi**)

Question	Type	N.Gaza Gaza	Gaza N.Gaza	Gaza Rafah	Rafah Gaza	KhanY. Gaza	Gaza KhanY.
Decreasing total trip time by bus by 10 min.	Bus	33	37	43	40	17	14
	Shared taxi	21	17	17	27	15	16
	Total	54	54	60	67	32	30
Decreasing total trip time by bus by 20 min.	Bus	38	40	47	52	20	18
	Shared taxi	16	14	13	15	12	12
	Total	54	54	60	67	32	30

Statistical Analysis for Bus and Shared Taxi Riders (continued)

(**Part Three: Shared taxi**)

Question	Type	M.area Gaza	Gaza M.area	M.area Rafah	Rafah M.area	M.area KhanY.	KhanY. M.area
Riding Shared taxi	Yes	33	28	8	8	12	14
	No	0	0	0	0	0	0
	Total	33	28	8	8	12	14
Reasons for not riding a shared taxi	High fare	0	0	0	0	0	0
	Irregular time	0	0	0	0	0	0
	unsafe	0	1	0	0	0	0
	Bad manner of driver	0	0	0	0	0	0
	# of shared taxi stops	1	0	0	0	0	0
	Increase in road accidents	0	3	0	0	0	0
	All of them	0	0	0	0	0	0
	Total	0	0	0	0	0	0
Trip purpose	Education	15	20	1	8	4	6
	Work	14	6	1	0	3	2
	Social	4	2	4	0	2	4
	Shopping	0	0	2	0	2	0
	Others	0	0	0	0	1	2
	Total	33	28	8	8	12	14

Statistical Analysis for Bus and Shared Taxi Riders (continued)

(**Part Three: Shared taxi**)

Question	Type	M.area Gaza	Gaza M.area	M.area Rafah	Rafah M.area	M.area KhanY.	KhanY. M.area
# of trips using a shared taxi per week	1	6	2	1	0	3	0
	2-4	22	24	5	4	5	2
	> 4	5	2	2	4	4	12
	Others	0	0	0	0	0	0
	Total	33	28	8	8	12	14
Reason for choosing a shared taxi	Safety & comfort	5	7	2	3	4	5
	Speed	13	15	2	3	5	4
	The only mode	4	3	1	1	3	2
	Shared taxi route	8	3	3	1	2	1
	Others	3	0	0	0	0	2
	Total	33	28	8	8	12	14
Preference for a shared taxi to a bus	Waiting time	11	6	3	3	4	5
	Discomfort	17	15	1	0	0	0
	Slow	0	2	1	0	1	1
	#of bus stops	5	5	3	5	7	8
	Bus station is far	0	0	0	0	0	0
	Total	33	28	8	8	12	14
Trip cost using a shared taxi	High	16	14	5	6	7	6
	Suitable	17	14	3	2	5	8
	Low	0	0	0	0	0	0
	Total	33	28	8	8	12	14

Statistical Analysis for Bus and Shared Taxi Riders (continued)

(**Part Three: Shared taxi**)

Question	Type	M.area Gaza	Gaza M.area	M.area Rafah	Rafah M.area	M.area KhanY.	KhanY. M.area
Decreasing bus fare by one-third	Bus	28	23	4	3	5	6
	Shared taxi	5	5	4	5	7	8
	Total	33	28	8	8	12	14
Decreasing bus fare by half	Bus	25	21	5	4	8	10
	Shared taxi	8	7	3	4	4	4
	Total	33	28	8	8	12	14
Waiting time for a shared taxi before launching the trip	An hour	0	0	0	0	0	0
	Three quarters of an hour	0	0	0	0	0	0
	Half an hour	2	3	1	0	2	3
	Quarter	28	20	5	6	7	7
	< that	3	5	2	2	3	4
	Total	33	28	8	8	12	14
Time taken from the beginning of the shared taxi trip till the end	Quarter	3	2	0	0	2	3
	Half an hour	30	23	6	7	10	11
	Three quarters of an hour	0	3	2	1	0	0
	An hour	0	0	0	0	0	0
	> an hour	0	0	0	0	0	0
	Total	33	28	8	8	12	14

Statistical Analysis for Bus and Shared Taxi Riders (continued)

(**Part Three: Shared taxi**)

Question	Type	M.area Gaza	Gaza M.area	M.area Rafah	Rafah M.area	M.area KhanY.	KhanY. M.area
Decreasing total trip time by bus by 10 min.	Bus	20	22	4	3	8	11
	Shared taxi	13	6	4	5	4	3
	Total	33	28	8	8	12	14
Decreasing total trip time by bus by 20 min.	Bus	23	20	6	5	4	6
	Shared taxi	10	8	2	3	8	8
	Total	33	28	8	8	12	14

ANNEX 4

Table of Z Values

Table of Z Value

Confidence Level	Z Factor
99.9	3.2905
99.7	3.0000
99.5	2.8070
99.0	2.5758
98.0	2.3263
95.5	2.0000
95.0	1.9600
90.0	1.6449
85.0	1.4395
80.0	1.2816

(Renckly, 2002)