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تقييم النقل بالحافلات في قطاع غزة باستخدام نظم المعلومات الجغرافية

Evaluation of Bus System as A Transportation Mode in Gaza Strip Using (GIS)

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DEDICATION

To my parents, who gave me life twice, once when I was born, and again when they thought I have to go to school..

To my wife, Sara, who always pushed me to finish this thesis..

To my son, Mahmoud, whom I do all of this for..

To my brothers, Adham and Moataz, and my sisters, Reema, Ghada, Heba, and Deema..

To my teachers, along my academic trip extending over 20 years..

To my country, Palestine, united Palestine...

I dedicate this work.

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ملخص الدراسة

يعاني قطاع غزة من تزايد مطرد في أعداد المركبات العمومية، حيث تعتمد الأغلبية العظمى من مواطنين القطاع على هذه الوسيلة في التنقل، خاصةً التنقل الداخلي. يؤدي تزايد الاعتماد على المركبة العمومية وتناقص الاعتماد على وسائل النقل الجماعي، وهي في غزة الحافلات فقط، إلى مزيد من الاختناقات المرورية والتأثيرات السلبية على البيئة.

يتناول البحث بالدراسة والتحليل حالة الحافلات العمومية في قطاع غزة ويناقش من خلال الاستبيان فرضيات تساهم في عزوف المجتمع عن هذه الوسيلة من وسائل المواصلات، ومدى صحة هذه الفرضيات. كما يحتوي البحث على تقييم حالة دراسية لشبكة النقل بالحافلات في قطاع غزة، تشمل عشرة مواقع حافلات في مدينة غزة، وذلك من خلال قياس مدى ملاءمتها كمواقف حافلات باستخدام مجموعة من المعايير مثل الوصولية، التغطية، الإضاءة، وتأثير نقطة الانتظار على حركة المرور في المنطقة، كما تم استخدام نظم المعلومات الجغرافية (GIS) في عملية تقييم هذه المواقع من ناحية تغطية المستخدمين حولها. ويضم البحث حالة دراسية تصميمية لنظام الحافلات في منطقة الجامعات في مدينة غزة، من خلال تقديم تصميم مبسط يتضمن آلية اختيار المكان الدقيق لموقف الحافلة وكذلك تكرار مرور الحافلات بها بناءً على تعداد ركاب تم إجراؤه في تلك المنطقة.

اتضح من البحث أن هناك انحداراً في رضا المواطنين عن خدمة الحافلات في قطاع غزة، من حيث طبيعة الحافلة وسلوك السائق وأماكن الانتظار. كما وضعت الدراسة خطة نقل داخلية في منطقة الجامعات تتضمن تكرار وصول الحافلات وأماكن انتظار الطلاب المقترحة بناءً على معايير خاصة.

وختاماً، فقد أوصى الباحث بإعطاء مزيد من الاهتمام لنظام النقل بالحافلات في قطاع غزة، من خلال خطوات عملية في هذا المجال مثل التأكد من توافر شروط الراحة والأمان في الحافلات قبل تجديد رخصتها السنوية، خفض قيمة الضرائب والجمارك الخاصة باستيراد حافلات جديدة، ورفع مستوى الوعي المروري والعام لدى سائقي الحافلات من خلال محاضرات خاصة.

كما أوصى الباحث بإنشاء نظام نقل بالحافلات في منطقة الجامعات في مدينة غزة بالاعتماد على التصميم الذي وضعته هذه الدراسة، ووضع دراسة شاملة لحاجة القطاع من مواقع الحافلات من حيث أعدادها ومواقعها بالاعتماد على الحاجة الحقيقية للسكان.

ABSTRACT

The Gaza Strip suffers from a continuous increase in taxi numbers. The majority of Gaza Strip citizens use taxi in their movement. Relying completely on taxi, neglecting the availability of bus as a transport mean, causes more traffic congestions and bad environmental effects.

This study discusses the conditions of bus service in Gaza Strip through testing certain hypotheses assuming that public is not satisfied with bus system in Gaza. This testing is proceeded using questionnaire. The study also includes the evaluation of ten bus stops in Gaza city as a case study. This evaluative case study measures the suitability of the ten points as bus stops, with respect to certain criteria like accessibility, coverage, lighting and the effect on traffic system. Geographic information software (ArcGIS) is used in evaluating the ten bus stops with respect to coverage. The research also includes a design case study for the bus system in the university zone in Gaza city, through introducing a simple design for the exact location of bus stop and its bus frequency, depending on passengers count.

The research indicates that there is a general dissatisfaction with bus system in Gaza Strip, with respect to buses in service, drivers and bus stops. The study also gives a design for a bus stop and its frequency in university zone in Gaza city.

Finally, the researcher recommends that more interest is given to bus system, through actual procedures such as insuring the suitability of bus for transferring passengers before updating bus license, decreasing taxes of importing new buses, and holding awareness raising sessions for bus drivers.

The researcher also recommends establishing a bus system in the university zone depending on the design given in this research, and making a study about the need of bus stops in Gaza Strip, including the number and locations of bus stops, depending on demand.

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1 INTRODUCTION

The introductory chapter gives an idea about the incitements for this thesis. In this chapter, a brief introduction is given including the objectives of this master thesis together with its limitations, methodology and structure.

1.1 Background

The system of public transportation in Gaza Strip is divided into two main types; buses and taxis. Buses are considered a basic constituent in the public transportation system in the Gaza Strip.

Bus, as a transportation mode, is less expensive than taxi, less noisy and less air pollutant due to its advantage of replacing ten taxis at least, knowing that a bus maximum load is 50 passenger, while a taxi is fully loaded by only five. This advantage can be useful in minimizing traffic congestions. Another advantage is that buses have specific stations and private lanes of movement, which means that the jams caused by taxi downloading and uploading can be reduced. Despite all of these advantages, buses are not widely used in Gaza.

Until June, 2012, the number of buses in Gaza Strip was 212. The buses form about 0.3% of the total number of vehicles in Gaza Strip (Ministry of Transport, Gaza, 2012).

The percent of buses is very low compared to the taxi in Gaza, which form about 19% of Gazians' means of transport (Ministry of Transport, Gaza, 2012).

Encouraging public transport system can strongly reduce the use of taxis, and hence can contribute in decreasing the level of congestion leading to better levels of service in streets.

1.2 Public Transport in Gaza

Gaza Strip has one of the highest population densities in the world with 1,713,505 Capita living on 360 km², which means a density of about 4760 Capita/km². The growth rate in population in Gaza Strip is 3.2% (Ministry of Interior, Gaza). Gaza consists of five main governorates, from North to South: Northern Governorate, Gaza Governorate, The Middle Governorate, Khan Yunus Governorate, and Rafah Governorate. (Figure 1.1). (Ministry of Local Government, 2012).

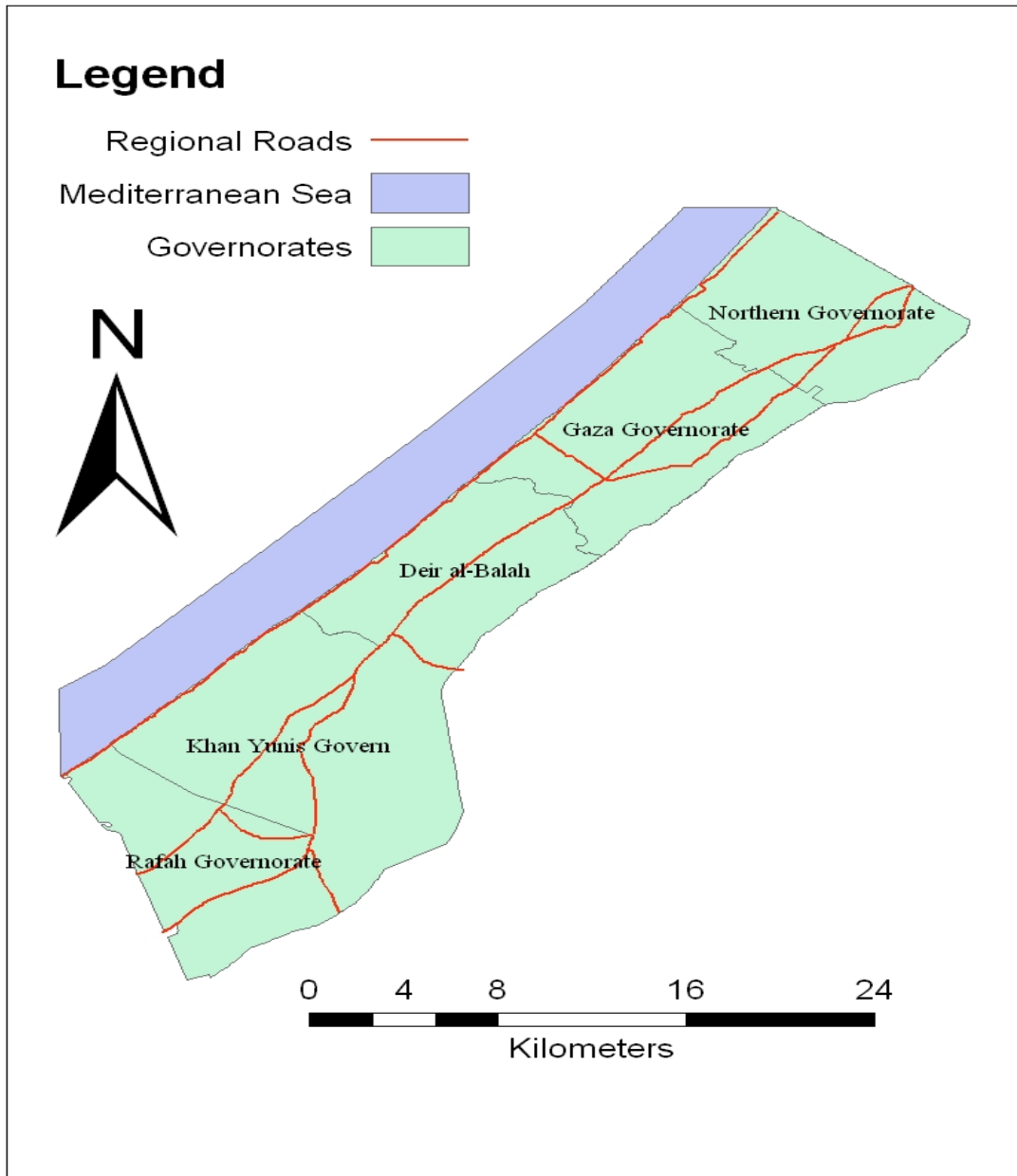


Figure 1.1: Gaza Strip Governorates.

The main regional roads of Gaza Strip are:

1. Salah El-Deen Road: extends from Rafah (South) to Biet Hanoon in the Northern Governorate (North). Salah El-Deen road is 58 kilometers (Ministry of Planning, Gaza, 2012).
2. Al-Karama Road: extends from Rafah (South) to Biet Lahia in the Northern Governorate (North), to the east of Salah El-Deen road. Al-Karama road is 20 kilometers (Ministry of Planning, Gaza, 2012).
3. Al-Rasheed Road: extends from Rafah (South) to Biet Hanoon in the Northern Governorate (North) along the coastal line of Gaza. Al-Rasheed road is 45 kilometers (Ministry of Planning, Gaza, 2012).

Thus, the total length of regional roads of Gaza Strip is 123 Km. The total length of road network in Gaza Strip is 898 Km (Ministry of Planning, Gaza, 2012).

The growth rate of vehicles in Gaza Strip is about 23%, whereas the growth rate of buses approaches to zero (Ministry of Transport, Gaza, 2012).

Gaza Strip bus fleet is formed of 182 buses (until July 2012) distributed on 18 public transport companies, as shown in table 1.1 (Workshop, Ministry of Transport and companies owners, attached in Annex 3).

Table (1.1)

Number of Buses in Each Company in Gaza Strip.

| No. | Company Name | Number of Buses |
|------------|----------------------------|------------------------|
| 1 | Nusairat | 7 |
| 2 | Abu Elba | 22 |
| 3 | Elia'a Al-Tayyiba | 15 |
| 4 | Hafil | 16 |
| 5 | Abu Elba and his Sons | 21 |
| 6 | Sweety Tours | 14 |
| 7 | Al-Ettihad | 5 |
| 8 | Soboh | 3 |
| 9 | Gaza and Southern Villages | 30 |
| 10 | Kardash | 15 |
| 11 | Al-Wosta | 3 |

| No. | Company Name | Number of Buses |
|-------|--------------------|-----------------|
| 12 | Qishta | 8 |
| 13 | Al-Nasman | 3 |
| 14 | Al-Salam | 3 |
| 15 | Hamdona | 4 |
| 16 | Madi | 4 |
| 17 | Abu-Libda & Ajjori | 4 |
| 18 | Al-Rawamis | 5 |
| Total | | 182 |

These companies make about 131 between-cities trips daily. About 72% of these trips use Salah El-Deen regional road.

Gaza buses are mostly used in transferring university students. Since universities are located in Gaza city, buses travel from other cities to Gaza city daily. (Workshop, Ministry of Transport and companies owners, attached in Annex 3).

It can be said that a bus system with constant schedules and routes does not exist in Gaza Strip. What exists is: 182 buses come from all over Gaza Strip to Gaza city at 8:00 o'clock and leave at 15:00, transferring university students.

1.3 Problem Statement

Serious problems face the development of bus as a transportation mode in Gaza Strip. Some of these problems are the low number of buses in service, the tendency of bus drivers to over-load their buses, the lack of modern stations and the random routing of buses.

In a workshop held in the Ministry of Transport (See Annex 3), It was mentioned that bus trips in Gaza Strip run as follows:

- Each driver in the company is responsible for a bus, and some of them (especially who live and drive far from the center of the company) have to park the bus near or inside their homes.
- Early at the morning, the driver picks a number of people who are used to ride from the parking point of the bus.
- Through its known route, the bus picks up any person who points in the road.

It can be deduced that this bus system causes the following problems:

1. Noise and congestion in the area the bus uses as a random park.
2. Huge traffic jams in each place the bus stops in to pick a person, knowing that few meters may separate two successive riders.
3. Mechanical problems in buses due to the big number of stops.
4. Strengthening the culture of (The transport mean must stop where I am waiting!).
5. Increasing the chances of accidents due to the big number of stops, especially on regional roads, where vehicles speed exceeds 100 km/hr.
6. The delay caused by the big number of stops.

These problems and others make people in Gaza consider buses the last choice of transportation modes to think in. This in turn increases the chance of taxi in attracting people, and hence increases the number of people who offer the service of taxi, leading to more traffic jams, more pollution and more transportation cost.

The evaluation of bus system in Gaza Strip is rarely considered by researchers, either in academic or governmental institutions.

In this thesis, the service of buses in Gaza Strip is evaluated. The evaluation includes measuring the public satisfaction of bus transport service using questionnaire, evaluating bus stops by GIS using certain criteria, and designing a schedule of a bus system in university zone in Gaza city.

1.4 Research Aim

The aim of this study is to evaluate the bus as a transportation mode in Gaza Strip using GIS, in order to help governmental transportation planners and decision makers in developing the system of bus in Gaza, with respect to routing, stations and satisfaction of customers.

1.5 Research Objectives

To achieve the aim of the research, the following objectives are to be considered:

1. Evaluating public satisfaction of bus transportation system in Gaza Strip.
2. Evaluating bus stops and routing system using GIS.
3. Designing a schedule of a bus system in university zone in Gaza city.

1.6 Research Importance

This research introduces a description for the situation of bus transportation in Gaza Strip. It also measures the public satisfaction with bus transportation in Gaza through questionnaire, and employs the questionnaire results together with GIS technology in introducing a suggestion for developing the situation of bus transportation in Gaza Strip.

The suggestions introduced in this research can help in minimizing the traffic jams caused by buses in Gaza, enhancing the culture of stations and eliminating the idea of (The station is where I want to wait) that people believe and implement in Gaza Strip.

One of the most important benefits of this research is to understand what people think about the service of buses in Gaza, and whether they feel satisfied with it or not, and to what extent they are satisfied/not satisfied.

1.7 Brief Research Methodology

1.7.1 Data Collection

The data of the research may be obtained from the Palestinian Ministry of Transport, bus Companies of Gaza, the ministry of local governance, and from bus users through questionnaire.

1.7.2 Research Questionnaire

The questionnaire to be used in the study aims to measure the public satisfaction of bus transport system in Gaza Strip. It can also be used in obtaining information about bus system, such as waiting points locations and names.

The questionnaire is targeted to sample group representing customers of all bus companies in Gaza.

The questionnaire discusses bus capacity and over-loading (Seat availability), travel time, punctuality, price, information, cleanliness, driver behavior, bus comfort, bus stop security, safety from accidents, and coverage of waiting points.

1.7.3 Data Analysis

In this research, the following techniques are used:

- Analyzing questionnaire results using SPSS.
- Using GIS in studying coverage of a sample of bus stops.
- Using questionnaire data in evaluating a sample of bus stops.
- Using public transport customers count in university zone in determining a time-related demand of public transport, in order to design a bus schedule for university zone in Gaza city.

1.8 Research Structure

Chapter 1:

Introduction: Background, Aim, Objectives, Problem Statement, Scope of the Study and Thesis Structure.

Chapter 2:

Literature Review.

Chapter 3:

Research Methodology.

Chapter 4:

Questionnaire

Chapter 5:

Questionnaire Results and Discussion.

Chapter 6:

Case Study: Bus Stops Evaluation and Design Sample in Gaza City

Chapter 7:

Conclusion and Recommendations.

2 LITERATURE REVIEW

2.1 Public Transport

Public transport: public transportation or public transit is a shared passenger transportation service which is available for use by the general public, as distinct from modes such as taxicab, car pooling or hired buses which are not shared by strangers without private arrangement. Public transport modes include buses, trolleybuses, trams and trains, rapid transit (metro/subways/undergrounds etc) and ferries. Public transport between cities is dominated by airlines, coaches, and intercity rail. (Wikipedia, 2012).

While there are indications of experiments with public transport in Paris as early as 1662, there is evidence of a scheduled "bus route" from Market Street in Manchester to Pendleton in Salford UK which was started by John Greenwood in 1824. (Wikipedia, 2012).

Public transport is used widely in the developed countries as an alternative of private vehicles, due to the advantages of public transport that can effectively eliminate the disadvantages of private vehicles.

Private car use has grown rapidly during the last decades. The number of motorized vehicles in the world grew from about 75 million to about 675 million between 1950 and 1990. Around 80% of these vehicles were primarily used for personal transportation, i.e., cars and motorcycles. The increasing car use has generated various environmental, social and economic problems. Environmental problems concern the emissions of toxic and harmful substances, which, among other things, contribute to global warming, smog and acid precipitation. Next, scarce raw materials and energy are needed to produce and use cars. The extension of road infrastructure causes distortion and fragmentation of natural areas, which might disrupt natural habitats. On the social level, car use threatens the urban quality of life because it is noisy, causes odor annoyance, local air pollution and yields traffic accidents. In 1998, about 42,000 people

were killed in traffic accidents in the European Union. Moreover, less space is available for walking, cycling and playing, especially in urban areas. Whereas more and more people own a car, those without access to cars become more disadvantaged and socially isolated as workplaces, shops and leisure facilities relocate to suit car users. Economic problems of car use are related to the decreased accessibility of economically important destinations. Congestion in European cities is estimated to cost 100 billion Euro per year, and projected to double in the next decade. Motorists are allowed to shift external costs such as accident costs, costs for managing environmental nuisance and noise, and maintenance of traffic safety to society as a whole. (Steg, 2012).

Public transport should be an active alternative to prevent the mentioned dangers especially in developing countries.

In Gaza strip, where the growth rate of population is about 3.2%, an activation of public transport is considered a must, knowing that the rate of infrastructure developing activities is very low due to the bad and unstable economical and political situations.

2.2 Public Transport Evaluation

Wikipedia (2012) defines the term "Evaluation" as "a systematic determination of a subject's merit, worth and significance, using criteria governed by a set of standards. It can assist an organization to assess any aim, realizable concept or proposal, or any alternative, to help in decision-making; or to ascertain the degree of achievement or value in regard to the aim and objectives and results of any such action that has been completed. The primary purpose of evaluation, in addition to gaining insight into prior or existing initiatives, is to enable reflection and assist in the identification of future change".

Depending on the previous definition, the process of public transport evaluation must depend on an evaluation system. This is what Baskaran and Krishnaia (2011) tried to do in their study. As the researchers stated, at present, there is no system for bus route evaluation for Chennai city in India, where they run their research. This paper discusses the development of a comprehensive bus route evaluation system using various performance indicators according to rules and regulation of metropolitan transport corporation of Chennai. Analytic Hierarchy Process (AHP) model is built, which integrates quantitative and qualitative attributes of the routes. To demonstrate the real

world application of this developed system, seven bus routes from Chennai city have been taken for study. Considering all mentioned performance indicators, the developed system prioritized all seven routes from best to worst.

Khateeb (2011) discussed the problems of public transport in Jenin, one of the largest Palestinian cities in the west bank.

Khateeb study aimed to identify the up-to-date situation of public transportation in Jenin Governorate in terms of the existing roads, traffic volume and the factors affecting it, in addition to the main problems that the transportation sector faces in this area.

In this study, a descriptive analytical approach is used. A field investigation is carried out in collecting data such as traffic count and roads geometric design.

The study offers important results such as the high effect of the Israeli separation wall on the cost of public transportation.

The researcher presented a number of recommendations, such as:

- The importance of encouraging people to use public transport in order to reduce the impacts on the environment and alleviate traffic jam in the center of the Governorate especially during rush hour time.
- Increasing the number of public transportation means, such as buses and taxis.
- Constructing new public stations.

Abdel-All (2009) discussed the situation of public transportation in Jadda as an indicator of the public transportation in Saudi Arabia generally. The most important goal in his study was to determine the demand relating all transport means, especially public transport means. The study also aimed to investigate the reasons behind the decrease in using public transport means in Jadda, where indicators state clearly that there is a sharp decrease in public transport customers.

The study recommended that suitable policies should be followed for reducing the dependency on private car. The researcher recommended also establishing a modern information system that controls the public transport system.

2.3 Public Satisfaction Measurement

“When does an event begin? It does not begin. There is always something before.” This was the beginning of Kerstin Ekman's book, *Hunden* (The Dog). (Ekman, 1986, p. 5).

People do not complain if the service they get is the best. People in the Gazian society always complain of public transport service in general and of bus service in particular.

Budiono (2009) investigated the customer satisfaction with Indonesia public bus transport. Budiono stated that it is important to investigate which service quality attributes that have the most influence to customer satisfaction in Indonesia public bus transport. The study aimed also to investigate the structure of service quality in Indonesia's public bus transport in order to make priority on quality improvements in the future. The study used a questionnaire to achieve its goals. The questionnaire was divided into three parts; demographics, travel pattern behavior, and items measuring satisfaction such as frequency, travel time, punctuality, price, information, cleanness, staff behavior, comfort, seat availability, bus stop security and condition, safety, and information. The researcher concluded that Indonesian customer is not satisfied with public bus transport service.

Eboli and Mazzulla (2007) introduced a tool for measuring customer satisfaction in public transport. A structural equation model is formulated to explore the impact of the relationship between global customer satisfaction and service quality attributes. The public transport service analyzed is the bus service habitually used by University of Calabria students to reach the campus from the urban area of Cosenza (southern Italy). To calibrate the model, some data collected in a survey addressed to a sample of students were used. The proposed model can be useful both to transport agencies and planners to analyze the correlation between service quality attributes and identify the more convenient attributes for improving the supplied service.

Technology can be widely implemented in measuring public satisfaction with transport means. Gebeyehu and Takano (2007), developed an ordered logit model to examine Addis Ababa citizens' perceptions of the bus condition, as a determining factor for their choice of bus transportation. The study's objective is to analyze the public transport modal choice behavior of residents and their perception on bus condition parameters as a determining factor in their bus choice. The research approach implemented in this study involved modeling travelers' perception on bus transportation and its influence on public transport mode choice using logit models.

The study presents a diagnostic analysis of the existing public transport situation in Addis Ababa. A binary logit model was assessed for the public transportation mode choice analysis; and an ordered logit model is implemented to analyze the ranking responses of citizens' perceptions on the condition of the current bus service.

2.4 GIS in Public Transport Studies

Geographical Information Systems (GIS) is a widely used technology in many fields. GIS technology gains its importance and spread from its advantage of linking data and geographical location. This advantage can generate very vital applications in scientific and engineering research.

ESRI defines GIS as "an integrated collection of computer software and data used to view and manage information about geographic places, analyze spatial relationships, and model spatial processes. A GIS provides a framework for gathering and organizing spatial data and related information so that it can be displayed and analyzed." (ESRI, 2012).

ESRI's ArcGIS is a geographic information system (GIS) for working with maps and geographic information. It is used for creating and using maps, compiling geographic data, analyzing mapped information, sharing and discovering geographic information, using maps and geographic information in a range of applications, and managing geographic information in a database. (Wikipedia, 2012)

Nayati, (2008) created a GIS based school transport management system which helps in bus-stop allocation, and designing the fastest and safest bus routes. The result of this study has helped to develop a school bus routing and scheduling prototype model for Sujatha High School, Hyderabad, India.

Tanaboriboon, Anh, and Hung, (2005) examined the bus service in Hanoi, Vietnam through the application of Geographic Information Systems (GIS). The specific objectives of this study are to investigate the existing bus system in Hanoi, to examine the bus service characteristics and user characteristics, to analyze the deficiencies of bus service by applying GIS concept as well as to compare efficiencies of bus service operation to each bus company. The performance indicators through resource, service efficiency and effectiveness were analyzed on bus routes and their performance were

compared among bus companies. GIS package was employed as a tool to clearly identify the operating deficiencies and the causes of poor operations of these bus routes. It was found that 90 percent of bus routes were identified as deficient.

2.5 Selecting/Evaluating Bus Stops Accessibility and Location

Darnell and Associates (2006) developed suggested design criteria that should be considered when designing and placing transit facilities. This information is not to be used as a set of standard details on which to base a final design, but rather as recommended criteria and general guidance for the placement and safe design of transit facilities. It cannot be overemphasized that these guidelines must be used in conjunction with sound evaluation of the facts and engineering judgment.

Carruthers, Dick and Saurkar defined "Accessibility" as the term which "describes the ease with which all categories of passenger can use public transport. For example, buses with high steps are notoriously difficult to board, particularly if they are one-person operated and there is no assistance. They are also difficult to use for those carrying luggage or shopping or with young children. Accessibility is also sometimes used to describe the ease of accessing the bus stop or station, although sometimes these parts of the journey are referred to as part of the "public transport environment". If a walk is intimidating or dangerous, a bus stop at 200 meters distance may be perceived as inaccessible to a fit 14-year old boy because of the risk of mugging. Accessibility also includes ease of finding out about travel possibilities, i.e., the information function."

Foda and Osman (2010), introduced a new approach for estimating transit stop access coverage based on the actual pedestrian road network surrounding the bus stop. The idea here is to identify all the pedestrian road network links that lie within the specified maximum walking distance of the 400m access threshold, measured along the network paths around the bus stop. Joining the ends of those links creates a polygonal area, which is referred to as the "actual access coverage" for the bus stop. This polygonal area is considered more representative than a 400m circular buffer for measuring the access coverage of a bus stop.

By applying the presented approach for estimating bus stop access coverage, new assessment indices are developed in an attempt to provide a more spatial evaluation of

the bus stop location. These indices can be used to evaluate both the accessibility to a bus stop through the surrounding pedestrian road network and the ratio of actual access coverage to the ideal access coverage of a bus stop.

As one of the major roadways in the city of Alexandria, Egypt, the locations of bus stops along Gamal Abd-Elnaser roadway were identified as a case study for the proposed analysis in this research.

2.6 Conclusion

As shown in the previous discussion, most of the studies encourage the use of public transport, due to the problems caused by private cars. Developing an effective public transport system requires an accurate evaluation of the existing one. Most of the studies mentioned in the literature review either give an evaluation of the public transport system in a certain area, or suggest an evaluation methodology. The studies in the field of evaluating public transport systems always discover problems facing the system they evaluate. The problems discussed in the literature review include problems in public satisfaction, routing system, control and management of public transport system.

Using GIS in the process of evaluating public transport system is common in the modern research. Researchers used GIS to achieve different objectives in this field of research. For example, Nayati, (2008) created a GIS based school transport management system which helps in bus-stop allocation, and designing the fastest and safest bus routes, while Tanaboriboon, Anh, and Hung, (2005) examined the bus service in Hanoi, Vietnam through the application of GIS. Moreover, Foda and Osman (2010), introduced a new approach for estimating transit stop access coverage based on the actual pedestrian road network surrounding the bus stop.

3 RESEARCH METHODOLOGY

3.1 Introduction

This chapter contains a detailed description about the methodology of the research. It includes research strategy, questionnaire design and content, including sample size and pilot study, and a short description about the evaluation work.

3.2 Research Strategy

3.2.1 General Description

This research tries to answer the question: What is the condition of bus service in Gaza Strip? And how can it be better?

In order to ask the previous question, the research passes through the following phases:

1. Phase I: Literature Review and Data Collection

In this phase, data are collected about buses in Gaza Strip and bus companies system of work. Data are collected through visiting intended governmental institutions, field investigation, and holding a workshop with bus companies owners in the Ministry of Transport in Gaza Strip. Similar researches in more than ten countries around the world were studied in order to understand the conditions of bus systems in these countries.

2. Phase II: Questionnaire

Knowing that direct questionnaire is a common method for measuring public opinion in such a case, this phase includes the process of questionnaire design, achieving, and analysis.

3. Phase III: Analysis of Bus Stops Using GIS

Using the results of questionnaire, a general assessment for bus stops in Gaza Strip is introduced. Fourteen evaluation criteria were passed on three experts to give them weights, and hence were used in evaluating ten bus stops in Gaza city as a case study. GIS is used in evaluating bus stops accessibility and coverage. A design sample for a bus system in the university zone in Gaza city is illustrated as a case study.

The chart shown in figure (3.1) illustrates the methodology of research as follows:

1. Public Questionnaire. This step leads to two main outcomes:
 - a. Determining public satisfaction with bus system in Gaza Strip.
 - b. Testing to what extent international standards can satisfy bus customers in Gaza in order to formulate (Gazian criteria) for evaluating and designing a bus system in Gaza.
2. Using the outcome (a) in previous step, a questionnaire oriented to experts is prepared to explore their point of view about the criteria that is believed to be suitable for a bus system in Gaza.
3. Selected bus stops in Gaza city are evaluated with respect to the criteria generated from the previous steps.
4. Using GIS, the accessibility and coverage of bus stop as an important criteria is measured.
5. Passengers' Count: This step leads to determining an accurate demand in the university zone in Gaza city as a case study.
6. Using bus stops criteria generated in steps (1) and (2), bus stops are located in certain points in university zone.
7. Steps (5) and (6) can help in designing a simple bus system in the university zone in Gaza city.

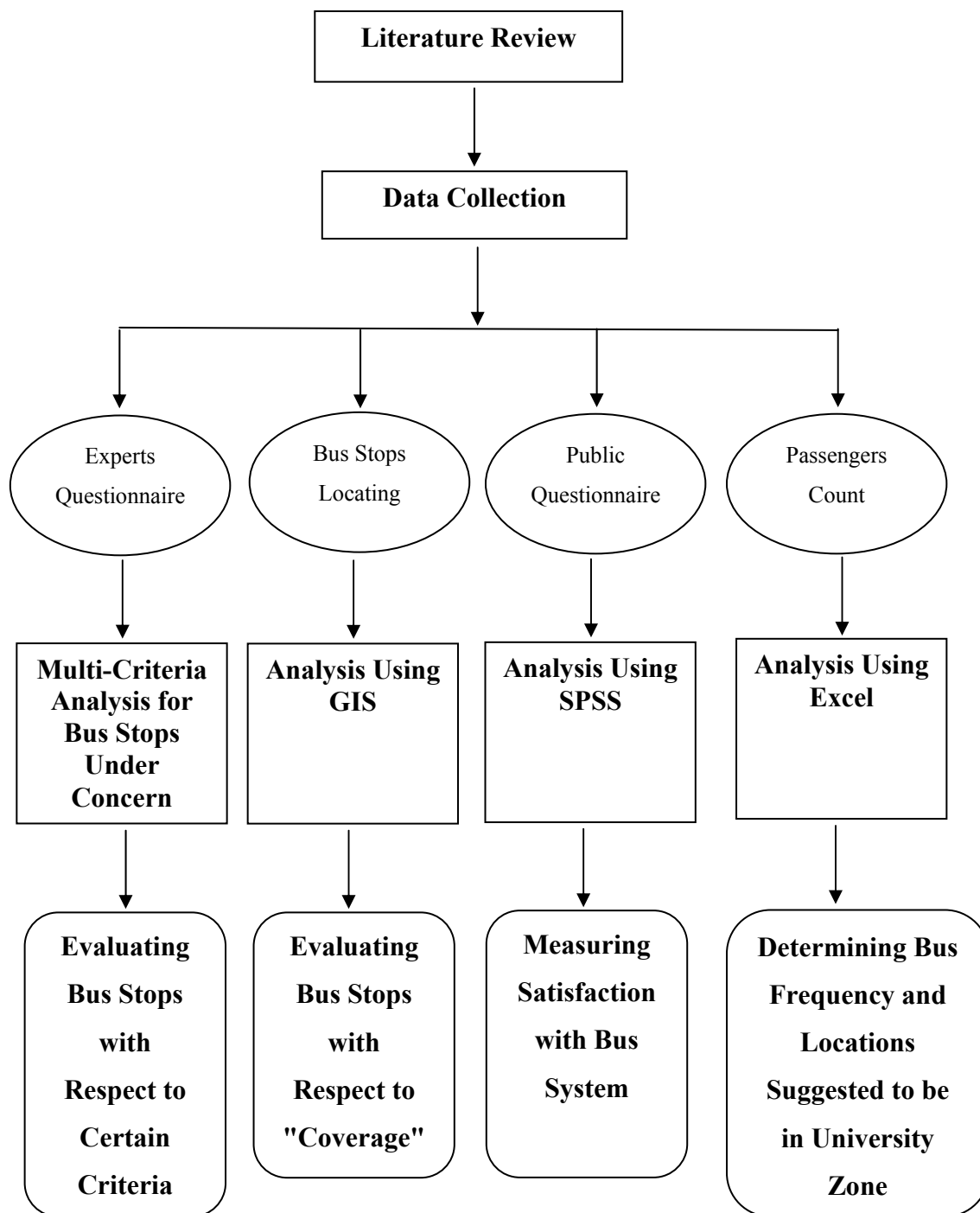


Figure (3.1) The Methodology of Research.

3.3 Population and Sample Size

University students comprise the majority of bus users. (Workshop, Ministry of Transport and companies owners, attached in Annex 3). This is due to the following reasons :

1. University students find it less expensive to travel in bus.
2. Bus companies find it more stable and profitable to deal with the huge number of university students. This makes them fit their timing and routing systems to be suitable for students.
3. People, other than university students, rarely make out-of-cities trips, so, if they do, they pay for more comfortable and less time consuming mean of transportation.

It was found that about 131 trips are run in Gaza Strip daily (Workshop, Ministry of Transport and companies owners, attached in Annex 3). Knowing that 50 persons is the full capacity of bus, we can say that the number of persons using bus in Gaza Strip are about 6550, most of them are university students.

Statistically, a pilot sample of 30 persons, and an actual sample of 360 are needed to have a representative public measure.

3.4 Questionnaire Design and Content

The design and content of the questionnaire were formulated to answer the questions of the research and to achieve its objectives. Budiono (2009) thesis (Customer satisfaction in public bus transport - A study of travelers' perception in Indonesia) was a very good guide for designing the questionnaire.

The questionnaire is divided into two main parts:

- A. General Information: about gender, age, living place, usual target and how many times the person uses a bus weekly.
- B. Questions in the field of research: This part includes five sections:
 1. Questions about the bus, including bus safety, security, cleanliness, physical satisfaction, seat availability, accuracy and price.

2. Questions about the driver, including punctuality, giving information, respecting traffic law and politeness.
3. Questions about bus stops, including bus stops existence in the place of living, and those which exist in study/work places. The questions include: waiting time, security, the distance between station and home, cleanliness and environmental effects including noise and vehicles exhaust.

3.5 Evaluation Process

Using questionnaire data, ten bus stops in Gaza city (a case study) are evaluated with respect to certain criteria. The criteria are given weights ranging between 1-5, and Likert Scale is used in giving every bus stop a mark that is used later in giving an indication about the suitability of that point as a bus stop.

3.6 Design of Questionnaire Sample

The data gathered bus companies owners workshop, the information obtained from analyzing questionnaire, and a passengers count can all be an input in the process of outputting a suggested bus system design in Gaza Strip. The university zone is suggested to be a case study.

This phase includes the following:

- Determining the best sites for bus stations in the university zone.
- Determining demand, and hence frequency of buses in this area.

4 CHAPTER 4: QUESTIONNAIRE

4.1 Introduction

This chapter discusses the methods, procedures, and methodology that have been used in conducting the questionnaire. It includes the methodology of data collection, the population, and the sample of the study. It also describes the statistical methods used in analyzing data.

4.2 Methodology Of The Study

A descriptive analytical method which tries to "evaluate the system of bus in the Gaza Strip" is used in this part of the study.

4.3 The Population and the Study Sample

The study population consists of the users of bus amongst the students of the university zone in Gaza. The population of the study is about 6550 students. The number (6550) is obtained from bus companies workshop, where bus companies owners are required to give details about their daily trips. The details are included in Annex (3).

The sample size was determined according to Yamane formula for sample size determination. (Yamane, 1967).

$$N/(1+N*e^2).$$

Where;

N = Population Size.

e = Significance Value.

A random sample of (360) person is selected depending on the previous equation. Having a population of (6550), and a significance level of 0.05, the value of $n = 376$ persons.

$$n = \frac{6550}{(1+6550 \cdot e^{-2})} = 376.$$

A number of (360) answered questionnaire are returned knowing that 400 questionnaire are distributed.

4.4 Tools of Study

The questionnaire is composed of two parts:

1. General Information.
2. "Bus System", that contains the four main dimensions, it contains (64) paragraphs which are:
 - First dimension: Bus, (9) paragraphs.
 - Second dimension: " Driver" , (11) paragraphs.
 - Third dimension: "Bus Stop in Living Area", (22) paragraphs.
 - Fourth dimension: "Bus Stop in Study/Work Area", (22) paragraphs.

4.5 Questionnaire Correction

Likert scale is used to correct questionnaire paragraphs. According to five-points scale, the results appear as: Strong Approval: (5) degrees, Approval: (4), Neutral answer: (3), Disapproval (2), Strong Disapproval: (1). (Likert, 1932)

Table (4.1)

Likert Scale.

| Scale | Strong Disapproval | Disapproval | Neutral | Approval | Strong Approval |
|-----------------|--------------------|-------------|---------|----------|-----------------|
| Relative weight | 1 | 2 | 3 | 4 | 5 |

4.6 Statistical Tools Used

- Statistical Package for the Social Sciences (SPSS) was used in analyzing the questionnaire. The following styles were used:
- Descriptive Statistics: such as percentage, arithmetic average, standard deviation, relative arithmetic average.
- Person Correlation Coefficient: to verify the consistency between questionnaire paragraphs.
- Cronbach's Alpha Coefficient: to know the reliability of questionnaire paragraphs.
- Spearman-Brown: to know the reliability of questionnaire paragraphs.
- Kolomogrov – Smernov (1- Sample K-S): to know if data follow normal distribution or not.
- t- test: for the mean single sample (One sample t-test) to know the difference between the mean paragraph and medium neutral "3".

4.7 Procedure for the Application of the Study

1. A questionnaire to study the assessment of the bus system in the Gaza Strip was prepared.
2. The questionnaire was distributed to a sample consisting of reconnaissance (30) bus users.
3. The validity of the questionnaire to measure the variables of the study was insured.
4. The questionnaire was distributed to a sample consisting of 400 students.
5. The questionnaire was analyzed using SPSS.

The number of recovered questionnaires was (360) of the total questionnaires distributed (400), which means that the response rate is approximately 90 %. Thus, (360) questionnaires were analyzed.

4.8 Validity And Reliability Of The Study

4.8.1 Validity of the Study

A. Arbitrators Validity:

The questionnaire was studied by arbitrators composed of members of the faculty specialists at the Islamic University of Gaza. The arbitrators explained their opinions in the phrases and structure of the questionnaire. They also gave opinions about how suitable each statement is to the area to which it belongs, and the sufficiency of statements to cover all of the subjects of study, in addition to propose what they deem necessary to modify or delete the formulation of statements. Based on the feedback and directions of arbitrators, the questionnaire was adjusted to its final form.

B. Internal Consistency Validity:

The internal consistency was calculated for questionnaire paragraphs on a study sample of (360). This was done by calculating correlations coefficient between each dimension. Table (4.2) shows that the correlation coefficients indicate significance at the level of 0.05, where the probability value of each paragraph is less than 0.05, so the paragraphs of the questionnaire are valid to set the measure.

Table (4.2)

Internal Validity for Questionnaire Paragraphs.

| No | Paragraph | Relation Coefficient | Significance level |
|----------------------|---|----------------------|--------------------|
| First Dimension: Bus | | | |
| 1 | The bus system in Gaza Strip is generally uncomfortable. | 0.538 | 0.000* |
| 2 | You always do not find a vacant seat in the bus. | 0.483 | 0.000* |
| 3 | The bus is always dirt. | 0.685 | 0.000* |
| 4 | In most cases, you reach your destination late. | 0.668 | 0.000* |
| 5 | Bus tariff is not suitable from your point of view. | 0.525 | 0.000* |
| 6 | During one of your trips, the bus was out of order once at least. | 0.687 | 0.000* |
| 7 | You feel unsafe when you use bus. | 0.649 | 0.000* |

| No | Paragraph | Relation Coefficient | Significance level |
|--|---|----------------------|--------------------|
| 8 | You witnessed a bus accident once at least, and you were one of the bus users. | 0.629 | 0.000* |
| 9 | You always feel unsafe of accidents in buses. | 0.675 | 0.000* |
| Second Dimension: Driver | | | |
| 1 | Commonly, You are not satisfied with the way the bus driver treats you. | 0.741 | 0.000* |
| 2 | The driver always behaves impolitely. | 0.793 | 0.000* |
| 3 | The driver, once at least, attacked you orally. | 0.721 | 0.000* |
| 4 | The driver, once at least, talked to you impolitely. | 0.784 | 0.000* |
| 5 | Unexpectedly, the trip path is always changed. | 0.669 | 0.000* |
| 6 | The driver drives too fast during the trip. | 0.721 | 0.000* |
| 7 | The driver does not respect traffic sign and signals during the trip. | 0.638 | 0.000* |
| 8 | The driver always quarrels with other drivers. | 0.773 | 0.000* |
| 9 | The driver does not care about his personal cleanliness and look. | 0.676 | 0.000* |
| 10 | The driver tried, once at least, to extort you in abnormal conditions by asking for extraordinary money. | 0.507 | 0.000* |
| 11 | Commonly, you do not feel comfortable when dealing with bus drivers in Gaza Strip. | 0.555 | 0.000* |
| Third Dimension: Bus Stop in Living Area | | | |
| 1 | In your living area, the bus stop is not more than 600 meters far from your home. | 0.401 | 0.000* |
| 2 | In your living area, you consider the road leading to the bus stop invalid for pedestrian use. | 0.508 | 0.000* |
| 3 | In your living area, the bus stop is not defined by a sign to be a bus stop. It is a random point, known by public as a bus stop. | 0.377 | 0.000* |
| 4 | In your living area, the bus can pick you from any point in the street. | 0.359 | 0.000* |
| 5 | During the trip, the bus always stops at any point in the street to pick passengers. | 0.369 | 0.000* |
| 6 | In your living area, it is common that the bus arrives late to the bus stop. | 0.607 | 0.000* |
| 7 | In your living area, you wait more than five minutes till the bus gets full and starts moving. | 0.584 | 0.000* |
| 8 | In your living area, you feel that the bus stop is an unsafe place. | 0.574 | 0.000* |
| 9 | You suffered from health troubles resulting from vehicles exhausts in the bus stop in your | 0.664 | 0.000* |

| No | Paragraph | Relation Coefficient | Significance level |
|--|---|----------------------|--------------------|
| | living area. | | |
| 10 | You think that traffic noise is too loud in the bus stop in your living area, so that it affects your psychological status. | 0.698 | 0.000* |
| 11 | You are usually subjected to annoying by the drivers in the bus stop in your living area. | 0.633 | 0.000* |
| 12 | You are usually subjected to annoying by the customers in the bus stop in your living area. | 0.654 | 0.000* |
| 13 | The bus stop in your living area is located in an isolated place. | 0.505 | 0.000* |
| 14 | The bus stop in your living area causes travel jams. | 0.669 | 0.000* |
| 15 | In the bus stop in your living area, there are no sidewalks, or they are not wide enough for pedestrians to wait the bus on. | 0.555 | 0.000* |
| 16 | In the bus stop in your living area, there are no crosswalks. | 0.377 | 0.000* |
| 17 | The bus stop in your living area affects property owners negatively. | 0.537 | 0.000* |
| 18 | In your living area, the bus stop area is always congested. | 0.704 | 0.000* |
| 19 | In your living area, there are obstacles that interrupts vision. | 0.520 | 0.000* |
| 20 | The bus stop in your living area is not lit at night. | 0.549 | 0.000* |
| 21 | The bus stop in your living area is adjacent to exhaust-sensitive facilities like hospitals and schools. | 0.591 | 0.000* |
| 22 | The bus stop in your living area is adjacent to population densities. | 0.590 | 0.000* |
| Fourth Dimension: Bus Stop in Study - Work Area | | | |
| 1 | In your Study/Work area, the bus stop is not more than 600 meters far from your home. | 0.358 | 0.000* |
| 2 | In your Study/Work area, you consider the road leading to the bus stop invalid for pedestrian use. | 0.467 | 0.000* |
| 3 | In your Study/Work area, the bus stop is not defined by a sign to be a bus stop. It is a random point, known by public as a bus stop. | 0.582 | 0.000* |
| 4 | In your Study/Work area, the bus can pick you from any point in the street. | 0.437 | 0.000* |
| 5 | During the trip, the bus always stops at any point in the street to pick passengers. | 0.499 | 0.000* |
| 6 | In your Study/Work area, it is common that the | 0.618 | 0.000* |

| No | Paragraph | Relation Coefficient | Significance level |
|----|--|----------------------|--------------------|
| | bus arrives late to the bus stop. | | |
| 7 | In your Study/Work area, you wait more than five minutes till the bus gets full and starts moving. | 0.359 | 0.000* |
| 8 | In your Study/Work area, you feel that the bus stop is an unsafe place. | 0.559 | 0.000* |
| 9 | You suffered from health troubles resulting from vehicles exhausts in the bus stop in your Study/Work area. | 0.606 | 0.000* |
| 10 | You think that traffic noise is too loud in the bus stop in your Study/Work area, so that it affects your psychological status. | 0.559 | 0.000* |
| 11 | You are usually subjected to annoying by the drivers in the bus stop in your Study/Work area. | 0.622 | 0.000* |
| 12 | You are usually subjected to annoying by the customers in the bus stop in your Study/Work area. | 0.606 | 0.000* |
| 13 | The bus stop in your Study/Work area is located in an isolated place. | 0.553 | 0.000* |
| 14 | The bus stop in your Study/Work area causes travel jams. | 0.613 | 0.000* |
| 15 | In the bus stop in your Study/Work area, there are no sidewalks, or they are not wide enough for pedestrians to wait the bus on. | 0.617 | 0.000* |
| 16 | In the bus stop in your Study/Work area, there are no crosswalks. | 0.511 | 0.000* |
| 17 | The bus stop in your Study/Work area affects property owners negatively. | 0.616 | 0.000* |
| 18 | In your Study/Work area, the bus stop area is always congested. | 0.491 | 0.000* |
| 19 | In your Study/Work area, there are obstacles that interrupts vision. | 0.606 | 0.000* |
| 20 | The bus stop in your Study/Work area is not lit at night. | 0.549 | 0.000* |
| 21 | The bus stop in your Study/Work area is adjacent to exhaust-sensitive facilities like hospitals and schools. | 0.621 | 0.000* |
| 22 | The bus stop in your Study/Work area is adjacent to population densities. | 0.629 | 0.000* |

* Correlation is statistical significant at $\alpha \leq 0.05$

C. Structure Validity

Table (4.4) indicates the correlation coefficients between the degree of each dimension of the questionnaire and the total degree for the questionnaire. The correlation coefficients have statistical significance at $\alpha \leq 0.05$, while the probability value for all paragraph is less than 0.05.

Table (4.3)

The Total Degree of Questionnaire

| Dimension No. | Dimension | Relation Coefficient | Significance level |
|----------------------|-------------------------------|-----------------------------|---------------------------|
| First | Bus | 0.777 | 0.000* |
| Second | Driver | 0.825 | 0.000* |
| Third | Bus Stop in Living Area | 0.919 | 0.000* |
| Fourth | Bus Stop in Study - Work Area | 0.885 | 0.000* |

* Correlation is statistical significant at $\alpha \leq 0.05$

4.8.2 Reliability of Study

The reliability of questionnaire tests if this questionnaire gives the same result if it was redistributed in other time under the same circumstances and conditions. In other words, the reliability of questionnaire means the stability in the results of the questionnaire. There are two methods for measuring Reliability:

A. Reliability by Cronbach's Alpha Method:

The value of Cronbach's alpha for the total questionnaire was found to be 0.9521, this means that the questionnaire has a high coefficient of reliability. See Table (4.4).

Table (4.4)

Cronbach 's Alpha Coefficient for the Reliability Scale.

| Dimensions | Dimensions Title | Number of paragraphs | Cronbach's alpha Coefficient |
|--------------------------------|-----------------------------|-----------------------------|-------------------------------------|
| First | Bus | 9 | 0.7951 |
| Second | Driver | 11 | 0.8826 |
| Third | Bus Stop in Living Area | 22 | 0.8850 |
| Fourth | Bus Stop in Study/Work Area | 22 | 0.8848 |
| Total questionnaire paragraphs | | 64 | 0.9521 |

B. Reliability by Split-half method

Questionnaire paragraphs are separated into two parts, namely the odd-numbered questions, and even-numbered questions, then the correlation coefficient between odd questions degrees and even questions degrees was determined. Correlation coefficient is then corrected by Spearman Brown:

Average correlation coefficient = $\frac{2r}{1+r}$, where r is the correlation coefficient between individual questions degrees and even questions degrees.

It was found that the value of corrected correlation coefficient is high, which means that the questionnaire has a high reliability degree. The results are indicated in Table (4.5):

Table (4.5)
Reliability Coefficients by Split-half Method.

| Dimension | Dimension Title | Correlation coefficient by spearman | Reliability coefficient by brown method |
|--------------------------------|-------------------------------|--|--|
| First | Bus | 0.5614 | 0.7191 |
| Second | Driver | 0.7246 | 0.8403 |
| Third | Bus Stop in Living Area | 0.7320 | 0.8453 |
| Fourth | Bus Stop in Study - Work Area | 0.6686 | 0.8014 |
| Total questionnaire paragraphs | | 0.7496 | 0.8596 |

5 QUESTIONNAIRE RESULTS AND DISCUSSION

5.1 Introduction:

The questionnaire was analyzed statistically, and necessary tests were conducted and have been detailed in the previous chapter. In this chapter, the result of the questionnaire is going to be illustrated in details.

5.2 Normal Distribution Test: Kolmejrov - Samarnov Test (1- Sample K-S)

The following test, Kolmejrov – Samarnov aims to check wither the data follow a normal distribution or not. This test is necessary in the case of hypothesis testing, because most laboratory tests require that the data have normal distribution. Table (5.1) gives the results of the probability value of each dimension, which is more than 0.05 ($sig . > 0.05$). This indicates that the data follow a normal distribution and parametric tests could be used.

Table (5.1)

1-Sample Kolmogorov-Smirnov Test.

| Dimension | Dimension Title | Z-Value | Probability Value |
|--------------------------------|-------------------------------|---------|-------------------|
| First | Bus | 0.828 | 0.499 |
| Second | Driver | 0.781 | 0.573 |
| Third | Bus Stop in Living Area | 0.766 | 0.600 |
| Fourth | Bus Stop in Study - Work Area | 0.989 | 0.282 |
| Total questionnaire paragraphs | | 0.7496 | 0.734 |

5.3 The Statistical Description of the Study Sample According to the Characteristics and Personality Traits

5.3.1 Distribution of the Sample According to Gender

Table (5.2)

The Sample According to Gender.

| Gender | Frequency | Percentage% |
|--------|-----------|-------------|
| Male | 177 | 49.2 |
| Female | 183 | 50.8 |
| Total | 360 | 100.0 |

It's clear from the results in Table (5.2) that 49 % from the sample are male, while female are 51 %, which means that the study sample is well distributed between with respect to gender.

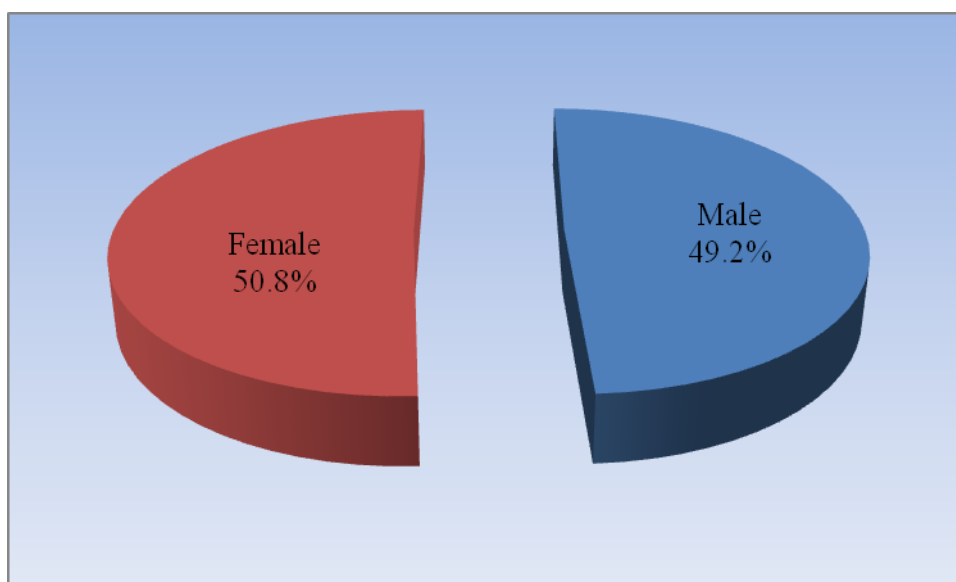


Figure (5.1): Distribution of Sample According to Gender.

5.3.2 Distribution of the Sample According to Age:

Table (5.3)

The Sample According to Age

| Age | Frequency | Percentage% |
|-------------------------|-----------|-------------|
| from 18 to less than 23 | 289 | 80.3 |
| From 23 to less than 40 | 71 | 19.7 |
| Total | 360 | 100.0 |

It is clear from the results in table (8) that 80 % from the sample are from 18 to less than 23 years old, while 20 % are from 23 to less than 40 year old. This is because most of bus users in Gaza Strip are university students.

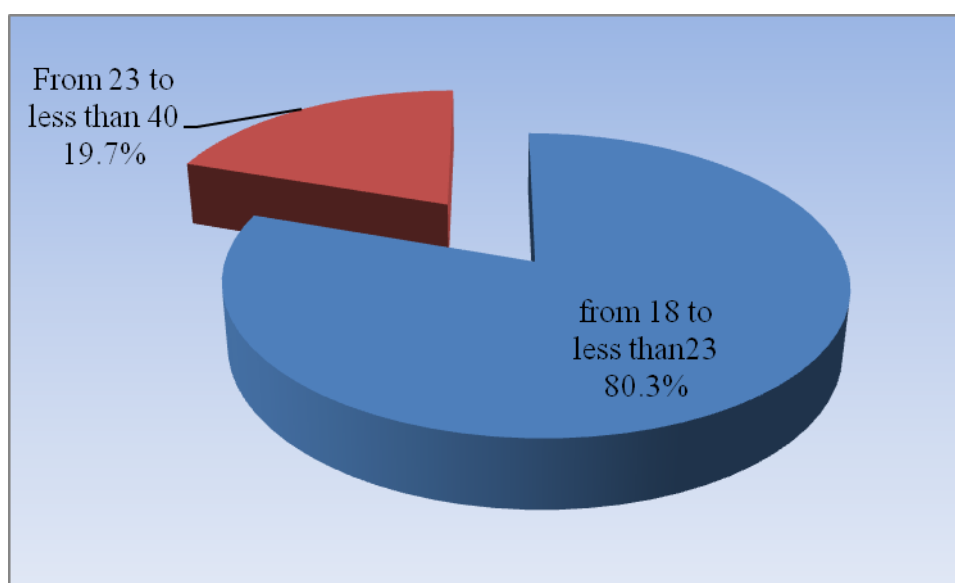


Figure (5.2): Distribution of Sample According to Age.

5.3.3 Distribution of the Sample According to Academic Qualification

Table (5.4)

The Sample According to Academic Qualification

| Academic Qualification | Frequency | Percentage % |
|------------------------|-----------|--------------|
| Master | 18 | 5.0 |
| Bachelor | 290 | 80.6 |
| Diploma | 16 | 4.4 |
| High School | 36 | 10.0 |
| Total | 360 | 100.0 |

Table (5.4) shows that the majority of the sample are Bachelor students, (81 %), while 5% are master students or carriers. About 4% have Diploma, while the 10% are high school students.

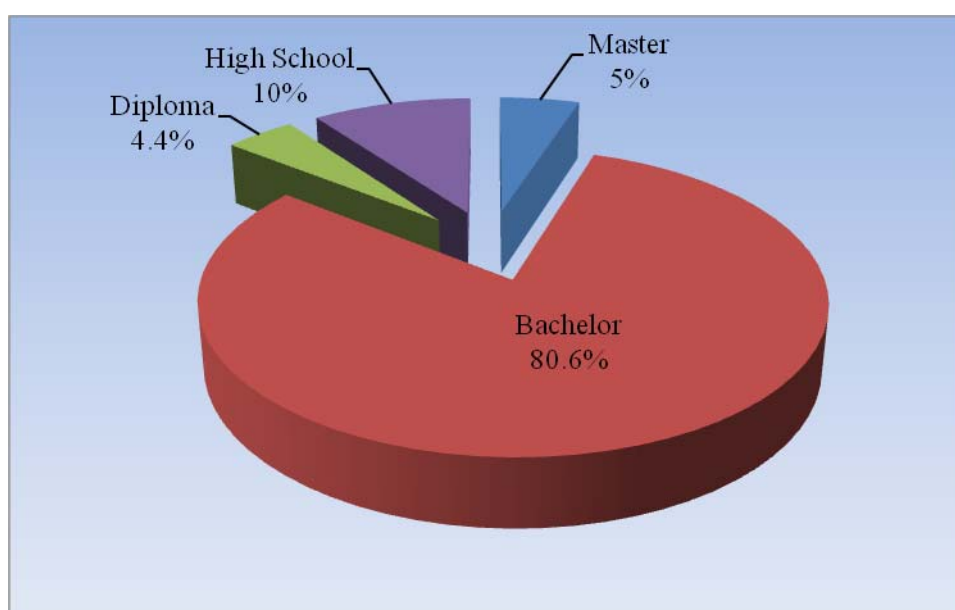


Figure (5.3): Distribution of the Sample According to Academic Qualification

5.3.4 Distribution of the Sample According to Professional Career

Table (5.5)

The Sample According to Professional Career.

| Professional Career | Frequency | Percentage % |
|---------------------|-----------|--------------|
| Public sector | 20 | 5.6 |
| Private sector | 28 | 7.8 |
| Student | 291 | 80.8 |
| Unemployed | 21 | 5.8 |
| Total | 360 | 100.0 |

Table (5.5) shows that the majority of the sample are students, (81 %), while 8% work in private sector. The unemployment percentage in the sample is about 6%.

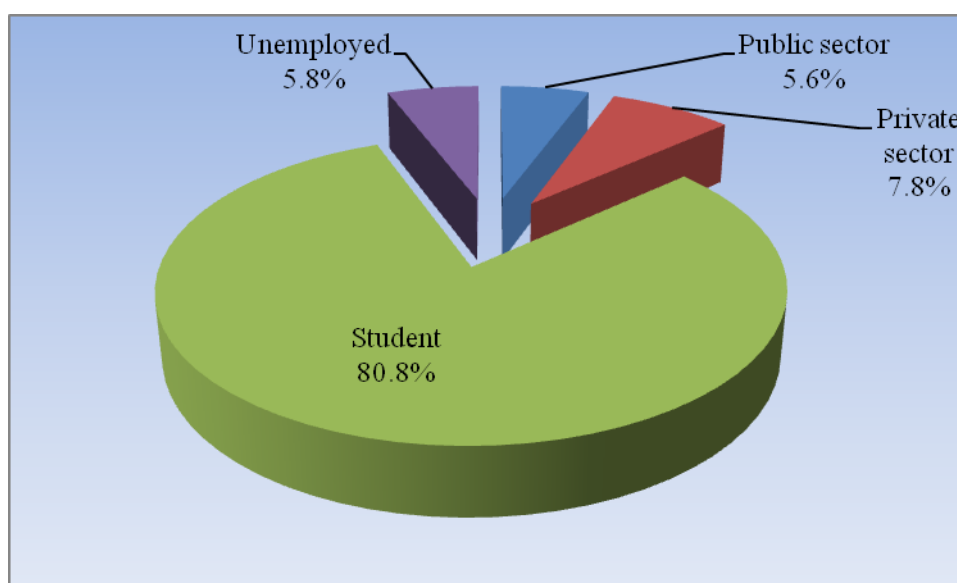


Figure (5.4): Distribution of the Sample According to Professional Career

5.3.5 Distribution of the Sample According to Living Area:

Table (5.6)

The Sample According to Living Area

| Living Area | Frequency | Percentage % |
|-------------|-----------|--------------|
| North | 39 | 10.8 |
| Gaza | 58 | 16.1 |
| Middle | 57 | 15.8 |
| Khan Younis | 132 | 36.7 |
| Rafah | 74 | 20.6 |
| Total | 360 | 100.0 |

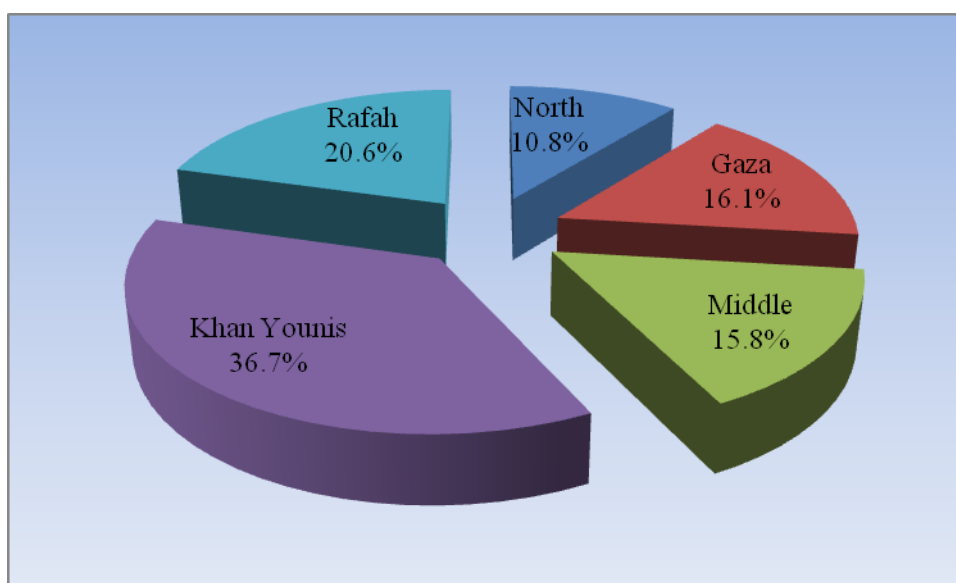


Figure (5.5): Distribution of the Sample According to Living Area.

5.3.6 Distribution of Study Sample by the Usual Destination:

Table (5.7)

The Sample According to Usual Destination.

| Usual Destination | Frequency | Percentage % |
|--------------------|-----------|--------------|
| North | 9 | 2.5 |
| Gaza | 327 | 90.9 |
| Middle Governorate | 5 | 1.4 |
| Khan Yunus | 12 | 3.3 |
| Rafah | 7 | 1.9 |
| Total | 360 | 100.0 |

Table (5.7) shows that the destination of almost the whole sample is Gaza city. This is because the majority of bus users are university students, and it is known that Gaza city is the center of Gaza Strip universities.

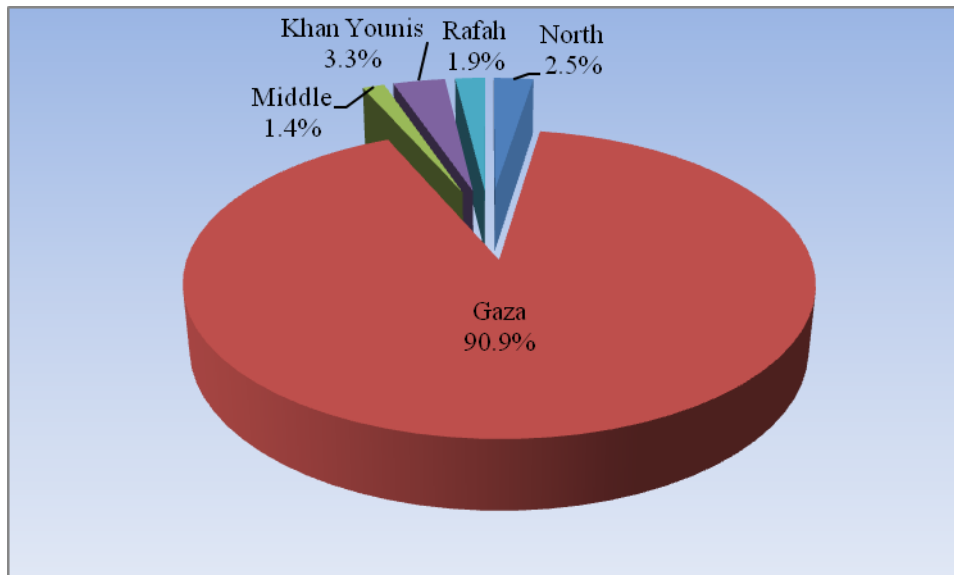


Figure (5.6):Distribution of the Sample According Usual Destination

5.3.7 Distribution of Study Sample Depending on Driver License Ownership

Table (5.8)

The Sample According to Driver License Ownership.

| Response | Frequency | Percentage% |
|----------|-----------|-------------|
| Yes | 52 | 14.4 |
| No | 308 | 85.6 |
| Total | 360 | 100.0 |

Table (5.8) shows that about 86% of the respondents do not have driving license. This is because the sample is mainly formed of university students, who do not think that driving license is a priority in this period of their lives, in addition to the low income of the majority of Gazian families, which makes it difficult to have a car, and hence makes it unnecessary to have a driving license.

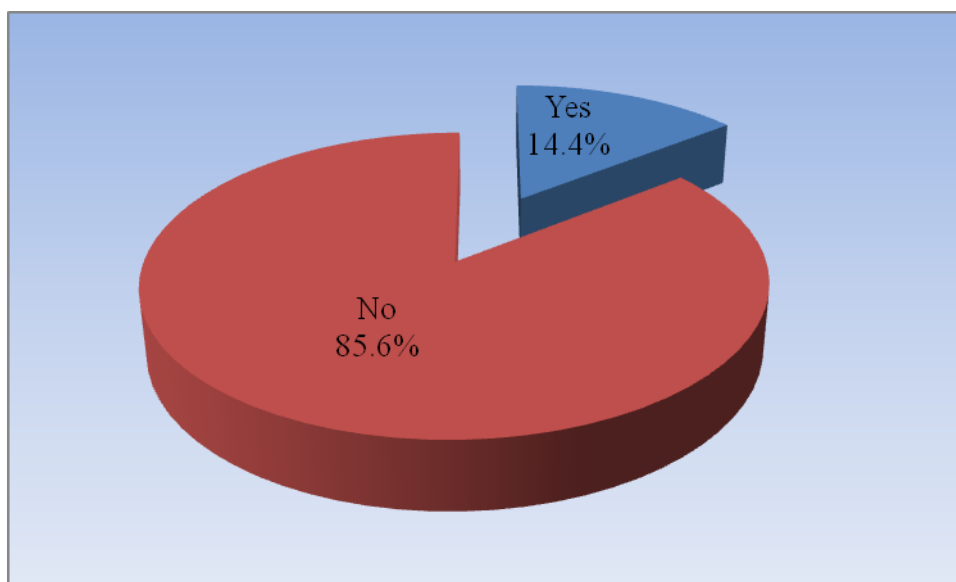


Figure (5.7): The Sample According to Driver License Ownership.

5.3.8 Arithmetic Mean and Standard Deviation of the monthly income and the number of family members of sample

Table (5.9)

The Standard Deviation of the Monthly Income and the Number of Family Members of Sample.

| Variable | Arithmetic Mean | Standard Deviation |
|------------------|-----------------|--------------------|
| Monthly Income | 2082.1 | 2752.1 |
| Number of Family | 8.0 | 2.97 |

5.4 Analysis of Study Dimensions

Using T test, the arithmetic average of the degree of response of each paragraph of the questionnaire dimensions was checked to see if it is equal to the degree of neutrality (3) or not. If the value of (p-value) (sig) is more than the significance level, then the study population is approaching a degree of neutrality (3). If the value of (p-value) (sig) is less than the significance level, the average response is checked to see if it is more than or less than the degree of neutrality, through a reference value. If the reference test is positive then the arithmetic mean of response is over the degree of neutrality and vice versa.

5.4.1 Analysis of the Paragraphs of the First Dimension "Buses"

The first dimension was tested to see if the average degree of response of each paragraph of the dimension and the dimension in general has reached a degree of neutrality or increased or decreased. It was found that the arithmetic mean of all paragraphs equals 2.86, the standard deviation equals 0.75, the relative weight equals 57.26%, the value of test T equals -3.46, and the p-value equals 0.001, which is less than 0.05. The p-value indicates that the average degree of response to the dimension of the "Buses" has dropped under the degree of neutrality. This means that the sample showed disapproval towards the condition of buses in Gaza Strip. Table (5.10).

Table (5.10)

Results of T-test, Arithmetic Mean, and Relative Weight for the Paragraphs of the First Dimension.

| No | Paragraph | Mean | Standard Deviation | Relative Weight % | t-test | Sig. Level | Rank |
|---------------------------------------|--|------|--------------------|-------------------|--------|------------|------|
| 1 | The bus system in Gaza Strip is generally uncomfortable. | 3.49 | 1.14 | 69.89 | 8.20 | 0.000* | 2 |
| 2 | You always do not find a vacant seat in the bus. | 3.59 | 1.15 | 71.78 | 9.71 | 0.000* | 1 |
| 3 | The bus is always dirt. | 3.01 | 1.23 | 60.17 | 0.13 | 0.898// | 3 |
| 4 | In most cases, you reach your destination late. | 2.83 | 1.25 | 56.61 | -2.58 | 0.000* | 5 |
| 5 | Bus tariff is not suitable from your point of view. | 2.75 | 1.32 | 55.06 | -3.54 | 0.000* | 6 |
| 7 | During one of your trips, the bus was out of order once at least. | 2.58 | 1.19 | 51.56 | -6.71 | 0.000* | 7 |
| 8 | You feel unsafe when you use bus. | 2.39 | 1.22 | 47.72 | -9.57 | 0.000* | 8 |
| 9 | You witnessed a bus accident once at least, and you were one of the bus users. | 2.29 | 1.21 | 45.72 | -11.24 | 0.000* | 8 |
| 10 | You always feel unsafe of accidents on bus. | 2.84 | 1.28 | 56.83 | -2.35 | 0.019* | 4 |
| Total degree for the first dimension. | | 2.86 | 0.75 | 57.26 | -3.46 | 0.001* | |

* arithmetic mean is statistical significant at $\alpha \leq 0.05$

// arithmetic mean is not statistical significant at $\alpha \leq 0.05$

5.4.2 Analysis of the Paragraphs of the Second Dimension "Driver"

The second dimension was tested to see if the average degree of response of each paragraph of the dimension and the dimension in general has reached a degree of neutrality or increased or decreased. It was found that the arithmetic mean of all paragraphs equals 2.50, the standard deviation equals 0.83, the relative weight equals 49.99%, the value of test T equals -11.47, and the p-value equals 0.000, which is less than 0.05. The p-value indicates that the average degree of response to the dimension of

the "Drivers" has dropped under the degree of neutrality. This means that the sample showed disapproval towards the condition of driver behavior and treatment in Gaza Strip. Table (5.11).

Table (5.11)

Results of T-test, Arithmetic Mean, and Relative Weight for the Paragraphs of the Second Dimension.

| No. | Paragraph | Mean | Standard deviation | Relative Weight % | T Test | Sig. level | Rank |
|---------------------------------------|--|------|--------------------|-------------------|--------|------------|------|
| 1 | Commonly, You are not satisfied with the way the bus driver treats you. | 2.29 | 1.17 | 45.78 | -11.57 | 0.000 * | 8 |
| 2 | The driver always behaves impolitely. | 2.06 | 1.08 | 41.17 | -16.48 | 0.000 * | 10 |
| 3 | The driver, once at least, attacked you orally. | 1.95 | 1.08 | 38.94 | -18.51 | 0.000 * | 11 |
| 4 | The driver, once at least, talked to you impolitely. | 2.22 | 1.19 | 44.39 | -12.41 | 0.000 * | 9 |
| 5 | Unexpectedly, the trip path is always changed. | 2.48 | 1.22 | 49.67 | -8.02 | 0.000 * | 6 |
| 7 | The driver drives too fast during the trip. | 2.59 | 1.13 | 51.72 | -6.96 | 0.000 * | 5 |
| 7 | The driver does not respect traffic sign and signals during the trip. | 2.45 | 1.13 | 48.94 | -9.32 | 0.000 * | 7 |
| 8 | The driver always quarrels with other drivers. | 2.76 | 1.27 | 55.17 | -3.61 | 0.000 * | 3 |
| 9 | The driver does not care about his personal cleanliness and look. | 2.66 | 1.21 | 53.28 | -5.26 | 0.000 * | 4 |
| 10 | The driver tried, once at least, to extort you in abnormal conditions by asking for extraordinary money. | 3.03 | 1.55 | 60.67 | 0.41 | 0.683 // | 1 |
| 11 | Commonly, you do not feel comfortable when dealing with bus drivers in Gaza Strip. | 3.01 | 1.32 | 60.17 | 0.12 | 0.905 // | 2 |
| Total degree of the second dimension. | | 2.50 | 0.83 | 49.99 | -11.47 | 0.000 * | |

5.4.3 Analysis of the Paragraphs of the third Dimension "Bus Stop in Living Area"

The third dimension was tested to see if the average degree of response of each paragraph of the dimension and the dimension in general has reached a degree of neutrality or increased or decreased. It was found that the arithmetic mean of all paragraphs equals 2.96, the standard deviation equals 0.67, the relative weight equals 59.21%, the value of test T equals -1.12, and the p-value equals 0.265, which is more than 0.05. The p-value indicates that the average degree of response to the dimension of the " Bus Stop in Living Area " is approximately the same as the degree of neutrality. This means that the sample showed neutral impression towards the condition of bus stop in living areas in Gaza Strip. Table (5.12).

Table (5.12)
Results of T-test, Arithmetic Mean, and Relative Weight for the Paragraphs of the Third Dimension.

| No. | Paragraph | Mean | Standard Deviation | Relative Weight % | t-test | Sig. Level | Rank |
|-----|---|------|--------------------|-------------------|--------|------------|------|
| 1 | In your living area, the bus stop is not more than 600 meters far from your home. | 3.04 | 1.40 | 60.78 | 0.53 | 0.598// | 8 |
| 2 | In your living area, you consider the road leading to the bus stop invalid for pedestrian use. | 2.65 | 1.23 | 53.06 | -5.36 | 0.000* | 18 |
| 3 | In your living area, the bus stop is not defined by a sign to be a bus stop. It is a random point, known by public as a bus stop. | 3.63 | 1.26 | 72.67 | 9.54 | 0.000* | 2 |
| 4 | In your living area, the bus can pick you from any point in the street. | 3.48 | 1.26 | 69.56 | 7.22 | 0.000* | 4 |
| 5 | During the trip, the bus always stops at any point in the street to pick passengers. | 3.89 | 1.14 | 77.78 | 14.78 | 0.000* | 1 |
| 6 | In your living area, it is common that the bus arrives late to the bus stop. | 2.77 | 1.17 | 55.33 | -3.79 | 0.000* | 15 |

| No. | Paragraph | Mean | Standard Deviation | Relative Weight % | t-test | Sig. Level | Rank |
|-----|--|------|--------------------|-------------------|--------|------------|------|
| 7 | In your living area, you wait more than five minutes till the bus gets full and starts moving. | 3.32 | 1.30 | 66.44 | 4.72 | 0.000* | 5 |
| 8 | In your living area, you feel that the bus stop is an unsafe place. | 2.51 | 1.21 | 50.11 | -7.75 | 0.000* | 20 |
| 9 | You suffered from health troubles resulting from vehicles exhausts in the bus stop in your living area. | 2.91 | 1.29 | 58.17 | -1.35 | 0.178// | 11 |
| 10 | You think that traffic noise is too loud in the bus stop in your living area, so that it affects your psychological status. | 3.04 | 1.33 | 60.78 | 0.55 | 0.581// | 8 |
| 11 | You are usually subjected to annoying by the drivers in the bus stop in your living area. | 2.45 | 1.15 | 49.06 | -9.02 | 0.000* | 21 |
| 12 | You are usually subjected to annoying by the customers in the bus stop in your living area. | 2.68 | 1.19 | 53.50 | -5.19 | 0.000* | 17 |
| 13 | The bus stop in your living area is located in an isolated place. | 2.19 | 1.03 | 43.89 | -14.77 | 0.000* | 22 |
| 14 | The bus stop in your living area causes travel jams. | 2.78 | 1.26 | 55.50 | -3.38 | 0.001* | 14 |
| 15 | In the bus stop in your living area, there are no sidewalks, or they are not wide enough for pedestrians to wait the bus on. | 2.92 | 1.39 | 58.33 | -1.14 | 0.256// | 10 |
| 16 | In the bus stop in your living area, there are no crosswalks. | 3.57 | 1.29 | 71.44 | 8.40 | 0.000* | 3 |
| 17 | The bus stop in your living area affects property owners negatively. | 2.70 | 1.25 | 53.94 | -4.60 | 0.000* | 16 |

| No. | Paragraph | Mean | Standard Deviation | Relative Weight % | t-test | Sig. Level | Rank |
|----------------------------------|--|------|--------------------|-------------------|--------|------------|------|
| 18 | In your living area, the bus stop area is always congested. | 2.87 | 1.31 | 57.39 | -1.89 | 0.060// | 12 |
| 19 | In your living area, there are obstacles that interrupts vision. | 2.60 | 1.13 | 51.94 | -6.78 | 0.000* | 19 |
| 20 | The bus stop in your living area is not lit at night. | 3.14 | 1.21 | 62.72 | 2.14 | 0.033* | 7 |
| 21 | The bus stop in your living area is adjacent to exhaust-sensitive facilities like hospitals and schools. | 2.86 | 1.23 | 57.17 | -2.18 | 0.030* | 13 |
| 22 | The bus stop in your living area is adjacent to population densities. | 3.15 | 1.24 | 63.06 | 2.34 | 0.020* | 6 |
| Total degree for third dimension | | 2.96 | 0.67 | 59.21 | -1.12 | 0.265// | |

5.4.4 Analysis of the Paragraphs of the Fourth Dimension "Bus Stop in Study - Work Area"

The fourth dimension was tested to see if the average degree of response of each paragraph of the dimension and the dimension in general has reached a degree of neutrality or increased or decreased. It was found that the arithmetic mean of all paragraphs equals 2.92, the standard deviation equals 0.66, the relative weight equals 58.41%, the value of test T equals -2.28, and the p-value equals 0.023, which is less than 0.05. The p-value indicates that the average degree of response to the dimension of the "Bus Stop in Study - Work Area" has dropped under the degree of neutrality. This means that the sample showed disapproval towards the condition of bus stop in study - work area in Gaza Strip, which is mostly concentrated in university zone in Gaza city. Table (5.13).

Table (5.13)
Results of T-test, Arithmetic Mean, and Relative Weight for the Paragraphs of the Fourth Dimension.

| No. | Paragraph | Mean | Standard Deviation | Relative Weight % | t-test | Sig. Level | Rank |
|-----|---|------|--------------------|-------------------|--------|------------|------|
| 1 | In your Study/Work area, the bus stop is not more than 600 meters far from your home. | 3.02 | 1.39 | 60.44 | 0.30 | 0.761// | 9 |
| 2 | In your Study/Work area, you consider the road leading to the bus stop invalid for pedestrian use. | 2.92 | 1.23 | 58.44 | -1.20 | 0.230// | 12 |
| 3 | In your Study/Work area, the bus stop is not defined by a sign to be a bus stop. It is a random point, known by public as a bus stop. | 3.07 | 1.33 | 61.39 | 0.99 | 0.321// | 7 |
| 4 | In your Study/Work area, the bus can pick you from any point in the street. | 3.11 | 1.27 | 62.17 | 1.62 | 0.106// | 5 |
| 5 | During the trip, the bus always stops at any point in the street to pick passengers. | 3.15 | 1.32 | 63.00 | 2.15 | 0.032// | 4 |
| 6 | In your Study/Work area, it is common that the bus arrives late to the bus stop. | 2.87 | 1.24 | 57.44 | -1.95 | 0.052// | 13 |
| 7 | In your Study/Work area, you wait more than five minutes till the bus gets full and starts moving. | 3.77 | 1.20 | 75.44 | 12.21 | 0.000* | 1 |
| 8 | In your Study/Work area, you feel that the bus stop is an unsafe place. | 2.55 | 1.14 | 51.06 | -7.46 | 0.000* | 20 |
| 9 | You suffered from health troubles resulting from vehicles exhausts in the bus stop in your Study/Work area. | 2.86 | 1.23 | 57.17 | -2.18 | 0.030* | 14 |
| 10 | You think that traffic noise is too loud in the bus stop in your Study/Work area, so that it affects your psychological status. | 3.21 | 1.24 | 64.28 | 3.28 | 0.001* | 2 |
| 11 | You are usually subjected to annoying by the drivers in the bus stop in your Study/Work area. | 2.49 | 1.12 | 49.83 | -8.63 | 0.000* | 21 |

| No. | Paragraph | Mean | Standard Deviation | Relative Weight % | t-test | Sig. Level | Rank |
|-----------------------------------|--|------|--------------------|-------------------|--------|------------|------|
| 12 | You are usually subjected to annoying by the customers in the bus stop in your Study/Work area. | 2.59 | 1.17 | 51.89 | -6.59 | 0.000* | 19 |
| 13 | The bus stop in your Study/Work area is located in an isolated place. | 2.34 | 1.16 | 46.78 | -10.84 | 0.000* | 22 |
| 14 | The bus stop in your Study/Work area causes travel jams. | 2.81 | 1.22 | 56.17 | -2.99 | 0.003* | 15 |
| 15 | In the bus stop in your Study/Work area, there are no sidewalks, or they are not wide enough for pedestrians to wait the bus on. | 2.71 | 1.26 | 54.28 | -4.30 | 0.000* | 18 |
| 16 | In the bus stop in your Study/Work area, there are no crosswalks. | 3.06 | 1.29 | 61.28 | 0.94 | 0.350// | 8 |
| 17 | The bus stop in your Study/Work area affects property owners negatively. | 2.72 | 1.16 | 54.33 | -4.62 | 0.000* | 17 |
| 18 | In your Study/Work area, the bus stop area is always congested. | 3.21 | 1.27 | 64.17 | 3.12 | 0.002* | 3 |
| 19 | In your Study/Work area, there are obstacles that interrupts vision. | 2.73 | 1.13 | 54.50 | -4.60 | 0.000* | 16 |
| 20 | The bus stop in your Study/Work area is not lit at night. | 2.94 | 1.08 | 58.89 | -0.97 | 0.331// | 11 |
| 21 | The bus stop in your Study/Work area is adjacent to exhaust-sensitive facilities like hospitals and schools. | 3.01 | 1.23 | 60.17 | 0.13 | 0.898// | 10 |
| 22 | The bus stop in your Study/Work area is adjacent to population densities. | 3.09 | 1.21 | 61.83 | 1.44 | 0.151// | 6 |
| Total degree for fourth dimension | | 2.92 | 0.66 | 58.41 | -2.28 | 0.023* | |

5.5 Public Satisfaction with Routes

Through the questionnaire, it was found that bus users prefer Salah Eddine road from Al-Rasheed.

About 37% of respondents said that they prefer Salah Eddine road in their bus trips, 24% said that Al-Rasheed is better, while 39% said it is the same.

This is because Salah Eddine road passes through the residential zones, while Al-Rasheed road passes through the western side of governorates only, parallel to the coast. Only bus users who live near the western zone of their governorates can use Al-Rasheed road, on the other hand, Salah Eddine road covers a wider area of each governorate due to the way it penetrates Gaza cities.

The following table shows the percentage of people voted for Salah Eddine road versus those who prefer Al-Rasheed in each governorate.

Table (5.14)

Salah Eddine versus Al-Rasheed Roads.

| Governorate | Percentage of people who prefer Al-Rasheed | Percentage of people who prefer Salah Eddine |
|-------------|--|--|
| North | 0 | 8 |
| Gaza | 8 | 6 |
| Wosta | 30 | 14 |
| Khan Yunus | 28 | 56 |
| Rafah | 34 | 16 |

5.6 Conclusion

From questionnaire analysis, it was found that there is a general dissatisfaction with bus system in Gaza Strip. Most of bus customers feel that buses in Gaza Strip are bad with respect to occupancy (vacancy of seats), cleanliness, punctuality, tariff, mechanical condition, security, and safety.

It was also found that most of bus customers feel that bus drivers in Gaza Strip need more improvement in politeness, punctuality, respecting traffic law and personal cleanliness.

Most of bus customers feel that bus stops in Gaza Strip are bad with respect to accessibility, paths leading to bus stops, waiting time, noise, effect on surrounding traffic, security, and the existence of sidewalks and crosswalks.

6 CASE STUDY: BUS STOPS EVALUATION AND DESIGN SAMPLE IN GAZA CITY

6.1 Introduction

As a case study, this chapter introduces an evaluation for ten bus stops in Gaza city with respect to certain criteria. It also introduces a design for a simple bus system in the university zone in Gaza city, including bus stop locations and bus frequency.

6.2 Bus Stops in Gaza Strip

6.2.1 Current Situation

By visiting a number of bus companies in Gaza, and by field observation, it was found that in most cases the bus stop in Gaza Strip is a point where people used to wait bus in, without a traffic sign or a shelter that marks this point as a bus stop.

The questionnaire includes a question that discusses this point, stating:

(In your living area, the bus stop is not defined by a sign to be a bus stop. It is a random point, known by public as a bus stop.)

The percent of people who accepted this statement is about 65%, knowing that about 20% of the sample size did not give an answer, making the people who claim that this statement is false not more than 15%.

6.2.2 Bus Stops Evaluation Criteria

Darnell and Associates (2006) defined the following factors to be the main determinant in choosing the site or evaluating a bus stop:

1. Spacing along the route.

2. Proximity to the location of the expected passenger traffic generator, either based on population density and/or specific use (i.e. major employment centers, regional shopping centers, hospitals, etc.), for the stop.
3. Pedestrian safety (Eyes on the street).
4. Access to stop (pathways leading to and from bus stop areas should be level, have a firm surface, and be free of obstacles).
5. Adequate space for buses to stop and return to the traffic flow (Curb clearance).
6. Relation to the nearest intersection (at least 6 meters far).
7. Presence of crosswalks (at least 6 meters far).
8. Width and condition of sidewalks (Place for shelter).
9. Effect on adjacent property owners.
10. Conflict with other traffic.
11. Open and visible spaces for personal security and passenger visibility
12. Street illumination.
13. Ability to restrict parking if needed.
14. Volumes and turning movements of other traffic, including bicycle.
15. Street and sidewalk grade.
16. Ease for bus re-entering traffic stream.
17. Unusual intersection angles or predominant turning movements.
18. Sight Distance at adjacent intersections and driveways.
19. far from properties that are sensitive to bus fumes.
20. 0.5 meters far from a fire hydrant

Being suitable to the general situation in Gaza Strip, the following elements were selected:

| | | |
|--|------------------------------|--------------|
| 1 Coverage and Accessibility | 6 Effect on Traffic | 11 Obstacles |
| 2 Route Suitability | 7 Sidewalks | 12 Lighting |
| 3 Security | 8 Crosswalks | 13 Noise |
| 4 Effect on Health due to Exhausts | 9 Congestion in the Area | |
| 5 Effect on Exhaust-Sensitive Facilities | 10 Effect on Property Owners | |

6.2.3 Criteria Measurement

1. Coverage and Accessibility of A Bus Stop

Mohamed A. Foda, M., and Osman, A. mentioned that a circular buffer of 400m radius (area of 0.502 km²) is considered a buffer of coverage of a bus stop. By dividing the total length of roads in this buffer by the area of the buffer we get the (Ideal Stop-Accessibility Index ISAI). The Ideal Stop-Accessibility Index (ISAI) can be used to evaluate the accessibility to a bus stop through the surrounding pedestrian road network. (Foda and Osman, 2010).

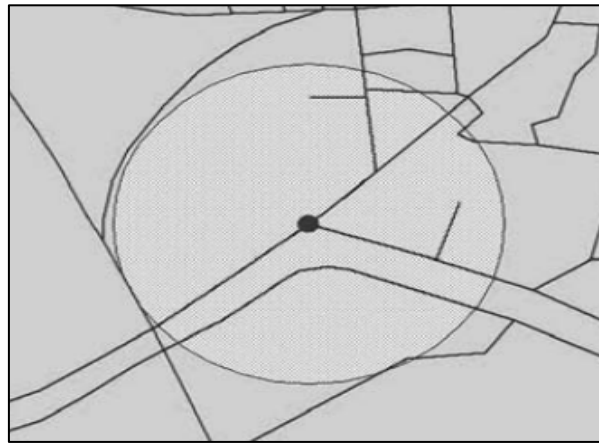


Figure (6.1): The Ideal Stop-Accessibility Index (ISAI) Determination.

This method is going to be used in determining the accessibility and coverage of bus stops in the case study area.

The researcher created the following assumptions to measure the condition of a bus stop with respect to the mentioned criteria:

2. The Suitability of Routes Leading to A Bus Stop

The routes leading to the bus stop may be of a good pavement case having a credit of (4 to 5), or of a bad pavement case having a credit of (2), or unpaved, having a credit of (1).

3. Security of A Bus Stop

If the area of a bus stop is isolated and far from a police point or a permanent existence of policemen, then it can be considered unsecure, with a credit of (1-2). On the other hand, if the area is always under police and public eyes, it can have a credit of (3-5).

4. Effect of A Bus Stop on Health (due to Exhausts)

If the area of a bus stop is much crowded by vehicles, it can have (1-2), while it can have (4-5) if it is not always crowded. A credit of (3) means that the area is medium with respect to congestion.

5. Effect of A Bus Stop on Exhaust-Sensitive Facilities

If exhaust-sensitive facilities, such as hospitals and schools exist near a bus stop, it can reduce its credit to (1) in this part of evaluation, while being far from these facilities gives a bus stop a credit of (5).

6. Effect of A Bus Stop on Traffic

The effect of a bus stop on traffic is mainly dependent on the width of the road a bus stop is located at. A wide road with more than two lanes means that a bus can stop and move freely, with a minimum disturbance of traffic in the street. A road side of more than 10 meters width is given (5). A road ranging between 8-10 meters in width is given (4). A road ranging between 6-8 meters in width is given (3), while a road side of less than 6 meters in width is given (1-2).

7. Sidewalks in A Bus Stop Area

A wider sidewalk is better, since it gives the chance of building a wider waiting shelter in a bus stop. As the sidewalk increases, the credit given to the bus stop increases. A bus stop located on a sidewalk of 1 meter width is given a credit of (1), while a credit of (2) is given to a bus stop located on a sidewalk of 2 meters width, and so on.

8. Crosswalks in A Bus Stop Area

Knowing that a crosswalk is an advantage in a bus stop area, a bus stop located near a well-painted crosswalk is given a credit of (3-5). A bus stop located near a point where a crosswalk should be painted (but currently not painted) is given (1-2). If none of the previous conditions is available, a bus stop is given (0) in this criterion.

9. Congestion in A Bus Stop Area

The level of congestion in the bus stop area is determined by field observation.

10. Effect of A Bus Stop on Property Owners

The credit of a bus stop in this criterion is inversely proportional with the number of properties existing in the area. This part is determined by field observation.

11. Obstacles in A Bus Stop Area

The level of obstacles in the bus stop area is determined by field observation.

12. Lighting in A Bus Stop Area

A bus stop area having 3-4 lighting units is given a credit of (5), while 2-1 lighting units gives a bus stop a credit of (3). If no lighting units is available in the area, a credit of (1) is given to a bus stop, since it can be partially lit by the properties surrounding it.

13. Noise in A Bus Stop Area

The level of noise in the bus stop area is determined by field observation.

6.2.4 Criteria Weights

The previous criteria do not have the same effect on the result of evaluation, there must be a variety in effect between criteria, or in other words: a weight.

A questionnaire for determining the weights of effect of the previous criteria was given to three traffic experts in the college of engineering in the Islamic University of Gaza. (See Annex 2).

The experts were asked to give each of the thirteen criteria mentioned above a weight on a scale of 1-5 according to Likert scale. The result is shown in table (6.1).

Table (6.1)

Experts Questionnaire Results about Criteria Weights

| No | Criteria | Expert (1) Weights | Expert (2) Weights | Expert (3) Weights | Average Weight |
|----|--|--------------------|--------------------|--------------------|----------------|
| 1 | Coverage | 5 | 5 | 3 | 4 |
| 2 | Route Suitability | 4.5 | 4.5 | 4.5 | 5 |
| 3 | Security | 5 | 4 | 4.5 | 5 |
| 4 | Effect on Health due to Exhausts | 1.5 | 1 | 3.5 | 2 |
| 5 | Noise | 1.5 | 1 | 3.5 | 2 |
| 6 | Effect on Traffic | 4 | 4.5 | 5 | 5 |
| 7 | Sidewalks | 1.5 | 4 | 5 | 4 |
| 8 | Crosswalks | 3.5 | 3 | 5 | 4 |
| 9 | Effect on Property Owners | 2 | 2.5 | 4.5 | 3 |
| 10 | Congestion in the Area | 2.5 | 4.5 | 5 | 4 |
| 11 | Obstacles | 2 | 3 | 4 | 3 |
| 12 | Lighting | 2.5 | 4 | 5 | 4 |
| 13 | Effect on Exhaust-Sensitive Facilities | 1.5 | 1 | 3.5 | 2 |
| 14 | Effect on Residential Areas | 1.5 | 1.5 | 3.5 | 2 |

6.2.5 Evaluation Procedures

The evaluation process is divided into two parts, part (I) that measures the accessibility and coverage of bus stops under study, and part (II) that measures the other 12 criteria. This reason of this separation is the difference in measurement tool between (the accessibility and coverage) and the other criteria, as mentioned section 6.2.3.

6.2.5.1 Case Study Area

Gaza city bus stops are suggested to be the case study of this part of research. This is because the highest percentage of questionnaire respondents that gave full names and geographical description of their bus stops was in Gaza city. Table (6.2) gives this percentage.

Table (6.2)

Respondents in Gaza Strip Governorates.

| | Governorate | Number of Respondents | Percentage of Respondents | Number of Respondents who gave full description of bus stop | Percentage of Respondents who gave full description of bus stop |
|---|-------------|-----------------------|---------------------------|---|---|
| 1 | Gaza | 58 | 16.1 | 36 | 62.1 |
| 2 | North | 39 | 10.8 | 23 | 59 |
| 3 | Rafah | 74 | 20.6 | 38 | 51.4 |
| 4 | Alwosta | 57 | 15.8 | 29 | 50.9 |
| 5 | Khan Younus | 132 | 36.7 | 57 | 43.2 |

The following bus stops were mentioned in the answers of questionnaire respondents:

Table (6.3)

Bus Stops Mentioned in the Answers of Questionnaire Respondents

| No. | Bus Stop | Description |
|-----|--------------------|--|
| 1 | Al-Sanafor | An intersection in Ejdayda destrict, falling on Salah Edden regional road. |
| 2 | Al-Hidaya | An intersection in Tal Al-Hawa destrict. |
| 3 | Haidar Abdel-Shafi | A roundabout in Southern Rimal. |
| 4 | Al-Jomaa Market | A square in Al-Shijaeya destrict, usually used as a market only on Friday. |
| 5 | Beach Camp Market | A square in the beach camp of refugees. |
| 6 | Fras Market | A square in Al-Balda Al-Qadeema destrict. |
| 7 | Shaafot | A point in Al-Zaitoon destrict. |
| 8 | Shifaa | The biggest hospital in Gaza Strip, falling in the Northern Rimal. |
| 9 | Shijaeya | Shijaeya intersection exists at the entrance of Al-Shijaeya destrict. |
| 10 | Falasteen Square | The biggest square in Gaza city, in Al-Balda Al-Qadeema destrict. |

6.2.5.2 Evaluation Part (I): Accessibility and Coverage

In order to evaluate bus stops with respect to accessibility and coverage, the following procedures were followed:

1. The coordinates of the bus stops under study were determined using google earth software (Table 6.4).

Table (6.4)

Gaza City Bus Stops Coordinates.

| BS Name | E | | | N | | | East | North |
|---------------------|----------|----|----|----------|----|----|-------------|--------------|
| Shijaeya | 2.88 | 28 | 34 | 9.69 | 30 | 31 | 34.5 | 31.5 |
| Saha | 41.79 | 27 | 34 | 22.55 | 30 | 31 | 34.5 | 31.5 |
| Sanafor | 13.76 | 28 | 34 | 23.15 | 30 | 31 | 34.5 | 31.5 |
| Jomaa Market | 6.4 | 28 | 34 | 44.42 | 29 | 31 | 34.5 | 31.5 |
| Fras Market | 32.32 | 27 | 34 | 28.62 | 30 | 31 | 34.5 | 31.5 |
| Shifa Hospital | 37.46 | 26 | 34 | 23.09 | 31 | 31 | 34.4 | 31.5 |
| Kateeba | 16.91 | 26 | 34 | 57.29 | 30 | 31 | 34.4 | 31.5 |
| IUG Bus Park | 19.63 | 26 | 34 | 38.59 | 30 | 31 | 34.4 | 31.5 |
| Hidaya Intersection | 42.15 | 25 | 34 | 14.1 | 30 | 31 | 34.4 | 31.5 |
| Haidar Roundabout | 17.01 | 26 | 34 | 18.38 | 31 | 31 | 34.4 | 31.5 |
| Camp Market | 41.55 | 26 | 34 | 54.44 | 31 | 31 | 34.4 | 31.5 |
| Shaafoot | 10.72 | 27 | 34 | 29.78 | 29 | 31 | 34.5 | 31.5 |

2. The google earth coordinates were converted to local coordinates using ArcGIS.
3. The local coordinates were used to layout the bus stops on their exact location on GIS map as the first step in the process of GIS analysis. (Figure 6.2).
4. Using ArcGIS, a circular buffer of 400m radius was created around the ten bus stops, knowing that the area of the circle forming the buffer is 0.502 km². (Figure 6.3).

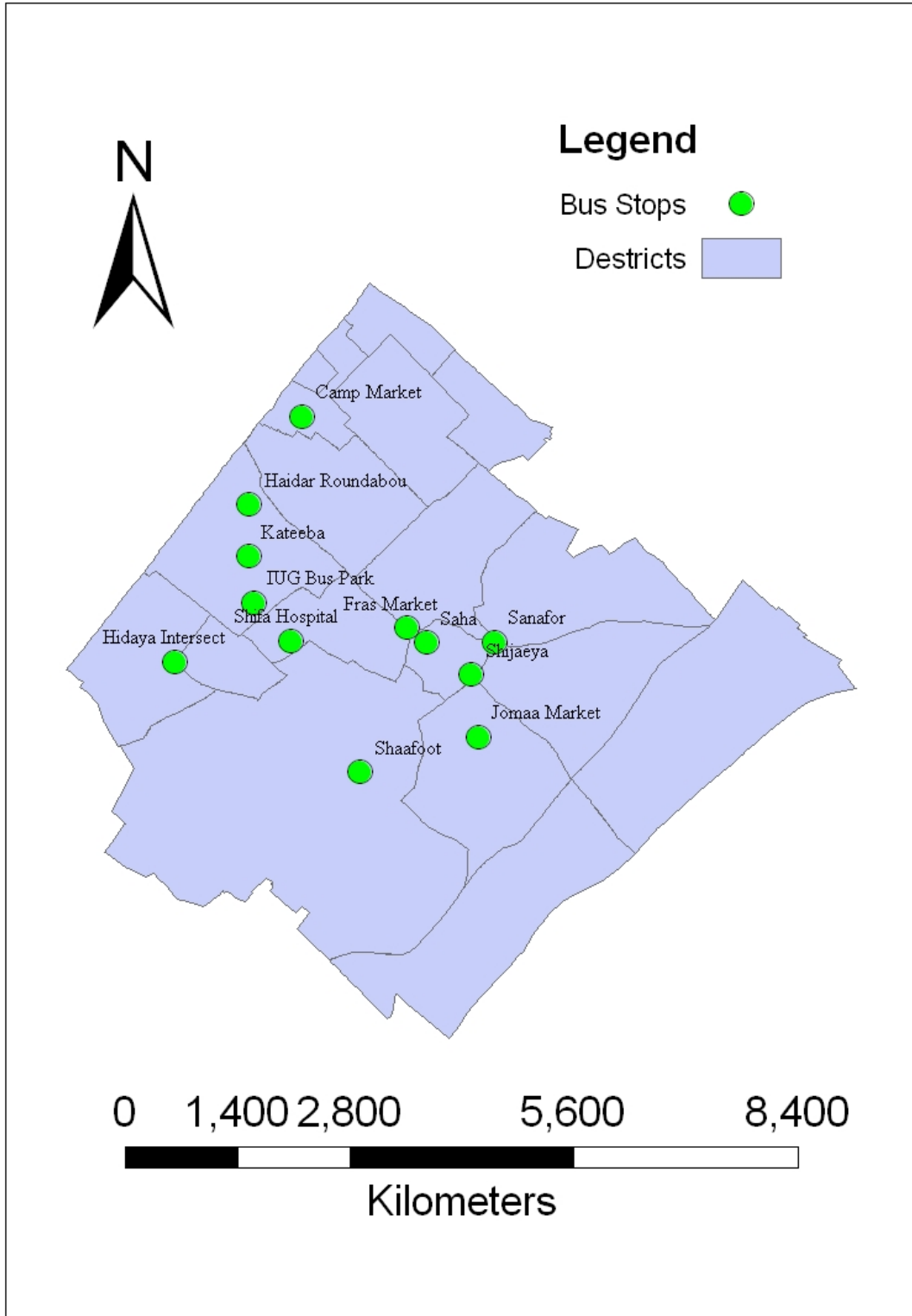


Figure (6.2): Bus Stops on Gaza City Map

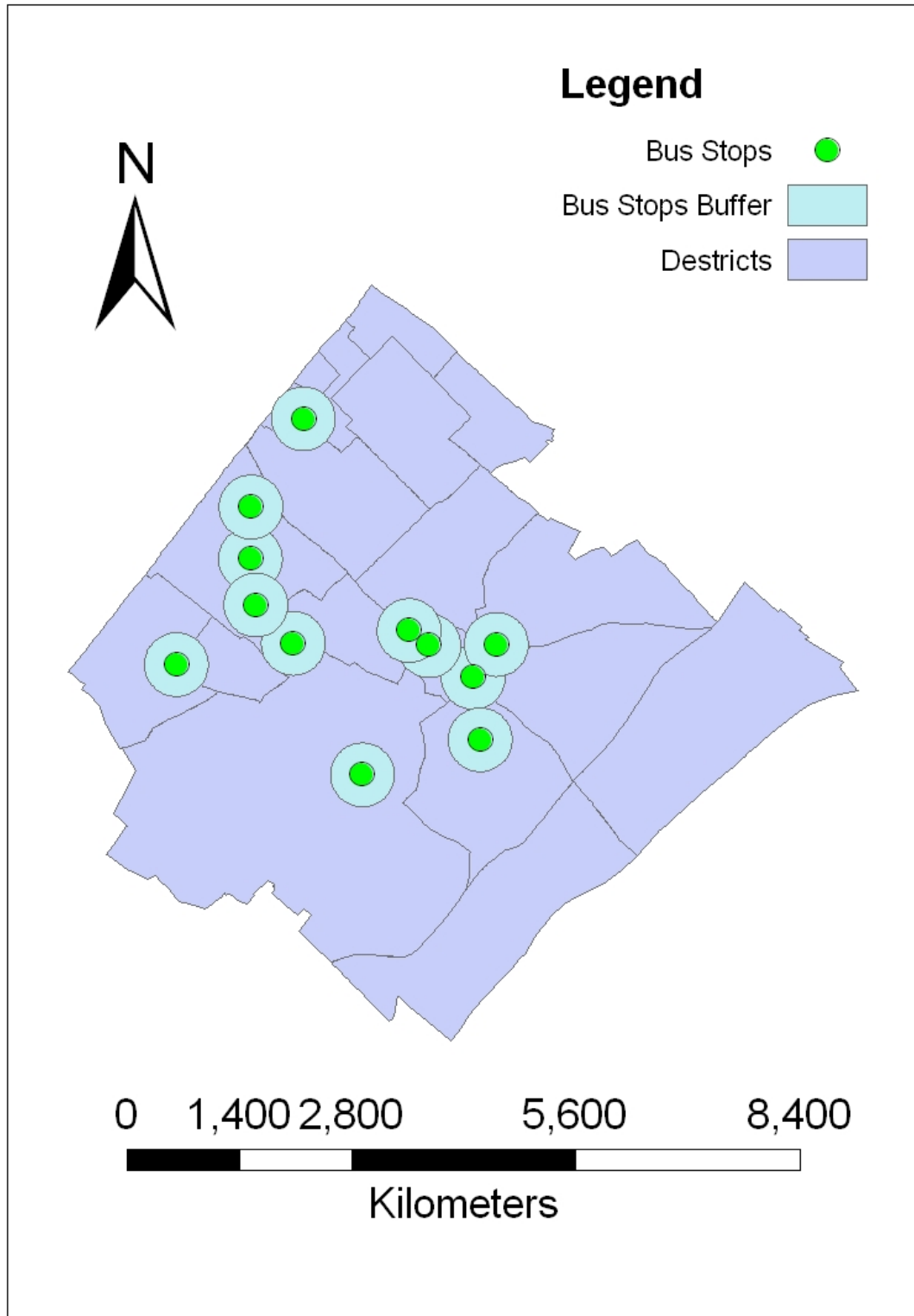


Figure (6.3): 400m-Radius Buffer Around Bus Stops

5. The total length of roads leading to the bus stop and lying within the circular buffer was calculated (Table 6.5).

Table (6.5)

Total Length of roads in 0.5 km² Buffer in Bus Stop Area.

| Bus Stop | Total Length of Roads in 0.5 Km² Area Buffer |
|---------------------|--|
| Shijaeya | 16.5 |
| Shaafoot | 15 |
| Sanafor | 14.6 |
| Falasteen Square | 14 |
| Shifa Hospital | 13.5 |
| Fras Market | 13.3 |
| Hidaya Intersection | 12.8 |
| Jomaa Market | 12.3 |
| Haidar Roundabout | 10 |
| Camp Market | 8.7 |

Figure (6.4) shows a sample of roads bounded by the buffer.

6. The Ideal Stop-Accessibility Index ISAI was calculated for each bus stop. Table (6.6) shows the result:

Table (6.6)

The Ideal Stop-Accessibility Index ISAI for Bus Stops Under Study.

| Bus Stop | ISAI |
|---------------------|-------------|
| Shijaeya | 32.9 |
| Shaafoot | 29.9 |
| Sanafor | 29.1 |
| Falasteen Square | 27.9 |
| Shifa Hospital | 26.9 |
| Fras Market | 26.5 |
| Hidaya Intersection | 25.5 |
| Jomaa Market | 24.5 |
| Haidar Roundabout | 19.9 |
| Camp Market | 17.3 |

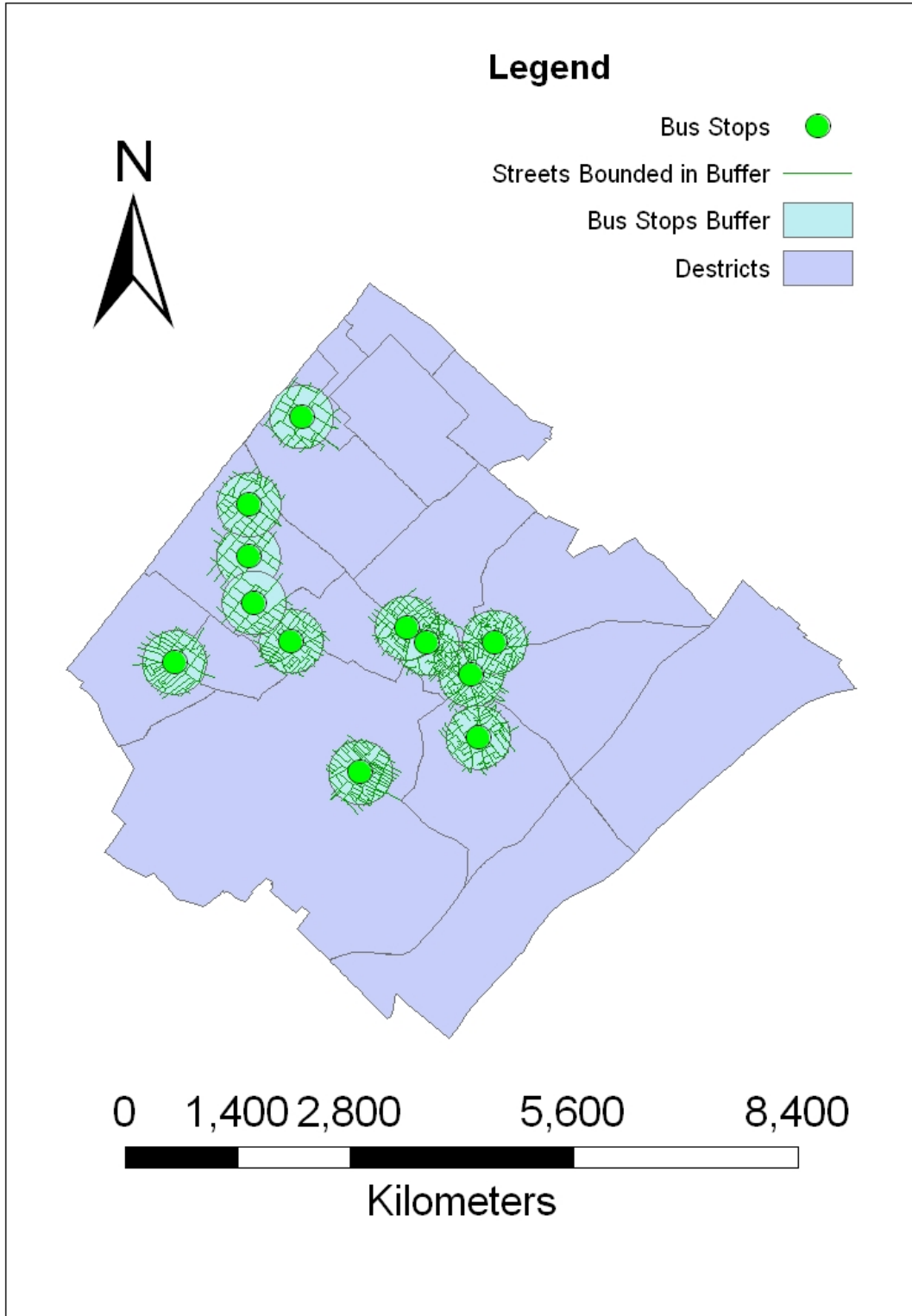


Figure (6.4): Roads within the Buffer

6.2.5.3 Evaluation Part (II): The Other Criteria

1. The previously mentioned twelve criteria need site visits for running the process of evaluation.
2. The sites of the ten bus stops of the case study are visited to measure the level of the twelve criteria in each.
3. The following table shows the evaluation results of two bus stops (Al-Shifa'a and Al-Jom'aa Market). The rest of the evaluation results is available in Annex (3).

Table (6.7)

Bus Stops Evaluation Results

| No | Criteria | Weight | Optimum Score | Al-Shifaa | | Al-Jomaa | |
|----|--|--------|---------------|-----------|--------------|----------|--------------|
| | | | | Mark | Score | Mark | Score |
| 1 | The suitability of road leading to BS | 4.5 | 22.5 | 3 | 13.5 | 2 | 9 |
| 2 | Security | 4.5 | 22.5 | 4 | 18 | 2 | 9 |
| 3 | Effect on health due to exhausts | 2 | 10 | 3 | 6 | 4 | 8 |
| 4 | Noise | 2 | 10 | 3 | 6 | 4 | 8 |
| 5 | Effect of BS on Traffic | 4.5 | 22.5 | 5 | 22.5 | 5 | 22.5 |
| 6 | Sidewalks | 3.5 | 17.5 | 3 | 10.5 | 2 | 7 |
| 7 | Availability of crosswalks | 4 | 20 | 1 | 4 | 0 | 0 |
| 8 | Effect on properties | 3 | 15 | 4 | 12 | 4 | 12 |
| 9 | Congestion in the area | 4 | 20 | 3 | 12 | 4 | 16 |
| 10 | Obstacles | 3 | 15 | 5 | 15 | 3 | 9 |
| 11 | Lighting | 4 | 20 | 5 | 20 | 5 | 20 |
| 12 | Effect on exhaust-sensitive facilities | 2 | 10 | 1 | 2 | 1 | 2 |
| | Total | | 205 | | 141.5 | | 122.5 |

The following photos show the general condition of the bus stops mentioned above. The photos of the other bus stops are available in Annex (3):



Figure (6.5): Left: Al-Shifa Bus Stop. Right: Jomaa Market Bus Stop

4. The following table shows the final results of the evaluation of the ten bus stops under study (The bus stops are arranged from best to worst depending on study results):

Table (6.8)

Summary of Bus Stops Evaluation Results

| Bus Stop | Score | Optimum Score |
|------------------|-------|---------------|
| Shifaa | 141.5 | 205 |
| Falasteen Square | 130 | 205 |
| Sanafor | 128.5 | 205 |
| Jomaa | 122.5 | 205 |
| Hidaya | 121.5 | 205 |
| Shijaeya | 121.5 | 205 |
| Haidar | 118.5 | 205 |
| Shafot | 113.5 | 205 |
| Fras | 111.5 | 205 |
| Beach Camp | 68.5 | 205 |

Figure 6.3 shows the differences between the bus stops with respect to the evaluation results:

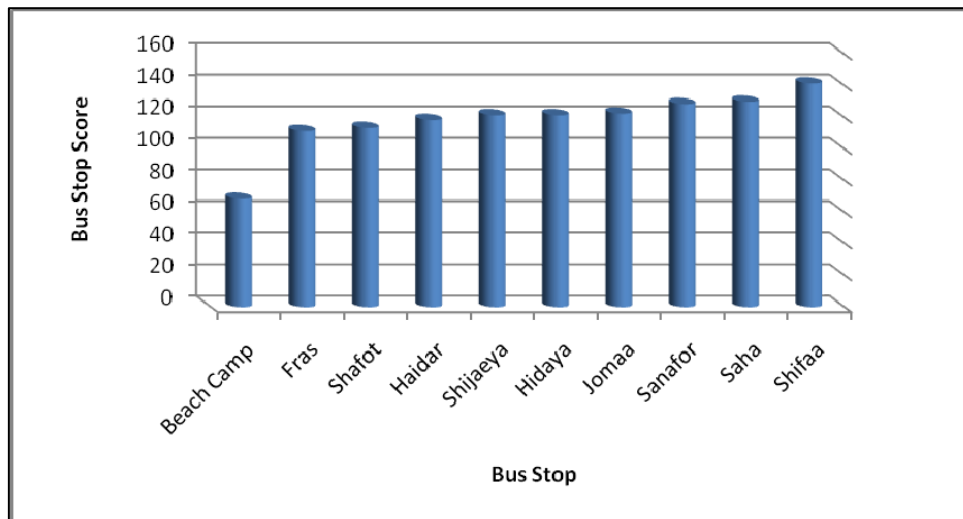


Figure (6.6): Differences between Bus Stops with Respect to the Evaluation Results

- In order to understand to what extent the bus stops under study is far from the optimal condition, a value called (The Optimal Score) is calculated. The optimal score is the total of the optimal scores of all criteria, while the optimal score of a certain criterion equals its weight multiplied by the highest credit (5). Figure (6.4) shows the difference between the conditions of bus stops under study and the optimal score.

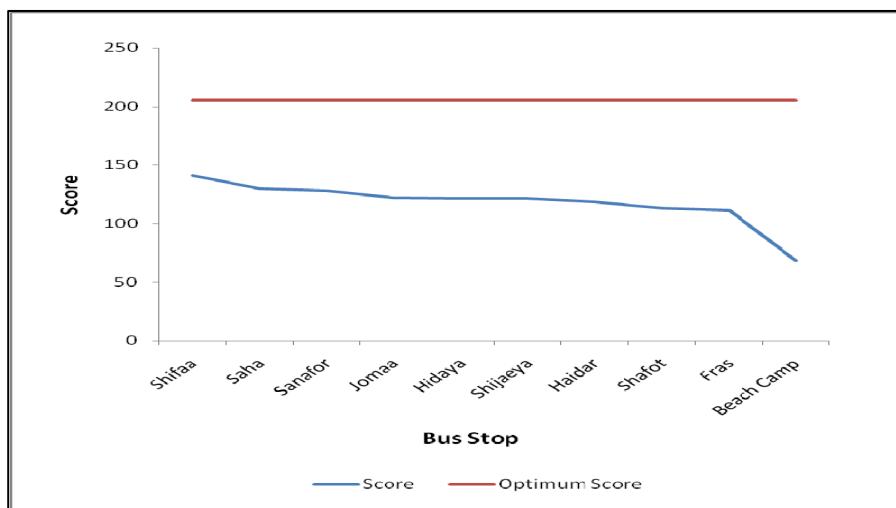


Figure (6.7): The Difference between the Conditions of Bus Stops under Study and the Optimal Score

6.3 University Zone

6.3.1 Current Situation in University Zone

The university zone in Gaza city is the area falling from Jamal Abdennasir street (North) to Bierut street (South), and from Al-Kateeba park (West) to Al-Aqsa street (East). (Figure 6.6)

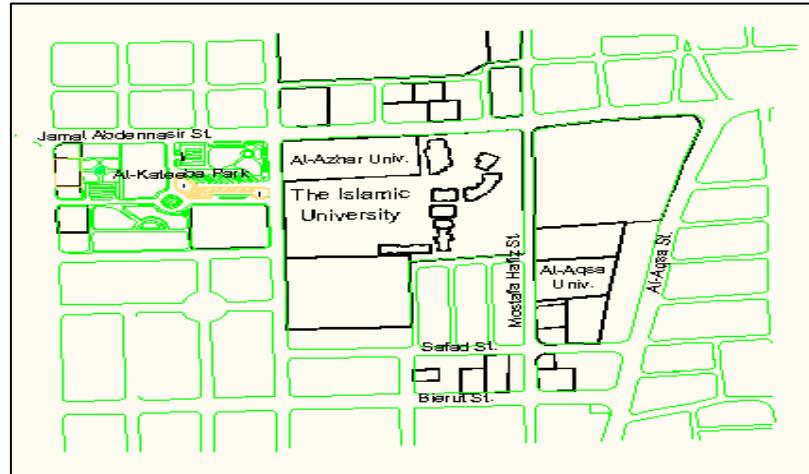


Figure 6.8: University Zone.

The university zone in Gaza city is occupied by three main universities, namely the Islamic University, Al-Azhar University, and Al-Aqsa University.

About 50,000 student study in this zone, which makes it one of the most congested areas in Gaza strip, especially in peak hours, which are always 8:00 am and 3:00 pm.

With respect to transportation system, the students of the three universities are divided into two main categories:

A. Students coming from the Northern and Southern cities:

They always use the following points to ride a transportation mean (See the attached figure):

- Al-Kateeba and Safad Street Parks (for students who prefer buses).
- Bierut Street Park (for students who prefer 7-passengers yellow cars).

B. Students coming from Gaza city:

They always use the following points to ride a transportation mean (Figure 6.7):

- Points (1,4,5,7,10) for the students living in the districts: Al-Shijaeya, Al-Daraj, Al-Shiekh Radwan, Al-Sabra, Al-Tuffah, Al-Balda Al-Qadeema, and Al-Zaitoon.
- Points (2,3,6,8,9) for the students living in the districts: Al-Shiekh Radwan, Al-Nassir, and the Beach Camp.

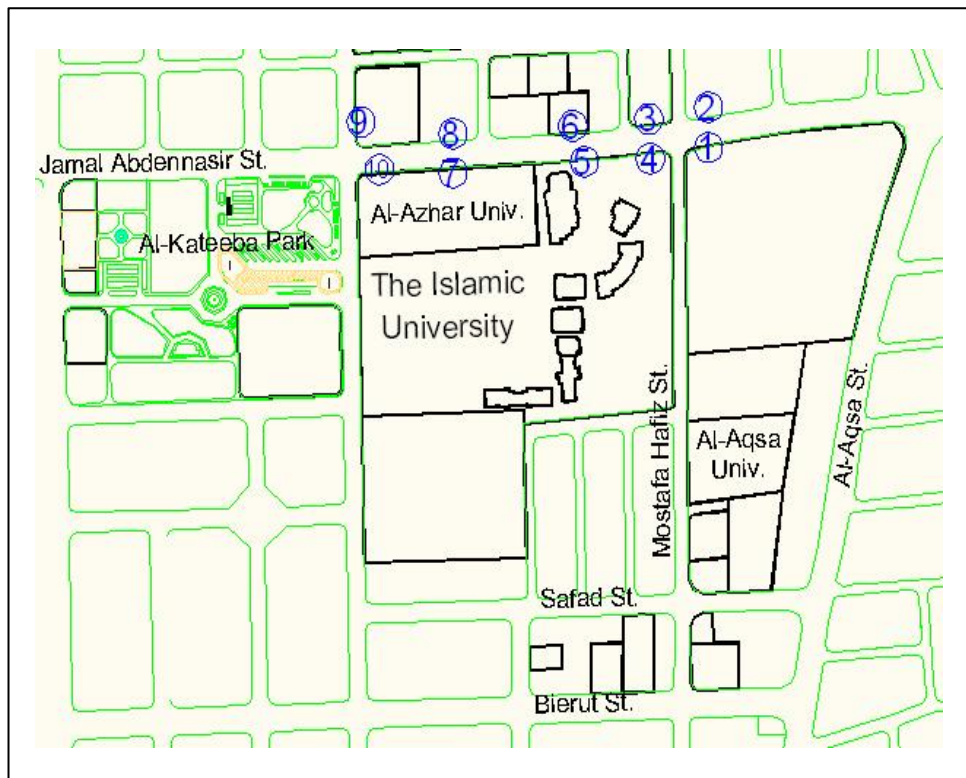


Figure (6.9): University Zone Waiting Points

This part of the study is focused on the part of Jamal Abdennasir street extending from the point of intersecting Al-Aqsa street to the beginning of Al-Kateeba park. This part is considered the main constituent of the congestion in the area due to the following reasons:

- The importance of Jamal Abdennasir street, since it is considered one of the three main roads extending from East to West along Gaza city. This makes

not only university students use Jamal Abdennasir street, but also the whole public.

- Besides universities, this part of Jamal Abdennasir street serves also a series of bookshops and commercial shops. The headquarters of the UNRWA is also located in this part of the street.
- The lack of the culture of station or waiting point, since students used to wait taxi wherever they feel it is as near as possible to the gate of the university. This can be seen in the points in figure (6.7), where, for example, points (1,4,5,7,10) serve one line, but what makes them five points is that every point is as near as possible to the gate of a number of students.
- There is no bus system in this part of the street, because: students prefer taxi, the tariff of bus is nearly the same as the tariff of taxi, and buses do not have a constant frequency that helps in minimizing the time consumed in waiting for a full capacity of bus in order to move. The lack of a bus system encourages taxi system, which leads to more and more traffic load and hence to more congestion.

6.3.2 Design Procedures

A. Frequency Determination

1. In order to determine the frequency of buses needed to evacuate the points 1-10, a count is needed. The students waiting for taxi are needed to be counted in time intervals of 15 minutes. From field observation, it was found that the congestion in then area starts at 13:00 and finishes at 16:00 o'clock. So, this period of time is considered our target in designing a frequency system depending on existing situation.
2. Five observers were asked to observe the ten points from 13:00 to 16:00 and every one of them was responsible of two points.
3. A form similar to the that attached in Annex (4) was given to each observer.

4. For accuracy, observers were asked to count the person at the moment he/she rides the taxi. This gives the observer time to count and write down in the sheet, and insures not counting a person more than one time.
5. Every observer is asked to write down a slash (/) for each person he counts. The fifth slash crosses the previous four horizontally.
6. The following table shows the count results:

Table (6.10)

Pedestrian Count Results

| Destination | Point Time | 13:00 | 13:15 | 13:30 | 13:45 | 14:00 | 14:15 | 14:30 | 14:45 | 15:00 | 15:15 | 15:30 | 15:45 | Total |
|---------------|--------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | | 13:15 | 13:30 | 13:45 | 14:00 | 14:15 | 14:30 | 14:45 | 15:00 | 15:15 | 15:30 | 15:45 | 16:00 | |
| Saha + Jalaa | 1 | 55 | 63 | 44 | 51 | 42 | 45 | 56 | 54 | 55 | 114 | 121 | 52 | 752 |
| | 4 | 33 | 14 | 5 | 28 | 40 | 24 | 14 | 13 | 47 | 43 | 31 | 6 | 298 |
| | 5 | 32 | 33 | 47 | 50 | 20 | 24 | 39 | 55 | 100 | 80 | 54 | 25 | 559 |
| | 7 | 85 | 44 | 38 | 80 | 49 | 69 | 38 | 28 | 34 | 5 | 1 | 1 | 472 |
| | 10 | 62 | 26 | 26 | 70 | 145 | 90 | 35 | 28 | 73 | 11 | 15 | 3 | 584 |
| | Total | | 267 | 180 | 160 | 279 | 296 | 252 | 182 | 178 | 309 | 253 | 222 | 87 |
| Destination | Point Time | 13:00 | 13:15 | 13:30 | 13:45 | 14:00 | 14:15 | 14:30 | 14:45 | 15:00 | 15:15 | 15:30 | 15:45 | Total |
| | | 13:15 | 13:30 | 13:45 | 14:00 | 14:15 | 14:30 | 14:45 | 15:00 | 15:15 | 15:30 | 15:45 | 16:00 | |
| Nassir + Camp | 2 | 3 | 1 | 3 | 6 | 10 | 11 | 8 | 3 | 6 | 5 | 4 | 2 | 62 |
| | 3 | 26 | 28 | 17 | 40 | 35 | 14 | 24 | 25 | 57 | 62 | 27 | 2 | 357 |
| | 6 | 8 | 9 | 4 | 14 | 19 | 8 | 5 | 5 | 7 | 5 | 4 | 5 | 93 |
| | 8 | 25 | 34 | 23 | 27 | 27 | 27 | 20 | 15 | 12 | 2 | 2 | 1 | 215 |
| | 9 | 56 | 40 | 25 | 65 | 115 | 90 | 22 | 29 | 31 | 42 | 18 | 6 | 539 |
| | Total | | 115 | 111 | 69 | 146 | 196 | 139 | 71 | 74 | 107 | 111 | 51 | 14 |
| Total | | 382 | 291 | 229 | 425 | 492 | 391 | 253 | 252 | 416 | 364 | 273 | 101 | 3869 |

7. Now, if (50 persons) is the full capacity of bus, then the number of students each 15 minutes divided by (50) gives the number of buses needed each 15 minutes for each destination. (Table 6.11)

Table (6.11)

Pedestrian Count Results with Needed Buses.

| Destination | Point Time | 13:00 | 13:15 | 13:30 | 13:45 | 14:00 | 14:15 | 14:30 | 14:45 | 15:00 | 15:15 | 15:30 | 15:45 | Total | |
|---------------|----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| | | 13:15 | 13:30 | 13:45 | 14:00 | 14:15 | 14:30 | 14:45 | 15:00 | 15:15 | 15:30 | 15:45 | 16:00 | | |
| Saha + Jalaa | 1 | 55 | 63 | 44 | 51 | 42 | 45 | 56 | 54 | 55 | 114 | 121 | 52 | 752 | |
| | 4 | 33 | 14 | 5 | 28 | 40 | 24 | 14 | 13 | 47 | 43 | 31 | 6 | 298 | |
| | 5 | 32 | 33 | 47 | 50 | 20 | 24 | 39 | 55 | 100 | 80 | 54 | 25 | 559 | |
| | 7 | 85 | 44 | 38 | 80 | 49 | 69 | 38 | 28 | 34 | 5 | 1 | 1 | 472 | |
| | 10 | 62 | 26 | 26 | 70 | 145 | 90 | 35 | 28 | 73 | 11 | 15 | 3 | 584 | |
| | Total | | 267 | 180 | 160 | 279 | 296 | 252 | 182 | 178 | 309 | 253 | 222 | 87 | 2665 |
| | # buses | | 5 | 4 | 3 | 6 | 6 | 5 | 4 | 4 | 6 | 5 | 4 | 2 | |
| Nassir + Camp | 2 | 3 | 1 | 3 | 6 | 10 | 11 | 8 | 3 | 6 | 5 | 4 | 2 | 62 | |
| | 3 | 26 | 28 | 17 | 40 | 35 | 14 | 24 | 25 | 57 | 62 | 27 | 2 | 357 | |
| | 6 | 8 | 9 | 4 | 14 | 19 | 8 | 5 | 5 | 7 | 5 | 4 | 5 | 93 | |
| | 8 | 25 | 34 | 23 | 27 | 27 | 27 | 20 | 15 | 12 | 2 | 2 | 1 | 215 | |
| | 9 | 56 | 40 | 25 | 65 | 115 | 90 | 22 | 29 | 31 | 42 | 18 | 6 | 539 | |
| | Total | | 115 | 111 | 69 | 146 | 196 | 139 | 71 | 74 | 107 | 111 | 51 | 14 | 1204 |
| | # buses | | 2 | 2 | 1 | 3 | 4 | 3 | 1 | 1 | 2 | 2 | 1 | 0 | |
| Total | | 382 | 291 | 229 | 425 | 492 | 391 | 253 | 252 | 416 | 364 | 273 | 101 | 3869 | |

8. Table (6.12) summarizes the two previous ones:

Table (6.12)

Summary of Pedestrians Count Results

| No. | Destination | Point Time | 13:00 | 13:15 | 13:30 | 13:45 | 14:00 | 14:15 | 14:30 | 14:45 | 15:00 | 15:15 | 15:30 | 15:45 | Total |
|-----|---|----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | | | 13:15 | 13:30 | 13:45 | 14:00 | 14:15 | 14:30 | 14:45 | 15:00 | 15:15 | 15:30 | 15:45 | 16:00 | |
| 1 | Al-Shijaeya, Al-Daraj, Al-Shiekh Radwan, Al-Sabra, Al-Tuffah, Al-Balda Al-Qadeema, Al-Zaitoon | # buses | 5 | 4 | 3 | 6 | 6 | 5 | 4 | 4 | 6 | 5 | 4 | 2 | 54 |
| 2 | Al-Shiekh Radwan, Al-Nassir, Beach Camp | # buses | 2 | 2 | 1 | 3 | 4 | 3 | 1 | 1 | 2 | 2 | 1 | 0 | 22 |

So, we need at least two bus stops for students going to destination (1) in the table (6.12), and one bus stop for the students going to destination (2).

B. Bus Stops Locating

Depending on the previous analysis, three points are needed to be bus stops, two for destination (1) in table (6.12), and one for destination (1).

A. Destination (1)

Students who go to destination (1) always wait on the right side of the road, waiting for the taxis going East.

Through field observation for the right side of the part under study in the road, it was found that two points satisfy the criteria of best bus stops. Those points are shown in figure (6.8).

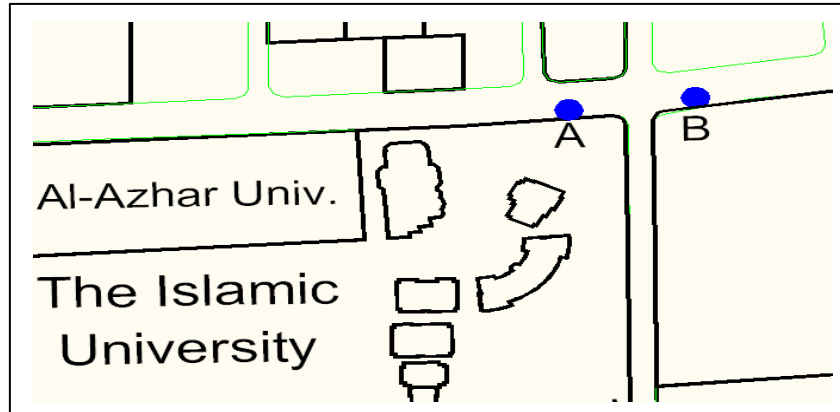


Figure (6.10): Points A and B.

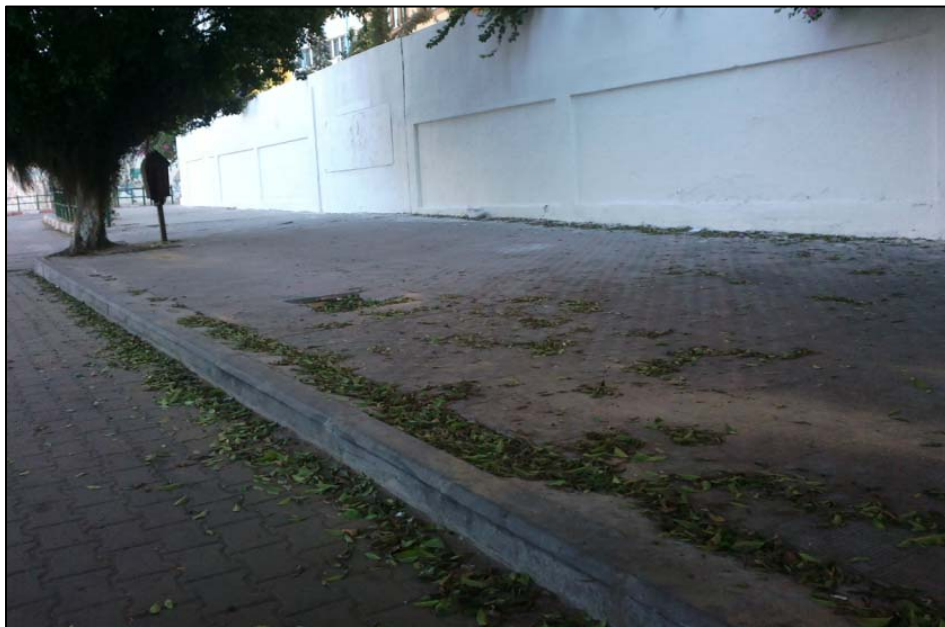


Figure (6.11): Point A



Figure (6.12): Point B

The criteria of best bus stops are the same criteria mentioned in section 5.2.2. The criteria (Route Suitability, Security, Effect on Health due to Exhausts, Noise, Congestion in the Area, Lighting, Effect on Exhaust-Sensitive Facilities, Obstacles, and Effect on Residential Areas) are considered large scale criteria, i.e. the difference between bus stops with respect to these criteria appears only when bus stops are in different areas or zones. Knowing that we are talking about a part of street with a length not more than 500 meters, we can consider the effect of these criteria as a common effect, either positive or negative.

On the other hand, a good result of differentiation between our points can be obtained when dealing with the other criteria (Accessibility, Effect on Traffic, Sidewalks, Crosswalks, Effect on Property Owners, Obstacles).

Since points A and B have nearly the same characteristics, the following descriptive analysis is given to the two points:

1. Accessibility: Both of the points A and B are less than 400 meters far from the main gates of the three universities in the area. (Figure 6.11)

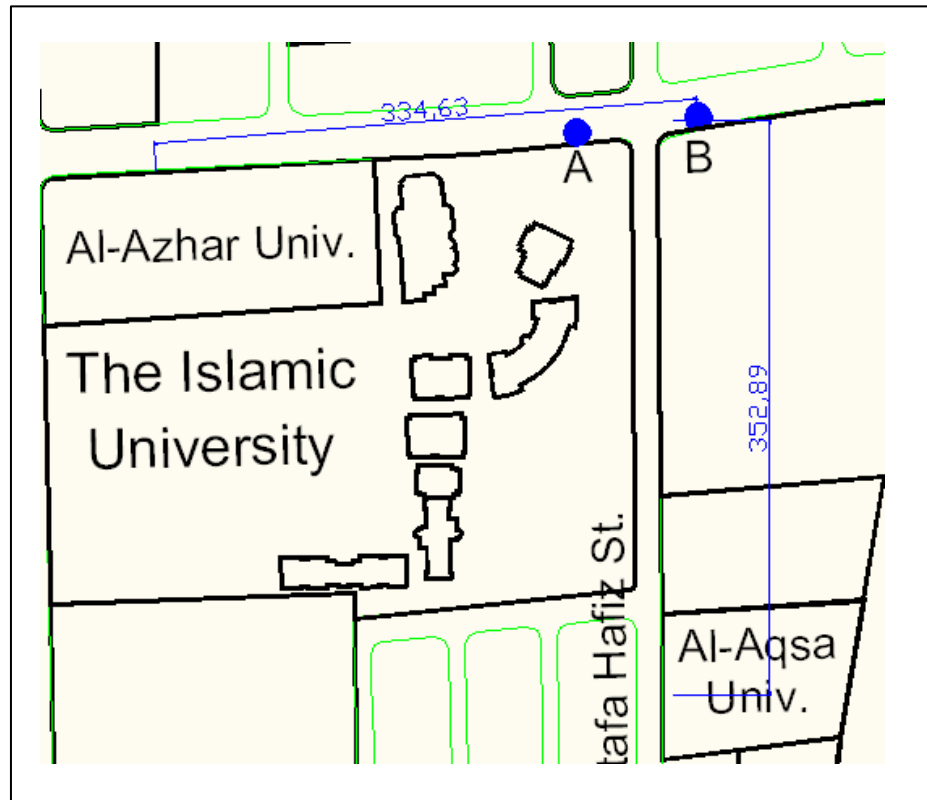


Figure (6.13): Walking Distance from the Extreme Points to A and B

2. Effect on Traffic: in both of the points A and B, the width of the street side is 10m, which makes it easy for a bus to easily stop and enroll in traffic stream. The width of sidewalk is 4m, which means that a suitable shelter can be placed for students who wait for bus, without disturbing pedestrian movement.
3. Sidewalks: The width of sidewalk is about 4m, which means that a suitable shelter can be placed for students who wait for bus, without disturbing pedestrian movement.
4. Crosswalks: in both points, there is a crosswalk, which makes it safe for pedestrians to cross the road -if needed- for riding the bus.
5. Effect on Property Owners: No private properties exist besides the two points.

B. Destination (2)

Only one bus stop is needed to cover the need of students going to destination (2). Along the Northern side of the part of street under concern, there is no point that can be suitable for a bus stop, due to the small width of the sidewalk. Moreover, this side of street is occupied by bookshops and properties, which may cause troubles with stakeholders if a bus stop is located there. It is suggested that point C in Figure (6.12) is used as a bus stop for destination (2). This point is located in an 8m street, with a very light traffic flow. The sidewalk at this point is narrow, but there is a possibility for widening the sidewalk and the street also, since there is a wide island located at the Southern side of the street.

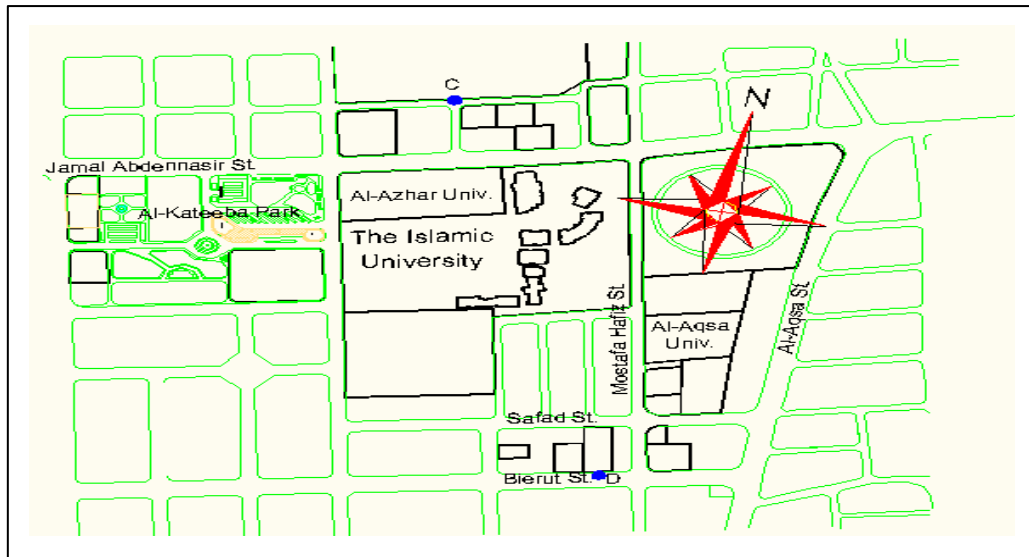


Figure (6.14): Points C and D.

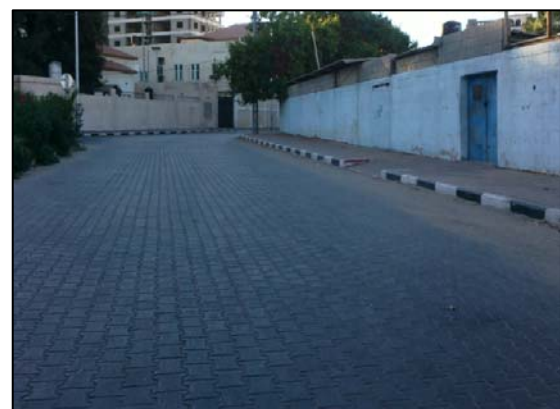
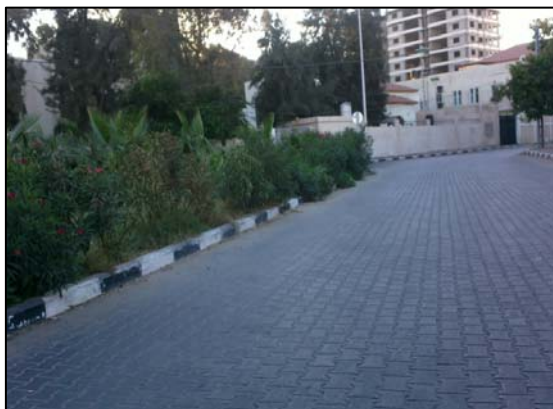


Figure (6.15): Al Nassir Suggested Bus Stop (1)

By measuring the distances between the gates of the three universities and point C, it was found that al-Azhar university gate and the Islamic University gate (male students gate, the Northern Gate) are less than 400m far from point C. on the other hand, it was found that the students of Al-Aqsa university and the female students of the Islamic University (Eastern gate) have to walk more than 400m to reach point C.

A bus stop (Point D) serving destination (2) is suggested to be in Bierut street shown in Figure (6.16). This point is less than 400m far from the gate of Al-Aqsa university and the female gate of the Islamic University. It also well lit, of a 3m sidewalk and a 10 m street width.



Figure (6.16): Al Nassir Suggested Bus Stop (2)

6.4 Conclusion

In Gaza city bus stops evaluation, it was found that the beach camp market bus stop is the worst with respect to:

| | | | | | |
|---|--|----|---------------------------|----|-----------|
| 1 | Coverage and Accessibility | 6 | Effect on Traffic | 11 | Obstacles |
| 2 | Route Suitability | 7 | Sidewalks | 12 | Lighting |
| 3 | Security | 8 | Crosswalks | 13 | Noise |
| 4 | Effect on Health due to Exhausts | 9 | Congestion in the Area | | |
| 5 | Effect on Exhaust-Sensitive Facilities | 10 | Effect on Property Owners | | |

On the other hand, Al-Shifa bus stop was the best with respect to the previous criteria excluding "Coverage and Accessibility". In "Coverage and Accessibility" analysis, Al-Shijaeya bus stop recorded the highest Ideal Stop-Accessibility Index ISAI.

The university zone can be a successful public transport environment, due to the existence of points that meet the criteria of good bus stops. In this research, four points were suggested as bus stops after being tested with respect to best bus stop criteria.

An accurate frequency system can strongly succeed in the university zone due to the relative constancy of students timetables, and hence their times of coming and leaving. This fact helped in suggesting a frequency system for this area as explained in this chapter.

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

7.1.1 Conclusions from Studying the Bus System in Gaza Strip

Through field investigation and meeting bus companies owners, it was found that the bus system Gaza Strip does not follow a definite system of routing and scheduling. It was also found that buses mostly serve university students, while other passengers prefer other means of transport.

Due to the unsystematic bus management, many problems are found to be existing in bus system in Gaza Strip. Some of these problems are: noise and congestion in the areas buses use as random parks, traffic jams, and delay.

7.1.2 Conclusions from Questionnaire

The questionnaire was used to measure the opinions of 360 persons, 80% of which are university students.

From questionnaire analysis, it was found that there is a general dissatisfaction with bus system in Gaza Strip.

With respect to bus as a transport mean in Gaza, most of bus users feel that buses in Gaza Strip are bad with respect to many factors such as occupancy (vacancy of seats), cleanliness, punctuality, tariff, mechanical condition, security, and safety.

The questionnaire also measures the satisfaction of bus users with drivers of buses. It was found that the majority of bus customers feel that bus drivers in Gaza Strip need more improvement in politeness, punctuality, respecting traffic law and personal cleanliness.

Most of bus customers feel that bus stops in Gaza Strip are bad with respect to accessibility, paths leading to bus stops, waiting time, noise, effect on surrounding traffic, security, and the existence of sidewalks and crosswalks.

It was found that bus users prefer Salah Eddine road to Al-Rasheed as a bus route. This is because they do not need to walk a long distance when using Salah Eddine road.

7.1.3 Conclusions from the Case Study (Bus Stops Evaluation and University Zone Public Transport Suggestion)

A. Bus Stops Evaluation

A case study that included ten bus stops was under focus in this part of research. The study showed that in Gaza Strip, there is no interest in bus stop as a concept, in bus companies, governmental institutes and bus customers. This can be concluded from observing bus system. The questionnaire shows that also, since a question focused on this point asking if the bus stop in the region of the respondent is really known as a bus stop and marked with a sign, or it is just a popular waiting point.

A multi criteria analysis was achieved to measure to what extent the ten bus stops under study satisfy bus stops criteria that are common in the public transport systems in the world. It was found that the worst bus stop in Gaza city is the market of the beach camp, which is used as a bus stop by the beach camp residents. This point is proved to be the worst with respect to accessibility and coverage (by measuring Ideal Stop-Accessibility Index ISAI), and also with respect to other criteria such as the effect of bus stop on traffic, the existence of sidewalks and crosswalks in the area of bus stop, and the condition of routes leading to the bus stop.

The ISAI measurement was the highest in Al-Shijaeya bus stop, due to the high density of population and buildings, and hence local streets, around Al-Shijaeya intersection. Al-Shifa bus stop was the best with respect to the other criteria excluding "Coverage and Accessibility".

It is important here to say that ISAI does not measure the level of accessibility and coverage with respect to an optimal case. Instead, it is useful in measuring the differences between bus stops with respect to coverage and accessibility.

The method of calculating the condition of bus stops with respect to the other twelve criteria mentioned in chapter (6) can give an optimal condition. It was found that the best bus stop in Gaza city (Al-Shifaa Bus Stop) is less than the optimal condition by about 64 credits, which is relatively high. The worst (Beach Camp Bus Stop) is 136 credits less than the optimal case.

B. University Zone Public Transport Suggestion

Through a passengers' count followed by analytical study, it was found that a bus system (bus stops and frequency system) can succeed in the university zone. This is due to the regularity of traffic in this area, which is a result of the accurate and semi-constant timing of university schedules of arrival and departure.

The count and analysis result in a suggestion of considering four main points in the university zone as bus stops. These points are accessible and located in light traffic areas. Buses are suggested to pass through these points according to a schedule that is designed depending on the passengers' count.

7.2 Recommendations

1. Improving buses through the following procedures:

- Increasing limitations on bus companies relating to bus conditions; i.e. bus license should not be updated unless bus is insured to be suitable for transferring passengers.
- Decreasing taxes of importing new buses. This step helps in avoiding mechanical and service problems resulting from the aging of bus, and helps also in decreasing the problem of over-load in buses.
- Admitting a clear tariff depending on routes and bus stops. This tariff must be much less than taxi tariff.
- Every bus should carry safety tools such as fire extinguisher. Governmental control and monitoring is responsible for ensuring this.

2. Improving drivers personal skills and politeness through the following procedures:

- Holding awareness raising sessions.
- Every bus company should have complaint box which is checked periodically.
- Every driver should have a serial number printed clearly on a card placed in front of his cabinet, to make it easy for any passenger to have information about driver in case of complaint.

3. Improving bus stops through the following procedures:

- Making a study about the need of bus stops in Gaza Strip, including the number and locations of bus stops, depending on demand.
- Ensuring that the following criteria are taken in consideration in selecting the locations of bus stops: (Accessibility - Route Suitability – Security - Effect on Health due to Exhausts – Noise - Effect on Traffic – Sidewalks – Crosswalks - Effect on Property Owners - Congestion in the Area – Obstacles – Lighting - Effect on Exhaust Sensitive Facilities - Effect on Residential Areas).

4. Establishing a bus system in the university zone through the following procedures

The study suggests four points in the university zone as bus stops for the trips moving from the university to Gaza city districts. The four bus stops are selected depending on certain criteria such as the distance between the gates of the three universities in the area and the bus stop, which is not more than 400 meters in all of the four cases. The study also suggests a bus frequency system built on passengers count.

Justifications and Benefits

Traffic congestion in the university zone at peak hours, especially the evening peak hour is mainly caused by the accumulation of students in certain places

waiting for taxis. One of the main causes of congestion is also the time it takes a taxi to select the students whose destination meets its route. The large number of taxis entering the university zone at peak hours is also an effective contributor in congestion.

Buses carry the name of their destination, and a bus can replace about ten taxis. This contributes significantly in reducing the problem explained in the previous paragraph. Students of one destination move to their bus at the moment it arrives, and have their seats in less than five minutes.

Application Mechanism

- The idea is based on the principle of "Concession", which gives the right to one bus company to enter the university zone in the peak hours, provided its response to the conditions of concession. The most important condition in concession should be minimize the tariff of riding the bus. The concessionaire company is selected for a certain number of years within a special tendering process.
- A minimized tariff attracts students to use the bus, and thus breaks the culture of refusing bus as a transport mode among university students in Gaza.
- The concession also tempts the bus company to reduce the value of the tariff based on the large number of students who will be using company buses daily. (The census of the study revealed that the number of students who wait taxis daily in the peak time interval (13:00-16:00) are about 3869 students, thus the bus company winning the concession can run 54 trips daily).
- Being the concessionaire makes the company responsible of providing all the luxuries and comfort means for the students on board during the trip.
- The concessionaire company is also responsible of providing an electronic screen showing the reduced trip tariff as well as the destination of the trip, the name of the driver, and other necessary information.

Obstacles

It is expected that students' response to the change in transport system in the university zone will not be instantaneous, this is due to the resistance of change, which is of course inherent in the human psyche. This can also be due to the negative idea that university students have about bus service in Gaza, which appeared in the results of the questionnaire. This obstacle can be overcome by offering inducements for students that can push them to use the bus, such as wireless internet, TV, air conditioning, in addition to reducing bus tariff to the half of taxi tariff at least.

5. Further Research

The following topics can be good titles for further research in the field of public transport in Gaza Strip:

- The suitability of waiting points in Gaza governorates to serve as bus stops.
- The bus origin-destination percentages between Gaza bus stops.
- Bus scheduling in Gaza Strip depending on demand.
- Measuring the tendency of using buses as a transport mode in Gaza Strip.

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ANNEX 1: PUBLIC QUESTIONNAIRE



الجامعة الإسلامية بعزة
برنامج الدراسات العليا
كلية الهندسة - قسم البنية التحتية

يرجى التكرم بالعلم بأن الباحث يقوم بإعداد رسالة ماجستير بعنوان:
تقييم نظام النقل بالحافلات في قطاع غزة

باستخدام نظم المعلومات الجغرافية

وعليه فإن الباحث يأمل في مساعدتكم الكريمة في تعبئة هذا الاستبيان بأقصى درجة
ممكنة من الدقة والموضوعية لضمان نجاح هذه الدراسة وتحقيق أهدافها.

شاكرين لكم حسن تعاونكم

الباحث / محمد محمود المكشبة

القسم الأول/ معلومات عامة

| | | |
|----|---|--|
| 1. | الجنس | أ. ذكر ب. أنثى |
| 2. | السن | أ. 18- أقل من 23 ب. 23- أقل من 40 ت. 40- أقل من 60 ث. 60 عاماً فأكثر. |
| 3. | المؤهل العلمي | أ. دراسات عليا ب. بكالوريوس ت. دبلوم متوسط ث. ثانوية عامة ج. أقل |
| 4. | العمل | أ. قطاع عام ب. قطاع خاص ت. طالب/ة ث. عاطل عن عمل |
| 5. | مكان السكن/ محافظة: | أ. الشمال ب. غزة ت. الوسطى ث. خان يونس ج. رفح |
| 6. | الوجهة المعتادة (الدراسة أو العمل)/ محافظة: | أ. الشمال ب. غزة ت. الوسطى ث. خان يونس ج. رفح |
| 7. | تمتلك رخصة قيادة | أ. نعم ب. لا |
| 8. | عدد أفراد الأسرة | فرداً _____ |
| 9. | دخل الأسرة الشهري | شيكلاً _____ |

10. اسم الشارع الإقليمي الذي تفضل/ين مرور حافلتك منه (مثلاً: صلاح الدين، الرشيد.. إلخ): _____
11. في منطقة سكنك، ما اسم وطبيعة المكان الذي تنتظر فيه الحافلة؟ (مثلاً: سوق الأريعاء، سوق شعبي): _____
12. في منطقة عملك/دراستك، ما اسم وطبيعة المكان الذي تنتظر فيه الحافلة؟ _____
13. يبعد أقرب مفترق عن موقف الحافلات في مكان سكنك مسافة _____ متر.
14. يبعد أقرب مفترق عن موقف الحافلات في مكان عملك/دراستك مسافة _____ متر.
15. غالباً تستقل حافلة الذهاب الصباحية في تمام: الساعة: _____ الدقيقة: صباحاً _____

16. غالباً تستقل حافلة العودة المسائية في تمام: الساعة: _____ الدقيقة: _____ مساءً
17. حدد/ي الأيام التي تستخدم/ين فيها الحافلة: أ. السبت ب. الأحد ت. الاثنين ث. الثلاثاء ج. الأربعاء ح. الخميس
18. اسم شركة الحافلات التي تفضل/ين التعامل معها: _____

القسم الثاني/ خدمة النقل بالحافلة

| أ. المحور الأول/ الحافلة | | | | | |
|--------------------------|---|------------|-------|-------|------------|
| م | الفقرة | موافق بشدة | موافق | محايد | معارض بشدة |
| 1 | النقل بالحافلة في قطاع غزة غير مريح عموماً. | | | | |
| 2 | لا تجد/ين مقعداً فارغاً في الحافلة في أغلب الأحيان. | | | | |
| 3 | لا تجد/ين الحافلة نظيفة في أغلب الأحيان. | | | | |
| 4 | توصلك الحافلة إلى وجهتك متأخراً في كثير من الأحيان. | | | | |
| 5 | تسعيرة النقل بالحافلة غير مناسبة من وجهة نظرك. | | | | |
| 6 | تعرضت الحافلة للعطل وأدت إلى تأخير الرحلة -أكثر من مرة-. | | | | |
| 7 | تشعر/ين بانعدام الأمن خلال ركوبك الحافلة. (تخشى/ين من مخاطر شخصية كالإيذاء أو السرقة). | | | | |
| 8 | تعرضت الحافلة لحادث -مرة على الأقل- خلال رحلة كنت أحد ركبائها. (الحادث يشمل الاصطدام بمركبة أخرى أو عائق على الطريق أو دهس أحد المشاة). | | | | |
| 9 | تشعر/ين دائماً بالخطر من ناحية التعرض للحوادث خلال استخدامك للحافلة. | | | | |
| ب. المحور الثاني/ السائق | | | | | |
| م | الفقرة | موافق بشدة | موافق | محايد | معارض بشدة |
| 10 | يعاملك سائق الحافلة بطريقة غير مريحة في أغلب الأحيان. | | | | |
| 11 | يقوم السائق بتصرفات مخلة بالأداب خلال قيادته للحافلة. | | | | |
| 12 | تعرضت لاعتداء لفظي من سائق الحافلة -لمرة واحدة على الأقل-. | | | | |
| 13 | يتلفظ السائق بألفاظ مخلة بالأداب خلال قيادته للحافلة. | | | | |
| 14 | يفاجئك سائق الحافلة بتغيير خط سير الرحلة في كثير من الأحيان. | | | | |
| 15 | يفقد السائق بسرعة غير اعتيادية خلال الرحلة. | | | | |
| 16 | لا يلتزم السائق بالإشارات المرورية والضوئية بالقدر الكافي. | | | | |
| 17 | يدخل السائق في مشاحنات متكررة مع سائقين آخرين خلال الرحلة. | | | | |
| 18 | لا يهتم السائق بمظهره ونظافته الشخصية خلال عمله. | | | | |
| 19 | حاول سائق -مرة واحدة على الأقل- ابتزازك مالياً للحصول على أجرة فوق المعتادة مقابل إيصالك في ظروف غير اعتيادية (كظروف جوية أو أمنية صعبة). | | | | |

| | | | | | | |
|--|-------|-------|-------|------------|---|----------|
| | | | | | تشعر/بين بعدم الارتياح - بشكل عام - تجاه سائقي الحافلات في قطاع غزة. | 20 |
| ج. المحور الثالث/ نقطة توقف الحافلات في منطقة السكن | | | | | | |
| | | | | | الفقرة | م |
| معارض بشدة | معارض | محايد | موافق | موافق بشدة | | |
| | | | | | في منطقة سكنك، تبعد نقطة توقف الحافلة عن بيتك مسافة تزيد عن 600م (مدة سير تزيد عن 10 دقائق). | 21 |
| | | | | | في منطقة سكنك، تعتبر/بين الطريق التي تستخدمها/بينها للوصول إلى نقطة توقف الحافلة غير صالحة لاستخدام المشاة. | 22 |
| | | | | | في منطقة سكنك، نقطة توقف الحافلة عبارة عن نقطة على أحد الطرقات غير مخصصة كموقف حافلات بإشارة مرورية، ولكن تم التعارف عليها على أنها منطقة التقاء الركاب بالحافلة. | 23 |
| معارض بشدة | معارض | محايد | موافق | موافق بشدة | الفقرة | م |
| | | | | | في منطقة سكنك، ليس بالضرورة أن تستخدم/ي نقطة توقف الحافلة لكي تستقل/ي الحافلة، فالحافلة قد تقلك من أي نقطة على الطريق (كسيارة الأجرة). | 24 |
| | | | | | خلال رحلة الذهاب، تقوم الحافلة بالتوقف أكثر من مرة في غير مناطق توقفها المتعارف عليها، وذلك لتحميل ركاب (كنظام سيارة الأجرة). | 25 |
| | | | | | في منطقة سكنك، كثيراً ما يصل السائق إلى نقطة توقف الحافلة متأخراً عن الموعد المتعارف عليه. | 26 |
| | | | | | في منطقة سكنك، تنتظر في نقطة توقف الحافلة لفترة تزيد عن 5 دقائق حتى تمتلئ الحافلة بالركاب. | 27 |
| | | | | | في منطقة سكنك، تشعر/بين أن نقطة توقف الحافلة منطقة غير آمنة (تخشى/بين فيها على نفسك من أي اعتداء أو سرقة). | 28 |
| | | | | | في منطقة سكنك، عانيت من مشاكل صحية ناتجة عن العوادم في نقطة توقف الحافلة. | 29 |
| | | | | | في منطقة سكنك، تشعر/بين أن الضوضاء في نقطة توقف الحافلة مرتفعة جداً إلى درجة التأثير على حالتك النفسية العامة. | 30 |
| | | | | | في منطقة سكنك، تعرضت لمضايقات من السائقين في نقطة توقف الحافلة. | 31 |
| | | | | | في منطقة سكنك، تعرضت لمضايقات من الركاب في نقطة توقف الحافلة. | 32 |
| | | | | | في منطقة سكنك، نقطة توقف الحافلة تقع في مكان معزول. | 33 |
| | | | | | في منطقة سكنك، توقف الحافلة في المكان المتعارف عليه لتوقفها يؤدي إلى عرقلة حركة السير على الطريق. | 34 |
| | | | | | في منطقة سكنك، لا توجد أرصفة في منطقة توقف الحافلة أو أنها ذات عرض غير كافٍ لوقوف الركاب عليها في انتظار الحافلة. | 35 |
| | | | | | في منطقة سكنك، لا توجد ممرات مشاة في منطقة توقف الحافلة. | 36 |
| | | | | | في منطقة سكنك، وجود نقطة توقف الحافلة في مكانها المتعارف عليه يؤثر سلباً | 37 |

| | | | | | | |
|--|-------|-------|-------|------------|--|----------|
| | | | | | على السكان وأصحاب المحلات في تلك المنطقة. | |
| | | | | | في منطقة سكنك، منطقة توقف الحافلة تعاني من اختناقات مرورية بشكل دائم. | 38 |
| | | | | | في منطقة سكنك، توجد معوقات تعيق رؤية سائق الحافلة للركاب في المنطقة الموجودة فيها نقطة توقف الحافلة (أشجار، منشآت.. إلخ). | 39 |
| | | | | | في منطقة سكنك، لا توجد في نقطة توقف الحافلة إضاءة كافية ليلاً. | 40 |
| | | | | | في منطقة سكنك، نقطة توقف الحافلة قريبة من أماكن تتأثر سلباً بعوادم المواصلات كالمستشفيات والمدارس. | 41 |
| | | | | | في منطقة سكنك، نقطة توقف الحافلة قريبة جداً من أماكن التجمعات السكانية وتؤثر عليها سلباً بالضوضاء وعوادم الحافلات. | 42 |
| المحور الرابع/ الوصولية إلى نقطة توقف الحافلة في منطقة دراستك/ عملك | | | | | | |
| | | | | | الفقرة | م |
| معارض بشدة | معارض | محايد | موافق | موافق بشدة | تبعد نقطة توقف الحافلة عن مكان دراستك/عملك مسافة تزيد عن 600م (فترة سير تزيد عن 10 دقائق). | 43 |
| | | | | | تعتبر/بين الطريق التي تستخدمها للوصول إلى نقطة توقف الحافلة في مكان دراستك/عملك غير صالحة لاستخدام المشاة. | 44 |
| | | | | | نقطة توقف الحافلة في مكان دراستك/عملك عبارة عن نقطة على أحد الطرقات غير مخصصة كموقف حافلات بإشارة مرورية، ولكن تم التعارف عليها على أنها منطقة التقاء الركاب بالحافلة. | 45 |
| | | | | | الفقرة | م |
| معارض بشدة | معارض | محايد | موافق | موافق بشدة | في رحلة العودة، ليس بالضرورة أن تستخدم/ي نقطة توقف الحافلة في مكان دراستك/عملك لكي تستقل/ي الحافلة، فالحافلة قد تقلك من أي نقطة في الطريق كسيارة الأجرة تماماً. | 46 |
| | | | | | خلال رحلة العودة، تقوم الحافلة بالتوقف أكثر من مرة في غير مناطق توقفها المتعارف عليها، وذلك لتحميل ركاب (كنظام سيارة الأجرة). | 47 |
| | | | | | كثيراً ما يصل السائق إلى نقطة توقف الحافلة في مكان دراستك/عملك متأخراً عن الموعد المتعارف عليه. | 48 |
| | | | | | تنتظر في نقطة توقف الحافلة في مكان دراستك/عملك لفترة تزيد عن 5 دقائق حتى تمتلئ الحافلة بالركاب. | 49 |
| | | | | | تشعر/بين أن نقطة توقف الحافلة في مكان دراستك/عملك منطقة غير آمنة (تخشى/بين فيها على نفسك من أي اعتداء أو سرقة). | 50 |
| | | | | | عانيت من مشاكل صحية ناتجة عن العوادم في نقطة توقف الحافلة في مكان دراستك/عملك. | 51 |

| | | | | | | |
|--|--|--|--|--|--|----|
| | | | | | تشعر/ين أن الضوضاء في نقطة توقف الحافلة في مكان دراستك/عملك مرتفعة جداً إلى درجة التأثير على حالتك النفسية العامة. | 52 |
| | | | | | تعرضت لمضايقات من السائقين في نقطة توقف الحافلة في مكان دراستك/عملك. | 53 |
| | | | | | تعرضت لمضايقات من الركاب في نقطة توقف الحافلة في مكان دراستك/عملك. | 54 |
| | | | | | نقطة توقف الحافلة في مكان دراستك/عملك تقع في مكان معزول. | 55 |
| | | | | | توقف الحافلة في المكان المتعارف عليه في مكان دراستك/عملك يؤدي إلى عرقلة حركة السير على الطريق. | 56 |
| | | | | | في مكان دراستك/عملك لا توجد أرصفة في منطقة توقف الحافلة أو أنها ذات عرض غير كافٍ لوقوف الركاب عليها في انتظار الحافلة. | 57 |
| | | | | | لا توجد ممرات مشاة في منطقة توقف الحافلة في مكان دراستك/عملك. | 58 |
| | | | | | وجود نقطة توقف الحافلة في مكانها المتعارف عليه في مكان دراستك/عملك يؤثر سلباً على السكان وأصحاب المحلات. | 59 |
| | | | | | المنطقة الموجودة فيها نقطة توقف الحافلة في مكان دراستك/عملك تعاني من اختناقات مرورية بشكل دائم. | 60 |
| | | | | | توجد معوقات تعيق رؤية سائق الحافلة للركاب في المنطقة الموجودة فيها نقطة توقف الحافلة في مكان دراستك/عملك (أشجار، منشآت.. إلخ). | 61 |
| | | | | | لا توجد في نقطة توقف الحافلة في مكان دراستك/عملك إضاءة كافية ليلاً. | 62 |
| | | | | | نقطة توقف الحافلة في مكان دراستك/عملك قريبة من أماكن تتأثر سلباً بعوادم المواصلات كالمستشفيات والمدارس. | 63 |
| | | | | | نقطة توقف الحافلة في مكان دراستك/عملك قريبة جداً من أماكن التجمعات السكانية وتؤثر عليها سلباً بالضوضاء وعوادم الحافلات. | 64 |

وشكراً لحسن تعاونكم



The researcher is preparing a master thesis titled as:

Evaluating Bus System in Gaza Strip Using Geographical Information Systems (GIS)

The researcher wishes that you help him by filling this questionnaire as accurately as possible.

Thanks for your time.

Researcher:
Mohammed M. Alokshiya

Section 1: General Information

| | | |
|---|--------------------------------|---|
| 1 | Gender | A. Male B. Female |
| 2 | Age | A. 18-less than 20 B. 20-less than 40 C. 40-less than 60 D. 60 and more. |
| 3 | Last Certificate | A. Postgraduate B. Bachelor C. Diploma D. High School E. Less. |
| 4 | Job | A. Public Sector B. Private Sector C. Student D. Do not Work. |
| 5 | Residence of | A. North B. Gaza C. Alwosta D. Khan Yunus E. Rafah |
| 6 | Daily Destination | A. North B. Gaza C. Alwosta D. Khan Yunus E. Rafah |
| 7 | Do you have a driving license? | A. Yes B. No |
| 8 | Family Members | ----- Members |
| 9 | Monthly Income | ----- Sheqles |

10. What is the name of the regional street you prefer your bus to use? -----
11. In you residence area, what is the name of the point you wait bus at? -----
12. In you work/study area, what is the name of the point you wait bus at? -----
13. In your residence area, the nearest intersection is far from your bus waiting point ----
---- m.
14. In your work/study area, the nearest intersection is far from your bus waiting point -
----- m.
15. You always ride your bus going to work/study area at: ----- O'clock.
16. You always ride your bus going back area at: ----- O'clock.
17. Mark the days you use bus in: Saturday – Sunday – Monday – Tuesday –
Wednesday – Thursday – Friday.
18. The bus company you prefer is: -----.

Section 2: Bus Service

| Bus | | | | | | |
|-----|--|-------------------|----------|---------|---------|------------------|
| No. | Statement | Strongly Disagree | Disagree | Neutral | Approve | Strongly Approve |
| 1 | The bus system in Gaza Strip is generally uncomfortable. | | | | | |
| 2 | You always do not find a vacant seat in the bus. | | | | | |
| 3 | The bus is always dirt. | | | | | |
| 4 | In most cases, you reach your destination late. | | | | | |
| 5 | Bus tariff is not suitable from your point of view. | | | | | |

| | | | | | | |
|--------------------------------|--|--|--|--|--|--|
| 6 | During one of your trips, the bus was out of order once at least. | | | | | |
| 7 | You feel unsafe when you use bus. | | | | | |
| 8 | You witnessed a bus accident once at least, and you were one of the bus users. | | | | | |
| 9 | You always feel unsafe of accidents in buses. | | | | | |
| Driver | | | | | | |
| 10 | Commonly, You are not satisfied with the way the bus driver treats you. | | | | | |
| 11 | The driver always behaves impolitely. | | | | | |
| 12 | The driver, once at least, attacked you orally. | | | | | |
| 13 | The driver, once at least, talked to you impolitely. | | | | | |
| 14 | Unexpectedly, the trip path is always changed. | | | | | |
| 15 | The driver drives too fast during the trip. | | | | | |
| 16 | The driver does not respect traffic sign and signals during the trip. | | | | | |
| 17 | The driver always quarrels with other drivers. | | | | | |
| 18 | The driver does not care about his personal cleanliness and look. | | | | | |
| 19 | The driver tried, once at least, to extort you in abnormal conditions by asking for extraordinary money. | | | | | |
| 20 | Commonly, you do not feel comfortable when dealing with bus drivers in Gaza Strip. | | | | | |
| Bus Stop in Living Area | | | | | | |
| | In your living area, the bus stop is not more than 600 meters far from your home. | | | | | |
| | In your living area, you consider the road leading to the bus stop invalid for pedestrian use. | | | | | |

| | | | | | |
|---|--|--|--|--|--|
| In your living area, the bus stop is not defined by a sign to be a bus stop. It is a random point, known by public as a bus stop. | | | | | |
| In your living area, the bus can pick you from any point in the street. | | | | | |
| During the trip, the bus always stops at any point in the street to pick passengers. | | | | | |
| In your living area, it is common that the bus arrives late to the bus stop. | | | | | |
| In your living area, you wait more than five minutes till the bus gets full and starts moving. | | | | | |
| In your living area, you feel that the bus stop is an unsafe place. | | | | | |
| You suffered from health troubles resulting from vehicles exhausts in the bus stop in your living area. | | | | | |
| You think that traffic noise is too loud in the bus stop in your living area, so that it affects your psychological status. | | | | | |
| You are usually subjected to annoying by the drivers in the bus stop in your living area. | | | | | |
| You are usually subjected to annoying by the customers in the bus stop in your living area. | | | | | |
| The bus stop in your living area is located in an isolated place. | | | | | |
| The bus stop in your living area causes travel jams. | | | | | |
| In the bus stop in your living area, there are no sidewalks, or they are not wide enough for pedestrians to wait the bus on. | | | | | |
| In the bus stop in your living area, there are no crosswalks. | | | | | |
| The bus stop in your living area affects property owners negatively. | | | | | |
| In your living area, the bus stop area is always congested. | | | | | |
| In your living area, there are obstacles that interrupts vision. | | | | | |

| | | | | | | |
|------------------------------------|---|--|--|--|--|--|
| | The bus stop in your living area is not lit at night. | | | | | |
| | The bus stop in your living area is adjacent to exhaust-sensitive facilities like hospitals and schools. | | | | | |
| | The bus stop in your living area is adjacent to population densities. | | | | | |
| Bus Stop in Study/Work Area | | | | | | |
| | In your Study/Work area, the bus stop is not more than 600 meters far from your home. | | | | | |
| | In your Study/Work area, you consider the road leading to the bus stop invalid for pedestrian use. | | | | | |
| | In your Study/Work area, the bus stop is not defined by a sign to be a bus stop. It is a random point, known by public as a bus stop. | | | | | |
| | In your Study/Work area, the bus can pick you from any point in the street. | | | | | |
| | During the trip, the bus always stops at any point in the street to pick passengers. | | | | | |
| | In your Study/Work area, it is common that the bus arrives late to the bus stop. | | | | | |
| | In your Study/Work area, you wait more than five minutes till the bus gets full and starts moving. | | | | | |
| | In your Study/Work area, you feel that the bus stop is an unsafe place. | | | | | |
| | You suffered from health troubles resulting from vehicles exhausts in the bus stop in your Study/Work area. | | | | | |
| | You think that traffic noise is too loud in the bus stop in your Study/Work area, so that it affects your psychological status. | | | | | |
| | You are usually subjected to annoying by the drivers in the bus stop in your Study/Work area. | | | | | |
| | You are usually subjected to annoying by the customers in the bus stop in your Study/Work area. | | | | | |

| | | | | | | |
|--|--|--|--|--|--|--|
| | The bus stop in your Study/Work area is located in an isolated place. | | | | | |
| | The bus stop in your Study/Work area causes travel jams. | | | | | |
| | In the bus stop in your Study/Work area, there are no sidewalks, or they are not wide enough for pedestrians to wait the bus on. | | | | | |
| | In the bus stop in your Study/Work area, there are no crosswalks. | | | | | |
| | The bus stop in your Study/Work area affects property owners negatively. | | | | | |
| | In your Study/Work area, the bus stop area is always congested. | | | | | |
| | In your Study/Work area, there are obstacles that interrupts vision. | | | | | |
| | The bus stop in your Study/Work area is not lit at night. | | | | | |
| | The bus stop in your Study/Work area is adjacent to exhaust-sensitive facilities like hospitals and schools. | | | | | |
| | The bus stop in your Study/Work area is adjacent to population densities. | | | | | |

ANNEX 2: EXPERTS QUESTIONNAIRE

الإخوة الكرام/ الخبراء ومسئولي قطاع النقل والمواصلات في قطاع غزة،،

يقوم الباحث بعمل دراسة بعنوان

تقييم نظام النقل بالحافلات العمومية في قطاع غزة باستخدام نظم المعلومات الجغرافية

وعليه فإن الباحث يأمل من سيادتكم تعبئة هذا النموذج البسيط، والذي يهدف إلى وضع معايير واضحة لاختيار أماكن توقف الحافلات في مدينة غزة كحالة دراسية، ضمن مقترح يرمي إلى دراسة إمكانية استخدام الحافلة الصغيرة في النقل العام في المدينة.

يُقصد بأماكن توقف الحافلات (Bus Stop) تلك الأماكن التي تتوقف فيها الحافلة بغرض تحميل وتنزيل ركاب.

يرجى تعبئة خانة (الوزن) بما ترونه مناسباً، حيث يعبر (الوزن) عن درجة أهمية المعيار بالنسبة لنقطة توقف الحافلة، ويتدرج الوزن من 1 إلى 10، بحيث يعني الرقم 1 أدنى أهمية

والرقم 10 أقصى أهمية.

نسخة لكل من السادة المحترمين:

خبير (1): د. يحيى السراج

خبير (2): د. عصام المصري

خبير (3): د. محمد الكحلوت

معايير اختيار أفضل الأماكن لنقاط توقف الحافلات في مدينة غزة

| الوزن (10-1) | المعيار | رقم |
|--------------|--|-----|
| | القرب من أماكن الكثافة السكانية أو (Traffic Generators). | 1 |
| | توفر عنصر الأمان في المنطقة. | 2 |
| | سهولة وصول الراكب إلى نقطة توقف الحافلة. | 3 |
| | وجود مساحة كافية لوقوف الحافلة ثم اندماجها مرة أخرى بالتدفق المروري. | 4 |
| | بعد نقطة التوقف عن المفترقات مسافة لا تقل عن ستة أمتار. | 5 |
| | وجود ممرات مشاة. | 6 |
| | وجود أرصفة ذات عروض كافية. | 7 |
| | تأثير نقطة التوقف على الملكيات القريبة. | 8 |
| | وجود نقطة التوقف في أماكن مكشوفة لتسهيل الرؤية. | 9 |
| | إضاءة الشارع. | 10 |
| | الحجم المروري في المنطقة. | 11 |
| | ميل الشارع. | 12 |
| | البعد عن مناطق حساسة لعوادم وسائل المواصلات. | 13 |
| | البعد عن منازل المواطنين. | 14 |

معايير أخرى:

| الوزن (10-1) | المعيار | رقم |
|--------------|---------|-----|
| | | 1 |
| | | 2 |
| | | 3 |
| | | 4 |
| | | 5 |

Dear experts and officials in transportation sector in the Gaza Strip,

The researcher conducted a study entitled:

Evaluating Bus System in Gaza Strip Using Geographical Information Systems (GIS)

Thus, the researcher hopes that you will fill out this simple form, which aims to establish clear criteria for selecting sites suitable as bus stops in Gaza city. This is a part of a suggestion to study the possibility of using the bus in public transportation in the city.

Bus Stops are those places where the bus stops for the purpose of loading and unloading passengers.

Please fill in the box (weight) as you think suitable. The "Weight" expresses the degree of importance of the criterion for determining the suitability of a point as a bus stop. The weight ranges from 1 to 10. The number 1 refers to the lowest importance, while the number 10 means the highest importance.

Copy to each of:

Expert (1): Dr. Yahia Al-Sarraj

Expert (2): Dr Isam Al-Masry

Expert (3): Dr Mohammed Al-Kahlout

Criteria for Selecting the Best Points as Bus Stops in Gaza city

| No. | Criterion | Weight (1-10) |
|-----|---|---------------|
| 1 | How much the point is far from population densities (Traffic Generators) | |
| 2 | Security in the area | |
| 3 | Accessibility of the point | |
| 4 | The existence of enough area for the bus to stop and rejoin to traffic stream | |
| 5 | The distance from the intersection | |
| 6 | Existence of crosswalks | |
| 7 | Existence of sidewalks with enough width | |
| 8 | The effect of the bus stop on properties | |
| 9 | Existence of enough sight distance | |
| 10 | Lighting | |
| 11 | Traffic Volume | |
| 12 | Road Inclination | |
| 13 | How much the bus stop is far from exhaust-sensitive facilities | |
| 14 | How much the bus stop is far from residential areas. | |

Other Criteria

| No. | Criterion | Weight (1-10) |
|-----|-----------|---------------|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |

ANNEX 3: BUS STOPS EVALUATION

A. RESULTS

| No | Criteria | Weight | Beach Camp | | Hidaya | | Shijaeya | |
|-------|---|--------|------------|-------|--------|-------|----------|-------|
| | | | Mark | Score | Mark | Score | Mark | Score |
| 1 | The suitability of road leading to Bus Stop | 4.5 | 2 | 9 | 3 | 13.5 | 2 | 9 |
| 2 | Security | 4.5 | 3 | 13.5 | 3 | 13.5 | 5 | 22.5 |
| 3 | Effect on health due to exhausts | 2 | 3 | 6 | 3 | 6 | 1 | 2 |
| 4 | Noise | 2 | 1 | 2 | 4 | 8 | 1 | 2 |
| 5 | Effect of Bus Stop on Traffic | 4.5 | 1 | 4.5 | 1 | 4.5 | 4 | 18 |
| 6 | Sidewalks | 3.5 | 1 | 3.5 | 2 | 7 | 2 | 7 |
| 7 | Availability of crosswalks | 4 | 0 | 0 | 1 | 4 | 1 | 4 |
| 8 | Effect on properties | 3 | 1 | 3 | 4 | 12 | 4 | 12 |
| 9 | Congestion in the area | 4 | 1 | 4 | 4 | 16 | 1 | 4 |
| 10 | Obstacles | 3 | 3 | 9 | 5 | 15 | 5 | 15 |
| 11 | Lighting | 4 | 1 | 4 | 3 | 12 | 4 | 16 |
| 12 | Effect on exhaust-sensitive facilities | 2 | 5 | 10 | 5 | 10 | 5 | 10 |
| Total | | | | 68.5 | | 121.5 | | 121.5 |

| No | Criteria | Weight | Haidar | | Shafot | | Fras | |
|-------|---|--------|--------|-------|--------|-------|------|-------|
| | | | Mark | Score | Mark | Score | Mark | Score |
| 1 | The suitability of road leading to Bus Stop | 4.5 | 4 | 18 | 3 | 13.5 | 3 | 13.5 |
| 2 | Security | 4.5 | 4 | 18 | 3 | 13.5 | 4 | 18 |
| 3 | Effect on health due to exhausts | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| 4 | Noise | 2 | 3 | 6 | 2 | 4 | 1 | 2 |
| 5 | Effect of Bus Stop on Traffic | 4.5 | 2 | 9 | 4 | 18 | 3 | 13.5 |
| 6 | Sidewalks | 3.5 | 1 | 3.5 | 3 | 10.5 | 3 | 10.5 |
| 7 | Availability of crosswalks | 4 | 2 | 8 | 2 | 8 | 2 | 8 |
| 8 | Effect on properties | 3 | 4 | 12 | 1 | 3 | 1 | 3 |
| 9 | Congestion in the area | 4 | 2 | 8 | 1 | 4 | 1 | 4 |
| 10 | Obstacles | 3 | 4 | 12 | 5 | 15 | 5 | 15 |
| 11 | Lighting | 4 | 3 | 12 | 3 | 12 | 3 | 12 |
| 12 | Effect on exhaust-sensitive facilities | 2 | 5 | 10 | 5 | 10 | 5 | 10 |
| Total | | | | 118.5 | | 113.5 | | 111.5 |

| No | Criteria | Weight | Falasteen Square | | Sanafor | |
|----|---|--------|------------------|-------|---------|-------|
| | | | Mark | Score | Mark | Score |
| 1 | The suitability of road leading to Bus Stop | 4.5 | 4 | 18 | 2 | 9 |
| 2 | Security | 4.5 | 5 | 22.5 | 3 | 13.5 |
| 3 | Effect on health due to exhausts | 2 | 1 | 2 | 3 | 6 |
| 4 | Noise | 2 | 1 | 2 | 3 | 6 |
| 5 | Effect of Bus Stop on Traffic | 4.5 | 5 | 22.5 | 4 | 18 |
| 6 | Sidewalks | 3.5 | 4 | 14 | 2 | 7 |
| 7 | Availability of crosswalks | 4 | 1 | 4 | 2 | 8 |
| 8 | Effect on properties | 3 | 1 | 3 | 4 | 12 |
| 9 | Congestion in the area | 4 | 1 | 4 | 3 | 12 |
| 10 | Obstacles | 3 | 4 | 12 | 5 | 15 |
| 11 | Lighting | 4 | 4 | 16 | 3 | 12 |
| 12 | Effect on exhaust-sensitive facilities | 2 | 5 | 10 | 5 | 10 |
| | Total | | | 130 | | 128.5 |

B. PHOTOS



Al-Shifaa Bus Stop



Al-Falasteen



Al-Sanafor Bus Stop

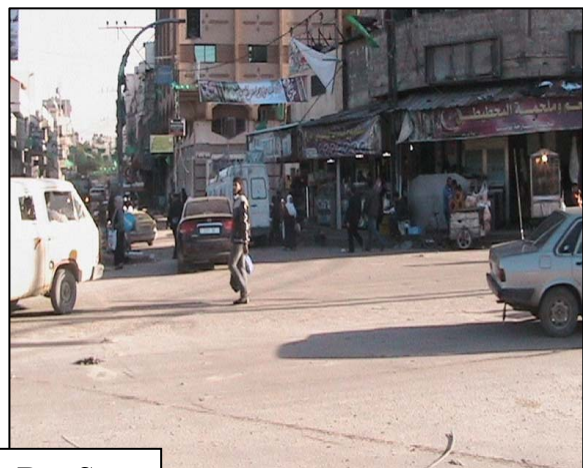




Al-Jomaa Market Bus Stop



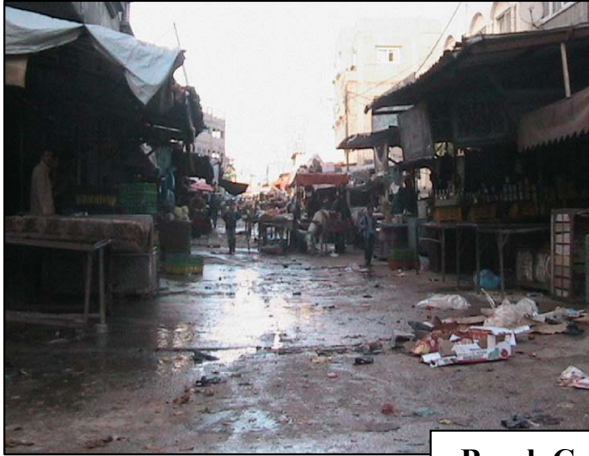
Al-Hidaya Bus Stop



Al-Shijaeya Bus Stop



Fras Market Bus Stop



**Beach Camp Market
Bus Stop**



ANNEX 4: WORKSHOP WITH BUS COMPANIES

- **Place:** Ministry of Transport – Gaza.
- **Time:** 10:00 am, 15 March, 2012.
- **Attendants:** Representatives of the bus companies shown in Annex 4.
- **Topics:**
 - Discussing the problems facing bus companies.
 - Filling "Company Information Form"
- **Company Information Form:** Bus companies representatives were asked to fill the following form:

Company Name: -----
Company Address: -----
Number of Buses:
Large (50 Persons Load): ----- Mini-Bus (20 – 30 Persons Load): -----

Daily Trips

| Origin | Destination | Route | Frequency of Trip |
|--------|-------------|-------|-------------------|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Was any of the company buses subjected to accident? Could you please describe losses?

Please, write down the obstacles you think facing company work.

ANNEX 5: BUS DAILY TRIPS IN GAZA

| Company Name | Origin | Destination | Daily Trips |
|----------------------------|---------------|---------------|-------------|
| Nusairat | Nusairat | Gaza | 5 |
| | Rafah | Gaza | 2 |
| Abu Elba | Gaza | Rafah | 1 |
| | Rafah | Gaza | 5 |
| | Dier Al-Balah | Gaza | 1 |
| Elia'a Al-Tayyiba | Khan Younis | Rafah | 15 |
| | Khan Younis | Dier Al-Balah | 2 |
| | Rafah | Dier Al-Balah | 2 |
| | Gaza | Dier Al-Balah | 2 |
| Hafil | Rafah | Gaza | 7 |
| Abu Elba and his Sons | Rafah | Gaza | 1 |
| | Khan Younis | Gaza | 1 |
| | Dier Al-Balah | Gaza | 1 |
| | Nusairat | Gaza | 1 |
| | Biet Hanoon | Gaza | 1 |
| | Jabalia | Gaza | 2 |
| Sweety Tours | Khan Younis | Gaza | 1 |
| | Rafah | Gaza | 1 |
| | Khan Younis | Rafah | 1 |
| | Biet Hanoon | Gaza | 1 |
| | Dier Al-Balah | Gaza | 1 |
| | Dier Al-Balah | Biet Hanoon | 1 |
| Al-Ettihad | Rafah | Al-Zahra | 2 |
| | Khan Younis | Al-Zahra | 1 |
| | Biet Hanoon | Al-Zahra | 1 |
| | Gaza | Al-Zahra | 2 |
| | Jabalia | Gaza | 1 |
| Soboh | Jabalia | Khan Younis | 2 |
| | Gaza | Khan Younis | 1 |
| Gaza and Southern Villages | Rafah | Gaza | 3 |
| | Khan Younis | Gaza | 11 |
| | Dier Al-Balah | Gaza | 2 |
| | Maghazi | Gaza | 1 |
| | Buraij | Gaza | 1 |
| Kardash | Gaza | Khan Younis | 1 |
| | Gaza | Rafah | 1 |
| | Gaza | Jabalia | 1 |

| Company Name | Origin | Destination | Daily Trips |
|--------------------------------------|---------------|---------------|-------------|
| Kardash | Gaza | Biet Hanoon | 1 |
| | Gaza | Rafah | 1 |
| | Gaza | Nusirat | 1 |
| | Gaza | Dier Al-Balah | 1 |
| Al-Wosta | Dier Al-Balah | Gaza | 2 |
| | Nusairat | Gaza | 1 |
| | Nusairat | Dier Al-Balah | 2 |
| Qishta | Rafah | Gaza | 3 |
| | Rafah | Khan Younis | 8 |
| Al-Nasman | Jabalia | Gaza | 1 |
| Al-Salam | Biet Hanoon | Gaza | 3 |
| Hamdona | Biet-Lahia | Gaza | 3 |
| | Biet-Lahia | Gaza | 2 |
| Madi | Biet-Hanoon | Gaza | 1 |
| | Rafah | Gaza | 1 |
| | Dier Al-Balah | Gaza | 1 |
| | Jabalia | Gaza | 3 |
| Abu-Libda & Ajjori | Jabalia | Gaza | 4 |
| | Nusairat | Dier Al-Balah | 1 |
| Al-Rawamis | Khan Younis | Gaza | 4 |
| | Rafah | Khan Younis | 1 |
| Number of Daily Trips | | | 131 |
| Number of Bus Users (50 for one bus) | | | 6550 |

ANNEX 6: PASSENGERS COUNT SHEET

| نموذج جمع بيانات | | | |
|-----------------------------|------------------------|------------------------|----------------|
| نقاط المراقبة / () () () | | الشارع / | الملاحظ / |
| عدد الركاب في نقطة () | عدد الركاب في نقطة () | عدد الركاب في نقطة () | الفترة الزمنية |
| | | | 13:00 – 13:15 |
| | | | 13:15 – 13:30 |
| | | | |

Passengers Count Sheet (Arabic Form)

| Data Collection Form | | | |
|----------------------|---------------|---------------------------------------|---------------|
| Observer\ | Street\ | Points under Observation\ () () () | |
| Time Interval | Persons in P1 | Persons in P2 | Persons in P3 |
| 13:00 – 13:15 | | | |
| 13:15 – 13:30 | | | |
| | | | |

Passengers Count Sheet (English Form)

| نموذج جمع بيانات | | الملاحظ / رصم | |
|------------------------|-----------------|--------------------------|--------------------------|
| نقاط المراقبة / الشارع | الشارع | عدد الركاب في نقطة (7) | عدد الركاب في نقطة (8) |
| () () () () | () () () () | عدد الركاب في نقطة () | عدد الركاب في نقطة () |
| | | 01:00 - 01:15 | 01:15 - 01:30 |
| | | 01:30 - 01:45 | |

A Sample of Filled Passengers Count Sheet