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Public Transport Accessibility and Service Gap–Nablus City

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Dedication

To my parents and my wife for their encouragement and support.

Acknowledgment

First of all, I am thankful to the almighty God for granting me good health, strength and peace throughout the research period.

I would like to express my sincere gratitude to my academic advisor Dr. Khaled Al-Sahili. I am grateful for his continuous support, patience, motivation, enthusiasm, and knowledge. His guidance helped me all the time of the research, and writing of this thesis that I would never reach on my own.

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الإقرار

انا الموقع أدناه مقدم الرسالة التي تحمل العنوان:

Public Transport Accessibility and Service Gap– Nablus City

اقر بأن ما اشتملت عليه هذه الرسالة إنما في نتاج جهدي الخاص، باستثناء ما تمت الإشارة إليه حيثما ورد، وأن هذه الرسالة ككل، أو أي جزء منها لم يقدم من قبل لنيل أية درجة علمية أو بحث علمي أو بحثي لدى أي مؤسسة تعليمية أو بحثيه اخرى.

Declaration

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

Student's Name: خليل جابر احمد قيس **إسم الطالب :**

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Date: 2/6/2015 **التاريخ:**

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List of Abbreviations

P.T	Public Transport
PNA	Palestinian National Authority
MOT	Ministry of Transportation
LIPTA	Local Index of Public Transport Availability
TTAI	Travel Time Accessibility Index
O-D's	Origins and Destinations
PCBS	Palestinian Central Bureau of Statistics
K.m	Kilometer
TCQSM	Transit Capacity and Quality of Service Manual
HCM	Highway Capacity Manual
LOS	Level of Service
TSA	Transit-supportive area
PTAL	The Public Transport Accessibility Level
AI	Accessibility index
PTAI	Public Transport Accessibility Index
LITA	Local Index of Transit Availability
GIS	Geographic Information Systems
TSI	Transit Service Indicator
Z-scores	Standard Scores
$\boldsymbol{WCAF}$	Weighted Composite Average Frequency
$\boldsymbol{CAF}$	Composite Average Frequency
MOLG	Ministry of Local Government
NCD	National Center for Sustainable Development
CBD	Central Business District
P.C	Private Car
St.Dev	Standard Deviation
ESRI	Environmental Systems Research Institute
POP	Population
ID	Identity Number
Co.	Company

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Abstract

The increasing interest in sustainable development has underlined the importance of accessibility concept as a key indicator to assess Public Transport (P.T) investments. To date measuring P.T accessibility in Palestine has been limited and local agencies have never had a specific and an accurate measure to assess local P.T service accessibility. This study outlines a proposed methodology for assessing accessibility of intra-city fixed route P.T service in Nablus City.

Previous studies showed that there are mainly two different types of research related to the accessibility of P.T systems. The first type deals with measuring access to the P.T systems and the second deals with measuring access to destinations through P.T systems. The major aim of this thesis is to study these two types of research through developing two indices to reflect accessibility level for each type. These indices are a Local Index of Public Transport Availability (LIPTA) and Travel Time Accessibility Index (TTAI).

The methodology of the study is based mainly on the quantitative and analytical methods using the collected data and the field survey of P.T frequency as well as travel time field data. ArcInfo v.10.0 Geographic Information System (GIS) program was used in analyzing and displaying the results by using the network analysis functions to measure spatial coverage of P.T service based on the actual walking distance on the pedestrian road network.

The results of this study showed clearly that the proposed indices provide a suitable methodology to measure and assessing P.T accessibility for urban area; LIPTA confirmed that the study area in general has a good P.T service availability and there is a lack of service along the peripheral areas. On the other hand, TTAI showed that there is a gap between private car based and P.T-based accessibility for studied O-D's.

The study recommends that the Ministry of Transportation and local agencies should take into account the accessibility concept to improve the P.T services as part of a comprehensive short and long-term transport plan. Nablus Municipality should relay on study results to support some policies that encourage the use of P.T as alternative transport mode.

Chapter One

Introduction

1.1 Background

One of the most important priorities of Palestinian Ministry of Transport is developing the Public Transport (P.T) sector (MOT, 2013), which reflects the development and improvement of the level of services provided to the citizens.

The public transport system has been considered as an important means of sustainable and social transportation alternative in creating livable and sustainable cities. Public transportation ensures long term sustainability in terms of resource consumption by relieving highway congestion and providing a very efficient means of moving large numbers of people with considerable flexibility to meet demand throughout any area. It improves systemic mobility without placing the economic and environmental burden of increased auto ownership on the traveling population, and provides mobility to those who do not have access to a car (P.T Disadvantaged) (Al-Mamun and Lownes, 2011). Therefore, P.T service is widely deemed as a means for ensuring all travelers can make use of transportation service and has been considered as a social service nowadays (Lei and Church, 2010).

Governments and P.T Planners in several countries share a common goal to ensure that P.T is accessible to all, and that the pedestrian and traffic environments are designed and managed to enable people to reach and use P.T safely and with confidence. On the other hand, different countries face challenges in making their P.T systems more accessible. This is one of the main reasons that make the transition from the use of private cars to the use of P.T services difficult. Therefore, P.T services to be attractive alternatives as compared to private cars, their performance in terms of service availability and spatial and temporal coverage must be satisfactory to the public, and it must provide an acceptable level of convenience.

1.2 Public Transport in Palestine

The definition of public transport varies from one location to another depending on type of services used. Public transport is that mode of transportation, which is considered as for-hire to the public. It includes buses, trains, taxis, paratransit, and shared-taxis (Issa, 2006).

There are three P.T modes in Palestine. These are buses, shared-taxis, and taxis. The fleet is owned and operated by the private sector, individuals, or firms. In addition, there is an illegal operation of private vehicles as shared-taxis or taxis. A shared-taxi is a mode of transport, which ranges from four-seat cars to vans. These vehicles are typically for hire, and usually take passengers on a fixed or semi-fixed route without timetables, but instead depart when all seats are filled. They may stop anywhere to pick up or drop off passengers. When most or some seats are vacant, the driver usually travels slower and honks the horn to attract the attention of potential passengers on the sidewalk. Often they are called "ser-vees" (service taxi), and they are often owner-operated.

No major developments in public transportation have been observed during the past few years. There were no funds assigned by the Palestinian National

Authority (PNA) for the development of the public transport facilities. As public transport is owned and operated by the private sector, the PNA depends on the private sector initiatives to develop the sector (Issa, 2006).

The following reasons clarify the decision of PNA to defer the development of public transport (Abu-Eisheh, Al-Sahili, and Kobari, 2004):

- Public transportation agencies are privately owned.
- PNA focused on physical infrastructure rather than on operation projects.
- Many intercity roads are still not controlled by the PNA.
- Some of public transportation development projects need public awareness.

The Ministry of Transport (MOT) is responsible for the regulations of P.T services. This implies, for example, that every bus and shared-taxi is required to have a permit, which specifies the route on which it must operate. The number of shared-taxis to operate on a line is also regulated by the MOT. In addition, the MOT only has the right to give a certain bus company the right to operate on a certain line, which is called exclusive rights.

During the second Intifadah (Palestinian uprising, which started in September 2000), the considerable decline in income to most of the population has pushed the MOT to take actions to ease regulations to deal with the condition, including the reduction of permit fees and the increase of the number of granted permits. The ministry considered these measures as ways to reduce the economic burden on the taxi drivers and to a absorb part of the unemployed work force (Issa, 2006). This action could result in the increase in the number of vehicles on some routes more than others, due to not using the principle of accessibility in the process of granting permits.

1.3 Problem Statement

According to statistics of PCBS there is an increase in number of private cars in the Palestinian society over the last years; the percentage of the registered vehicles as private cars was 63.9% in 2010 (PCBS, 2011 a), where it was 74.1% in 2013 (PCBS, 2014 a). This confirms a shift oriented to using private cars rather than using P.T service, and this is the opposite approach to the sustainable development for transport systems. On the contrary, over the last few years, transportation policies in different countries have aimed to shift transport demand from private car to P.T systems. To achieve this objective, the supplied P.T services must be available to as many users as possible. Accessibility measures are useful in helping to identify groups of people and locations with poor levels of access to P.T services and facilities. In Palestine to date measuring of P.T accessibility has been limited. Palestinian MOT and local agencies have never had a specific and an accurate measure to assess local P.T service accessibility and monitoring process of the extent of P.T service in local agencies. Therefore, this thesis investigates in developing index to measuring P.T accessibility at the local agency level, specifically for Nablus City to assist planners and policy makers in the assessment of P.T accessibility level. Accordingly, they work to evaluate and support some policies that evolve planning and operating processes for P.T sector.

1.4 Research Scope and Objective

Numerous methods and measures have been designed to assess P.T accessibility, which reflect differing points of view (e.g., customer versus operator) and for different modes (e.g. fixed-route versus demand-responsive). The aim of this thesis is to suggest a quantitative assessment method for P.T service accessibility. This comprehensive method include measuring access to or from locations of opportunities or activities with P.T service by assessing spatial and temporal availability of P.T service at statistical quarters level. The research will also include making comparison for individual accessibility by P.T mode with private car mode through comparing travel time for these two transport modes.

The method and measures that are of interest in this research are related to intra-city fixed-route P.T service (buses and shared-taxis modes). The results are intended to be used by the planner, the developer, and the user of P.T sector.

The particular objectives for this research are:

1. To measure accessibility levels of intra-city fixed-route public transport by developing a Local Index of Public Transport Availability (LIPTA) at statistical quarter scale in Nablus City.
2. To provide a relatively fast and easily understood measure for comparing accessibility of different transport modes through developing Travel Time Accessibility Index (TTAI) for public transport and private car between specific origins and destinations (O-D's) in Nablus City.

1.5 Research Importance

In transport policy formulation, attributes that give value to transport systems have been progressively changing. While in the past, speed and reduced travel times were the important assets of a good transportation system, currently the relevance of characteristics such as system reliability, low environmental impact, accessibility, and contribution to equity are now more relevant than ever. One of the most principal components of the transportation systems is public transportation, which is considered as an important element in the infrastructure for any society, as it provides mobility to a considerable share of the population. If P.T did not satisfy the population needs in a comfortable and suitable way, a transportation problem will float on surface, which must be faced by traffic and transportation engineers and planners.

Accessibility for P.T can be measured in two approaches; one uses specific measures to determine accessibility levels (from or to) a location of opportunities (to or from) P.T services, and another approach using measures to determine accessibility (through) P.T between specific origin- destination pairs and comparing this with other modes such as private cars. Most of studies in this field use only one of the two approaches to measure accessibility for P.T services. From a scientific point of view, using both approaches to measure accessibility level for the same region as in this research, makes the accessibility measurement process more comprehensive and integrative.

From a practical point of view, determining the accessibility levels by developing LIPTA, which includes studying spatial and temporal coverage, help in creating a framework to evaluate and support some policies that could contribute to improving the operation of P.T systems. This may include identifying number of permitted vehicles for each P.T route and determining the paths and extensions or end points of P.T routes, which must taking into account the principle of accessibility. On the other hand, developing TTAI for P.T and comparing it with private car mode provides easily understood and relatively fast measure for planners and decision-makers who would need quickly to identify the amount and relative difference in accessibility of important locations by specified modes of transport in order to develop actions associated with parking policy, high occupancy vehicle priority, P.T shift orienting, and similar mechanisms.

1.6 Study Area

The study area is Nablus City in the north of West Bank. It is located at latitude 32.13 N and at longitude 35.16 E. Nablus is the second largest city in the West Bank after Hebron in terms of population (PCBS, 2011 b). It is also considered as the largest commercial center, in turn joining the prosperity of economic conditions attracting commercial, shopping, and tourism activities. It has the largest university in the West Bank in terms of number of students.

Thus, Nablus City is considered as large and dense development. In recent years, it has been observed the increase in urban expansion development of the city in general. The Planning Department of Nablus Municipality is working on a plan to expand the master plan of the city especially from the western side to reach for new areas exceeding the current city boundaries. Therefore, the consideration of Nablus City as a case study is an appropriate and representative choice for the purpose of this research. Figure 1.1 shows location of Nablus Governorate with respect to West Bank, where Nablus City is in the heart of the governorates.

Figure (1.1): Location of Nablus in the West Bank

Source: (Palestinian Economic Council for Development and Reconstruction, 2007)

The study area covers statistical quarter boundaries for Nablus City used by the PCBS for 2007 with an area of about (29 K.m^2), with a built-up area of about 30% of the city area (Nablus Municipality, 2012). Figure 1.2 shows boundaries of the study area.

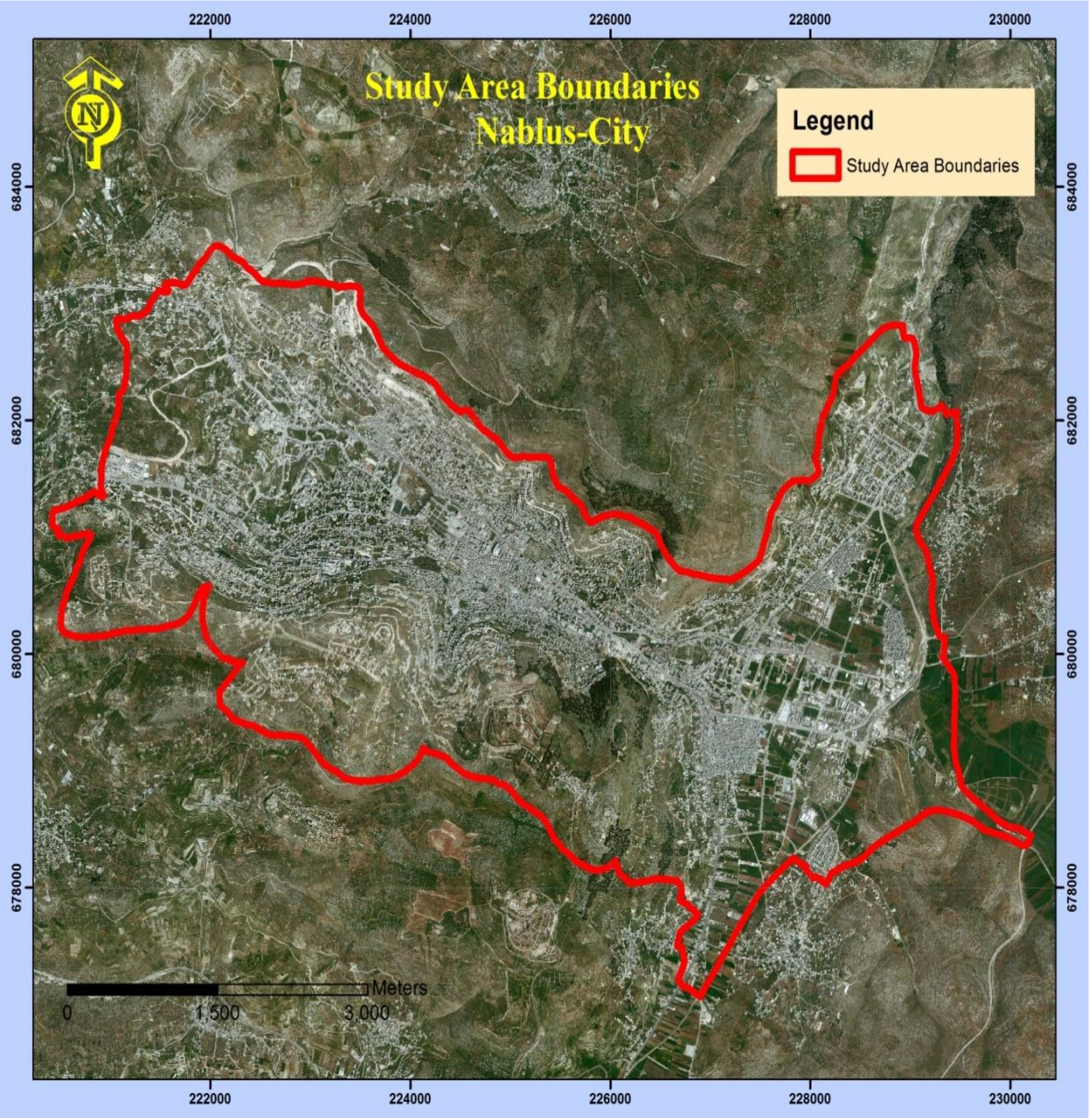


Figure (1.2): Study Area Boundaries

Source: Prepared by the researcher based on data from PCBS (2007)

1.7 Thesis Structure

This thesis is composed of six chapters. Chapter One includes the background and importance of P.T as a means of sustainable and social transportation, objectives, the research importance, study area, and thesis structure. Chapter Two presents a review of definitions and components of accessibility and some of practical applications used to measure P.T accessibility. Chapter Three outlines the data requirements and methodologies used to develop LIPTA and TTAI. Chapter Four explores data collection and manipulation process in preparing for analysis. Chapter Five is the presentation of analysis of collected data and presents and discusses the results. Finally, Chapter six provides the conclusions and recommendations of this study.

Chapter Two

Literature Review

2.1 Introduction

A number of means to measuring accessibility for different modes of transportation has been developed in several studies since the 1950s and continues to receive growing attention in the Public Transport (P.T) sector. In this chapter, a literature review of the theoretical framework of accessibility concepts and some international and local studies designed to measure P.T accessibility reflecting different points of view are presented. The main issues related to accessibility that will be discussed in the following sections are: accessibility definition and components, overview of accessibility measures, P.T accessibility measure, relevant P.T and accessibility studies, and conclusion.

2.2 Accessibility Definition and Accessibility Components

2.2.1 Accessibility Definition in Different Fields

One of the key challenges in this area is how to define accessibility. Various disciplines define accessibility in different ways. For example, in the field of geography; accessibility refers to the relative ease of reaching a particular location or area. In urban planning field, Hansen (1959) defined accessibility as an ability to interact between places or locations; Awadeh (2007) defined accessibility as “the ability of people and goods to move and move smoothly from one place to another”. Therefore, low accessibility levels or (inaccessibility) according to this definition means that the movement of people and goods incur long distances, waste a long time, substantial costs, and other obstacles and restrictions.

In social planning, accessibility refers to people's satisfactions and behaviors. Accessibility also refers to people's ability to use services and opportunities (Litman, 2007). From the perspective of economic development, accessibility understood as the ability of people to reach and participate in activities (Garb, 2002); it enables the exchange of people (labor) and goods (products) and hence an efficient functioning of the economy.

The accessibility to tourist attractions is defined as the ease to access the tourist attraction location, services, and activities. Interaction between attractions and accommodations depends on the distance between these locations, road network connectivity, the attractions' facilities and functions, and the number of tourists travelling between these locations (Al-Kahtani et al., 2009).

Theoretically, accessibility is conceptualized as opportunities (activities, services, goods and facilities) in relation to people who want to access those opportunities, and the convenience or difficulty of getting to the opportunities (Black and Conroy, 1977). Accessibility has been seen in two ways: potential and actual accessibility. Potential accessibility refers to opportunities that can be reached within a specific time or distance (Koeing 1980). Actual accessibility refers only to the physical accessibility to opportunities (Pirie, 1979; Handy and Niemeier, 1997). Ingram (1971) divided accessibility into relative and integral accessibility. Relative accessibility is the degree of accessibility between two points, whereas integral accessibility is the degree of accessibility of one point and all other points in the area.

2.2.2 Access vs. Accessibility

Interrelated issues to be addressed in providing P.T are access and accessibility to this mode of travel. Access is the opportunity for system use based upon proximity to the service and its cost (Jansson, 1993; Murray et al., 1998). If the distances or barriers to access a service are too great at either the trip origin or destination, then it is unlikely to be utilized as a mode of travel. Similarly, if the cost is either too expensive (i.e. cheaper modes exist) or unaffordable then utilization of the service is also unlikely.

Accessibility is the suitability of the P.T network to get individuals from their system entry point to their system exit location in a reasonable amount of time. Thus, accessibility encompasses the operational functioning of a system for regional travel. Access greatly impacts on the P.T system and complements service accessibility. This relationship is illustrated in Figure 2.1. Hillman and Pool (1997) made a distinction between ‘network’ and ‘local’ P.T accessibility. Local accessibility is seen as the accessibility of a particular residential or other location to P.T. Network accessibility is used to describe the accessibility of locations to specific destinations by using P.T. This mean that, the term ‘Network’, as used is close to the term ‘accessibility’ , while the term ‘local’ can be considered similar to the ‘access’ element.

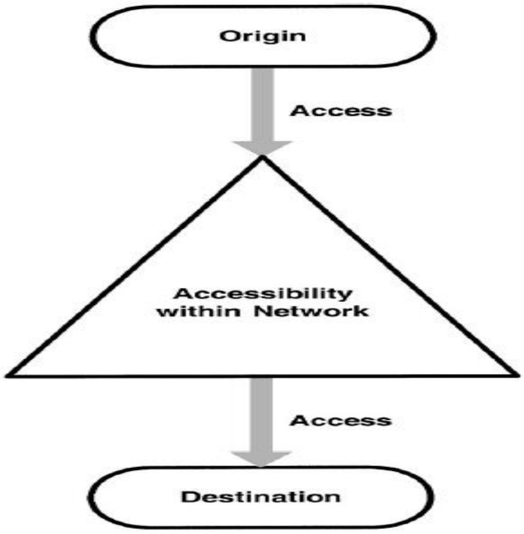


Figure (2.1): Public Transport System Access vs. Accessibility

Source: (Murray et al., 1998)

2.2.3 Accessibility vs. Mobility

The concept of accessibility had been developed, and cast into measurable indicators, in parallel with the concept of mobility. Bhat et al. (2000) credited Hansen (1959) with the first significant scholarly work on the subject. While mobility is concerned with the performance of transport systems in their own right, accessibility adds the interplay of transport systems and land use patterns as a further layer of analysis. Accessibility measures are thus capable of assessing feedback effects between transport infrastructure modal and participation on the one hand, and urban form and the spatial distribution of activities on the other hand. Some accessibility measures also include behavioral determinants for activity patterns in space and time, and the responses of transport users to physical conditions.

The term accessibility is often misused and confused with other terms such as mobility. Mobility measures the ability to move from one place to another

(Hansen, 1959). The word accessibility is derived from the words “access” and “ability”, thus meaning ability to access, where ”access” is the act of approaching something. The word is derived from the Latin (**accedere**) means “to come” or “to arrive.”

Litman (2003) points out that traffic and mobility planning have traditionally been concerned primarily with the movement of motor vehicles (traffic) or people and goods in general (mobility), while accessibility explicitly takes on board the land use–transport connection and handles trip numbers and travel time as indicators. There are a number of inherent conflicts or trade-offs between mobility or traffic and accessibility: for example, roads designed for maximum mobility or traffic throughput usually have poor accessibility for adjacent land uses, while areas where (multimodal) accessibility has been maximized may experience road traffic congestion and parking constraints. Figure 2.2 illustrates the relationship of functionally classified systems in serving traffic mobility and land access.

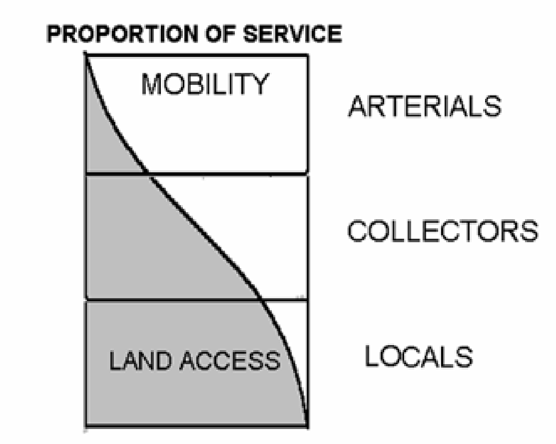


Figure (2.2): Accessibility vs. Mobility

Source: (FHWA, 2000)

2.2.4 Accessibility Definition in Transport Planning

In the specific field of transportation, the definitions and the uses of accessibility vary considerably. Some of the well-known definitions of accessibility include "the ease with which any land-use activity can be reached from a location using a particular transport system" (Dalvi and Martin, 1976). Litman (2003) defined accessibility as the ease of reaching opportunities (goods, services, activities and facilities) at a given destination. Geurs and Van Eck (2001) defined accessibility as "the extent to which the land use–transport system enables (groups of) individuals or goods to reach activities or destinations by means of a (combination of) transport mode(s)". In contrast, Bhat et al. (2000) used the following definition: "accessibility is a measure of the ease of an individual to pursue an activity of a desired type, at a desired location, by a desired mode, and at a desired time". It is notable that Geurs and Van Eck (2001) made specific reference to land use and transport, thus implying that accessibility is intricately linked to, and primarily determined or 'enabled' by transport infrastructure and urbanization patterns, whereas this spatial dimension is not at all emphasized, though still implicit in Bhat's et al. (2000) definition.

Generally, accessibility is defined as some measure of spatial distribution of activities about a point adjusted for the ability and the desire of people and firms to overcome separation. Ingram (1971) stated that accessibility may be defined as "the inherent characteristic (or advantage) of a place with respect to overcoming some form of spatially operating source of friction (for example, time and/or distance)". Black and Conroy (1977) define accessibility as: “the number of opportunities reached within a given travel time or distance”, similarly Hilbers and Verroen (1993) defined accessibility as “the possibility to reach a location within an acceptable amount of time, money, and effort with respect to a specific policy”.

Most of the aforementioned definitions indicate that accessibility is an attribute of transport system. In contrast, Jones (1981) defined accessibility as “it is the ease of reaching opportunities or the ease of being reached”. The author argued that the accessibility is an attribute of people and goods rather than transport modes or service provision and describes integrated systems from a user viewpoint.

2.2.5 Accessibility Components

A number of components of accessibility can be identified from the different definitions and practical measures of accessibility that are theoretically important in measuring accessibility. Four types of components can be identified: land-use, transportation, temporal, and individual (Geurs and Van Eck, 2001).

The transport component is concerned with measures such as travel time, cost, and effort of movement in space. The land use component measures the spatial distribution of activities or opportunities, and contains an assessment of the competitive nature of demand for activities at destinations, and of supply of potential users. The temporal component examines the time constraints users experience for their activity patterns, and the availability of activities or opportunities according to the time of the day, week, or year.

The individual component investigates the needs, abilities, and opportunities of transport users and thus takes in socio-economic and demographic factors. Figure 2.3 shows the relationships between these components and accessibility (as defined previously), and relationships between the components themselves; the land-use component (distribution of activities) is an important factor determining travel demand (transport component) and may also introduce time restrictions (temporal component) and influence peoples opportunities (individual component). The individual component interacts with all other components: a person's needs and abilities that influence the (valuation of) time, cost, effort of movement, types of relevant activities, and the times in which one engages in specific activities. Furthermore, accessibility may also influence the components through feedback mechanisms: i.e. accessibility as a location factor for inhabitants and firms (relationship with land-use component) influences travel demand (transport component). In practice, applied accessibility measures focus on one or more components of accessibility, depending on the perspective taken.

2.3 Overview of Accessibility Measures

2.3.1 Theoretical Framework of Accessibility Measures

Different accessibility measures have been developed over the past decades for various analytical and evaluative purposes. They can be broadly grouped into four types.

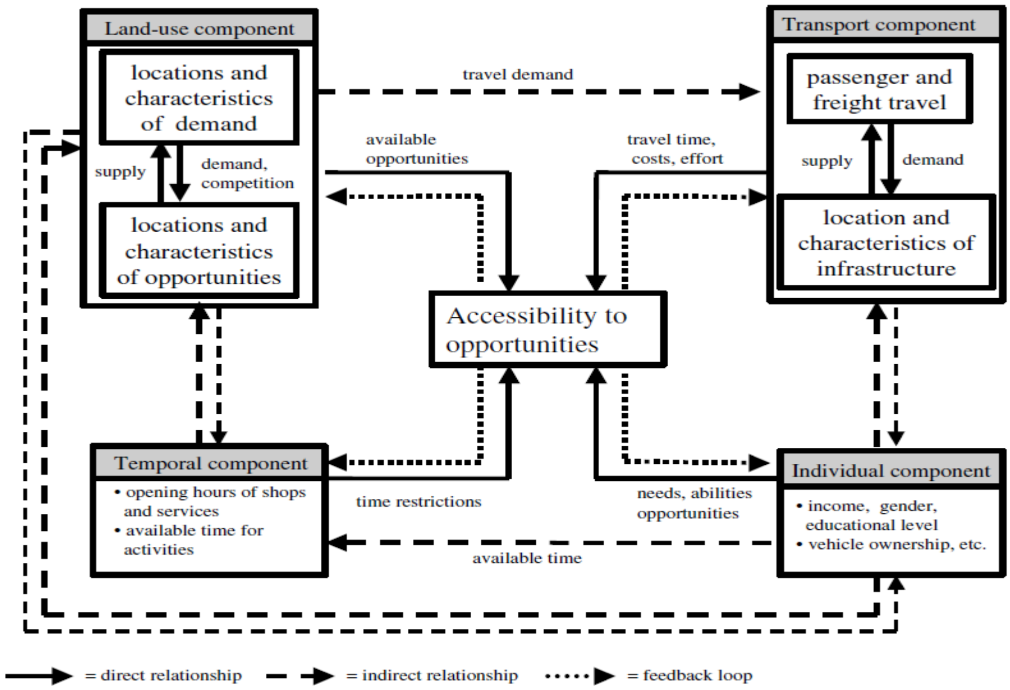


Figure (2.3): Relationships between Components of Accessibility

Source: (Geurs and Van Wee, 2004)

2.3.1.1 Infrastructure-Based Accessibility Measures

Infrastructure-based accessibility measures or (**the spatial separation model identified by Bhat et al. (2000)**) play an important role in current transport policies in many countries, for example, in European countries (Ypma, 2000) and the U.S.A (e.g. Ewing, 1993). Several measures are used to describe the functioning of the transport system, such as travel times, congestion, and operating speed on the road network. For example, policy options from the Dutch National Transport Policy Plan (DNTPP) were evaluated with a national transport model using travelling speed as an accessibility measure (AVV, 2000). The UK Transport 2010 policy plan was evaluated using congestion and total time lost in congestion as accessibility measures. Obviously, the advantages of this type of accessibility measure are related to the criteria of operationalization and communicability; the necessary data and transport models are often readily available and measures are easy to interpret for researchers and policy makers. However, this measure type does not incorporate the land-use component, and are not very capable of treating temporal constraints and individual characteristics. This may strongly affect the conclusions on accessibility.

2.3.1.2 Location-Based Accessibility Measures

Several types of location-based measures are used in accessibility studies. The distinguishable groups of measures are distance, contour, and potential measures.

Distance measures (also called connectivity measures) are the simplest class of location-based accessibility measures, e.g. the relative accessibility measures developed by Ingram (1971). Distance measures are often used in land use planning as standards for the maximum travel time or distance to a given location or to transport infrastructure. If more than two possible destinations are analyzed, a contour measure is derived.

A contour measure, (also known as isochronic measure, cumulative opportunities, proximity count, or daily accessibility) counts the number of opportunities, which can be reached within a given travel time, distance, or cost (fixed costs), or measure of the (average or total) time or cost required to access a fixed number of opportunities or (fixed opportunities). This measure is popular in urban planning and geographical studies (e.g. Gutierrez and Urbano, 1996; Bruinsma and Rietveld, 1998).

The advantages of distance and contour measures are related to the operationalization, interpretability, and communicability criteria. These measures are relatively undemanding of data and are easy to interpret for researchers and policy makers, as no assumptions are made on a person's perception of transport, land-use and their interaction. However, the distance and contour measures clearly have some disadvantages. Firstly, the measures include elements from the land-use and transport component, but fail to evaluate their combined effect. Secondly, the measures do not take competition effects into account, i.e. the spatial distribution of the demand for an opportunity and possible capacity restrictions of provided opportunities (e.g. for jobs, schools, and hospitals). Thirdly, the measures do not take individuals perceptions and preferences into account, i.e. the measure implies that all opportunities are equally desirable, regardless of the time spent on travelling or the type of opportunity.

Potential accessibility measures (also called gravity-based measures) have been widely used in urban and geographical studies, and it is derived from the denominator of the gravity model for trip distribution (Sonesson, 1998). Originally the gravity was theoretically justified in the analogy to a law of physics. Subsequently, arguments from statistical theory were used to support an exponential form of the model. Gravity-based measures were first devised by Hanson (1959), and have since then been widely used. They are obtained by weighting opportunities in an area with a measure indicating their attraction and discounting them by impedance measure (e.g. Kwan, 1998; Handy and Niemeier, 1997).

The potential measure overcomes some of the theoretical shortcomings of the contour measure; the measure evaluates the combined effect of land-use and transport elements, and incorporates assumptions on a person's perceptions of transport by using a distance decay function. On the other hand, it has some of disadvantages; since the measure is not easily interpreted and communicated as it combines land-use and transport elements, and weighs opportunities (according to the cost sensitivity function). Theoretical shortcomings are related to the exclusion of competition effects and temporal constraints.

2.3.1.3 Person-Based Accessibility Measures

Person-based accessibility measures (**individual measures, constrained – based measures)** are founded in the space-time geography of Hägerstrand (1970). The measures analyze accessibility from the viewpoint of individuals incorporating spatial and temporal constraints; i.e., whether and how observed or assuming individual or household activity programs can be carried out given time restrictions using space-time prisms to describe the travelling patterns in space and time. These space−time prisms can be regarded as accessibility measures, i.e., they give the potential areas of opportunities that can be reached given predefined time constraints. Although space-time approaches seem to have a fast growing interest in travel behavior research (Bhat and Koppelman, 1999), their application in accessibility studies is relatively rare. Recent applications are taken from Kwan (1998) and Recker et al. (2001).

Person-based measures have great theoretical advantages; Kwan (1998) demonstrated that space−time-based measures capture activity-based contextual effects, which are not incorporated in traditional location-based accessibility measures. This allows more sensitive assessment of individual variations in accessibility, including gender and ethnic differences. A remaining theoretical shortcoming is that up to now person-based approaches do not account for competition effects; the measures are demand-oriented and do not include potential capacity constraints of supplied opportunities (e.g. available hospital beds, job vacancies). However, the strongest disadvantages are related to operationalization and communicability. Despite advances in Geographic Information System (GIS) and spatial modeling, operationalization of person-based accessibility measures still faces many difficulties, including the detailed individual activity travel data required, their computational intensity, and the lack of feasible operational algorithms (Kwan, 1998). An important application difficulty is that necessary data on an individual's time budgets are often not available from standard travel surveys (Thill and Horowitz, 1997).

2.3.1.4 Utility-Based Accessibility Measures

Utility-based measures are based on random utility theory, and consist of the denominator of the multinomial logit model, also known as logsum (Handy and Niemeier, 1997; Sonesson, 1998). Utility theory is based on the assumption that individuals maximize their utility. This means that the individual gives each destination a utility value, and that the likelihood of an individual choosing a particular destination depends on the utility of that choice compared to the utility of all choices (Sonesson, 1998). The utility function contains variables representing the attributes of each choice, reflecting the attractiveness of the destination, the travel impedance, and the socio-economic characteristics of the individual or household. These measures occasionally resemble gravity-based measures, but with theoretical and empirical advantages (Handy and Niemeier, 1997).

The advantage of utility measures is that they enable the testing of alternative formulations of the utility function in the search for one that best matches actual travel behavior. The calibration determines the relative importance of various factors and need not be pre-specified as in the case of gravity-type measures.

2.3.2 Recommendations to Evaluate Accessibility Measures

Accessibility is a multifaceted concept, not readily packaged into a one-size-fits-all indicator or index. In Litman's (2003) words, "there is no single way to measure transportation performance that is both convenient and comprehensive". However, Geurs and Van Wee (2004) produced a checklist of recommendations of how any accessibility measure should behave, regardless of its perspective (or combinations thereof):

1. Accessibility should relate to changes in travel opportunities, their quality and impediment: "If the service level (travel time, cost, and effort) of any transport mode in an area increases (decreases), accessibility should increase (decrease) to any activity in that area, or from any point within that area".
2. Accessibility should relate to changes in land use: "If the number of opportunities for an activity increases (decreases) anywhere, accessibility to that activity should increase (decrease) from any place".

3. Accessibility should relate to changes in constraints on demand for activities: “If the demand for opportunities for an activity with certain capacity restrictions increases (decreases), accessibility to that activity should decrease (increase)”.
4. Accessibility should relate to personal capabilities and constraints: “An increase of the number of opportunities for an activity at any location should not alter the accessibility to that activity for an individual (or groups of individuals) not able to participate in that activity given the time budget”.
5. Accessibility should relate to personal access to travel and land use opportunities: “Improvements in one transport mode or an increase of the number of opportunities for an activity should not alter the accessibility to any individual (or groups of individuals) with insufficient abilities or capacities (e.g. driver’s license, education level) to use that mode or participate in that activity”.

2.4 Public Transport Accessibility Measures and Relevant Public Transport and Accessibility Studies

Accessibility for P.T could be considered into several different ways that affect on the kinds of methodologies which can be used, this including:

- Accessibility from a location to public transport services.
- Accessibility of the transport system to activities and opportunities such as jobs, education etc.
- Comparison of accessibility by different modes.

According to P.T accessibility definition, Polzin et al. (2002) described the importance of considering temporal elements as well as geographical or spatial elements. These include the time span of the service and frequency. Another distinction was made between availability and quality of P.T to help measure accessibility. Availability refers to the number of services and ease of access while the quality is a measure of the service provided once it has been accessed. One definition found to incorporate all of these elements is Litman (2008) who defined P.T accessibility as "the quality of transit serving a particular location and the ease with which people can access that service".

2.4.1 Public Transport Accessibility Measures

Attempts to develop P.T accessibility measures had been discussed in several studies since the 1950s and continue to receive growing attention in P.T sector (Schoon et al., 1999). Through these attempts different measures have been designed to reflect differing points of view, this subsection provide brief description of the related concepts and few of these attempts.

Some of the measures of P.T accessibility focused on local accessibility and considered both spatial and temporal coverage. The Time-of-Day-Based transit accessibility analysis tool developed by Polzin et al. (2002) is one measure that considers both spatial and temporal coverage at trip ends. In addition to the inclusion of supply side temporal coverage, this tool explicitly recognizes and considers the demand side of temporal coverage by incorporating the travel demand time-of-day distribution on an hourly basis.

A number of P.T accessibility indices have been adopted by various governing bodies in the U.S.A, U.K, and different countries. These have been adopted at various levels of government from local authority to state or national level (New Zealand Transport Agency, 2008). In the U.S.A the Transit Capacity and Quality of Service Manual (TCQSM) (2003) provides a systematic approach to assessing transit availability as well as quality of service from both spatial and temporal dimensions. Multi-modal Level of Service (LOS) for P.T have been developed based on similar ratings used for road capacity LOS in the widely used Highway Capacity Manual (HCM, 2000). The Transportation Research Board released a Transit Capacity and Quality of Service Manual in 1999 updated by Kittelson and Associates (2003); this contained multi-modal LOS indicators developed for all transport modes including specific ratings for P.T, with the aim of generalizing the measures for easy calculation and understanding.

TCQSM measures P.T accessibility of a system as a percentage of the transit-supportive area (TSA) covered by the service coverage area. TSA reflects the area with either a minimum household density or employment density that capable of supporting hourly transit service. Therefore, TSA identifies areas that need transit service based on minimum density criteria.

The public Transport Accessibility Level (PTAL) index developed in London, England is another measure that considers both the space and time dimensions of local transit availability (Kerrigan and Bull, 1992; Hillman and Pool 1997). It is essentially a measure of the density of the transit service at a point of interest in space. The computation of the index involves first calculating a measure of scheduled waiting time (SWT) based on scheduled service frequency. A mode-specific reliability factor was then added to the

SWT to produce the average waiting time (AWT). The sum of the AWT and the walk time from the point of interest to a transit access point gives the total access time, which was then converted to an Equivalent Doorstep Frequency **(EDF)** such that:

$$\boldsymbol{EDF(minutes) = \frac{30}{total\ access\ time\ (minutes)}} \ldots\ldots\ldots\ldots\ldots (\mathbf{3.1})$$

The $(\boldsymbol{EDF})$ values corresponding to all the routes within the catchment area of the point of interest are combined to give an accessibility index $\boldsymbol{(AI)}$:

$$\boldsymbol{AI = EDF_{max} + (0.5 * Sum\ of\ All\ Other\ EDFs)} \ldots\ldots\ldots\ldots.\ldots\ldots (\mathbf{3.2})$$

In the previous equation, the $(\boldsymbol{EDF})$ values for all but the most accessible or dominant route was halved to compensate for the fact that (1) the number of routes actually considered by a user are likely to be fewer than that included in the calculation; and (2) riders often have to change routes in order to reach the desired destination, leading to significant transfer delays to the journey. If more than one transit mode is present in the catchment area, the $\boldsymbol{(AI)}$ calculation is repeated for each available mode and the values are summed across all modes to give the PTAL index. The value of the PTAL was then mapped to six levels, with level 1 being the lowest level of accessibility and 6 being the highest. It should be noted that since the computation of PTAL was with reference to a point of interest and not the customers themselves, the measure accounts for the supply but not the demand of transit service.

There are few studies that paid attention to the comfort and convenience aspect of P.T service. Henk and Hubbard (1996) outlined the development of a transit availability index using factors designated as most effectively able to quantify the availability of service. The three factors proposed were capacity, frequency of service and areal coverage. Similarly, the Local Index of Transit Availability (LITA) is derived from the combination of these three factors. The LITA was developed with the intention to provide interested parties with a visual and quantitative representation of transit service availability through a grade assignment system. LITA relates the amount of transit service in an area to the region's population and land area.

LITA has been employed in several areas. Rood (1998) initially documented the use of the LITA for Riverside County, California. Other areas of use include Bradford, England (Pennycook et al., 2001), Vancouver, Canada (Vancouver Transit Accessibility, 2007), and Addis Ababa. Furthermore, the index is advocated by organizations such as the United States Environmental Protection Agency (EPA, 2009), the West Coast Environmental Law Organization, British Columbia (West Coast Environmental Law, 2008), and the Sustainable Communities Network (Smart Growth Online, 2009).

A beneficial characteristic of the LITA is the ability to assess transit intensity at several spatial levels for which population, transit and land area data are available. An additional benefit of the index is the ability to characterize results through the use of geographic information systems (GIS).

Fu et al. (2005) proposed an Origin-Destination based approach called Transit Service Indicator (TSI) to evaluate transit network accessibility by combining the various temporal attributes into one composite measure. To develop the TSI for a single O-D pair, they used ratio of the weighted door-to-door travel time by auto to the weighted door-to-door travel time by transit. Schoon et al. (1999) formulated another set of Accessibility Indices (travel time AI and travel cost AI) for different modes between an O-D pair. Travel time AIs for a particular mode was calculated using ratio of the travel time of a particular mode to the average travel time across all modes. Cost AIs were calculated in much the same way. For a given mode, such as transit for example, the AI is defined as:

$$\boldsymbol{AI_{bus}} = \frac{\boldsymbol{travel\ time\ by\ bus}}{\boldsymbol{average\ travel\ time\ across\ all\ modes}} \ldots\ldots.(\mathbf{3.3})$$

A variety of P.T accessibility measures have been proposed and have been defined on the basis of a wide range of concepts. Some methods measure accessibility level on the basis of access variables (e.g., spatial, temporal, and comfort, etc.), but without reflecting the actual need for transit services. A new approach to identify the geographical gaps in the quality of public transit service was developed by Currie (2004). This needs gap approach assesses the service of public transit by comparing the distribution of service supply with the spatial distribution of transit needs. Another study by Currie, et al. (2007) quantifies the associations between shortage of transit service and social exclusion and uniquely links these factors to the social and psychological concept of subjective well-being. The study investigates the equity of transit service by identifying the transport disadvantaged groups and evaluating their travel and activity patterns.

Bhat et al. (2006) described a customer-oriented, utility-based Transit Accessibility Measure (TAM) to identify the inequality between transit service provision and the level of transit need within a community. The TAM index combined the transit accessibility index (TAI) with the transit dependence index (TDI). This measure identifies the users who need the service most by comparing the level of service supply with the level of demand by the transit user.

The different methods, their coverage of analysis, the incorporated measures, and the most important features of the methods are summarized in Table (2.1).

Table (2.1): Summaries of Some of Public Transport Accessibility Measures

Author	**Type of Measure**	**Reflecting Local Accessibility**		**Reflecting Network Accessibility**	**Incorporated Accessibility Measure(s)**	**Important Feature**	**Computational Complexity**	**Intended Users**
		Spatial Coverage	Temporal Coverage					
TCQSM (2003)	LOS	Yes	Yes	No	Service Frequency, Hours of Service, Service Coverage, Demographic data.	LOS Concept	Some Technical Skill	Transit Operator Transit User
Rood (1998)	LITA (Grade)	Yes	Yes	Yes	Service Frequency, Vehicle Capacity, Route Coverage.	Comfort and Convenience	Little Technical Skill	Property Developer

Bhat et al. (2006)	TAI & TDI (Index)	Yes	Yes	Yes	Access distance, Travel time, Network Connectivity, Service Frequency, Hours of Service, Vehicle Capacity.	Transit Dependency Measure	Transportation Specialist	Transit Planner Transit Operator Transit User
Hillman And Pool (1997)	PTAL (Index)	Yes	Yes	Yes	Service Frequency, Service Coverage	Agg. Travel Time between O-D pairs	Transportation Specialist	Transit Planner Transit Operator

Table (2.1): Summaries of Some of Public Transport Accessibility Measures

Author	**Type of Measure**	**Reflecting Local Accessibility**		**Reflecting Network Accessibility**	**Incorporated Accessibility Measure(s)**	**Important Feature**	**Computational Complexity**	**Intended Users**
		Spatial Coverage	Temporal Coverage					
Currie et al. (2004)	Supply Index & Need Index	Yes	Yes	Yes	Service Frequency, Service Coverage, Travel time, Car Ownership, Demographic data.	Transport Needs Measure	Some Technical Skill	Transit Planner Transit Operator Property Developer
Polzin et al. (2002)	Time-of-Day tool (Index)	Yes	Yes	No	Service Coverage, Time-of-Day, Waiting Time,	Time-of-Day Trip Distribution	Transportation Specialist	Transit Planner

					Service Frequency, Demographic data			
Fu et al. (2005)	TSI (Index)	Yes	Yes	Yes	Service Frequency, Hours of Service, Route Coverage, Travel time components	Weighted Travel Time	Some Technical Skill	Transit Operator
Schoon et al. (1999)	AI (Index)	No	No	Yes	Travel Time, Travel Cost	Travel Cost	Little Technical Skill	Transit Planner Transit User

Source: (Al-Mamun and Lownes, 2011)

2.4.2 Relevant Public Transport and Accessibility Studies

2.4.2.1 Exploring and Modelling the Level of Service of Public Transport in Urban Areas: An-Application to the Greater Toronto and Hamilton Area (GTHA), Canada (Wiley, 2009)

In this study the author examined transit service intensity at the census tract level by assembling and analyzing a suitable GIS database for the Greater Toronto and Hamilton Area (GTHA). This research utilized an improved version of the LITA, which derives service levels based on the coverage, capacity, and frequency of the transit system. The calculation of an overall LITA score for each census tract was based on a composite of three individual index scores; frequency, capacity, and service coverage.

Each index was derived based on a computation representative of the index. The frequency component of the LITA was derived from the total number of transit vehicles on all of the route lines to enter and stop at least once in a tract over a twenty-four hour period. Since the size of tract affect on frequency score, the author divided the number of vehicles entering a tract by the developing area of the tract. The capacity measure for the LITA used an assortment of variables to gauge the ability of the transit service to accommodate the population of the tract; the computation of the index was based on the capacity (seats) of the total transit vehicles entering the tract, the length transit route within a tract, and the resident population and the employment corresponding for each census tract. The service coverage component was based on the density of transit stops. It was a simple ratio of the total number of transit stops completely within or bordering a tract to the area of developed land in the tract.

Finally, for every index, the scores of the census tracts are standardized to produce standard scores (Z-scores), an overall LITA transit Z-score was found by averaging the Z-scores from each index computed for a given tract. Classification scheme was implemented for the standardized Z-scores. A ranked percentile scheme was employed to categorize levels of transit. For each region, the total number of scores was divided into five quintiles.

Results indicated that the core areas of municipalities were not necessarily well serviced by public transit. Suburban peripheral tracts and those adjacent to the shoreline were characterized by average transit service at best level, and tracts adjacent to municipal borders indicated discontinuity in transit service.

2.4.2.2 Accessibility Indices: Pilot Study and Potential Use in Strategic Planning (Schoon, 1999)

Accessibility indices (AIs) for public and private transport were estimated in a pilot study in north east Hampshire. The AIs were based upon a formulation relating travel time and cost between specified origins and destination (O-Ds). The pilot study examined the role of the indices for wider use, particularly in reducing car dependency as one element in improving sustainability within the North East Hampshire Transport Strategy (NEHTS). The indices, which can be presented in simplified graphical fashion, are based upon door-to-door travel times and costs, and the O-Ds represent trips between home and important destinations. The main activities in formulating the indices as tools for describing existing accessibility between specified AIs in this study were summarized as follows:

1. Travel time estimates for private cars were made based upon the travel distances using available routes, travel speeds, and the access times for 'door to door' trips. The travel times for bus trips were based upon the scheduled arrival and departure times plus the walking times at each end of the trip and the waiting time for the bus to arrive.
2. The average travel cost for each of the trips by the different modes was determined. For P.T, fares comprised the total cost. For private cars, an average out-of-pocket operating cost and, when applicable, parking fees were the major costs. The private car costs were divided by average car occupancy to permit comparisons between modes on a person to person basis.
3. AIs for travel time were calculated. This was done by dividing each of the times for each mode by the un-weighted average time, to provide a comparison based upon a common level. This was expressed as:

   Car travel time AI = Time by car / (Time by car + Time by bus) / 2

   Bus travel time AI = Time by bus / (Time by car + time by bus) / 2
4. AIs for travel cost were calculated. This was done in a similar way to the AIs for travel time, in item 3, above.

The study was conducted on 15 O-D pairs in the study area. The general findings for each of the fifteen case studies a descriptive and a numerical/graphical summary were made in order to provide details of the individual O-Ds and associated travel corridor services. Bus trips in general take considerably longer than car trips between the same O-Ds, varying approximately from between one third to 2.5 times as long. Bus users' travel times ranged between 18 minutes and 61 minutes with an average of 41 minutes. The travel times by car were significantly lower compared with the bus travel times. On average, travel times by bus were more than twice those by car. The travel time AIs reflect the travel times related to the average values. The average travel time AI for buses was 1.4, compared to 0.6 for cars, thus indicating the far greater travel times by bus.

2.4.2.3 A Composite Index of Public Transit Accessibility (Al-Mamun and Lownes, 2011)

In this research the authors used a composite index to assessing accessibility of public transit, and they selected three methods for application in a case study in Meriden, Connecticut. Inconsistencies were noted across the methods, and a consistent grading scale was prepared to standardize scores. Finally, they proposed weighting factors for individual methods to formulate a composite measure based on individual accessibility component measures. This approach aimed to provide a robust and uniformly applicable measure that can be interpreted easily by planners to identify shortcomings in service coverage and promote equity in transit accessibility in the community.

Authors considered accessibility to had three primary components: (1) trip coverage - travelers would consider public transit accessible when it is available to and from their trip origins/destinations, (2) spatial coverage - travelers would consider public transit accessible when it is within reasonable physical proximity to their home/destination, and (3) temporal coverage - a service is accessible when service is available at times that one wants to travel. Another key aspect of public transit service is comfort. On this basis, three methods (LITA, TCQSM (2003), and Time-of-Day Tool) were selected to characterize the three transit accessibility coverage (trip, spatial coverage, and temporal coverage) aspects.

Analysis was conducted on the 17 census tracts of Meriden; LITA measured the transit service intensity of an area, TCQSM (2003) incorporates a service coverage measure to assess transit accessibility. GIS method was used to calculate the service coverage area, which requires overlying of different maps (i.e., study area map, transit map, etc.). To identify the spatial service coverage area, a 0.25-mile (400 meters) radius buffer area was applied around transit stops. The Time-of-Day Tool measure transit service accessibility using time-of-day travel demand distribution and provides the relative value of transit service provided for each specific time period.

The accessibility results for all census tracts in original scales for each method can be obtained, but to get a comparable picture of accessibility using the results of these methods, the results must be interpreted in terms of the applicable consistent grading scale. The limiting feature of this research is that this method cannot be directly generalized to all areas or to those that need to measure the level of transit accessibility with methods that are more sophisticated. This composite accessibility result cannot reflect the changes in accessibility level for the micro-level changes in socioeconomic and demographic characteristics (i.e., car ownership, income level, etc.) of transit users. In addition, the composite accessibility index can have different meanings in different areas.

2.4.2.4 Accessibility for Public Services in Irbid, Jordan (Al-Sahili and Abu-Ella, 1992)

In this study, the authors relied on descriptive accessibility by making a circle buffer representing the maximum walking distance for every service or facility in the coverage area, which was used as an indicator to identify areas serviced in whole or in part, or non-serviced. The authors took into account P.T network mainly to measure accessibility of 17 zones in Irbid city. The analysis showed that public service accessibility levels were proportional to the number of people being served by P.T.

Al-Sahili and Abu-Ella (1992) defined coverage area as a maximum distance or time that can be travelled by a person from the place (origin of trip) to the service center to be accessible (destination). They showed several methods to measure accessibility including theoretical methods, which were difficult to apply, and others that depend on measure of travel distance or time as criteria to measure and evaluate accessibility for each individual public service. In this study, the researchers showed in the literature review section some of public service accessibility analysis studies that used the gravity model.

2.4.2.5 Accessibility Measures to Public Services in Palestinian Cities-The Case of Nablus City (Awadeh, 2007)

Awadeh (2007) studied and analyzed the current situation of public services for Nablus City as a case study in Palestine through the application of certain accessibility measures to these services. The methodology of the study was based mainly on the descriptive and analytical methods using the available data and the field survey of public services as well as the results of the questionnaire distributed to a random sample in the city to measure the accessibility and determine the difficulties in access to these services.

The researcher distinguished among several levels of public service accessibility measures and analysis. On the first level of services that serve the city-wide. For example, for health services field analysis (measuring trip travel time) was used to study accessibility of health services such as hospitals. The travel time was determined by the following steps:

1. Divide the study area into 24 residential neighbourhoods (Zones).
2. Identify the geographical centers of the housing units in each zone.
3. Linking the geographical centers of each zone to location of target service through specific paths on transport network (usually the same paths used by P.T vehicles).
4. Measuring of travelling time in the field from the neighbourhood centers to the public service locations. That through analysing the values of distance, which the researcher measured in kilometres from the odometer, average vehicles speed to each route, and measured time in minutes by timer.

For second level of services, which concerns on the service which is presented to the residential neighbourhood, such as educational services, the researcher used the principal of coverage area criteria that corresponds for each type of services, through GIS buffer and determines the influence area for each service. According to the third level of services, which were services that differ in its type of service, a descriptive analysis (questionnaire) used to study the different opinions of people about the reasons of difficulty (inaccessible) to reach of public service.

The results of the study showed that the presence of P.T near place of residence makes the public services in the city more accessible. The lines (routes) of P.T were well dispersed in the city, which covers these neighbourhoods. But difficulty of access (inaccessibility) for some of public services from people's point of view is related to many factors such as: not owning a private car, the presence of traffic congestion, and lack of P.T service in some zones in the study area.

2.5 Conclusions

The concept of accessibility varies, depending on its aims and the scientific field in which the concept arises. In this study, the major objective is to suggest a quantitative assessment comprehensive method for measuring P.T service accessibility. Therefore, the more accessibility definition fits this objective, which is Bhat et al. (2000) definition, it is: "Accessibility is a measure of the ease of an individual to pursue an activity of a desired type, at a desired location, by a desired (P.T) mode, and at a desired time". This definition focuses on individual, transport, and temporal of accessibility components.

P.T, specifically intra-city services, in Palestine differs significantly from the P.T systems in other countries, especially in terms of ownership and daily operation as well as other characteristics. This service is privately owned and the daily operation is not well organized. It is a fixed-route to serve specific areas within a city. This leads to the absence of eligible data that can be relied on for analysis. Therefore, several methods and measures that have been discussed before to measure P.T accessibility are difficult to apply in this case, but the study can take advantage of some parts of these studies. The most appropriate method to measure P.T accessibility here is that method, which uses several complementarily, measures such as: spatial coverage, temporal coverage, comfort and convenience, and travel time comparison for different transport modes.

All the aforementioned studies enable the researcher to understand some of important points, which are related to P.T accessibility. These points assist in understanding the research purpose, and preparing best measuring methodology. These are as follow:

1. GIS technology is an important tool to measure P.T accessibility.
2. The main three elements that affect P.T accessibility are (spatial coverage, temporal coverage, and comfort and convenience).
3. Time span, travel time, and frequency of services are important indicators for temporal component of P.T accessibility.
4. LITA is a robust measure to determine P.T accessibility levels at local agencies scale.
5. Studying satisfactions of P.T users about the quality of service as an indicator of comfort and convenience component for this study is more appropriate than capacity index used by Wiley (2009). However,

this is not done in this study and instead it is recommended in future research.

6. Coverage index used by Wiley (2009) is easy to apply. But since the P.T stops in this study area are not well determined; therefore, identifying percent of people being served by P.T service for each statistical quarter is more appropriate indicator for coverage component of LITA.
7. The method used by Awadeh (2007) to measure P.T travel time can be applied. But in order for the study to be more comprehensive, the researcher can adopt a comparative value of travelling time to P.T and private one.

There are several different ways of considering accessibility for P.T, which affect the kinds of methodologies that can be used. These methods include accessibility from a location to P.T services, accessibility of the transport system to activities and opportunities, and in addition to studies that compare the accessibility for different transport modes. Therefore, the methodology that will be used in this study will rely mainly on LITA developed by Rood (1998), modified LITA by Wiley (2009), and travel time AI developed by Schoon (1999) with some modifications to suit the characteristics of the study area.

Chapter Three

Methodology

3.1 Introduction

To encourage and sustain P.T ridership, the service must be provided to meet the travel needs of the desired audience. P.T availability is a fundamental factor, which can greatly influence an individual's modal choice decision for their weekday travel needs. As captured in the review of the literature, assessment of P.T availability at an appropriate spatial scale can be an extremely valuable tool to P.T providers and municipal planners endeavoring to design policies to increase P.T ridership and implement smart growth development strategies. The purpose of this chapter is to describe the methodologies to assess P.T service levels within each of the designated Nablus City statistical quarters, and to compare accessibility between P.T and private car.

This chapter begins with assessing P.T availability levels and discusses the methodology employed to develop Local Index of Public Transport Availability (LIPTA). Then, the methodology to develop Travel Time Accessibility Index (TTAI) is described.

3.2 Assessing Public Transport Availability Levels

The LIPTA is an index that will be developed by modifying the typical Local Index of Transit Availability (LITA), which was proposed by Rood (1998) through integrating three factors. These are capacity, frequency of service, and area coverage. Similarly, the LIPTA is derived from combination of spatial coverage and temporal coverage with the intention to provide a visual and quantitative representation of P.T service availability through a grade assignment system.

3.2.1 Spatial Coverage Component

Being the first points of contact between the passenger and the P.T service, access to P.T stops is an important factor affecting overall P.T trip travel time. Physical access to P.T stop is interpreted in terms of the proximity of the passenger's origin or destination to the nearest P.T stop (TCRP, 1996), which is generally achieved by walking, riding a bicycle, or driving a car for a short distance (Murray and Wu, 2003). In planning for the provision of intra-city P.T service, accessing a P.T stop is considered to be achieved mainly by walking. Based on typical average walking speed of about 1.2 m/s, 5 minutes of walking is considered reasonable in urban areas, which is about 400 meters in terms of walking distance (Levinson, 1992). Most P.T service providers consider 400 meters an acceptable access/egress standard (Ammons, 2001). In Columbus, Ohio, it is stipulated that passengers do not exceed walking distances of 400 meters to P.T stops in urban areas (Central Ohio Transit Authority, 1999).

According to TCQSM (2003), service coverage is a measure of the area within walking distance of P.T service. TCQSM (2003) defined the area covered by a particular route as the air distance within 400 meters of a bus stop or 800 meters of a busway or rail station. This area can be performed by drawing appropriately sized circles around P.T stops using GIS software. However, this methodology does not embody any service coverage factors, as the effects of grades on walking distances, the proportion of older adults in the population, and the difficulty of crossing some streets. In addition, the number of people within walking distance is overestimated because a lack of pedestrian connectivity could reduce an area's access to P.T. Therefore, the TCQSM (2003) introduces four refinement factors to correct each P.T stop's service area. These factors are a street connectivity factor, a grade factor, a population factor, and a pedestrian crossing factor. In this way, each ideal P.T stop's service radius is reduced in proportion to the weight of each factor. This can be expressed mathematically as shown in equation (3.1):

$$\boldsymbol{r_s = r_o f_{sc} f_g f_{pop} f_{px}} \quad \text{..................} \ (3.1)$$

Where:

$\boldsymbol{r_s}$: Transit stop service radius (mi, m).

$\boldsymbol{r_o}$: Ideal transit stop service radius (mi, m), this value typically equals 0.25 mi (400 meters) for bus stops, and 0.5 mi (800 meters) for busway and rail stations.

$\boldsymbol{f_{sc}}$: Street connectivity factor.

$\boldsymbol{f_g}$: Grade factor.

$\boldsymbol{f_{pop}}$: Population factor.

$\boldsymbol{f_{px}}$: Pedestrian crossing factor.

Previous methodologies provide simple estimates for access coverage; however, they are unrealistic and have potential for error by measuring the access distance in terms of a rectilinear distance and ignoring the actual geography of the pedestrian road network surrounding the stops. Therefore, in this research, to be more accurate and using the benefits of the GIS network analysis functions, the determination of service coverage will be on the basis of the actual walking distance on pedestrian road network. Therefore, calculating service area that creates a series of polygons representing the distance from a facility (P.T stop) with impedance values at which to break the service area polygons as break distance equal to “transit stop service radius” will be used.

After determining the service area coverage for each statistical quarter in the study area, the percent of people being served by P.T service will be determined using overlay and proximity analysis by GIS on collected spatial distribution of the residential units’ data. This method eliminates the error associated with the assumption of uniform population distribution over statistical quarter, which is used through simple buffer method.

3.2.2 Temporal Coverage Component

The temporal aspect of P.T availability is important because a service within walking distance is not necessarily considered as available if wait times beyond a certain threshold level are required. This wait time for P.T is related to the frequency of the service as well as the threshold for tolerable waits for potential riders (Polzin et al., 2002).

The temporal coverage component for LIPTA is derived from weighted composite average frequency for each statistical quarter. This depends on the average number of trips for each P.T vehicle, which works on specific fixed P.T route per day per direction.

Since a quarter might have multiple P.T fixed route operated, and the specific P.T fixed route might be branched to multiple sub-P.T fixed routes, the weighted composite average frequency ($\boldsymbol{WCAF}$) are computed in two steps. First, determine a composite average frequency ($\boldsymbol{CAF}$) for each segment of major P.T fixed routes, which combines the frequencies of different sub-P.T fixed routes operated on the same path as follows:

$$\boldsymbol{CAF} = \sum_{i=1}^{n} \boldsymbol{f_i} \quad (3.2)$$

Where:

$\boldsymbol{f_i}$: Average daily frequency of sub-P.T fixed route.

$\boldsymbol{n}$: Number sub-P.T fixed routes operated on the same path.

Then, to derive the frequency for the entire statistical quarter, the composite average frequency weighted by service area to arrive at the weighted composite average frequency ($WCAF$), which is calculated as follows:

$$\boldsymbol{WCAF_k} = \sum_{i=1}^{n} \left(\frac{A_{ki}}{A_k}\right) \boldsymbol{CAF_i} \quad (3.3)$$

Where:

$\boldsymbol{WCAF_k}$: weighted composite average frequency for statistical quarter $\boldsymbol{k}$.

$\boldsymbol{A_{ki}}$: Area of overlapping between the service area of the P.T segment i and statistical quarter $\boldsymbol{k}$ (m^2).

$\boldsymbol{A_k}$: Total area of statistical quarter $\boldsymbol{k}$ (m^2).

$\boldsymbol{CAF_i}$: Composite average frequency for each segment of major P.T fixed route for its corresponding service area interacts with statistical quarter $\boldsymbol{k}$.

$\boldsymbol{n}$: Number segments of major P.T fixed route for which its corresponding service area interact with statistical quarter $\boldsymbol{k}$.

3.2.3 Summary of Methodology to Develop LIPTA

LIPTA for each statistical quarter is developed through two main components. These are spatial coverage, and temporal coverage. Spatial coverage component looks at the physical access to P.T stop and it is interpreted in terms of the proximity of the passenger's origin or destination to the nearest P.T stop, and by the percent of people being served by P.T service. On the other hand, temporal coverage component studies the average P.T frequency that serves each statistical quarter.

The main steps, which are followed in formulating the LIPTA in this research, are summarized as follows:

1. Review studies related to P.T accessibility and P.T availability.
2. For Spatial Coverage Component:
    - Compute the four refinement factors (which suggested by TCQSM (2003)) from study area characteristics and calculate transit stop service radius (r_s).
    - Collect and manipulate different related data by different research tools as discussed in the next chapter.
    - Identify P.T fixed route and P.T stations for each route in the study area.
    - Make Network Analysis (N.A) by ArcInfo v.10.0 GIS program to determine the service area for each P.T station.
    - Calculate percent population being served by P.T service for each statistical quarter through overlay analysis by ArcInfo v.10.0 GIS program.

3. For Temporal Coverage Component:
    - Collect and manipulate frequency data for each P.T fixed route as discussed in the next chapter.
    - Make proximity analysis and calculate weighted composite average frequency ($\boldsymbol{WCAF_k}$) for each statistical quarter.
4. The scores of spatial and temporal coverage for each statistical quarter will be standardized to produce standard scores (Z-scores). Then, the LIPTA is calculated by averaging the Z-scores from each component computed for a given statistical quarter.
5. Visualize the result by thematic map using ArcInfo v.10.0 GIS, and make comparison between statistical quarter.

3.3 Travel Time Accessibility Index

A key objective to developing TTAI in this study is to provide a simple, objective, and transparent method of portraying absolute and relative measures of accessibility by different modes between important locations. Travel time values are based on door-to-door travel times, and the O-Ds represent trips between home and important destinations.

There are several different methods to collect travel time data. Historically, the manual method has been the most commonly used travel time data collection technique. This method requires a driver and a passenger to be in the test vehicle. The driver operates the test vehicle while the passenger records time information at predefined checkpoints along a travel route.

The main activities, which are followed in formulating the index in this study, are summarized as follows:

1. Review literature related to P.T travel time and the methods to collect accurate travel time data.
2. Select of O-D pairs for important locations.
3. Identify specific paths used to travel for each P.T (shared-taxi) and private cars modes.
4. Collect and manipulate in-vehicle travel time data for two transport modes as discussed in the next chapter.
5. Calculate door-to-door travel time values for each transport mode. As follows:

$$\boldsymbol{T.T_{P.T} = Wl_{to} + Wi_{t1} + INV_{t1} + (transfer\ time\ ) + Wl_{td}} \text{... } \textbf{(3.4)}$$

$$\boldsymbol{transfer\ time = Wl_{t2} + Wi_{t2} + INV_{t2}} \text{.......................... } \textbf{(3.5)}$$

$$\boldsymbol{T.T_{P.C} = Wl_{top} + INV_{p.c} + Pa_t + Wl_{tpd}} \text{............................... } \textbf{(3.6)}$$

Where:

$\boldsymbol{T.T_{P.T}}$**:** Door-to-door travel time by P.T mode.

$\boldsymbol{Wl_{to}}$**:** Walk time from origin to P.T stop.

$\boldsymbol{Wi_{t1}}$**:** Waiting time for 1^{st} P.T route.

$\boldsymbol{INV_{t1}}$**:** In-vehicle travel time for 1^{st} P.T route**.**

$\boldsymbol{Wl_{td}}$**:** Walk time from the final P.T stop to destination.

$\boldsymbol{Wl_{t2}}$**:** walk time to 2^{nd} P.T route.

$\boldsymbol{Wi_{t2}}$**:** Waiting time for 2^{nd} P.T route.

$\boldsymbol{INV_{t2}}$**:** In-vehicle travel time for 2^{nd} P.T route.

$\boldsymbol{T.T_{P.C}}$ **:** Door-to-door travel time by privet car mode.

$\boldsymbol{Wl_{top}}$**:** Walk time from origin to the parking place.

$\boldsymbol{INV_{p.c}}$**:** In-vehicle travel time by private car.

$\boldsymbol{Pa_{t}}$**:** parking time.

$\boldsymbol{Wl_{tpd}}$**:** Walk time from the final parking place to destination.

6. TTAI's for each transport modes are calculated. This is done by dividing each of the times for each mode by the un-weighted average time, to provide a comparison based on a common level. This is expressed as:

$$\boldsymbol{TTAI_{P.T(shared-taxi)} = \frac{TT_{P.T}}{\left(\frac{TT_{P.T} + TT_{P.C}}{2}\right)}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (\mathbf{3.7})$$

$$\boldsymbol{TTAI_{P.C} = \frac{TT_{P.C}}{\left(\frac{TT_{P.T} + TT_{P.C}}{2}\right)}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \ (\mathbf{3.8})$$

7. Show the results of TTAI's for each O-D pair by each transport mode graphically to provide useful information and in an easily understood fashion.

The following flowchart (Figure 3.1) summarizes the methodology to develop P.T accessibility indices.

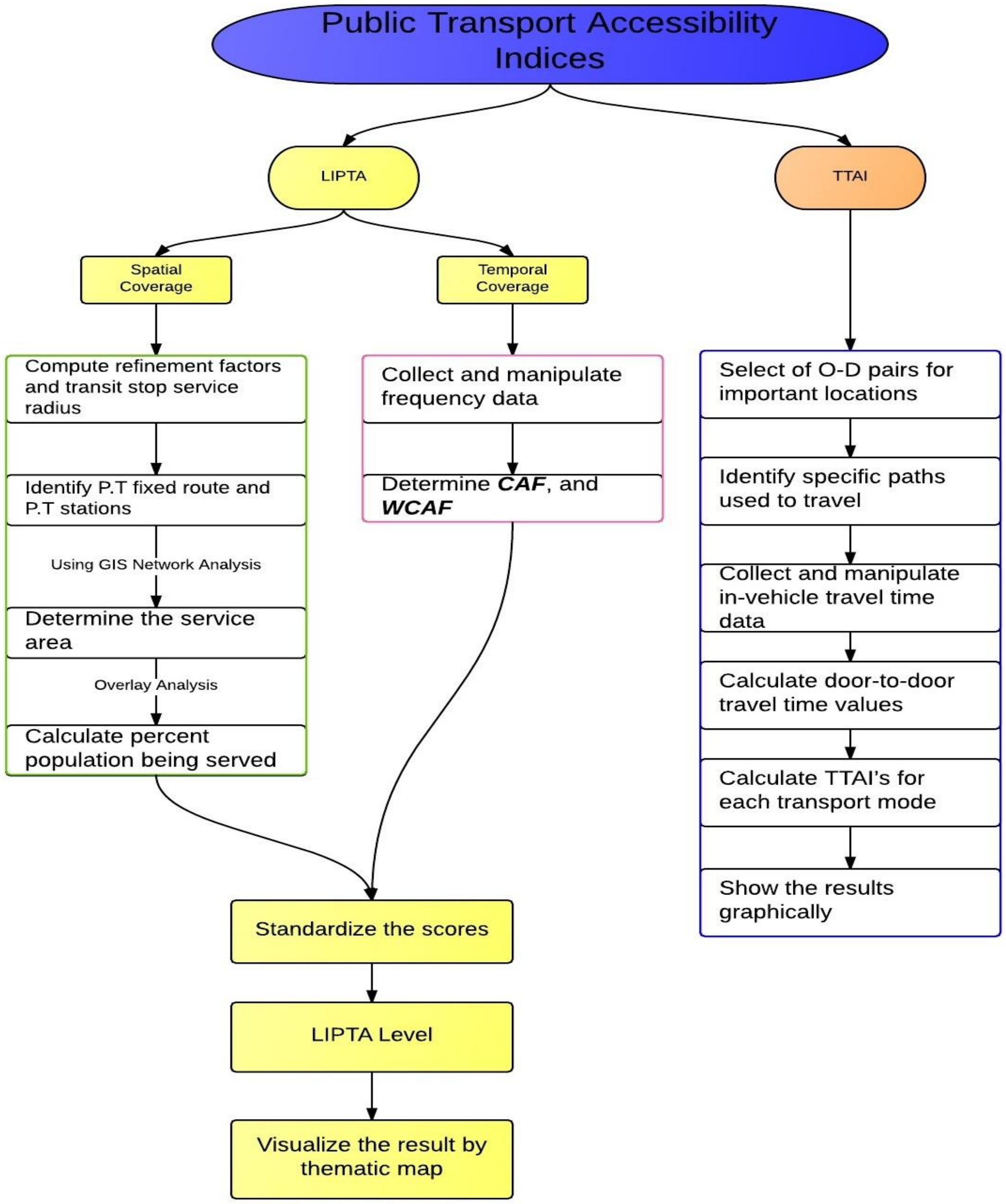


Figure (3.1): Summary of the Methodology to Develop P.T Accessibility Indices

Chapter Four

Data Collection and Processing

4.1 Introduction

This chapter provides a detailed description of sources and methods for collecting and processing different primary and secondary spatial and non-spatial data that is needed in this study to develop Local Index of Public Transport Accessibility (LIPTA) and Travel Time Accessibility Index (TTAI).

The data collected in this study can be classified according to their source and nature into five sources, as listed Ministry of Local Government (MOLG), Engineering and Planning Department.

1. Ministry of Transportation (MOT), Road Transportation Directorate in Nablus City.
2. Nablus Municipality.
3. Palestinian Central Bureau of Statistics (PCBS).
4. National Center for Sustainable Development (NCD), a private firm located in Nablus City.
5. Field survey.

4.2 Data Collection and Processing to Develop LIPTA

4.2.1 Data for Spatial Coverage Component

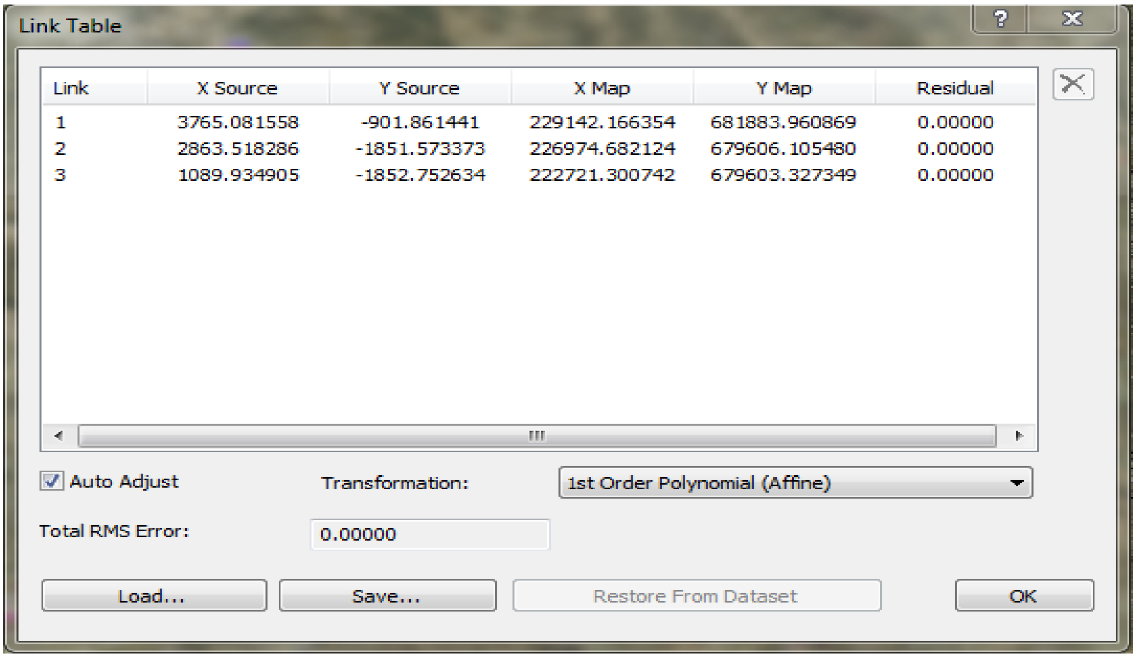
To complete the spatial coverage component calculations, statistical boundaries of statistical quarters set by the Palestinian Central Bureau of

Statistics (PCBS) of the study area for the year 2007 was adopted. In order to make the necessary analysis by GIS program, these statistical boundaries of statistical quarters must have specific geographical reference and are compatible with GIS program environments. Since these data are not available by PCBS, the researcher relied on a digital image published by PCBS and carried out the geo-referencing process and digitizing for bordering statistical quarters.

Geo-referencing and Digitizing of Digital Image

There is a great deal of geographic data available in formats that cannot be immediately integrated with other GIS data. In order to use these types of data in GIS, it is necessary to align it with existing geographically referenced data. Geo-referencing is also a necessary step in the digitizing process. Geo-referencing is the process of aligning a raster data set to known map coordinates and assigning a coordinate system. Geo-referencing creates additional information within the file itself and/or in supplementary files that accompany the image file that tells GIS software how to properly place and draw it.

The process of geo-referencing relies on the coordination of points on the digital image (target data) with points on a geographically referenced data. By “linking” points on the digital image with those same locations in the geographically referenced data one will create a polynomial transformation that converts the location of the entire digital image to the correct geographic location. In this study, the Orthophoto 2012 with Israeli projected coordinates system for the study area, which was obtained from MOLG, was used as a geographically referenced data. The Root Mean Square (RMS) error, which measures the accuracy of control points (Residual) and the geo-referenced digital image are as presented in Figure 4.1.



Link	X Source	Y Source	X Map	Y Map	Residual
1	3765.081558	-901.861441	229142.166354	681883.960869	0.00000
2	2863.518286	-1851.573373	226974.682124	679606.105480	0.00000
3	1089.934905	-1852.752634	222721.300742	679603.327349	0.00000

Figure (4.1.a): RMS Error in Geo-reference Process

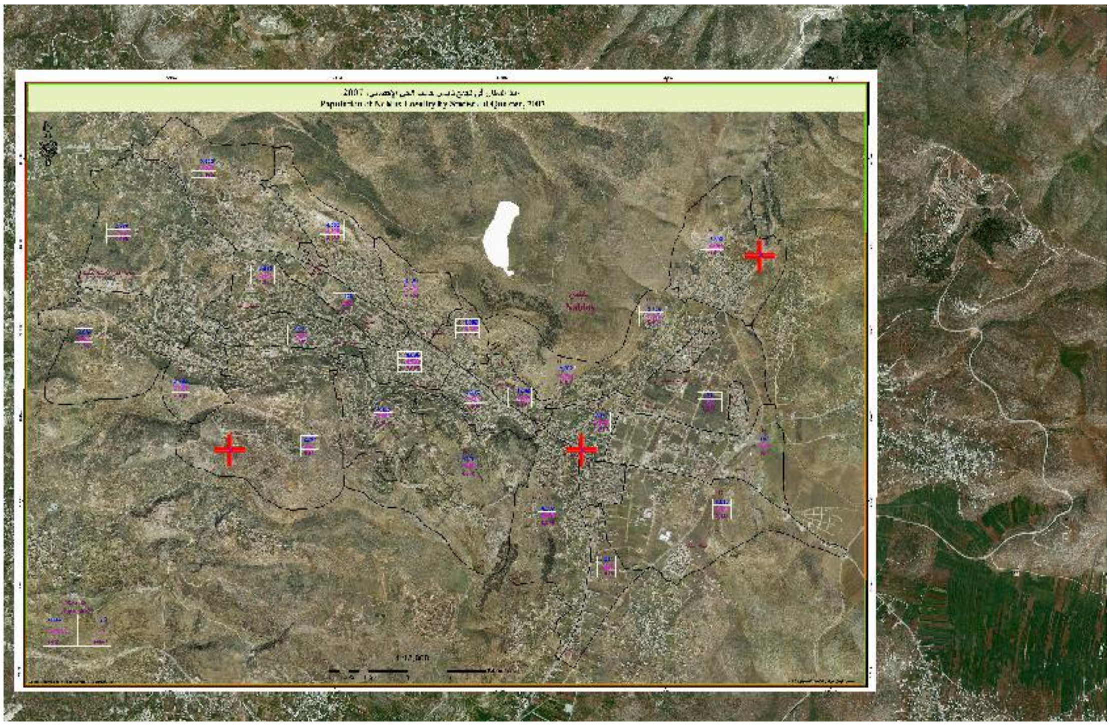


Figure (4.1.b): Geo-reference Process

Digitizing is the process of interpreting and converting paper map or image data to vector digital data. Digitizing on the computer screen in a GIS environment of geo-referenced digital image was used to create polygonal vector layer that represents statistical quarters for the study area. During the digitizing process, a special construction tool is used for adding adjacent polygons. The "polygon construction tool" is first used to enter polygons, which are located on the perimeter of the study area. Then to add adjacent polygons, polygon construction tool is switched to "Auto-Complete polygon tool" and digitize only the new part of polygon. This ensures that the polygons share coincident boundaries and free from topological error including gaps and overlap. The resultant statistical quarters of the study area is shown in Figure 4.2.

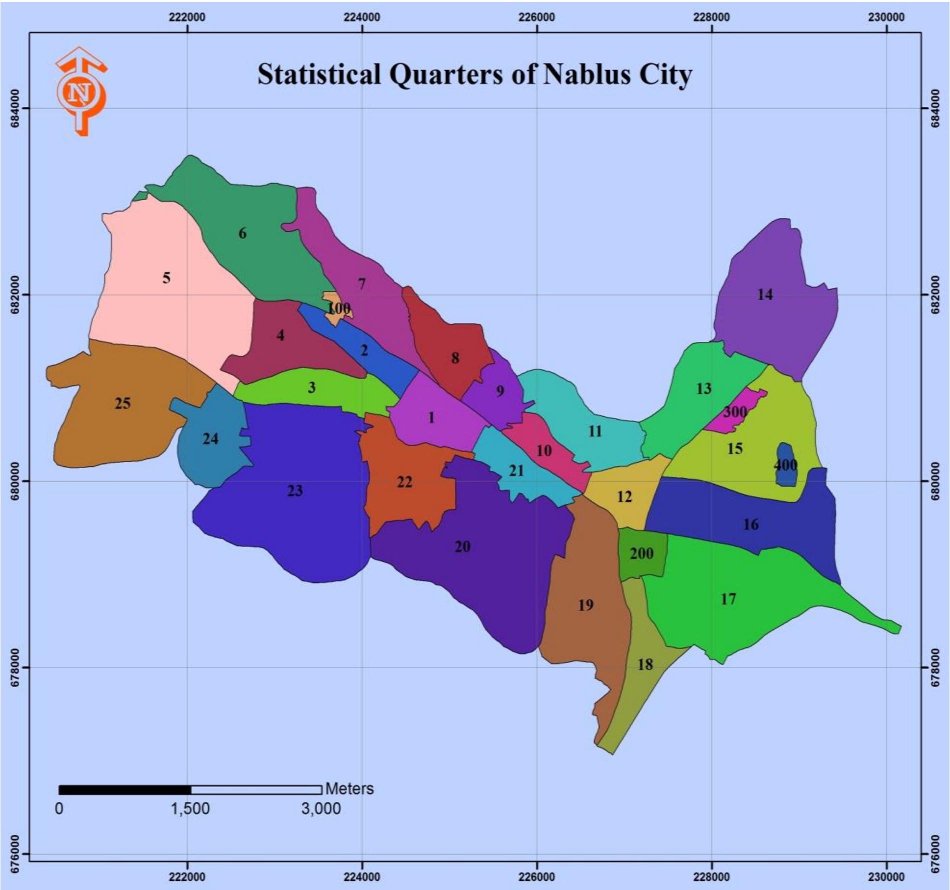


Figure (4.2): Statistical Quarters of the Study Area

Street Network and Public Transport Fixed Route Data

The required data to make network analysis was collected from several sources; the raw street network for Nablus City was obtained from MOLG, the number and paths of P.T fixed routes have been identified by the researcher in collaboration with the MOT (Road Transportation Directorate in Nablus City) and supervisors for each P.T fixed route for shared-taxi modes, as well as with bus companies managers. The P.T fixed routes for shared-taxi modes were nine routes, and for bus modes there were eight routes, as shown in Table 4.1. The following map (Figure 4.3) shows the paths of P.T fixed route in Nablus City. There are other service routes that are not used on a regular basis, but related to certain time periods, such as the route connecting between the Academy and An-Najah National University. These types of routes are not included in the study.

Table (4.1): Public Transport Fixed Route

No.	P.T Fixed Route Name
1	Al-Dahia/Al-Quds ST
2	Balata/Iskan Rojeeb
3	Asker/Masaken/Hijjawi College
4	North Mount
5	South Mount
6	Rafedia/Academy
7	An-Najah University/Makhfia
8	Ain Camp /Majeen
9	Al-Etehad
10	South Mount (Tamimi Bus Co.)
11	An-Najah University (Tamimi Bus Co.)
12	Academy (Tamimi Bus Co.)
13	Balata/Iskan Rojeeb (Tamimi Bus Co.)
14	Al-Quds ST (Tamimi Bus Co.)
15	Al-Quds Open University (Tamimi Bus Co.)
16	Iraq Tayeh/Water ST (Al-Waleed Bus Co.)
17	Asker/Masaken (Al-Waleed Bus Co.)

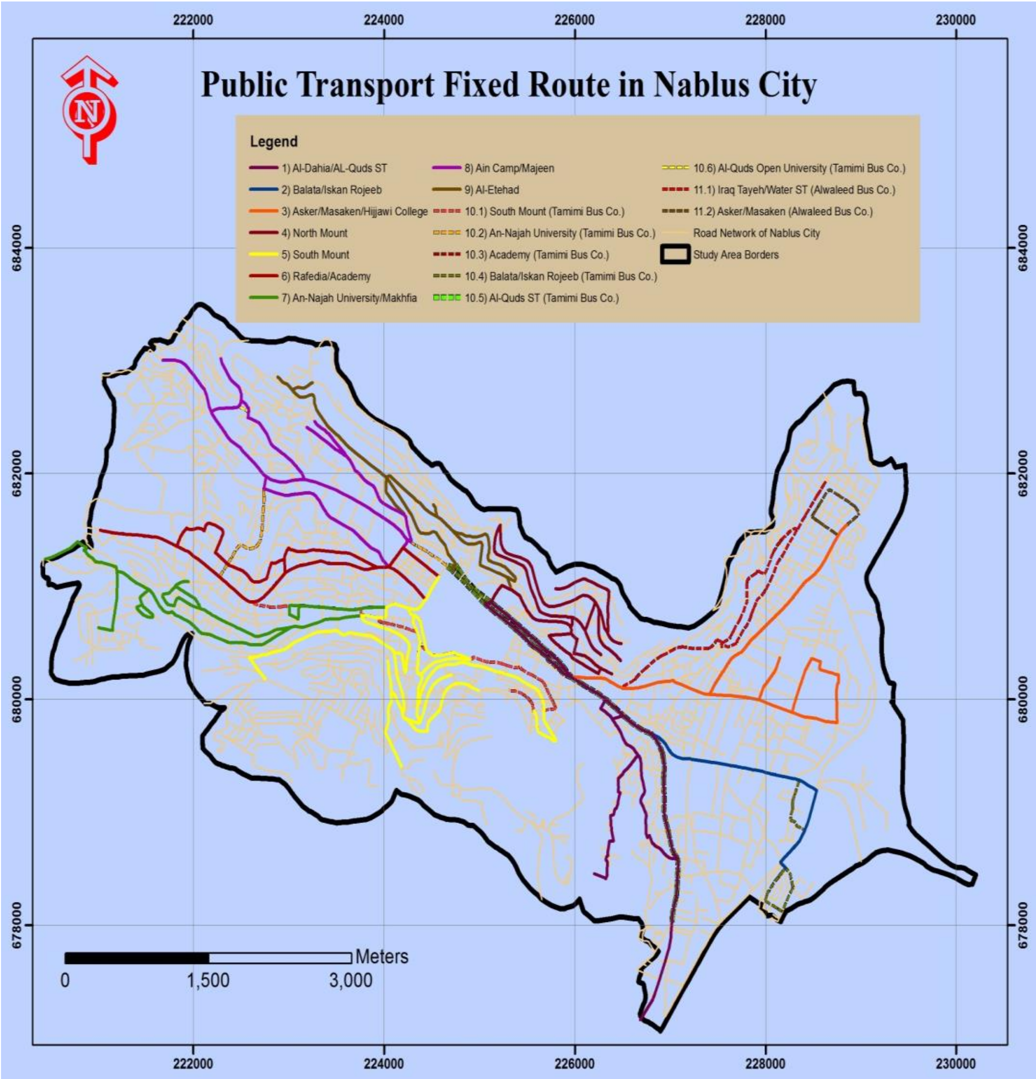
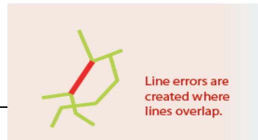
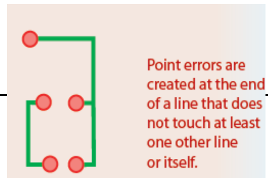
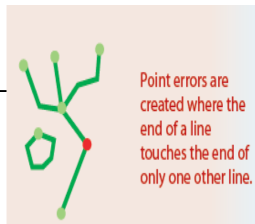


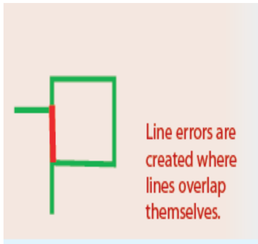
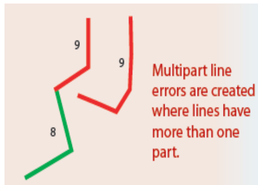
Figure (4.3): P.T Fixed Routes in Nablus City

Topology Analysis

Making a robust network analysis requires good quality network dataset. In order to ensure that data quality makes topology analysis to collected street data. Topology analysis is a collection of rules coupled with a set of editing tools and techniques, enables the geo-database to more accurately model geometric relationships. GIS implements topology analysis through a set of rules that define how features may share a geographic space and a set of editing tools that work with features that share geometry in an integrated fashion. Conducting topology analysis on street network of study area was fundamentally used to ensure data quality of the spatial relationships and to aid in data compilation. The rules used in topology analysis are shown in Table 4.2, and the number of errors that violate any topological rules for the study area road network is shown in Table 4.3 and Figure (4.4.a). The final road network after fixing topological errors is shown in Figure (4.4.b). Note that the exception is only for actual dead end nodes.

Table (4.2): Topological Rules Used for Topological Analysis

No.	Topological Rule	Describtion	Uses	Sketch
1	Must not overlap	Lines must not overlap	Use this rule with lines	
		any part of another	that should never occupy	
		line within a feature	the same space with	
		class or subtype.	other lines.	
2	Must not have dangles	The end of a line must	Use this rule when you want	
		touch any part of one	lines in a feature class or	
		other line or any part of	subtype to connect to	
		itself within a feature	one another	
		class		
3	Must not have	The end of a line	Use this rule to clean up data	
	pseudonodes	cannot touch the end of	with inappropriately	
		only one other line	subdivided lines.	
		within a feature class or		
		subtype. The end of a		
		line can touch any part of		
		itself		
4	Must not self overlap	Lines must not overlap	Use this rule with lines whose	

		themselves within a	segments should never occupy	
		feature class or subtype.	the same space as another	
		Lines can touch,	segment on the same line	
		intersect, and overlap		
		lines in another feature		
		class or subtype		
5	Must be single part	Lines within a feature	Use this rule when you want	
		class or subtype	lines to be composed of	
		must only have	a single series of connected	
		one part.	segments	

Source: Prepared by the researcher based on ArcGIS®

Geo-database Topology Rule Poster (Environmental Systems Research Institute (ESRI), 2009)

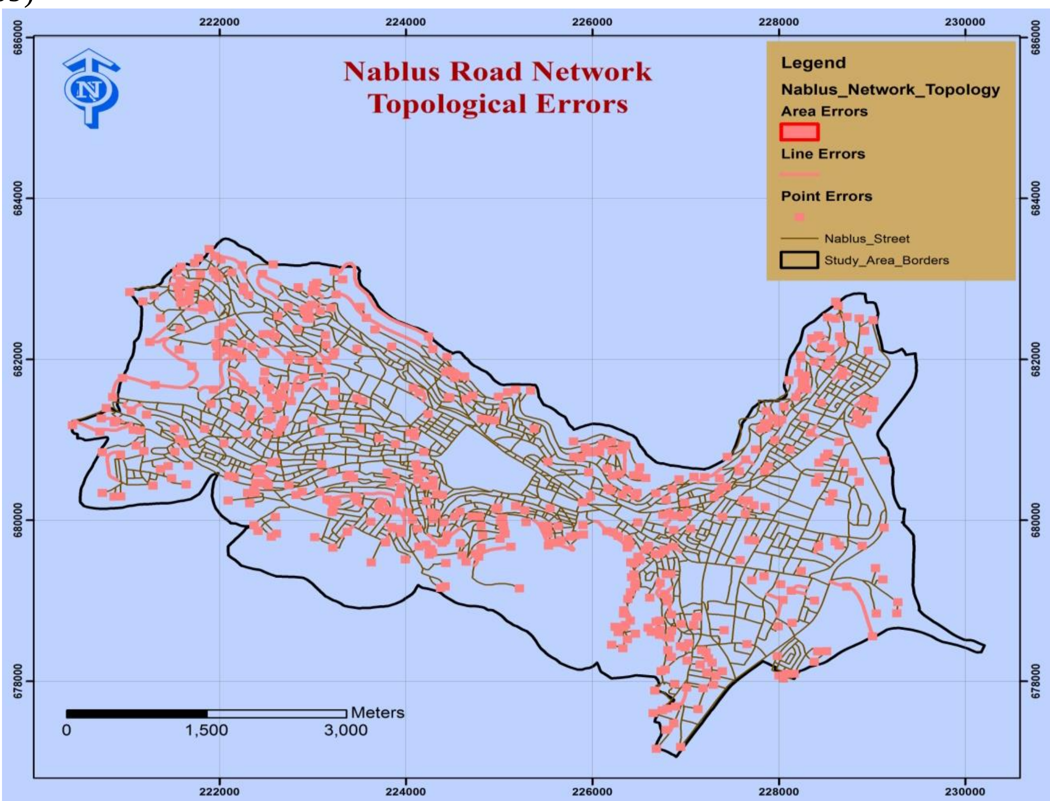


Figure (4.4.a): Nablus Roads Network Topological Errors

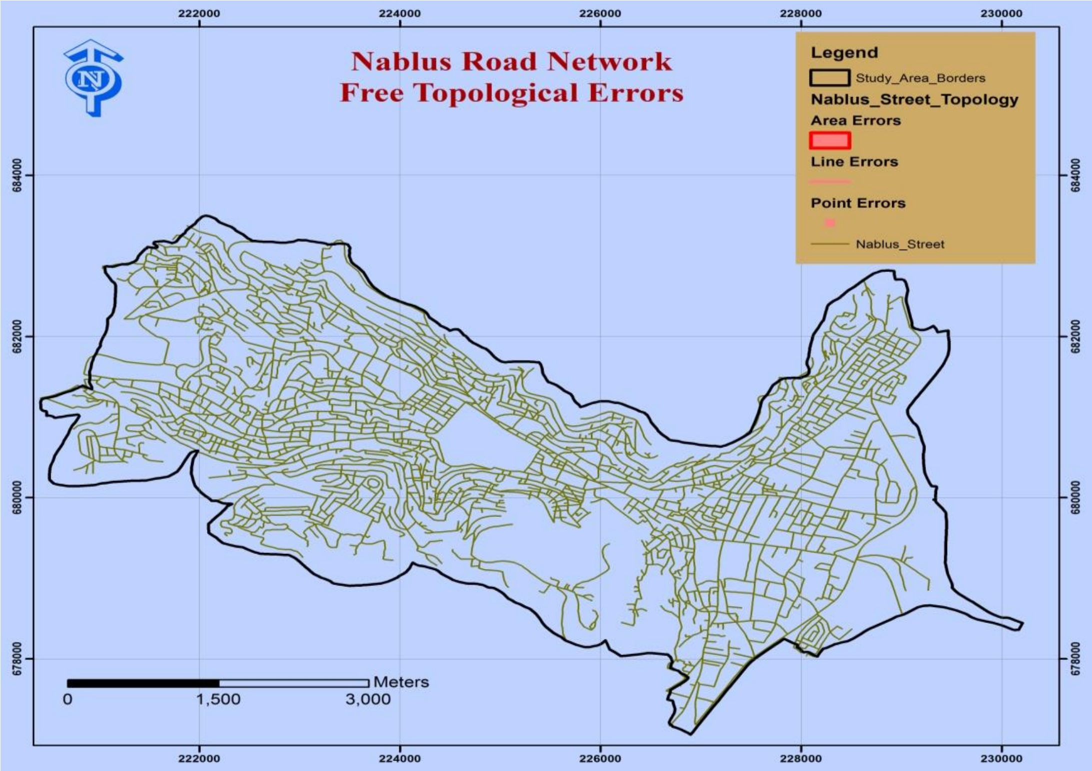


Figure (4.4.b): Nablus Roads Network Free of Topological Errors

Table (4.3): Number of Topological Errors

No.	**Topological Rule**	**Number of Errors**	**Exceptions**
1	Must not overlap	0	0
2	Must not have dangles	498	398
3	Must not have pseudonodes	67	0
4	Must not self overlap	0	0
5	Must be single part	95	0

The Spatial Distribution of the Residential Units

In order to be more accurate for calculating percent of people being served by P.T fixed route, the applied methodology in this study depends on the spatial distribution of population in the study area. This assumes that population is not uniformly distributed on the whole statistical quarter area or along the roads. Therefore, the spatial distribution of buildings was identified based on the results of the first phase of the project "Naming Streets and Numbering Buildings for Nablus City, 2014" (1). In this phase of the project a field survey for every residential or physical unit has been carried out, and the number of dwelling units for each story in each building is determined. After that, data is assembled in the geo-database. After reviewing the data obtained from the NCD any physical unit not used for residential purposes has been omitted from the database.

Figure 4.5 illustrates the spatial distribution of the residential units in the study area. It should be noted that statistical quarter number 20 has a partially shortage of data because of the Israeli limitation to enter that area and collect required information.

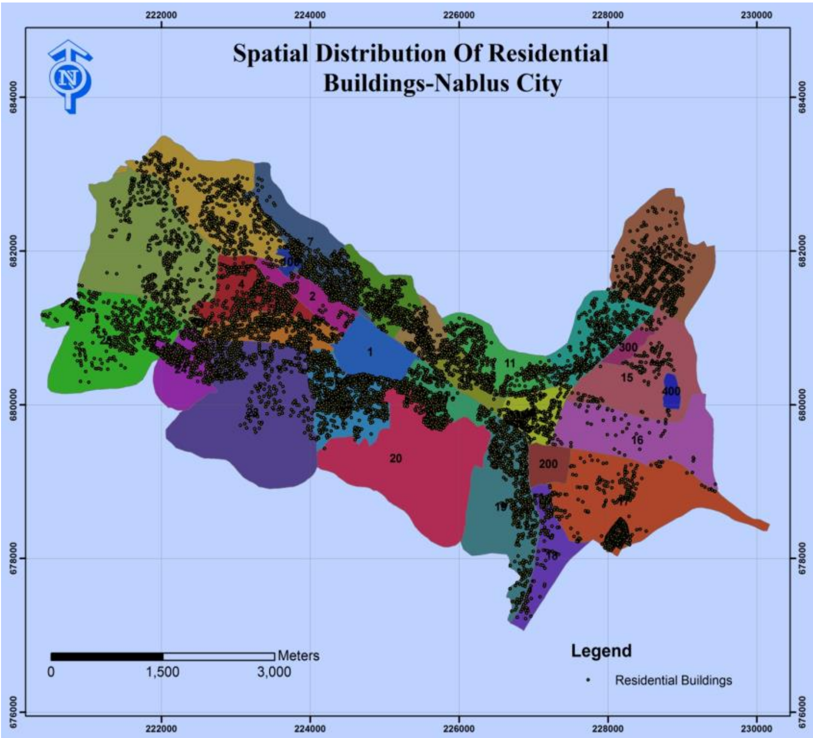


Figure (4.5): Spatial Distribution of Residential Buildings

Source: Prepared by researcher based on data from NCD (2014)

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(1):"Naming Streets and Numbering Buildings for Selected Municipalities" is a tendered project funded by USAID, administrated by Global Communities, and technically executed by NCD in 2014. Nablus City is one of the selected Municipalities.

Population Data

Population data for each statistical quarter in the study area was obtained from PCBS. The PCBS was entrusted by the Palestinian National Authority to lead the implementation of needed statistics for planning. The census covered all of Palestinian Territories except the part of Jerusalem, which was annexed by Israel in 1967.

The population of the year 2014 for each statistical quarter was determined based on the census of the year 2007 with (2.32%) population annual growth rate, which was calculated depending on population estimates of Nablus Governorate (PCBS, 2007). The population data for each statistical quarter is shown in Table 4.4.

Contour Map

Contour map with contour interval (5 m) was obtained from MOLG, which is used to calculate average grade of road network of Nablus City.

4.2.2 Data for Temporal Coverage Component

The temporal coverage component is based on weighted composite average frequency for each statistical quarter. This depends on the average number of trips for each P.T vehicle that works on a specific fixed P.T route per day per direction. According to Nablus Municipality the number of vehicles (shared-taxis or buses) with different capacities for each P.T fixed route is as presented in Table 4.5.

Table (4.4): Population Data for Each Statistical Quarter in Nablus City

<table>
<tr><th>Statistical Quarter-ID</th><th>Population 2007</th><th>Population 2014</th></tr>
<tr><td>1</td><td>9625</td><td>11302</td></tr>
<tr><td>2</td><td>2221</td><td>2608</td></tr>
<tr><td>3</td><td>6583</td><td>7730</td></tr>
<tr><td>4</td><td>4882</td><td>5732</td></tr>
<tr><td>5</td><td>5648</td><td>6632</td></tr>
<tr><td>6</td><td>7195</td><td>8448</td></tr>
<tr><td>7</td><td>8982</td><td>10547</td></tr>
<tr><td>8</td><td>4683</td><td>5499</td></tr>
<tr><td>9</td><td>3919</td><td>4602</td></tr>
<tr><td>10</td><td>2791</td><td>3277</td></tr>
<tr><td>11</td><td>5191</td><td>6095</td></tr>
<tr><td>12</td><td>4913</td><td>5769</td></tr>
<tr><td>13</td><td>5281</td><td>6201</td></tr>
<tr><td>14</td><td>5472</td><td>6425</td></tr>
<tr><td>15</td><td>1326</td><td>1557</td></tr>
<tr><td>16</td><td>377</td><td>443</td></tr>
<tr><td>17</td><td>2146</td><td>2520</td></tr>
<tr><td>18</td><td>1628</td><td>1912</td></tr>
<tr><td>19</td><td>8076</td><td>9483</td></tr>
<tr><td>20</td><td>4275</td><td>5020</td></tr>
<tr><td>21</td><td>4485</td><td>5266</td></tr>
<tr><td>22</td><td>11968</td><td>14053</td></tr>
<tr><td>23</td><td>5451</td><td>6401</td></tr>
<tr><td>24</td><td>4815</td><td>5654</td></tr>
<tr><td>25</td><td>4198</td><td>4929</td></tr>
<tr><td>100</td><td>3936</td><td>4622</td></tr>
<tr><td>200</td><td>15084</td><td>17712</td></tr>
<tr><td>300</td><td rowspan="2">11483</td><td rowspan="2">13483</td></tr>
<tr><td>400</td></tr>
<tr><td>Total</td><td>156634</td><td>183920</td></tr>
</table>

Source: (PCBS, 2009)

Table (4.5): Number of Permitted Vehicles for Each P.T Fixed Route

No.	P.T Route Name	Number Of Permitted Vehicles	Vehicles Capacity
1	Al-Dahia/Al-Quds ST	**40**	4 seats
2	Balata/Iskan Rojeeb	**89**	4 seats
3	Asker/Masaken/Hijjawi College	**101**	4 seats
4	North Mount	**26**	4 seats
5	South Mount	**35**	4 seats
6	Rafedia/Academy	**178**	4 seats
7	An-Najah University/Makhfia	**123**	30 Vans with 7 seats 93 Cars with 4 seats
8	Ain Camp /Majeen	**58**	4 seats
9	Al-Etehad	**27**	4 seats
10	South Mount (Tamimi Bus)	**1**	Mini-bus with 20 seats
11	An-Najah University (Tamimi Bus)	**5**	2 Buses with 55 seats 3 Mini-Bus with 20 seats
12	Academy (Tamimi Bus)	**6**	3 Buses with 55 seats 3 Mini-Bus with 20 seats
13	Balata/Iskan Rojeeb (Tamimi Bus)	**2**	Mini-buses with 20 seats
14	Al-Quds ST (Tamimi Bus)	**2**	Mini-buses with 20 seats
15	Al-Quds Open University (Tamimi Bus)	**8**	2 Buses with 55 seats 6 Mini-Buses with 20 seats
16	Iraq Tayeh/Water ST (Al-Waleed Bus)	**6**	Mini-buses with 20 seats
17	Asker/Masaken (Al-Waleed Bus)	**3**	Mini-buses with 20 seats

Source: (Nablus Municipality, 2014)

Sampling Method and Sampling Size for P.T Frequency Data

Average frequency data for nine shared-taxi P.T fixed routes was collected by field survey on a sample of them. The field survey was conducted in October, 2014 by asking the P.T service operator's (driver of the shared-taxi) about average number of trips per direction per normal day (Monday, Tuesday, or Wednesday). Total number of shared-taxis is 677 vehicles; these vehicles represent total vehicle population. The sample size required for a population size of approximately 700, ($\pm$ 5%) precision level, and with 95% confidence level is 255 presuming that the attributes being measured are distributed normally. For bus routes, the frequency was determined based on verbal information about headway for each route that was taken from the managers of bus companies.

There are different sampling methods used in statistics. The sampling method that was used to collect frequency data for shared -taxi mode is a stratified random sampling method. In this method the population is split into smaller groups known as strata; the strata are formed based on members' shared attributes or characteristics. A random sample from each stratum is taken in a number proportional to the stratum's size when compared to the population size; these subsets of the strata are then pooled to form a random sample. In order to assure normality distribution for data collected, any stratum's size must not be less than 30 observations (Yamane, 1967). Table 4.6 illustrates the sample size required for each stratum and the sample size taken.

Table (4.6): Sample Size Required and Taken

No.	Shared-Taxi P.T Route Name	Stratum Size Vehicles	Sampel size Required	Sampel size Taken
1	**Al-Dahia/Al-Quds ST**	40	15	30
2	**Balata/Iskan Rojeeb**	89	33	35
3	**Asker/Masaken/Hijjawi College**	101	36	40
4	**North Mount**	26	10	30
5	**South Mount**	35	12	30
6	**Rafedia/Academy**	178	65	70
7	**An-Najah University/Makhfia**	123	45	50
8	**Ain Camp /Majeen**	58	22	30
9	**Al-Etehad**	27	10	30
	Total	**677**	**248**	**345**

When collecting frequency data, it was observed that the specific P.T fixed route might be branched to multiple sub-P.T fixed routes; therefore, the routes were divided into major routes and sub-routes. Since the mean value is sensitive to extreme observations, 5% trimmed mean was used to solve this problem. It involves trimming 5 percent of outliers from both ends of observations. Average daily frequency was calculated based on 5% trimmed mean of sample for each route and sub-route and in proportional to the number of permitted vehicles on each P.T fixed route. Table 4.7 illustrates the summary of average shared-taxi P.T daily frequency per direction. Detailed collected frequency data and calculations are shown in Appendix B.

Built-Up Area

The Built-up Area (BUA) is a term used primarily in urban planning; it refers to the developed area. Figure 4.6 shows the built-up area of Nablus City.

Table (4.7): Summary of Average Shared-Taxi P.T Daily Frequency per Direction

No.	P.T Route Name	Major P.T Route No.	Sub.P.T Route No.	Sub.P.T Route Name*	Average Daily Frequancy Veh/Day)
1	Al-Dahia/ Al-Quds ST	1.1		To-Or-From-Al-Quds ST	**540**
		1.2		To-Or-From-Al-Ain	**108**
		1.3		To-Or-From-Al-Dahia	**254**
		1.4		To-Or-From-Dahia-Al-Alia	**13**
2	Balata/ Iskan Rojeeb	2.1	2.1.1	To-Balata	**1077**
			2.1.2	From-Balata	**1191**
		2.2		To-Or-From-Iskan Rojeeb	**115**
3	Asker/ Masaken/ Hijjawi College	3.1	3.1.1	To-Old Asker	**796**
			3.1.2	From-Old Asker	**639**
		3.2		To-Or-From-Masaken	**474**
		3.3	3.3.1	To-Hijjawi College	**227**
			3.3.2	From-Hijjawi College	**288**
		3.4	3.4.1	To-New Asker	**396**
			3.4.2	From- New Asker	**333**
4	North Mount	4.1		To-Or-From-Mouta ST/Khaleh Aleman	**257**
		4.2		To-Or-From-Bigar ST	**213**
		4.3		To-Or-From-Abu Baker ST	**91**
		4.4		To-Or-From-Alrawda College	**127**
		4.5		To-Or-From-Manjarah Area	**107**
5	South Mount	5.1		To-Or-From-10 ST	**170**
		5.2		To-Or-From-24 ST	**256**
		5.3		To-Or-From-Fatayer ST	**225**
		5.4		To-Or-From-Weqai Area	**81**
		5.5		To-Or-From-Krom Ashour and KshikaST and Khaleh Alamoud	**126**
		5.6		To-Or-From-Tawin Awsat ST	**126**
		5.7		To-Or-From-Al Basha ST	**121**
		5.8		To-Or-From-Al Dawai Area	**54**
		5.9		To-Or-From-Tell ST	**118**
6	Rafedia/Academy	6.1	6.1.1	To-Academy	**1602**
			6.1.2	From-Academy	**2036**

		6.2	6.2.1	To-Almraige ST/Rafedia Hospital/Old Al-Quds Open University	**1403**
			6.2.2	From-Rafedia Hospital	**450**
			6.2.3	From-Old Al-Quds Open University	**493**
7	An-Najah University /Makhfia	7.1	7.1.1	To-An-Najah University	**1430**
			7.1.2	From-An-Najah University	**1561**
		7.2	7.2.1	To-Makhfia	**598**
			7.2.2	From-Makhfia	**459**
		7.3		To-Or-From -Teipa Homes (Jneed)	**216**
8	Ain Camp /Majeen	8.1	8.1.1	To-Ain Camp and Majeen	**614.22**
			8.1.2	To-Open Qudes Univ	**136.3**
			8.1.3	From-Open Qudes Univ	**157.76**
			8.1.4	From-Ain Camp and Majeen	**592.76**
		8.2		To-Or-From-Zwata ST	**419.92**
		8.3		To-Or-From-Sekah ST	**218.08**
		8.4		To-Or-From-Malhes and Ain alsibian Area	**136.3**
9	Al-Etehad	9.1		To-Or-From-Namsawi and Asera ST and Najah Hospital	**200.07**
		9.2		To-Arsad ST	**285.93**
		9.3		To-Jeser ST	**275.4**
		9.4		From-Arsad ST and jeser ST	**558.9**
10	Tamimi Bus	10.1		To-Or-From-South Mount	**10**
		10.2		To-Or-From-Najah Univ	**40**
		10.3		To-Or-From-Acadimy	**40**
		10.4		To-Or-From-Balata/Eskan	**20**
		10.5		To-Or-From-Qudes ST	**20**
		10.6		To-Or-From-Open Qudes Univ	**34**
11	Al-Waleed Bus	11.1		To-Or-From-Iraq Tayeh/Water ST	**44**
		11.2		To-Or-From-Asker/Masaken	**33**

* To: From Central Business District (CBD) area to destination.

From: From destination to CBD area.

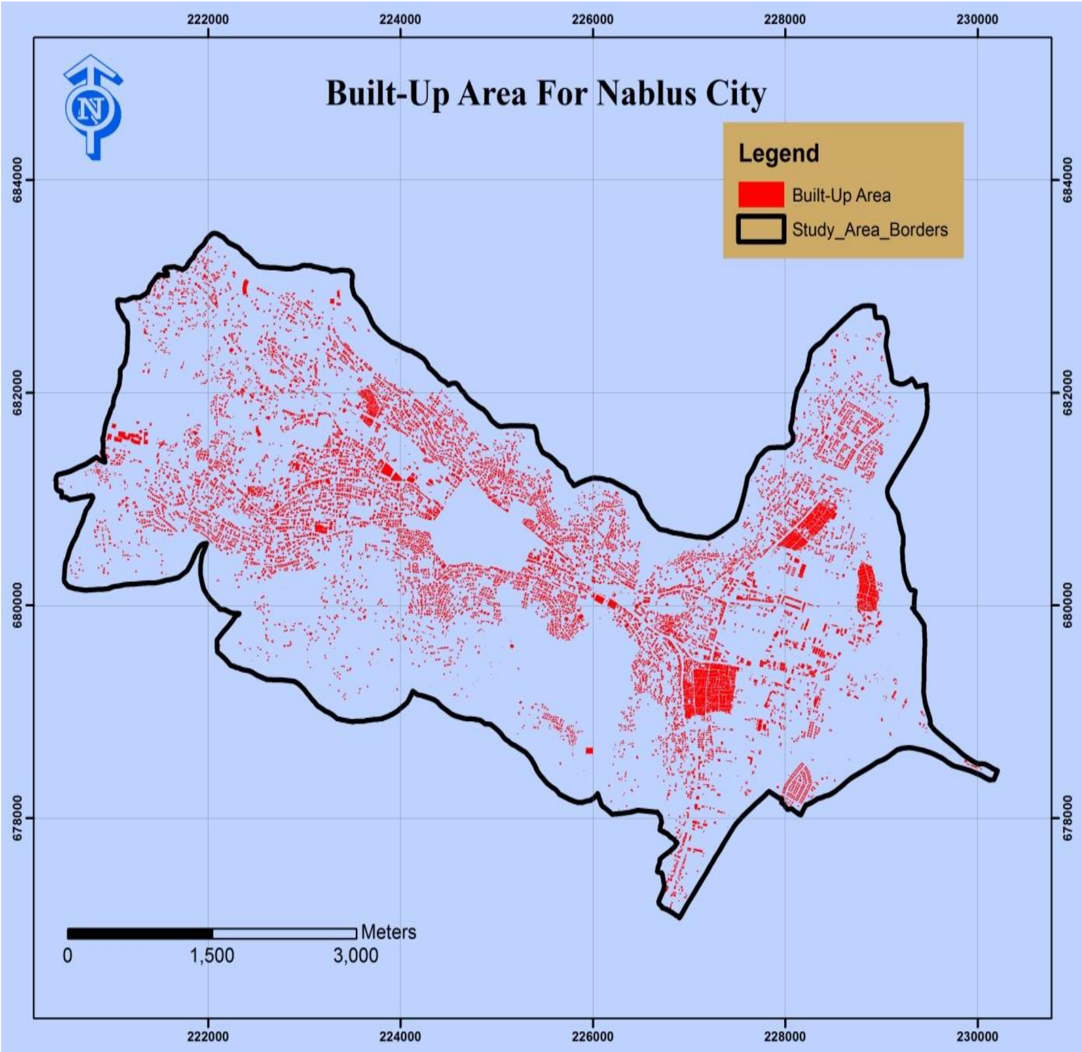

Figure (4.6): Built-Up Area of Nablus City

Source: (MOLG, 2014)

4.3 Data Collection and Processing to Develop TTAI

4.3.1 Travel Time Data Collection Process and Techniques

Several data collection techniques can be used to measure or collect in-vehicle travel times. These techniques are designed to collect travel times and average speeds on designated roadway segments or links. Typical steps in travel time data collection process are as shown in Figure 4.7. The purpose of this is to develop TTAI to compare accessibility level of private care and P.T (shared-taxi) modes, for specific important O-D's.

Data Collection Instrument and Technique

One of the travel time data collection techniques is the test vehicle technique. This technique has been used for travel time data collection since the late 1920s. Traditionally, this technique involves the use of a data collection vehicle within which an observer records cumulative travel time at predefined checkpoints along a travel route. This information is then converted to travel time, speed, and delay for each segment along the survey route. There are several different methods for performing this type of data collection, depending upon the instrumentation used in the vehicle and the driving instructions given to the driver. Since these vehicles are instrumented and then sent into the field for travel time data collection, they are sometimes referred to as "active" test vehicles. Conversely, "passive" Intelligent Transport System (ITS) probe vehicles are vehicles that are already in the traffic stream for purposes other than data collection. The instrumentation used to measure travel time with a test vehicle could be classified into three levels:

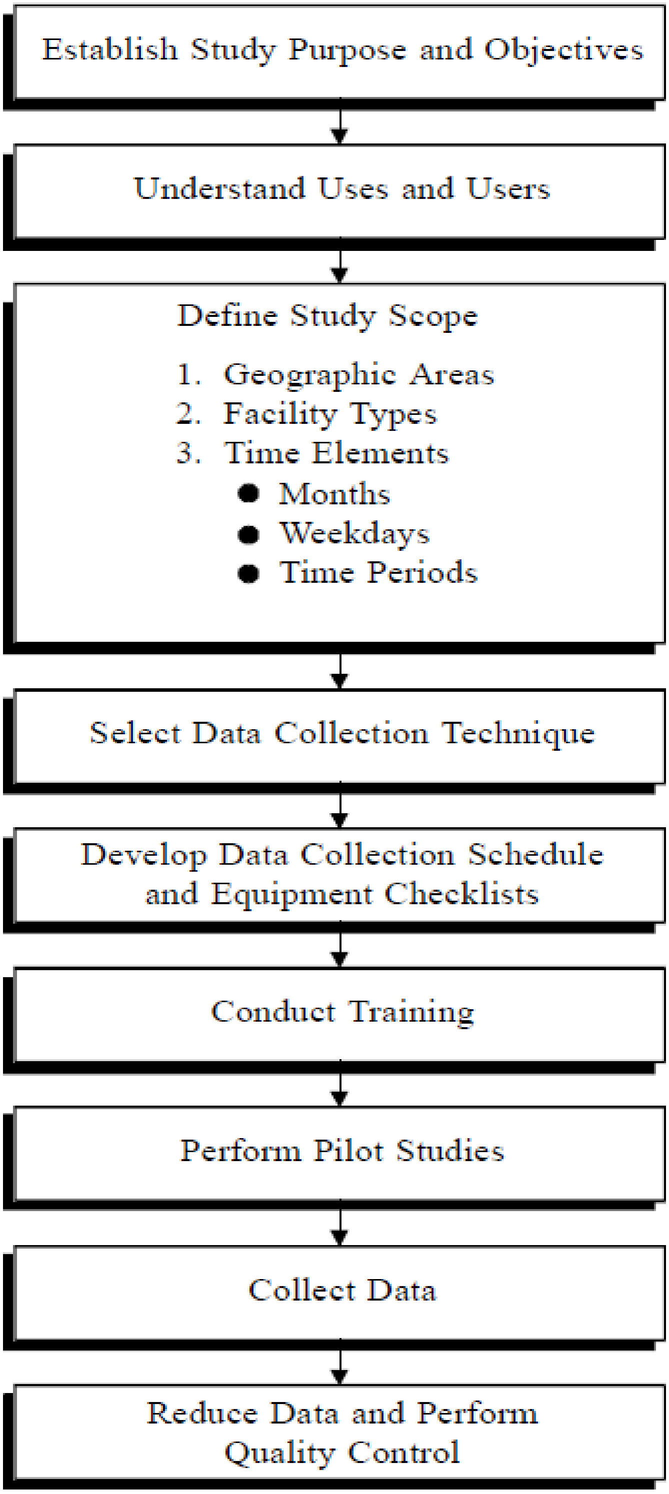

Figure (4.7): Travel Time Data Collection Process

Source: (Travel Time Data Collection Handbook, 1998)

- **Manual** - manually recording elapsed time at predefined checkpoints using a passenger in the test vehicle.
- **Distance Measuring Instrument (DMI)** - determining travel time along a corridor based upon speed and distance information provided by an electronic DMI connected to the transmission of the test vehicle.
- **Global Positioning System (GPS)** - determines test vehicle position and speed using signals from the Department of Defence (DOD) system of earth-orbiting satellites.

Driving Styles of Test Vehicle

Since the driver of the test vehicle is a member of the data collection team, driving styles and behavior can be controlled to match desired driving behavior. The following are three common test vehicle driving styles:

- Average car - test vehicle travels according to the driver's judgment of the average speed of the traffic stream.
- Floating car - driver "floats" with the traffic by attempting to safely pass as many vehicles as pass the test vehicle.
- Maximum car - test vehicle is driven at the posted speed limit unless impeded by actual traffic conditions or safety considerations.

Data collection technique used in this study was the test vehicle technique, with manual instrumentation, and an average car driving style. However, the researcher used two stopwatches, the first stopwatch start as the driver passes the first checkpoint, recording the cumulative elapsed time at subsequent checkpoints on the field sheet. A second stopwatch was used to record the amount of delay time incurred by the test vehicle when slowed or stopped (0 to 8 km/h, or 0 to 5 mph), also noting the cause of the delay. This procedure is followed through the entire course until the time at the final checkpoint is recorded.

Study Scope and O-D's selection

In order to represent commonly experienced conditions for the study it was decided that the TTAIs to be developed should be limited to predominantly educational and health-related trips. Therefore, data for the TTAIs was collected for the weekday morning peak period of travel. This implied that most of the people and students travelling would be engaged in educational and health trips, and would need to be at their target places by 08:00 O'clock. Based on familiarity of the study area, the general morning peak period of the study area is approximately 07:15 to 08:15, and was adhered to in most cases. In addition, the distance consideration between origin and destination should be far enough to capture the disparities in travel time between two transport modes. Therefore, the selected O-D's were in the far east and west ends of the study area.

The P.T riders are captive to follow P.T service path, while private car users are not. Therefore, paths used for private car differ from P.T paths based on the belief of private car drivers that it is faster to get to the destination. The in-vehicle travel time data was collected in November, 2014. A diagram showing the location of the selected O-Ds and predefined checkpoints along study paths is shown in Figure (4.8.a) and Figure (4.8.b), and coordinates for each point is shown in Table 4.8.

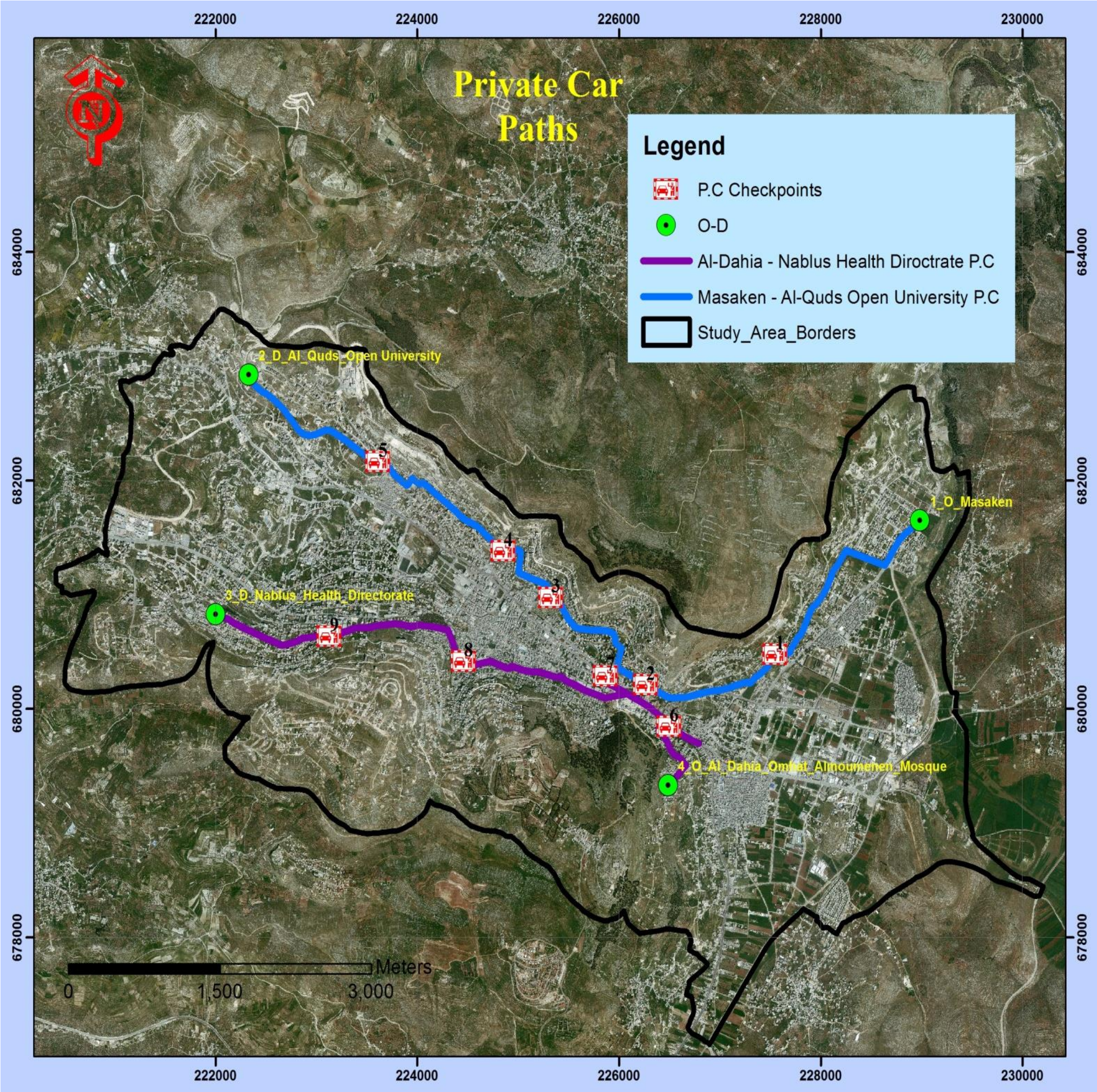

Figure (4.8.a): Private Car Paths

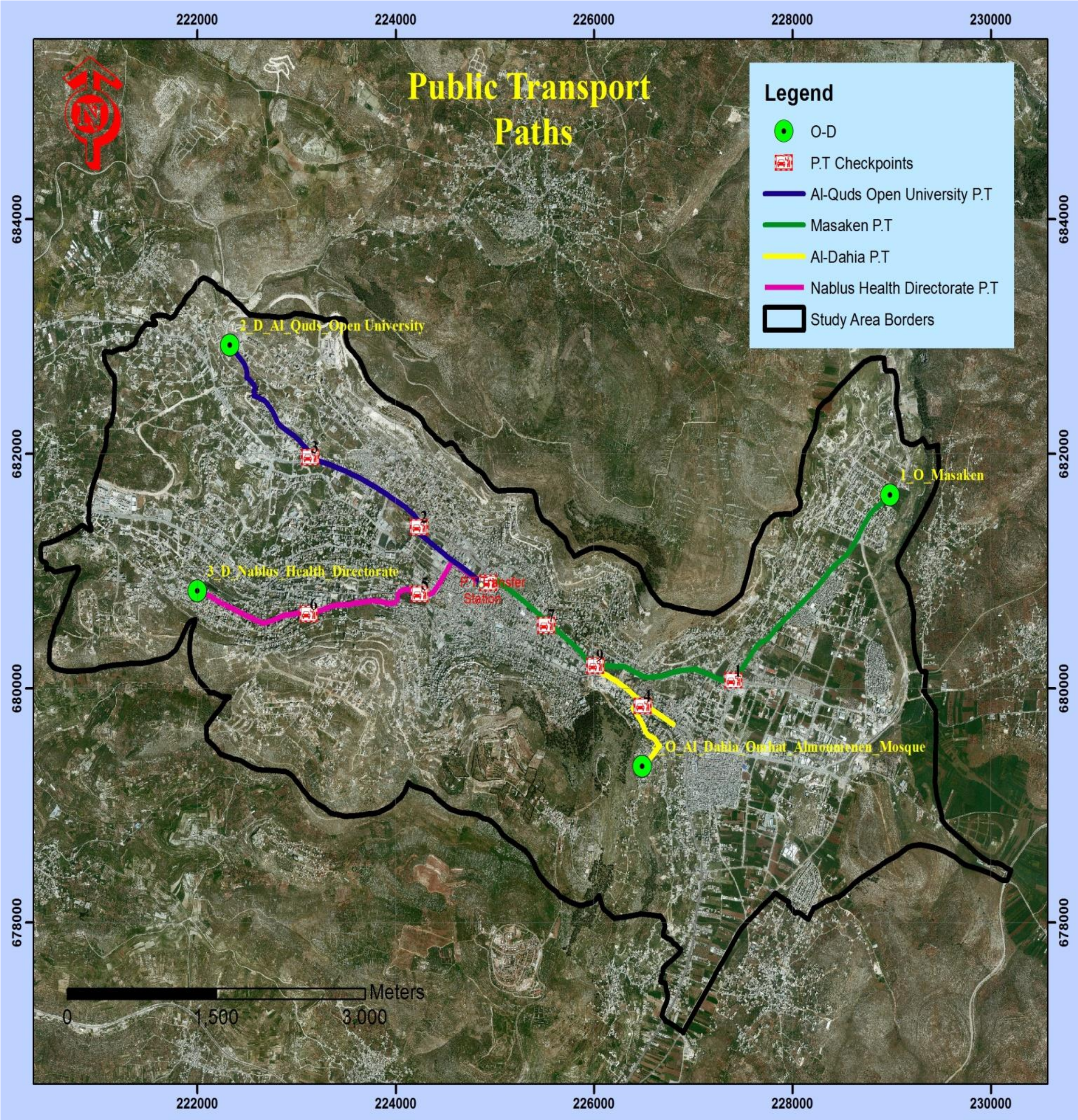

Figure (4.8.b): Public Transport (shared-taxi) Paths

Table (4.8): Description and Coordinates for P.C and P.T Checkpoints [(1)]

	CheckPoint -ID	Description	X-Coord	Y-Coord
P.C	1	Intersection at Asker Albalad Mosque	227546	680478
	2	Othman Mosque	226264	680210
	3	East Intersection Cemetery	225322	680975
	4	Al-Etehad Hospital	224849	681383
	5	Asekah Intersection	223606	682164
	6	Intersection with Faisal ST	226493	679848
	7	Education Dirocroate Intersection	225862	680290
	8	NEDCO	224455	680417
	9	Intersection behind An-Najah University	223125	680634
P.T	1	Al-Ghawi Intersection	227407	680064
	2	AL-Salam Mosque	224238	681374
	3	Majeen/Zawta Intersection	223137	681971
	4	Intersection with Faisal ST	226493	679848
	5	West Cemetery	224245	680803
	6	Intersection behind An-Najah University	223125	680634
	7	Mercy Clinic	225521	680535
	8	CBD	224934	680897
	9	Intersection with Faisal ST	226014	680191
O-D's	1	O-Masaken	228988	681648
	2	D-Al-Quds Open University	222332	682924
	3	D-Nablus Health Directorate	222003	680827
	4	O-Al-Dahia (Omhat Almoumenen Mosque)	226490	679331
	5	P.T-Transfer-Station	224866	680869

(1) Locations are shown in Figure 4.8.

4.3.2 Sample Size

Sample size requirements for the test vehicle technique dictate the number of "runs" that must be performed for a given roadway during the time period(s) of interest. The use of minimum sample size or a minimum number of travel time runs ensures that the average travel time obtained from the test vehicle is within a specified error range of the true average travel time for the entire vehicle population. The standard sample size equation is shown in equation 4.1.

$$\boldsymbol{n} = \left(\frac{\boldsymbol{t} * \boldsymbol{c.v}}{\boldsymbol{e}}\right)^{2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \mathbf{(4.1)}$$

Where:

$\boldsymbol{n}$**:** Minimum Sample Size.

$\boldsymbol{t}$: T-statistic from Student's t distribution for specified confidence level.

$\boldsymbol{c.v}$: Coefficient of Variation.

$\boldsymbol{e}$: Relative Error.

As shown in equations 4.3, minimum sample sizes are based on three parameters:

- **T-statistic**, t-value from the Student's t-distribution for (n-1) degrees of freedom. The t-statistic is based on the specified confidence level (two-tailed test) in the travel time estimate. Because the degrees of freedom for the t-statistic rely on a sample size "n", an initial sample size estimate must be assumed. Iterative calculations should be used to provide better estimates for the degrees of freedom. If sample sizes approach 30 or more, a Z-statistic from the normal distribution may be substituted for the t-statistic.

- **Coefficient of variation (C.V)**, the relative variability in the travel times, expressed as a percentage. The C.V values can be calculated from empirical data using the following equation 4.2, or approximate values from other studies.

$$\boldsymbol{c.v} = \frac{\boldsymbol{S}}{\boldsymbol{mean\ (x)}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (\mathbf{4.2})$$

Where:

$\boldsymbol{mean\ (x)}$: Mean travel time.

$\boldsymbol{S}$: Standard deviation of travel time

- **Relative allowable error (e),** the relative allowable error in the travel time estimate, expressed as a percentage. The relative error is specified by the study designer and will depend upon the uses of the travel time data. Commonly specified relative errors are ±5 percent for operations and evaluation studies and ±10 percent for planning and policy-level studies (Lomax et al., 1997).

Many agencies perform the maximum number of test vehicle runs that is practical given available data collection budgets (typically 3 to 6 runs per route). While this is a common practice, it should be recognized that the potential accuracy of the data falls at or below the lowest accuracy range (90% confidence level, ±10 percent error). For this study the assumed parameters are; $(\boldsymbol{n = 5})$, $(\boldsymbol{e = \pm 5}\%)$ and $(\boldsymbol{confidance\ level = 95}\%)$. Therefore, the degree of freedom $(\boldsymbol{d_f = 4})$, and $(\boldsymbol{t - value = 2.132})$. When substituting in equation 4.1, the $\boldsymbol{C.V = 5.2}\%$. Therefore, after data was collected, the researcher checked the C.V values to ensure the validity of estimated sample sizes.

4.3.3 Collected In-Vehicle Travel Time Data

The summaries of in-vehicle travel time data are shown in Table 4.9; the detailed data and special form used for data collection are presented in Appendix C.

Table (4.9): Summary of In-Vehicle Travel Time Data for P.T (shared-taxi) and P.C Modes

O-D	Travel Time (minutes)					Mean	St.Dev	C.V%
	Trial.1	Trial.2	Trial.3	Trial.4	Trial.5			
Masaken-Al-Quds Open University (P.C)*	16.92	15.42	16.17	15.58	14.92	**15.80**	**0.77**	**4.86**
Masaken-Al-Quds Open University (P.T)*	22.12	23.72	23.00	24.40	24.70	**23.59**	**1.05**	**4.45**
Al-Dahia-Nablus Health Directorate (P.C)	14.87	13.50	13.00	14.25	13.92	**13.91**	**0.71**	**5.13**
Al-Dahia-Nablus Health Directorate (P.T)	18.51	19.50	20.65	20.72	19.22	**19.72**	**0.95**	**4.83**

* P.C: Private Car Mode.

P.T: Public Transport (shared-taxi) Mode.

Chapter Five

Analysis and Results

5.1 Introduction

This chapter provides analysis of manipulated of the collected data and application of the methodologies to develop LIPTA for the study area and TTAI to compare accessibility level between P.T and private car modes. The first section describes the topological and network analysis that is needed to analyze spatial coverage component, and the second section discusses the proximity analysis for calculating temporal coverage component. The following section presents analysis of travel time data. Finally, results and discussion are presented.

5.2 Analysis of Data Needed to Develop LIPTA

5.2.1 Spatial Coverage Component Analysis

Spatial coverage is a critical measure for evaluating P.T service accessibility by estimating the covered area and population lying within a suitable access distance from the P.T stop (Foda and Osman, 2008). However, much previous research treated stop coverage as a simple circular buffer with a radius (400 meters) of the access threshold around each P.T stop, which causes an overestimation of the stop access coverage. The reason for such an overestimation is the implied assumption that passengers can reach the P.T stop from any location within the circular buffer (ideal case), and neglecting the actual geography of the pedestrian road network surrounding the P.T stop.

TCQSM (2003) determined the area covered by a particular route as the air distance within 400 meters of a bus stop or 800 meters of a busway or rail station. For more-detailed analysis, as it is clear in section 3.2.1 TCQSM (2003) introduces four refinement factors to correct ideal 400 meters threshold to a more practical value. By these factors each stop's service coverage area can be reduced in proportion to the additional time required to climb hills, cross busy streets, and to take into account effects of street connectivity pattern, and proportion of elderly from P.T users.

While being an important measure for the assessment of P.T availability, estimating the actual access coverage is complicated by the practical realities of spatial information. This means that proximity to stops must be interpreted creatively, which is possible using the powerful GIS network analysis functions. Fortunately, most commercial GIS packages offer capabilities for carrying out assessment of access on the basis of the pedestrian road network.

As illustrated in Figure 3.1 of methodology chapter, the idea here is to identify all the pedestrian road network links that lie within the specified maximum walking distance threshold (equal to refinement distance, which is calculated by TCQSM (2003) methodology) measured along the network paths around the P.T stop. Joining the ends of those links creates a polygonal area, which is referred to as the “actual access coverage” for the P.T stop. This polygonal area is named service area by network analyst in GIS program, and it is considered more representative than a 400 meters simple circular buffer for measuring the spatial coverage of P.T service. Figure 5.1 shows the difference between the ideal access coverage (simple circular area) and the actual access coverage (service area).

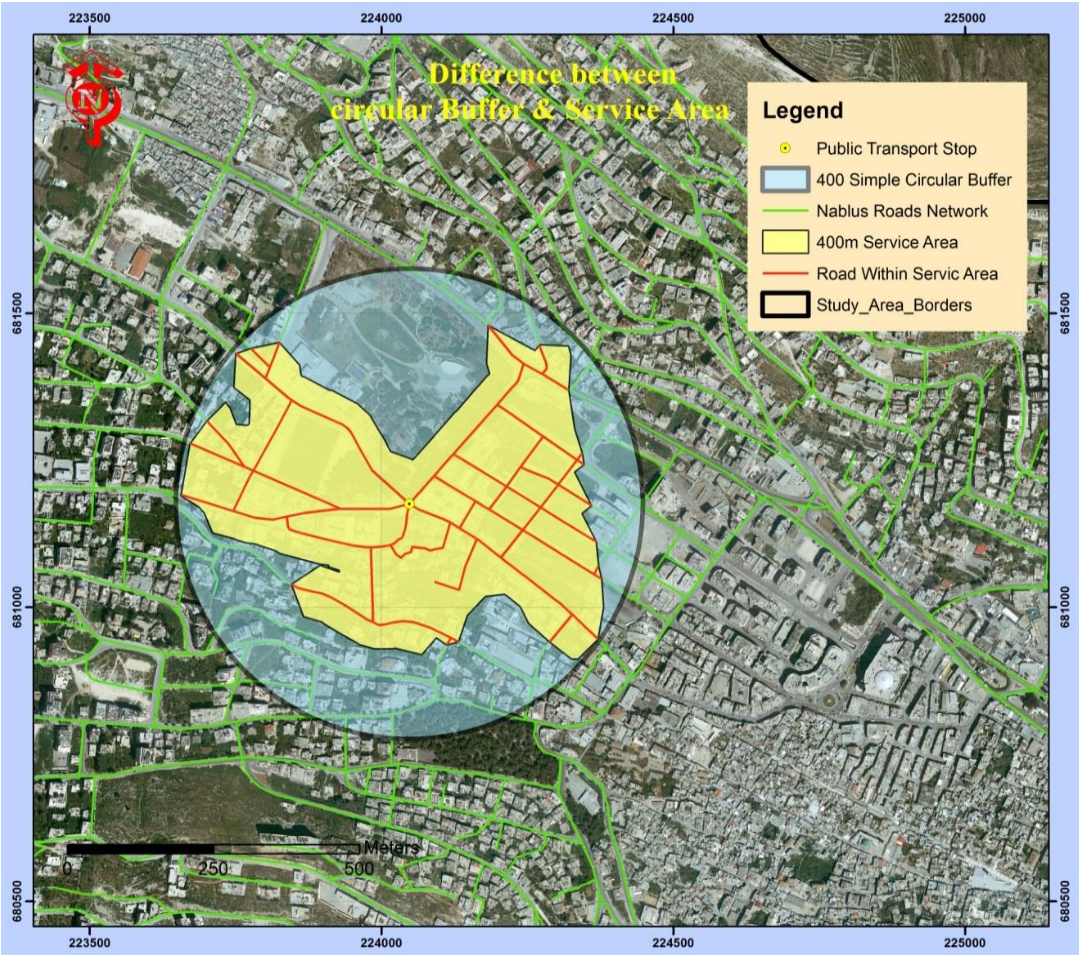

Figure (5.1): Differences between Simple Circular Buffer and Service Area Concepts

5.2.1.1 Service Area Refinement Factors

TCQSM (2003) suggests four factors to correct each P.T stop's service area. These factors are: a street connectivity factor, a grade factor, a population factor, and a pedestrian crossing factor. By these factors, each ideal transit stop's service distance is reduced in proportion to the weight of each factor. This can be expressed mathematically as shown in equation (3.1).

Refinement for Actual Walking Distances

There is a significant difference in service coverage areas defined by air distances from P.T stops, compared to the coverage areas when actual walking distances are used, particularly when there is poor street connectivity. This is particularly true and clear when GIS software is used with path-tracing functionality to create service area. The $\boldsymbol{f_{sc} = 1.00}$, as the buffers created by the software already account for street connectivity. Street connectivity factor is a factor for reducing P.T stop's service coverage area in relation to the amount of out-of-direction travel a pedestrian is forced to make to get to a P.T stop from the surrounding land uses. TCQSM (2003) defined three types of street patterns:

- Type 1, a traditional grid system.
- Type 2, a hybrid layout that incorporates elements of both Type 1 and Type 3 street patterns.
- Type 3, a cul-de-sac based street network with limited connectivity.

Figure 5.2 illustrates the three types of street patterns. These sketches may be used to estimate the area type surrounding the P.T stops under study. Starting with the grid street pattern as the best case (i.e., no reduction in coverage is made for a grid pattern), Table 5.1 provides suggested street connectivity factors for the other street patterns. The factor is based on the ratio of each street pattern's area covered to the area covered in a grid network.

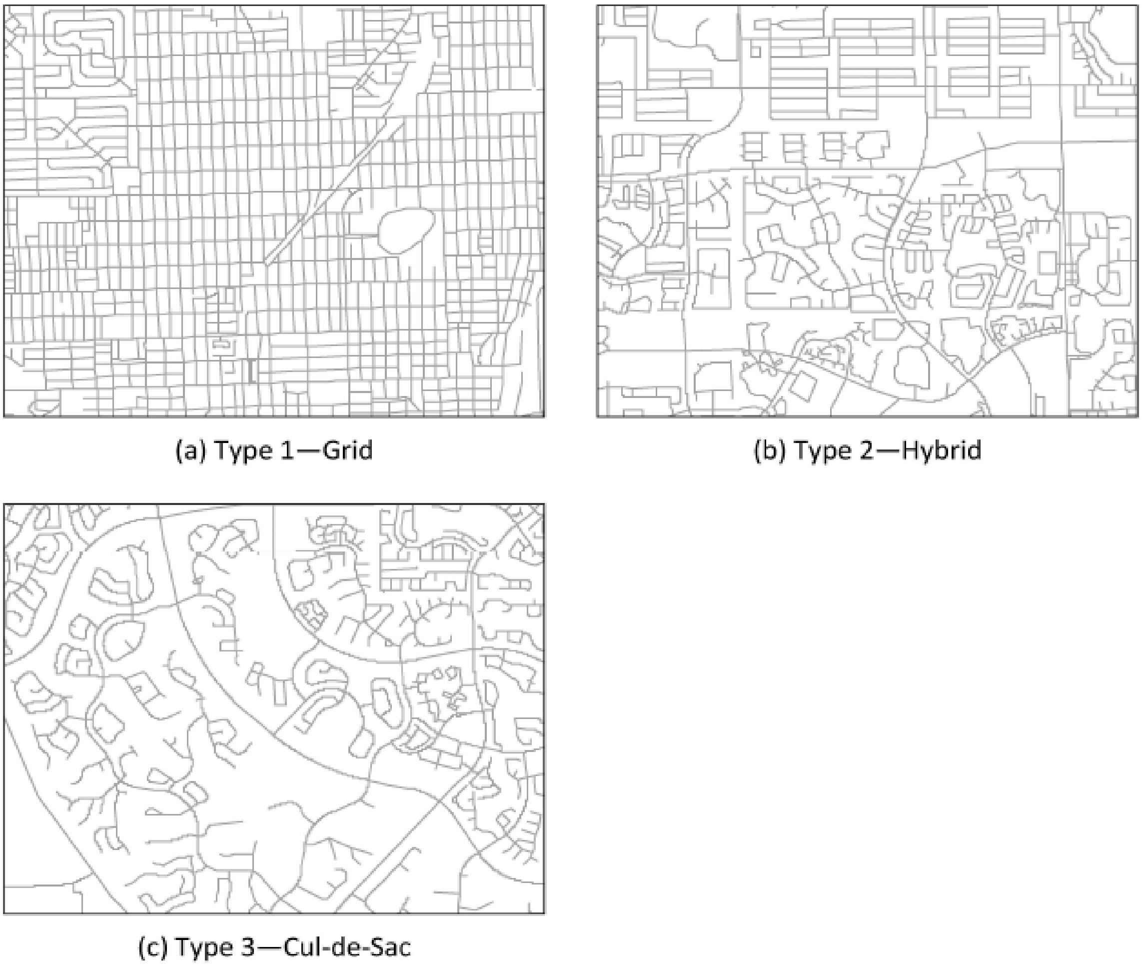

Figure (5.2): Street Pattern Types

Source: (TCQSM, 2003)

As an alternative to using the sketches, a measure of the network connectivity may be used instead to determine the area type. The network connectivity index is the number of links (i.e., street segments between intersections) divided by the number of nodes (i.e., intersections) in a roadway system. It is assumed for this application that all of the roadways provide for safe pedestrian travel. The index value ranges from about 1.70 for a well-connected grid pattern to approximately 1.20 for a cul-de-sac-based suburban pattern (TCQSM, 2003). Table 5.1 shows the relationship between the network connectivity index and the street pattern type.

Table (5.1): Street Connectivity Factor

Street Pattern Type	Network connectivity Index	Street Connectivity Factor (fsc)
Type1-Grid	>1.55	1
Type2-Hybrid	1.35 -1.55	0.85
Type3-cul-de-Sac	<1.3	0.45

Source: (TCQSM, 2003)

Based on the network and topological analysis results for the road network of the study area, the number of links was (2794), total number of nodes was (2127), and dead-end nodes were (398). Therefore,

$$\textbf{The network connectivity} = \frac{\mathbf{2794}}{\mathbf{2127 - 398}} = \mathbf{1.61}$$

Using GIS software with path-tracing functionality (Network Analyst) to create service area; therefore, the substitute of ($\boldsymbol{f_{sc} = 1.00}$) is an appropriate value to be used.

Refinement for Terrain

Grade plays an important influence on walking distance. In fact, the horizontal distance that pedestrian are able to travel in a given period of time decreases as the vertical distance climbed increases, particularly when the grade exceeds 5% (Municipal Planning Association, 1923). In this regard, TCQSM (2003) gives reduction factors for the effect of average grades on a given stop's service coverage area as shown in Table 5.2.

Table (5.2): Grade Factor

Average Grade	**Grade Factor (fg)**
0-5%	1
6-8%	0.95
9-11%	0.8
12-15%	0.65

Source: (TCQSM, 2003)

This factor assumes that pedestrians will have to walk uphill either coming or going. If the transit route network provides service on parallel streets, such that a person could walk downhill to one route on an outbound trip and downhill from another route back to one's origin on the return trip, use a grade factor of 1.0 (TCQSM, 2003).

To determine average grade for Nablus City road network, an approximation method is used by different analysis tools in GIS Program toolbox, and depending on elevation values of nodes corresponding to each link in road network and calculate perceptual slope by:

$$\boldsymbol{Avarage\ grade\ of\ link} = \frac{\boldsymbol{\Delta Z}}{\boldsymbol{Link\ segment\ Shape\ length}} \ldots\ldots (\mathbf{5.1})$$

Where:

$\boldsymbol{\Delta Z}$**:** The difference of elevation values for two nodes that connect to each link.

The following Figure 5.3 summarizes the steps to calculate weighted average grade for entire road network of the study area.

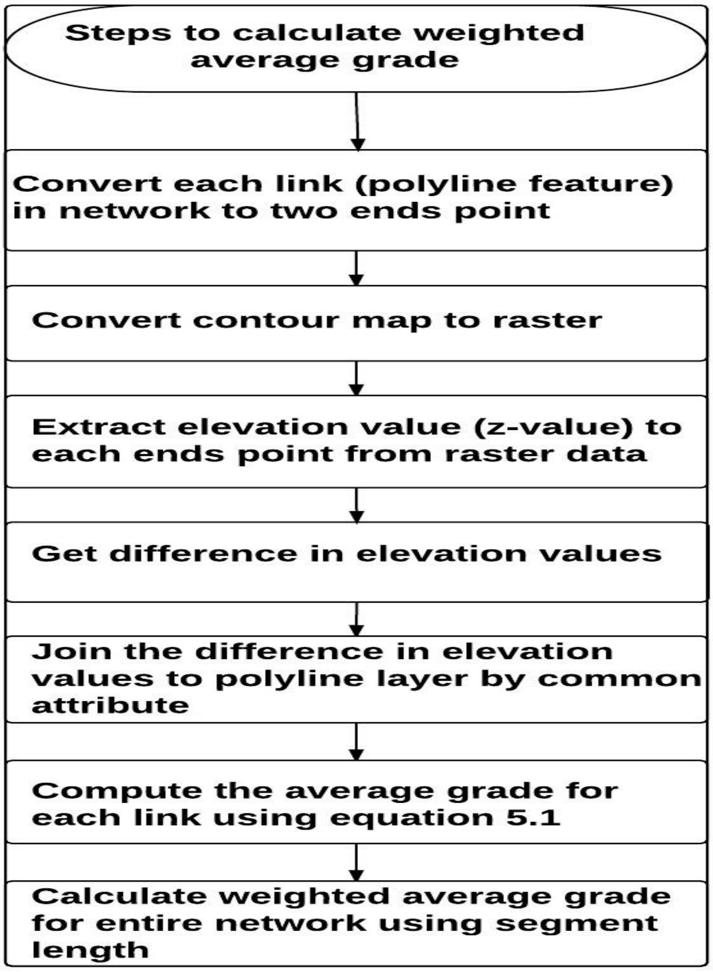

Figure (5.3): Steps to Calculate Weighted Average Grade

Finally, the average grade for Nablus City road network was calculated as 8.15%. Therefore, the corresponding grade factor by interpolation is (0.93). However, in the study area, P.T ridership usually use downhill road to reach P.T service. Therefore, the grade effect can be neglected, and a grade factor ($\boldsymbol{f_g = 1.00}$) is used.

Refinement for Population Characteristics

Average pedestrian walking speed depends on the proportion of elderly pedestrians (65 years or older) in the walking population. The typical walking speed of a younger adult is 4.0 ft/s (1.2 m/s), but when elderly pedestrians constitute 20% or more of the pedestrian population, a 3.3 ft/s (1.0 m/s) average speed should be used (Rouphail et al., 1998). For P.T stops where 20% or more of the boarding volume consists of elderly pedestrians, a population factor, $\boldsymbol{f_{pop}}$ of 0.85 should be used to account for the reduced distance traveled during a 5-min walk. For Nablus City as one of the cities in West Bank, the percent of elderly people (65 years or older) is nearly 3.2 % (PCBS, 2014 b). Based on percent of elderly people in population, also through researcher's experience in P.T users it can be considered as the elderly proportion of P.T users is much less than 20% threshold. Thus, the value of population factor $\boldsymbol{f_{pop}}$ is still equal to 1.00.

Refinement for Street Crossing Difficulty

Another factor that could be affecting the walking distance is the difficulty of crossing some streets. In particular, any crossing delay in excess of 30 seconds results in added travel time to reach P.T stop, in addition to the actual walking time (HCM, 2010). This causes a reduction of walking distance and a reduction in the size of a stop's service coverage area. According to Kittelson and Associates (2005) the equation used to calculate pedestrian crossing factor is:

$$\boldsymbol{f_{px} = \sqrt{\frac{(-0.000d^2{}_{ec} - 0.1157d_{ec} + 100\,)}{100}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots.(5.2)}$$

Where:

$\boldsymbol{d_{ec}}$**:** Pedestrian crossing delay exceeding 30 seconds.

Pedestrian crossing delay depends on crossing type. At signalized pedestrian crossings, average crossing delay is based on the cycle length and the amount of time available for pedestrians to begin crossing the street. At un-signalized pedestrian crossing where pedestrians do not have the right-of way, average crossing delay is based on the crossing distance, average pedestrian walking speed, and traffic volumes. For the study area in this research, crossing street delay is generally considered relatively low and there are a few regions that may have relatively high level of traffic flow; thereby, there is a considerable crossing delay. However, these regions are located near the CBD-area and along of Al-Quds Street, Faisal Street, and Rafedia Street. These regions have extensive P.T stops and are close to each other. In most areas of Nablus City, the pedestrians usually do not need to cross the street to get to the P.T service; this is due to the intensity of P.T stops. Therefore, the effect of pedestrian crossing factor is minimal and can be neglected. Therefore, for simplicity the researcher assumed ($\boldsymbol{f_{px}}$=1.00). Finally, when calculating the service coverage distance, it is still equals 400 meters.

5.2.1.2 Service Area and Network Analysis

Network data structures were one of the earliest representations in geographic information systems (GIS), and network analysis remains one of the most significant and persistent research and application areas in geographic information science (GI-Science). Network analysis has a strong theoretical basis in the mathematical disciplines of graph theory and topology, and it is the topological relationships inherent in networks that led to revolutionary advances in GIS data structures. Network Analyst is a GIS extension allow to analytically interface networks (systems of lines and points). The tool's features can help design efficient routes, determine service areas around a specific site (in terms of time and distance), and calculate the nearest facilities or vehicles. Specifically, a service area can be defined around a particular location at a set distance. This area is defined by joining the end points of all routes measured up to a defined distance away from an origin point.

Building a Network Dataset

Once the road and pathways data has been prepared it can be used to create a 'network dataset.' This is done using the 'Create Network Dataset' tool provided in ArcGIS Network Analyst. The tool allows the measuring units of the network to be specified (in this study used meters) as well as any restrictions of movement through the network. This study did not attach any restrictions to movement through the network because it focuses on pedestrian movement. Restrictions are generally used for traffic routing analysis, such as one-way streets. It is important to note that if the topological analysis is not completed then the network dataset will not function properly. All lines must be split at junctions and all lines must be connected at junctions. The study area road network that was used in network analyst is shown in Figure 5.4

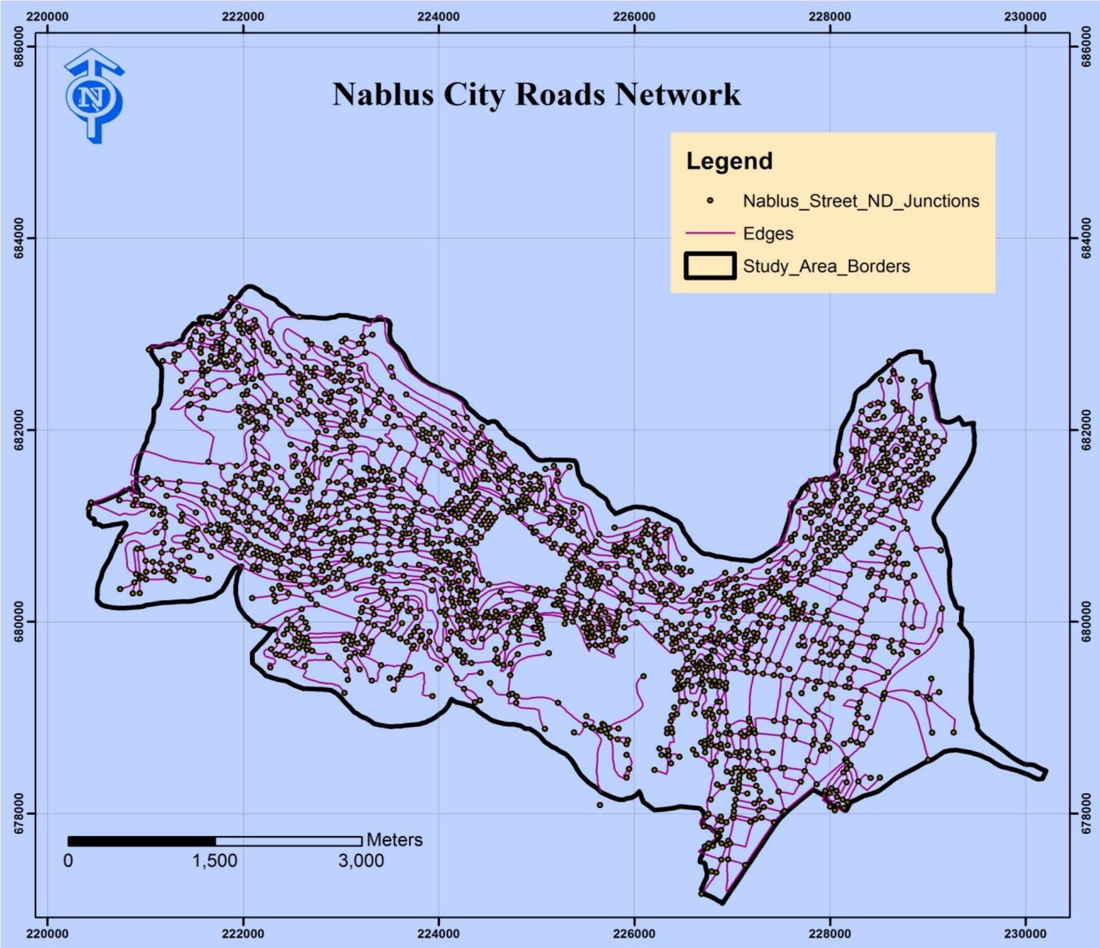

Figure (5.4): Nablus City Roads Network

Create Public Transport Stop's Service Area

To create service area, first determine the location of P.T stops. By knowing the spatial location of each P.T fixed route in the study area, Figure 5.5 shows the location of P.T stops. The location of P.T stops is determined based on intersection of paths of P.T route with any street segment.

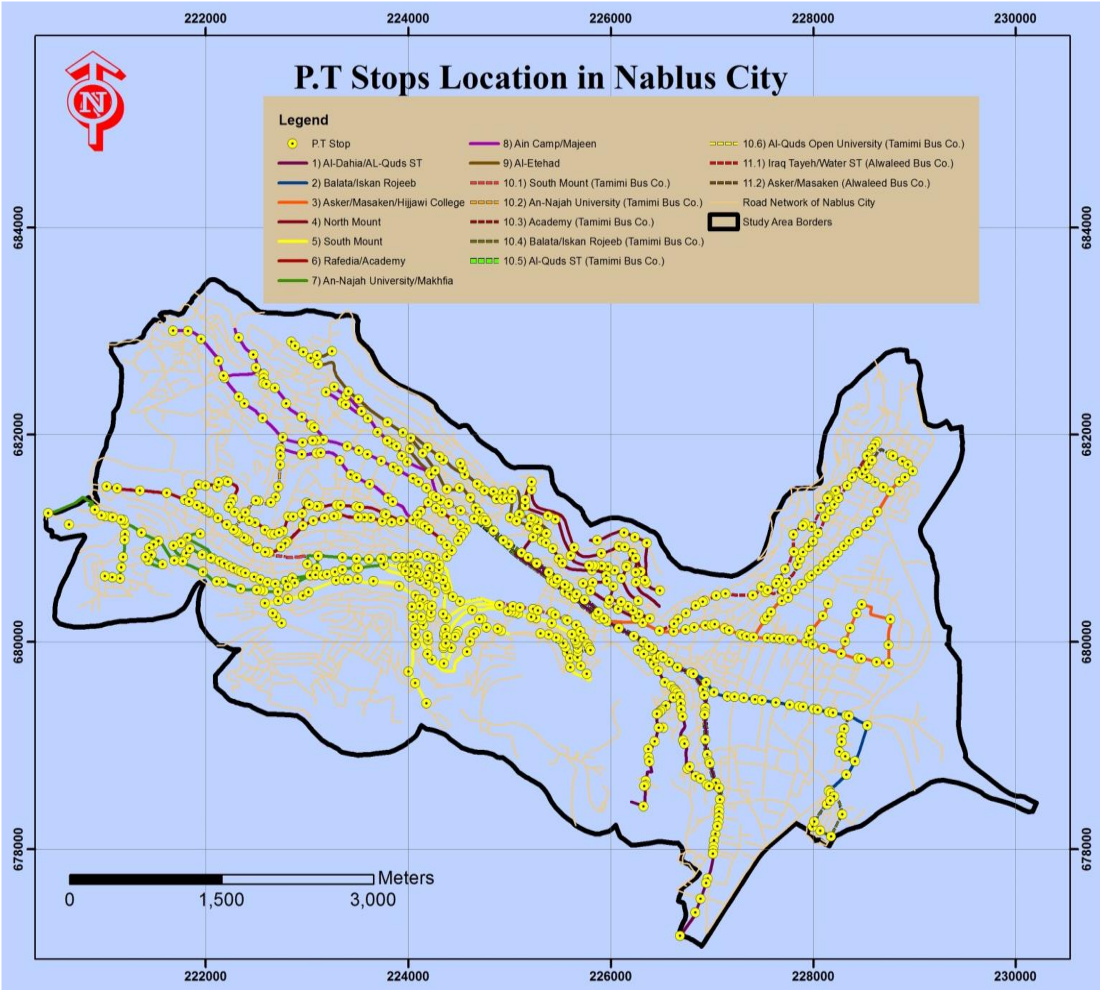

Figure (5.5): P.T Stops Location in Nablus City

The next step is adding P.T stops as facilities for which the service area polygons will be generated. After that, setting up the parameters for the analysis by specifying that service area will be calculated based on walking distance equals to 400 meters as impedance breaks, for the "Polygon Generation tab" making sure that "Generate Polygons" is checked, "Detailed polygons" are much more accurate, but need more time to be generated. Merge by breaks value" for "Multiple Facilities Options" to join polygons of multiple facilities that have the same break values. Finally, run the process to compute the service area, which is a series of polygons representing the distance that can be reached from a facility within a specified amount of impedance. Service area polygons could be exported to new shape-file or feature class to complete further analysis on it. The following map in Figure 5.6 illustrates the P.T service area for Nablus City.

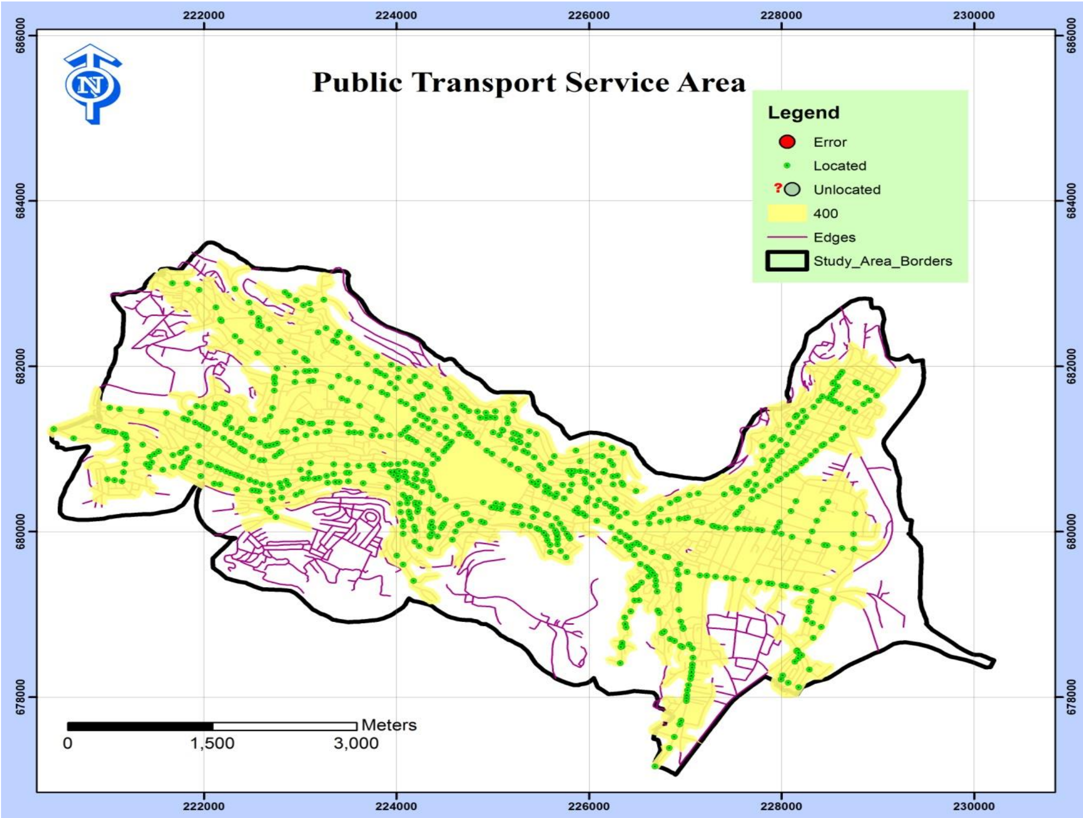

Figure (5.6): Nablus City P.T Service Area

5.2.1.3 Percent People Being Served

Spatial coverage for each statistical quarter is determined based on the total population being served on that quarter. This was conducted through overlay analysis from "intersect" tool in toolbox for GIS program, and by summarizing attribute from attribute tables. Intersect creates a new layer by overlaying the features from the input layers. The new output layer contains the input features or portions of the input features that overlaps. The output features have the attribute from two original features, which they intersect. Summarizing creates a new table containing one record for each unique value of the selected field along with statistics summarizing any of the other fields. The GIS-Model used to complete overlay analysis is shown in Figure 5.7.

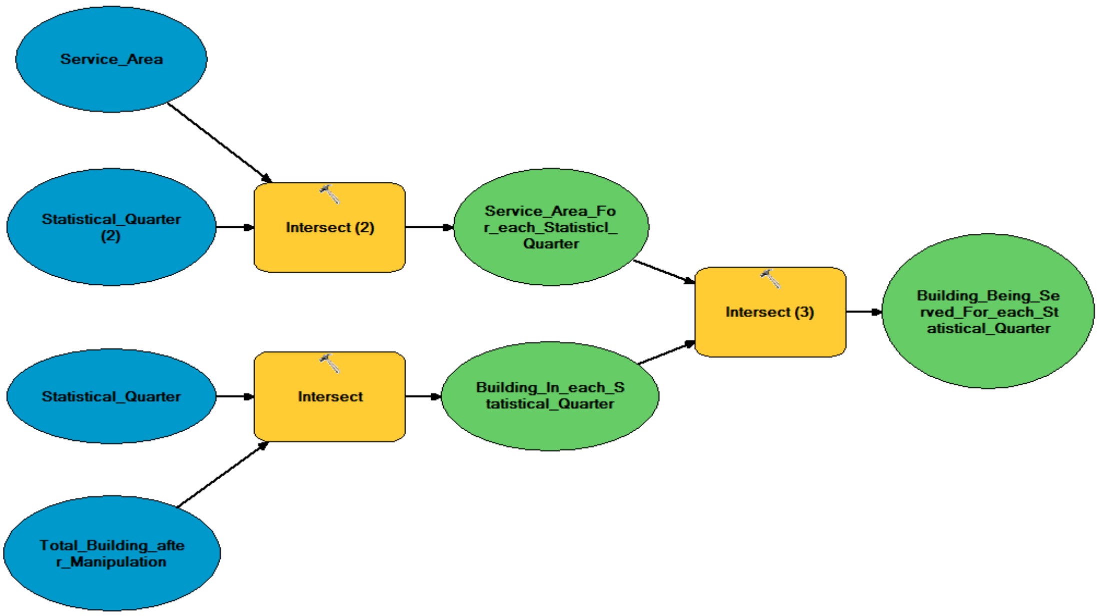

Figure (5.7): GIS-Model to Compute People Being served

By running the above model and making a summary, the total number of buildings and corresponding number of dwelling units being served by P.T service was determined. The percent of people being served in each statistical quarter is computed as the following:

$$\boldsymbol{Person\ per\ D.U = \frac{pop2014}{Total\ D.U}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.\ldots\ldots\ldots\ldots..(\mathbf{5.3})$$

$$\boldsymbol{People\ Being\ Served = person\ per\ D.U * Served\ D.U} \ldots\ldots.(\mathbf{5.4})$$

$$\%\boldsymbol{people\ Served = \left(\frac{Served\ D.U}{Total\ D.U}\right) * 100\%} \ldots\ldots\ldots\ldots..\ldots\ldots\ldots\ldots.(\mathbf{5.5})$$

Where:

$\boldsymbol{Person\ per\ D.U}$**:** Number of persons per dwelling unit in any statistical quarter.

$\boldsymbol{pop2014}$**:** Population of statistical quarter in year 2014.

$\boldsymbol{Total\ D.U}$: Total number of dwelling units in that statistical quarter.

$\boldsymbol{Served\ D.U}$**:** Total number of dwelling units being served for a statistical quarter.

Table 5.3 illustrates the spatial coverage analysis

Statistical Quarter ID	Statistical Quarter-Area (m2)	Total Building	Total Dwelling Units	Buildings Being Served	Dwelling Units Being Served	POP2007	POP2014	Persons per Dwelling Unit	POP Being Served	%POP Being Served
2	404187.10	68	553	68	553	2221	2608	4.72	2608	100
3	629439.85	432	2329	432	2329	6583	7730	3.32	7730	100
4	751766.86	329	1680	329	1680	4882	5732	3.41	5732	100
5	2396012.97	473	1993	340	1619	5648	6632	3.33	5387	81
6	1626258.28	492	3307	419	2971	7195	8448	2.55	7590	90
7	979402.20	418	2395	413	2380	8982	10547	4.40	10481	99
8	610182.33	343	1238	338	1225	4683	5499	4.44	5441	99
9	368016.36	245	784	244	781	3919	4602	5.87	4584	100
10	344424.88	165	643	165	643	2791	3277	5.10	3277	100
11	795810.85	376	1218	371	1203	5191	6095	5.00	6020	99
12	461284.44	351	1001	351	1001	4913	5769	5.76	5769	100
13	885832.66	395	1042	380	1008	5281	6201	5.95	5999	97
14	1543588.99	515	1388	467	1295	5472	6425	4.63	5995	93
15	1321474.36	130	331	106	277	1326	1557	4.70	1303	84
16	1391324.00	53	122	48	111	377	443	3.63	403	91
17	2042769.34	328	674	262	526	2146	2520	3.74	1967	78
18	604651.51	125	291	118	281	1628	1912	6.57	1846	97
19	1527633.59	546	1484	521	1438	8076	9483	6.39	9189	97
20	2461248.80	244	793	244	793	4275	5020	6.33	5020	100
21	466688.36	313	918	313	918	4485	5266	5.74	5266	100
22	960117.05	806	2927	775	2858	11968	14053	4.80	13722	98
23	2751369.66	423	1757	322	1551	5451	6401	3.64	5650	88
24	682230.54	276	1647	275	1647	4815	5654	3.43	5654	100
25	1759506.27	413	2268	398	2249	4198	4929	2.17	4888	99
100	61843.88					3936	4622		4622	100
200	271388.33					15084	17712		17278	97.55
300	142936.87					11483	13483		13483	100
400	89961.42									100

Table (5.3): Spatial Coverage Analysis

Statistical Quarter ID	Statistical Quarter-Area (m2)	Total Building	Total Dwelling Units	Buildings Being Served	Dwelling Units Being Served	POP2007	POP2014	Persons per Dwelling Unit	POP Being Served	%POP Being Served
2	404187.10	68	553	68	553	2221	2608	4.72	2608	100
3	629439.85	432	2329	432	2329	6583	7730	3.32	7730	100
4	751766.86	329	1680	329	1680	4882	5732	3.41	5732	100
5	2396012.97	473	1993	340	1619	5648	6632	3.33	5387	81
6	1626258.28	492	3307	419	2971	7195	8448	2.55	7590	90
7	979402.20	418	2395	413	2380	8982	10547	4.40	10481	99
8	610182.33	343	1238	338	1225	4683	5499	4.44	5441	99
9	368016.36	245	784	244	781	3919	4602	5.87	4584	100
10	344424.88	165	643	165	643	2791	3277	5.10	3277	100
11	795810.85	376	1218	371	1203	5191	6095	5.00	6020	99
12	461284.44	351	1001	351	1001	4913	5769	5.76	5769	100
13	885832.66	395	1042	380	1008	5281	6201	5.95	5999	97
14	1543588.99	515	1388	467	1295	5472	6425	4.63	5995	93
15	1321474.36	130	331	106	277	1326	1557	4.70	1303	84
16	1391324.00	53	122	48	111	377	443	3.63	403	91
17	2042769.34	328	674	262	526	2146	2520	3.74	1967	78
18	604651.51	125	291	118	281	1628	1912	6.57	1846	97
19	1527633.59	546	1484	521	1438	8076	9483	6.39	9189	97
20	2461248.80	244	793	244	793	4275	5020	6.33	5020	100
21	466688.36	313	918	313	918	4485	5266	5.74	5266	100
22	960117.05	806	2927	775	2858	11968	14053	4.80	13722	98
23	2751369.66	423	1757	322	1551	5451	6401	3.64	5650	88
24	682230.54	276	1647	275	1647	4815	5654	3.43	5654	100
25	1759506.27	413	2268	398	2249	4198	4929	2.17	4888	99
100	61843.88					3936	4622		4622	100
200	271388.33					15084	17712		17278	97.55
300	142936.87					11483	13483		13483	100
400	89961.42									100

Note that statistical quarter with ID of 1 is not included in the analysis. This is because ID=1 refers to the CBD-area for Nablus City, and this area by default has greatest value of LIPTA and all P.T accessibility. In addition, statistical quarters whose ID numbers of 100, 200, 300, and 400 refers to Ain, Balata, Old Asker, and New Asker Refugee Camps. These are areas with high population density. Therefore, for these areas assuming that the population is uniformly distributed on the entire area is reasonable. Since road network data for these areas is not available, the spatial coverage analysis was made by simple buffer with 400 meters air distance along the P.T routes that serve any camp. Therefore, the percent of people being served is computed based on the area ratio method, by computing the percent of area served with respect to the total camp area.

5.2.2 Temporal Coverage Component Analysis

How often P.T service is provided and when it is provided during the day are important factors in one's decision to use P.T. The more frequent the service, the shorter the wait time when P.T is missed or when the exact schedule is not known, and the greater the flexibility that customers have in selecting travel times. The number of hours during the day when service is available (service span) is also highly important. If P.T is not provided at the time one desires to travel, P.T will not be an option for that trip. However, because the nature of P.T service, especially shared-taxi mode, is usually departing when all seats are filled; therefore, the frequency values depend on service span. Thus, only frequency factor is used to determine temporal availability of P.T service.

For this study, frequency measure is based on collected data of average number of trips for each P.T vehicle, which works on specific fixed P.T route per day per direction. Since the specific P.T fixed route might branch to multiple sub-P.T fixe routes; therefore, the frequency data was determined to each branch of P.T separately as shown in Table 4.7. In addition, because of more than one P.T route work on the same segment of P.T fixed path, the composite average frequency value $\boldsymbol{CAF}$ is computed for each segment as follows:

$$\boldsymbol{CAF = \sum_{i=1}^{n} f_i} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \mathbf{(5.6)}$$

Where:

$\boldsymbol{f_i}$: Average daily frequency of sub-P.T fixed route.

$\boldsymbol{n}$: Number of sub-P.T fixed routes operated on the same segment.

To identify the frequency value for each statistical quarter that's needed to develop LIPTA, the composite average segment frequency is converted to represent the entire statistical quarter area served by this segment. This is done by calculating the weighted composite average frequency $\mathbf{WCAF_k}$ as shown in equation 5.7. Because a quarter might have multiple P.T segments affecting it, all weighted composite average frequencies are summed as follows:

$$\boldsymbol{WCAF_k = \sum_{i=1}^{n} \left(\frac{A_{ki}}{A_k}\right) CAF_i} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \mathbf{(5.7)}$$

Where:

$\boldsymbol{WCAF_k}$: weighted composite average frequency for statistical quarter $\boldsymbol{k}$.

$\boldsymbol{A_{ki}}$: Area of overlapping between the service area of the P.T segment i and statistical quarter $\boldsymbol{k}$ (m^2).

$\boldsymbol{A_k}$: Total area of statistical quarter $\boldsymbol{k}$ (m^2).

$\boldsymbol{CAF_i}$: Composite average frequency for each segment of major P.T fixed route, which its corresponding service area interact with statistical quarter$k$.

$\boldsymbol{n}$: Number of segments of major P.T fixed route, which its corresponding service area interact with statistical quarter $\boldsymbol{k}$.

The service area of each P.T segment is determined by a simple buffer with 400 meters air distance along the segment length. However, by this method of calculating the frequency value, it often merely becomes a function of statistical quarter size; i.e., large statistical quarter achieves a higher frequency score because it covers the more likely additional segments of P.T fixed route. To account for this effect, the researcher divided weighted composite frequency value for each statistical quarter by the total built-up area corresponding to that statistical quarter. Table 5.4 illustrates the temporal coverage analysis.

Table (5.3): Spatial Coverage Analysis

Statistical Quarter ID	Statistical Quarter-Area (m2)	Total Building	Total Dwelling Units	Buildings Being Served	Dwelling Units Being Served	POP2007	POP2014	Persons per Dwelling Unit	POP Being Served	%POP Being Served
2	404187.10	68	553	68	553	2221	2608	4.72	2608	100
3	629439.85	432	2329	432	2329	6583	7730	3.32	7730	100
4	751766.86	329	1680	329	1680	4882	5732	3.41	5732	100
5	2396012.97	473	1993	340	1619	5648	6632	3.33	5387	81
6	1626258.28	492	3307	419	2971	7195	8448	2.55	7590	90
7	979402.20	418	2395	413	2380	8982	10547	4.40	10481	99
8	610182.33	343	1238	338	1225	4683	5499	4.44	5441	99
9	368016.36	245	784	244	781	3919	4602	5.87	4584	100
10	344424.88	165	643	165	643	2791	3277	5.10	3277	100
11	795810.85	376	1218	371	1203	5191	6095	5.00	6020	99
12	461284.44	351	1001	351	1001	4913	5769	5.76	5769	100
13	885832.66	395	1042	380	1008	5281	6201	5.95	5999	97
14	1543588.99	515	1388	467	1295	5472	6425	4.63	5995	93
15	1321474.36	130	331	106	277	1326	1557	4.70	1303	84
16	1391324.00	53	122	48	111	377	443	3.63	403	91
17	2042769.34	328	674	262	526	2146	2520	3.74	1967	78
18	604651.51	125	291	118	281	1628	1912	6.57	1846	97
19	1527633.59	546	1484	521	1438	8076	9483	6.39	9189	97

20	2461248.80	244	793	244	793	4275	5020	6.33	5020	100
21	466688.36	313	918	313	918	4485	5266	5.74	5266	100
22	960117.05	806	2927	775	2858	11968	14053	4.80	13722	98
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25	1759506.27	413	2268	398	2249	4198	4929	2.17	4888	99
100	61843.88					3936	4622		4622	100
200	271388.33					15084	17712		17278	97.55
300	142936.87					11483	13483		13483	100
400	89961.42									100

Table (5.4): Temporal Coverage Analysis, *continued*

3.4	4.1	4.2	4.3	4.4	4.5	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8
						136.70	171.90	139.12	50.08	77.90	77.90	74.81	33.38
						182.71	270.48	125.68	45.24	70.38	70.38	67.58	30.16
						6.96	13.58	0.46	0.16	0.26	0.26	0.24	0.10
2.78	1.96	1.63	0.69	0.97	0.81	13.09	19.38	17.03	6.13	9.53	9.53	9.15	4.08
153.55	178.59	302.09	131.30	88.25	74.35	23.25	35.02	30.78	11.08	17.23	17.23	16.55	7.38
461.02	492.96	426.00	182.00	243.60	208.98					0.24			
715.71	463.98	234.15	115.64	254.00	207.72					16.86			
333.22	311.29	132.95	93.35	120.33	170.35								
586.88				14.84	8.56								
71.76													
520.59													
380.44													
17.06				0.14									
7.68						6.62		53.92	12.66	71.50	6.54	6.18	2.80
700.91	146.33	91.01	38.88	171.97	47.98			7.32		197.96		1.84	
4.55						258.28	215.60	443.90	123.42	210.40	191.38	152.30	82.02
						38.77	64.98	26.00	29.28	7.44	28.62	4.96	14.54
150.22													
729.00													

Table (5.4): Temporal Coverage Analysis, *continued*

5.9	6.1	6.2	7.1	7.2	7.3	8.1	8.2	8.3	8.4	9.1	9.2	9.3	9.4
79.23	2681.82	1879.24	1001.04	358.29	145.04	1500.96	839.99	406.58	272.00	306.55	46.24	45.78	339.68
150.28	3555.37	2134.21	2921.71	884.02	345.60	213.02	119.21	61.87	103.00	56.76			1.16
6.26	2607.12	1856.59	281.22	28.06	11.46	697.03	396.84	27.23	196.00	21.09			
	1044.41	514.83		46.93	15.14	105.43	272.32	136.42	27.00				
						858.10	574.98	362.51	56.00	193.66			1.89
8.93	427.75	333.37	108.61	44.90	16.34	646.74	361.94	77.64	62.00	397.78	119.86	115.25	363.92
16.14	232.87	203.95	195.63	81.81	29.55	223.39	125.02		40.00	71.44	285.99	272.70	328.72
											221.82	198.15	
											0.01		
											0.19	0.19	
99.36	93.55	42.75	335.39	138.63	56.66								
94.46	190.08	61.85	606.40	272.04	116.48								
103.90	1189.09	384.07	70.22	744.09	361.96								
	1252.74	327.23		370.04	370.96								
		30.91				1501.00	840.00	436.00	228.00	387.66			390.21

Table (5.4): Temporal Coverage Analysis, ***continued***

10.1	10.2	10.3	10.4	10.5	10.6	11.1	11.2	Total	Weighted-Frequency/ 1000 m2 Built-UpArea
10.78	54.40	79.99	11.22	11.22	67.98			**10899.82**	**156.14**
12.79	69.28	34.43	0.30	0.30	6.71			**11532.63**	**37.05**
6.91	41.80	77.24			29.78			**6306.65**	**14.43**
0.20	8.59	32.84			10.76			**2214.87**	**8.55**
	6.95	13.91			51.60			**2119.60**	**9.28**
2.78	13.78	21.73	3.62	3.62	29.32	1.00	0.38	**3285.60**	**13.97**
2.81	17.26	23.59	18.38	18.38	15.08	24.75	8.91	**4850.31**	**29.25**
0.59			25.43	25.43		55.96	38.10	**7176.59**	**59.36**
3.00			39.24	39.24		86.49	64.86	**9336.82**	**83.82**
			4.01	4.01		49.87	30.17	**3006.48**	**18.88**
			27.62	25.60		40.98	53.12	**5775.82**	**33.14**
						86.01	45.86	**1709.46**	**9.34**
						43.02	43.74	**1154.71**	**5.08**
						10.84	25.28	**1257.81**	**9.28**
			16.34	0.38			7.20	**661.45**	**4.51**
			24.02	2.10				**142.49**	**0.78**
			0.60	27.74				**1830.44**	**20.53**
			6.48	22.00		1.66	1.54	**1365.62**	**5.20**

5.78			1.56	1.56		0.89	0.66	**4758.71**	**42.02**
16.44			38.90	38.90		84.54	63.41	**6732.14**	**33.69**
13.64	4.48		0.23	0.23		0.52	0.38	**2622.82**	**9.37**
2.29	11.15							**1569.34**	**6.64**
2.69	13.11	13.53						**2882.66**	**20.62**
0.03	3.30	27.34						**2351.64**	**12.56**
	33.51	67.02			68.00			**3982.31**	**64.39**
			32.56	30.32				**4623.20**	**17.04**
						42.00	66.00	**2745.32**	**19.21**
								729.00	**8.10**

*: Major P.T fixed route number refers to Table 4.7

5.2.3 Comprehensive LIPTA Evaluation

For every component, the scores of the statistical quarter are standardized to produce standard score (Z-scores), as shown in Table 5.5, thus enabling a LIPTA grading scheme to be applied. An overall LIPTA Z-score is found by averaging the Z-scores from each component for a given statistical quarter. To enable using average Z-scores, the two score components must have identical distribution. Therefore, the score itself for each component is considered as an observation for the random variables. Furthermore, because the number of observations is less than 30 for each random variable, the best statistical test to be used to compare two distributions is non-parametric Friedman's Test. The statistical test is conducted through SPSS program and the results are as follows:

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distributions of Spatial and Temporal are the same.	Related-Samples Friedman's Two-Way Analysis of Variance by Ranks	.131	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure (5.8): Test Hypothesis for Scores Distributions

Therefore, spatial and temporal components have the same distribution at 5% significant level. The Z-scores for spatial and temporal component and the overall LIPTA for each statistical quarter are shown in Table 5.5.

Table (5.5): Z-Scores for Spatial and Temporal Components and LIPTA for each Statistical Quarter

Statistical Quarter-ID	Z-Score for Spatial Component	Z-Score for Temporal Component	LIPTA
2	0.7	4.0	2.4
3	0.7	0.3	0.5
4	0.7	-0.4	0.2
5	-2.5	-0.6	-1.5
6	-1.0	-0.5	-0.8
7	0.6	-0.4	0.1
8	0.5	0.1	0.3
9	0.6	1.0	0.8
10	0.7	1.8	1.2
11	0.5	-0.2	0.1
12	0.7	0.2	0.4
13	0.1	-0.5	-0.2
14	-0.5	-0.7	-0.6
15	-2.1	-0.5	-1.3
16	-0.8	-0.7	-0.7
17	-3.0	-0.8	-1.9
18	0.1	-0.2	0.0
19	0.2	-0.7	-0.2
20	0.7	0.5	0.6
21	0.7	0.2	0.5
22	0.9	-0.5	0.2
23	-1.3	-0.6	-1.0
24	0.7	-0.2	0.3
25	0.5	-0.4	0.0
100	0.7	1.2	0.9
200	0.3	-0.3	0.0
300	0.7	-0.2	0.2
400	0.7	-0.6	0.1

5.3 Analysis of Data Needed to Develop TTAI

P.T-Auto travel time measure is the door-to-door trip travel time difference between P.T and private car. It includes in vehicle travel time for modes, assumed access and egress times, wait time, transfer time for P.T (shared-taxi) mode, and egress time for private car mode. It measures how much longer or shorter a trip will take in P.T (shared-taxi) compared to auto.

Door-To-Door Travel Time

Some studies take into account every stage of a journey between its origin and destination when analyzing travel times and distances as shown in the following schematic diagram (Figure 5.9).

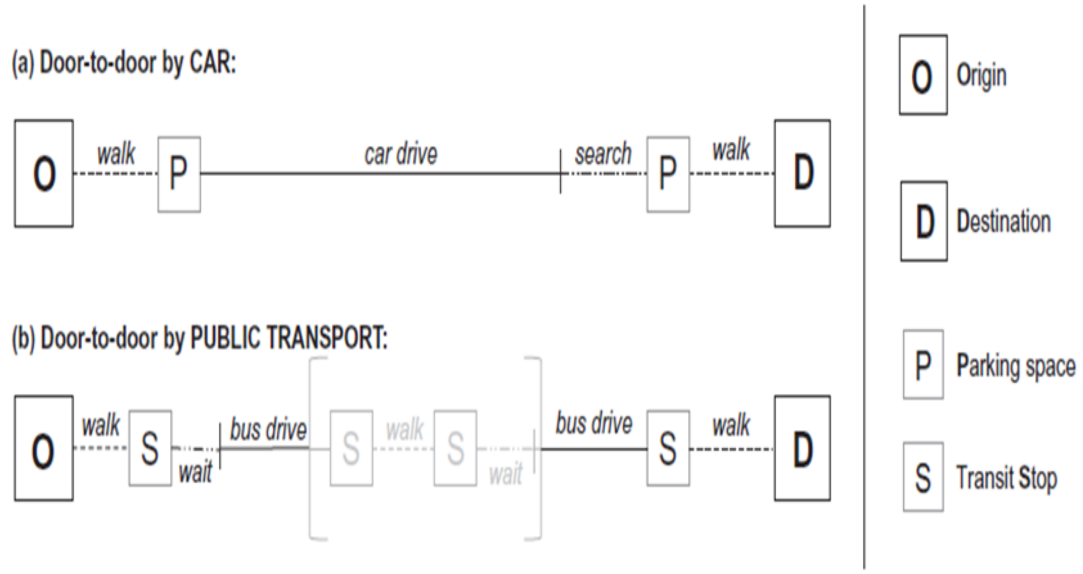

Figure (5.9): Examples of the door-to-door approach in (a) car journeys and (b) PT journeys

Source: (Salonen and Toivonen, 2013)

In this study, the researcher defines this ‘‘door-to-door travel time as follows. By car, a door-to-door journey includes:

1. Walking time from the point of origin to the place where the car parks.
2. In-vehicle travel time from origin to destination.
3. Parking time.

4. Walking from the parking space to the destination itself.

By public transport (shared-taxi), the journey may be slightly more complicated. The basic parts include:

1. Walking from the point of origin to the appropriate stop (access time).
2. Waiting for the transport vehicle to arrive and to depart.
3. Sitting in the vehicle between the initial and final stops.
4. Walking from the last stop to the final destination (egress time).

In addition, several public transport journeys include transfers from one route to another, which possibly imply walking from one stop to another and waiting for the next vehicle to depart.

For this study, previously defined door to door travel times for P.T and private car mode are calculated based on the in-vehicle travel time collected data in chapter four (Table 4.9), and proposed formulas in chapter three (equations 3.4, 3.5, and 3.6), with appropriate assumptions for other components of door-to-door travel time based on several observation and by experience of character of selected O-D’s.

Table (5.6): Assumed Values for Door-To-door Travel Time components

Time Component	Assumed value (minute)
Wl_{to}	3
Wi_{t1}	2
Wl_{td}	Negligible
Wl_{t2}	3
Wi_{t2}	2
Wl_{top}	Negligible
$Pa_t + Wl_{tpd}$	3

Notes for assumed values:

There time values can be estimated using several empirical models. However, for this study the researcher assumed these values for simplicity.

1. $\boldsymbol{Wl_{to}}$,walk time from origin to P.T stop, and $\boldsymbol{Wl_{t2}}$, walk time to 2nd P.T route were assumed based on typical walking speed (1.2 m/s), distance travelled by several passenger from their homes to closest P.T stop at origin places, and distance from drop-off passenger location in CBD-area to P.T transfer station are about 200 meters.
2. $\boldsymbol{Wi_{t1}}$, waiting time for 1st P.T route, and $\boldsymbol{Wi_{t2}}$, waiting time for 2nd P.T route, were estimated based on several observations in two origins and in P.T transfer station during travel time data collection periods.
3. $\boldsymbol{Pa_t + Wl_{tpd}}$, parking time, was assumed based on the time available for parking in multi-story garage, which in TCQSM is about 5 minutes, but for this study the on-street parking time was estimated by several observations at final destinations, which was less than 2 minutes. Therefore, combining this value with walk time from the final parking place to destination $\boldsymbol{Wl_{tpd}}$, the estimate is about 3 minutes.
4. $\boldsymbol{Wl_{top}}$, walk time from origin to the parking place for private car mode was considered negligible because parking places are usually close enough to passengers' homes.
5. $\boldsymbol{Wl_{td}}$, walk time from the final P.T stop to destination is considered negligible because the P.T service for selected destinations reaches close enough to destinations.

Based on previous assumptions, and using equations (3.7 and 3.8), door-to-door travel time and travel time accessibility index for the two modes are calculated as shown in Table 5.7.

Origin-Destination	Door-To-Door T.T (Minutes)	Average T.T For Modes (Minutes)	P.T (T.T AI)	P.C (T.T AI)
Masaken-Al-Quds Open University (P.C)*	18.8	26.2	1.28	0.72
Masaken-Al-Quds Open University (P.T)*	33.59			
AL-Dahia-Nablus Health Directorate (P.C)	16.91	23.31	1.27	0.73
AL-Dahia-Nablus Health Directorate (P.T)	29.72			

* P.C: Private Car Mode.

P.T: Public Transport (shared-taxi) Mode.

5.4 Results and Discussion

5.4.1 Results and Discussion for LIPTA

Classification scheme was implemented for the standardized Z-scores. A ranked percentile scheme was employed to categorize levels of P.T availability. The total number of scores was divided into four quintiles (25% of total scores for each level). Each 25% quintile was assigned a level. Level 1 represents the lowest 25 percentile of scores; level 2 is associated with the 25-50 percentile range and so on, to level 4, which represents the top 25% of the scores. By default, the statistical quarter ID-1(CBD region) with level 5 is assigned. Very broadly, the associations of the levels for the designated statistical quarters are as follows:

- **Level 1 -** No service or extremely limited availability.
- **Level 2 -** Sparse to less than average levels of availability.
- **Level 3 -** Average levels of availability.
- **Level 4 -** Average to good levels of availability.
- **Level 5 -** Excellent levels of availability, best in quarters.

The resulting of individual components and overall LIPTA are shown in Table 5.8 and maps in Figures 5.10 and 5.11.

Table (5.8): Individual Components and Overall LIPTA Levels

Statistical Quarter-ID	Spatial Component Levels	Temporal Component Levels	Overall LIPTA Levels
1	Level 5	Level 5	**Level 5**
2	Level 4	Level 4	**Level 4**
3	Level 4	Level 1	**Level 3**
4	Level 4	Level 1	**Level 2**
5	Level 1	Level 1	**Level 1**
6	Level 3	Level 1	**Level 2**
7	Level 4	Level 1	**Level 2**
8	Level 4	Level 1	**Level 3**
9	Level 4	Level 2	**Level 3**
10	Level 4	Level 3	**Level 3**
11	Level 4	Level 1	**Level 2**
12	Level 4	Level 1	**Level 3**
13	Level 4	Level 1	**Level 2**
14	Level 4	Level 1	**Level 2**
15	Level 2	Level 1	**Level 1**
16	Level 4	Level 1	**Level 2**
17	Level 1	Level 1	**Level 1**
18	Level 4	Level 1	**Level 2**
19	Level 4	Level 1	**Level 2**
20	Level 4	Level 2	**Level 3**
21	Level 4	Level 1	**Level 3**
22	Level 4	Level 1	**Level 2**
23	Level 2	Level 1	**Level 1**
24	Level 4	Level 1	**Level 3**
25	Level 4	Level 1	**Level 2**
100	Level 4	Level 2	**Level 3**
200	Level 4	Level 1	**Level 2**
300	Level 4	Level 1	**Level 2**
400	Level 4	Level 1	**Level 2**

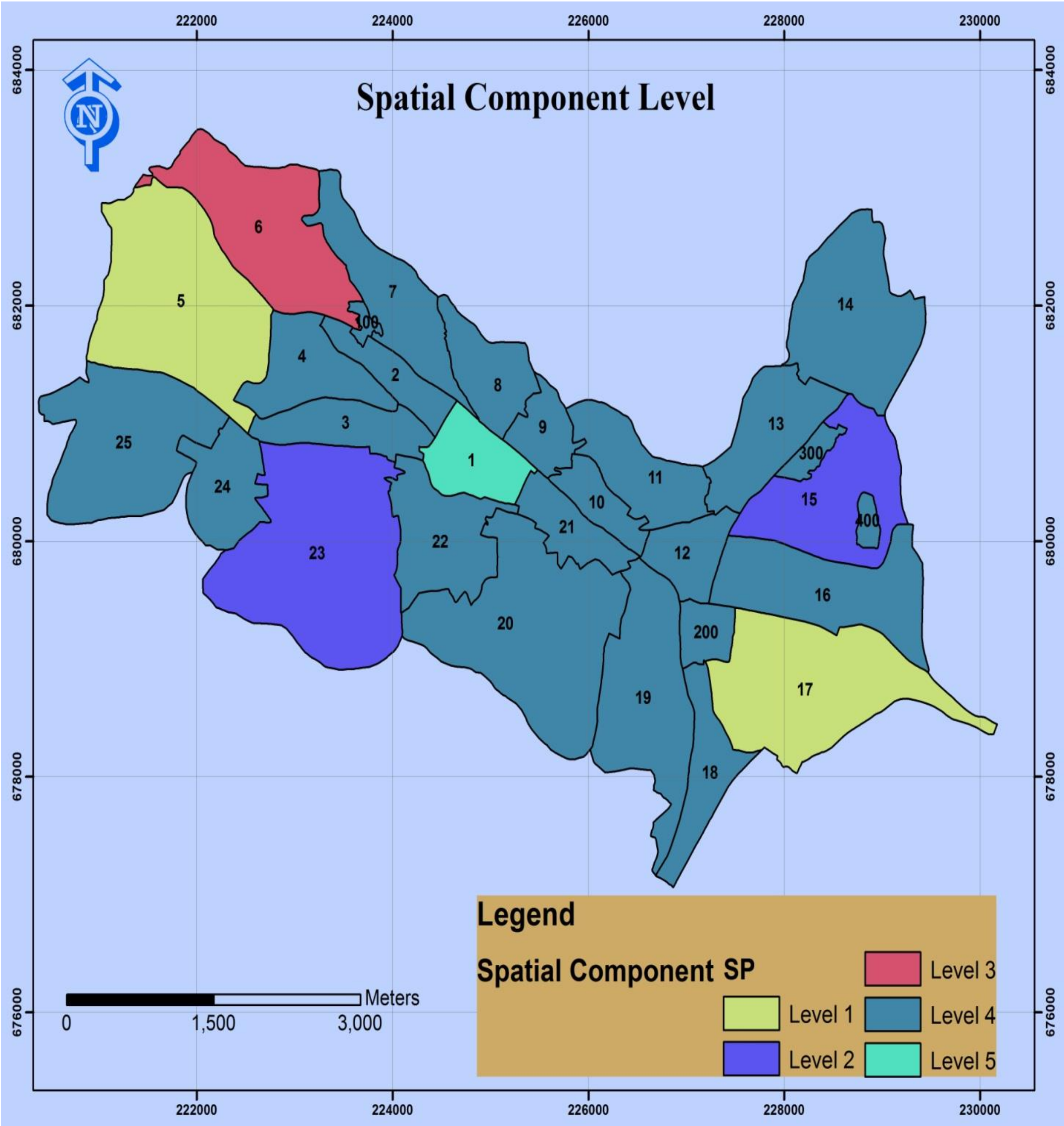

Figure (5.10.a): Spatial Component Level

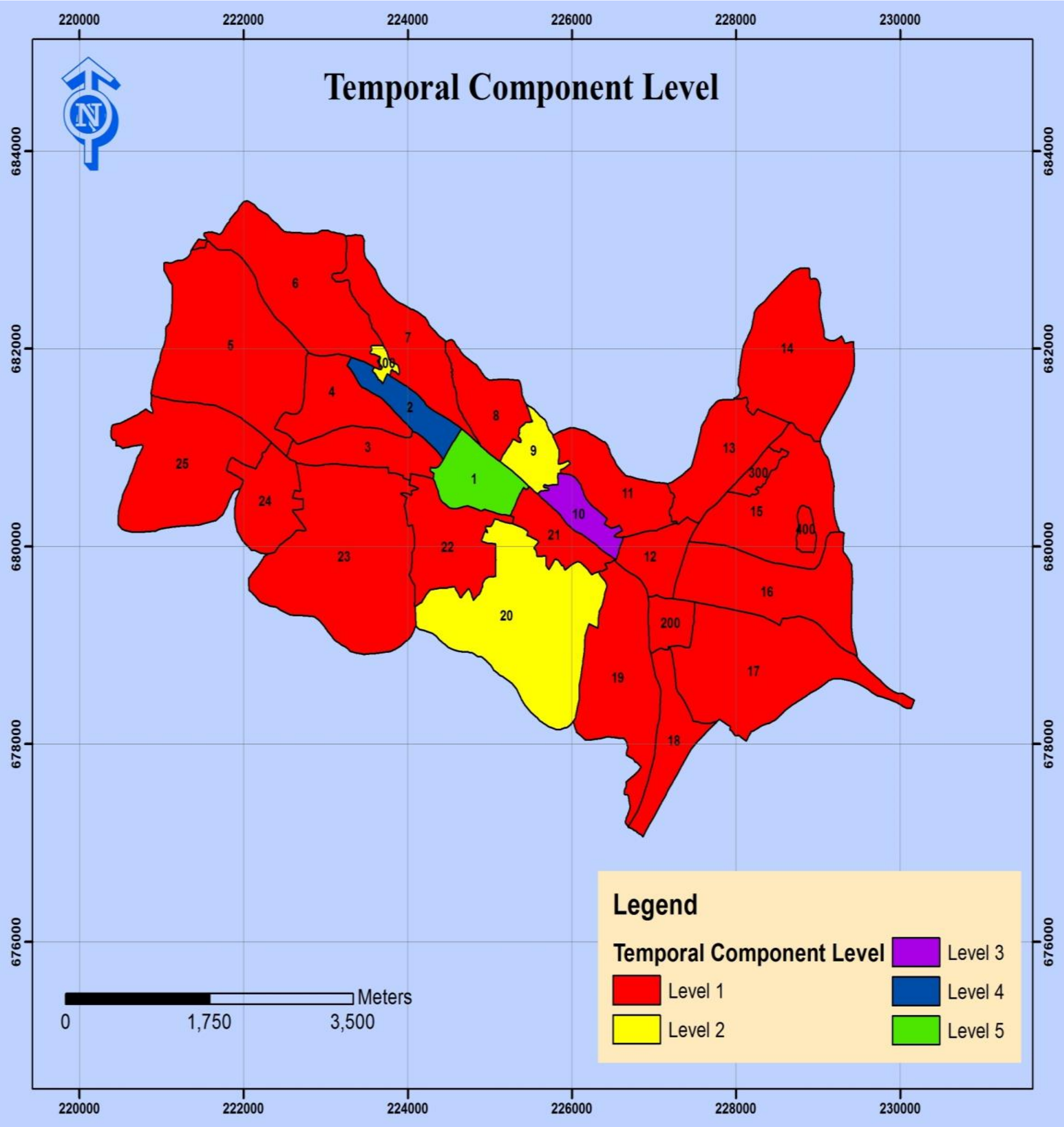

Figure (5.10.b): Temporal Component Level

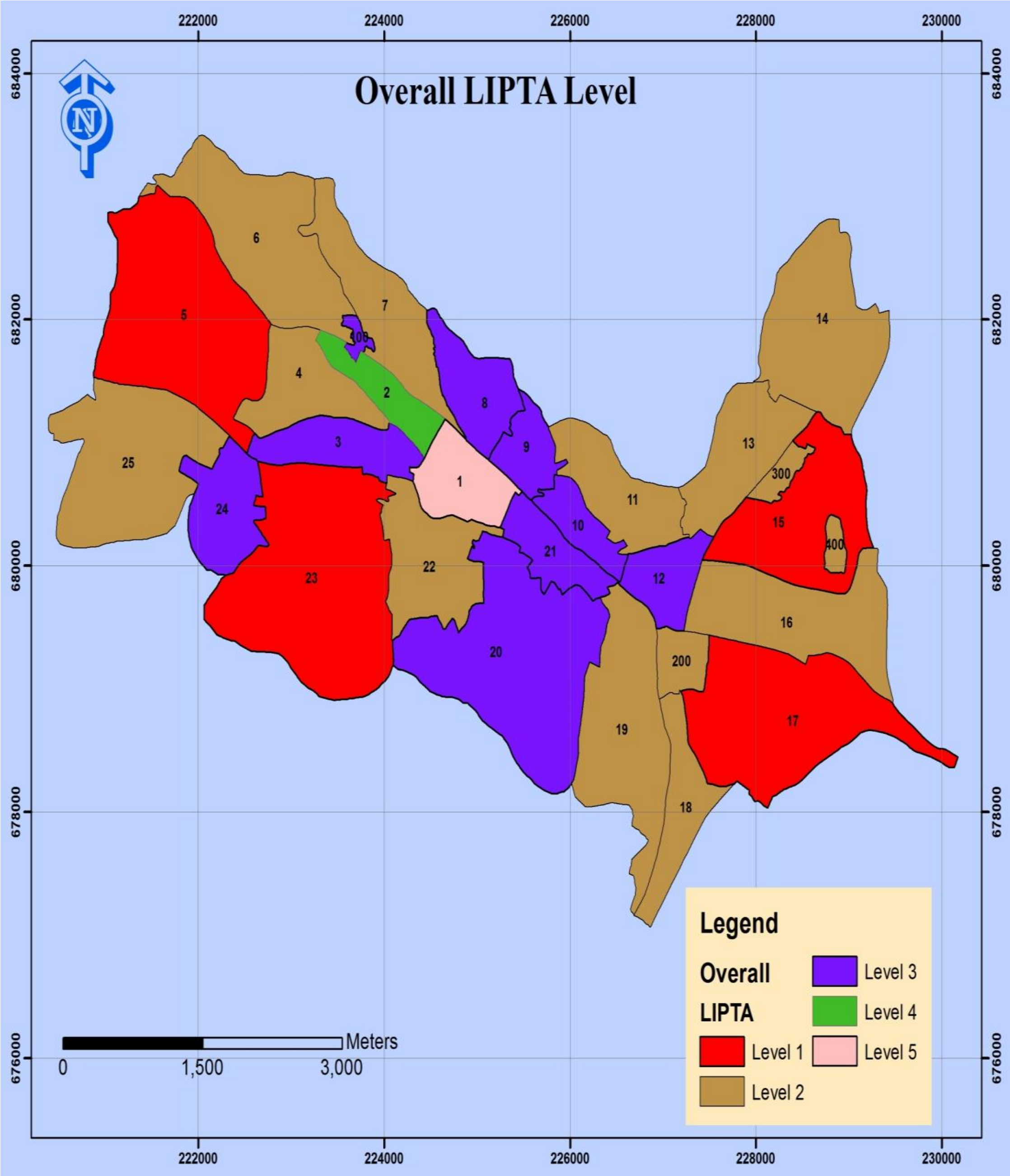

Figure (5.11): Overall LIPTA Level

As part of the research objective, a number of maps were produced using different GIS analysis techniques to enable comparison of results between statistical quarters. Therefore, from the results it is found that most of statistical quarters have level 4 for the spatial component while the CBD region has an excellent level of availability. This indicates that most of study area are spatially covered by P.T services except regions, which are located in the far east and west of the city such as statistical quarters (ID-17 and ID-5), which have a lowest level, indicating extremely limited P.T service availability. Statistical quarters (ID-15 and ID-23) have level 2, which indicates the presence of a relative lack of spatial coverage of P.T service. Statistical quarter (ID-6) is located in the far west of the study area; however, it has an average level of spatial coverage; this is due to presence of new development in this region, which is AL-Quds Open University.

For temporal coverage, it is clear that the CBD area and surrounding regions have highest level of temporal coverage component. This is because most of the fixed P.T routes pass through or near these regions while serving other regions in the study area. Most other statistical quarters have the same low level of temporal coverage as compared to the CBD and surrounding regions. This shows equality and regularity in the value of weighted composite average frequency for statistical quarters; however, it is low. To determine whether this thing is a problem or not, the temporal distribution of P.T demand and needed for each statistical quarter should be studied. It should be noted that in some regions of the study area, the taxi (demand-responsive) service takes the role of fixed-route service in illegal way; therefore this affects on the frequency values and change the current results of temporal coverage component.

According to overall LIPTA levels, statistical quarters (ID-1, ID-2, ID-3, ID-8, ID-9, ID-10, ID-12, ID-20, ID-21, ID-24, and ID-100) have average to excellent levels of P.T service availability. Other statistical quarters have level 2 except quarters, which lie at the east and west periphery of the study area (ID-5, ID-15, ID-17, and ID-23), which have relatively poor service availability. This is due to the weakness in both LIPTA components, particularly the spatial coverage component for these regions.

Through the intensive analysis of each LIPTA components, areas of high and low P.T service availability have been identified. Trends amongst the study area include a lack of accessibility along the periphery of the study area, increasing service levels towards the core downtown of the Nablus City. Therefore, areas of lowest scores are candidates for smart growth strategies, improved service planning, and remedial actions.

Through a comparison between (simple circular buffer)-based analysis and network-based analysis for service spatial coverage component, it is clear that the network-based analysis is more accurate, and the traditional (simple circular buffer) give larger estimates value. The total value of service spatial coverage in the study area by (simple circular buffer)-based analysis was 23.60 $K.m^2$, while by network-based analysis was 16.80 $K.m^2$. Therefore, the average increase in estimate when comparing the (simple circular buffer)-based analysis to network-based analysis is nearly 28.80%. The following Figure 5.12 illustrate this comparison between these two analyzes.

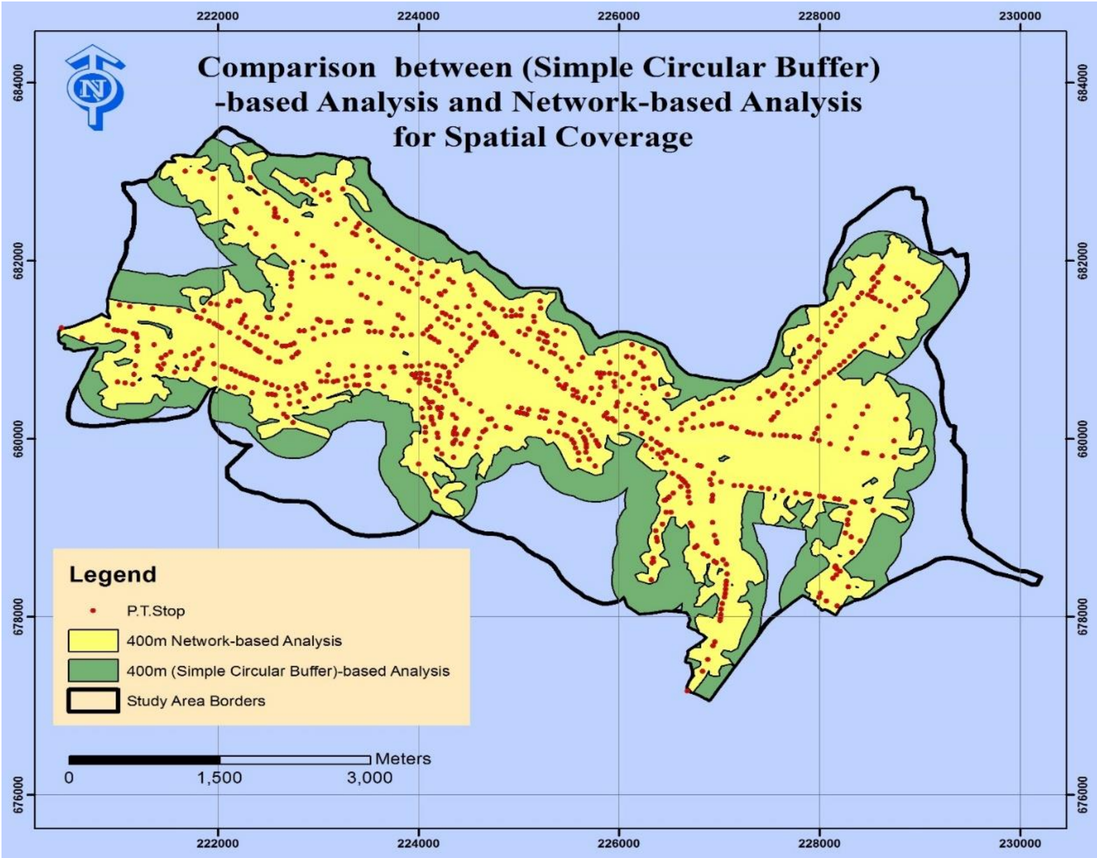

Figure (5.12): a comparison between (simple circular buffer)-based analysis and network-based analysis for service spatial coverage component

5.4.2 Results and Discussion for TTAI

An important factor in a potential P.T user's decision to use P.T on a regular basis is how much longer the trip will take in comparison with the automobile. The main objective to developing TTAIs in this study is to provide a simple, objective, and transparent method of portraying absolute and relative measures of accessibility by different modes for various key locations. The results of TTAIs are shown in Table 5.7 and presented graphically in Figure 5.13; graphical presentation often provides useful information that is easily understood by a wide range of interests.

P.T (shared-taxi) trips in general take considerably longer than private car trips between the same O-Ds, approximately 75% times as long. P.T (shared-taxi) users' travel times ranged between 29.72 minutes and 33.59 minutes with an average of 31.65 minutes. Compared with the P.T (shared-taxi) travel times, the travel times by private car were significantly lower, with average 17.85 minutes. As was evident from the individual O-Ds studies shown earlier, the waiting and walking portion of P.T (shared-taxi) trips often required a third of total door to door travel time. For both pairs of O-D's it is clear that travel time by private car is approximately half of that by P.T (shared-taxi) and that the TTAIs are 1.28 & 1.27 and 0.72 & 0.73 for P.T and private car, respectively. The averages of TTAI for the two modes are also shown in the graphs and they equal 1.

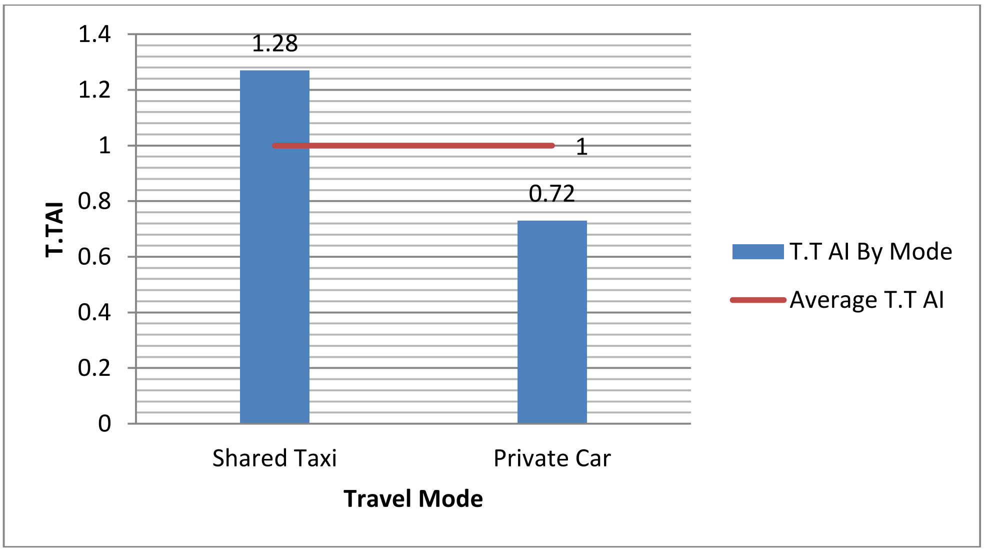

Figure (5.13.a): TTAI for Masaken – Al-Quds Open University

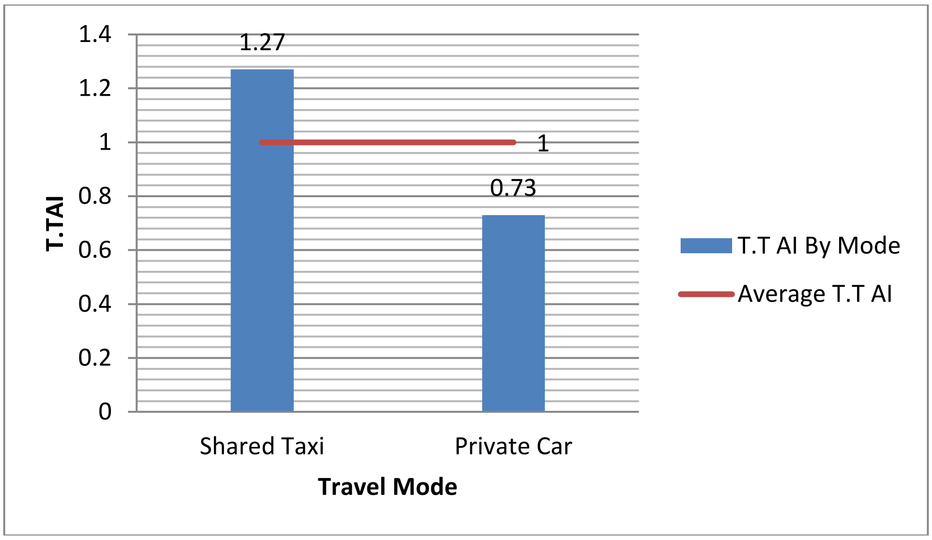

Figure (5.13.b): TTAI for Al-Dahia – Nablus Health Directorate

As well as TTAI provides an indication of the existing travel time, it is considered as a major determinant in the choice of travel modes; the index is formulated so that it can be used in a prescriptive way in future planning. For example, potential means of increasing P.T attractiveness between any two O-D pairs, such as P.T priority or improved P.T frequency, can be incorporated into the indices to estimate how much closer the alternative modes may become (i.e., offering greater equity in travel opportunities).

An illustrative example is provided in Figure 5.14 for the case of the travel time shown earlier. For this case it is assumed that it is desired to see how much closer to ‘equal’ travel times can become if a P.T (shared-taxi) priority scheme is introduced along a portion of the route. The effect will be similar to that shown in Figure 5.14, where, if the P.T (shared-taxi) time and index are reduced and the private car time and index consequently increased, the P.T (shared-taxi) and private car travel times and indices would be brought closer. Under normal circumstances, this would be expected to result in a relative increase in P.T (shared-taxi) users and a decrease in private car users - a modal shift to P.T (shared-taxi) travel. The amount would be estimated using appropriate modelling techniques. Nevertheless, the indices would provide an approximate and easily understood indicator of which routes to target and to what extent relative travel times should be altered to make them more ‘equal’ in achieving reduced private car use.

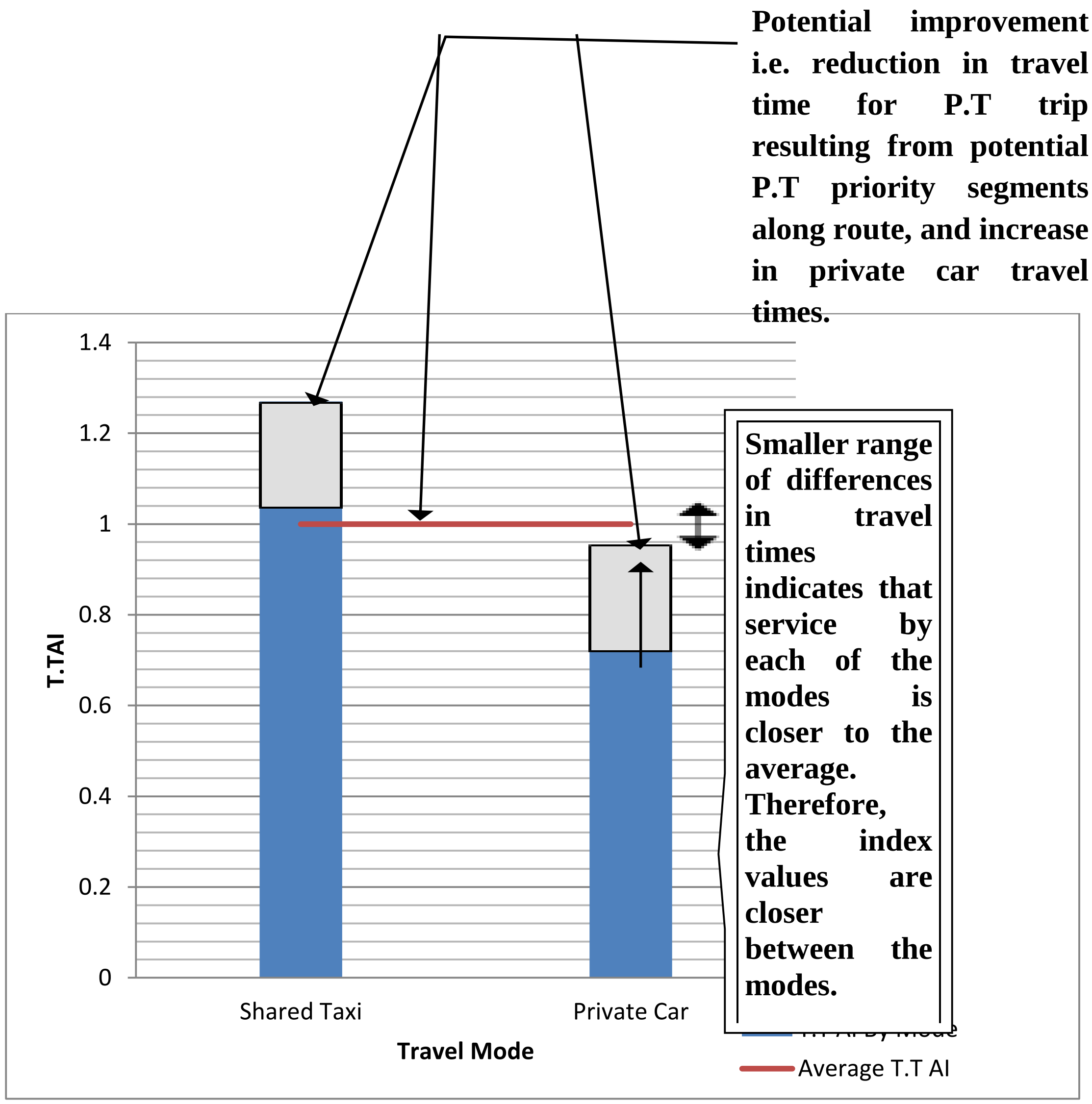

Figure (5.14): Use of the Indices in Examining Potential Service Policy Changes

Chapter Six

Conclusions and Recommendations

6.1 Introduction

Public transport (P.T) system consists of various components in which all must be considered together in order to develop an efficient and sustainable P.T network. Providing convenient accessibility to P.T enhances the service performance, reliability, and will also result in higher public usage. To achieve this objective, supplied P.T services must be available to as many users as possible. This study was set out to explore the concept of P.T accessibility. In this study, an extensively compiled database of intra-city fixed route P.T and its characteristics was used to derive comprehensive measures of P.T accessibility in Nablus City.

There are mainly two different types of research related to the accessibility of P.T systems, the first type deals with measuring access to the P.T systems and the second deals with measuring access to destinations through P.T systems. The first type was examined by developing a Local Index of Public Transport Availability (LIPTA) and the other one by developing Travel Time Accessibility Index (TTAI).

6.2 Conclusions

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

- Accessibility concept is used in several fields and there is no universal definition among the scholars about accessibility concept. In P.T planning, the accessibility commonly refers to physical access and ease of reaching opportunities depending on P.T service.

- Intra-city fixed route P.T service in Nablus City is provided mainly by shared-taxis, in addition to buses. The P.T service is entirely operated by the private sector and the daily operation is not well organized and without any coordination between them. It is a fixed-route to serve specific areas within the city.
- LIPTA was developed based on spatial and temporal coverage. The spatial coverage represents percent of people being served by P.T service within 400 meters of pedestrian road network surrounding each P.T stop in each statistical quarter. Temporal coverage deals with the average P.T frequency that serves each statistical quarter.
- It has been shown that the methodology introduced in this thesis can address well-documented issues and improvement on existing methods for determining the population with access to P.T service (spatial coverage). This was done using overlay and proximity analysis by Geographic Information System (GIS) on spatial distribution data of the residential units and through modelling the "service area" of P.T stops using the powerful GIS network analysis functions on the basis of actual walking distance on pedestrian road network. This methodology avoids the well-known and unrealistic assumptions associated with the existing methods and reduces overestimation of the population with access to P.T service.

- The methodology that was used in this thesis has a few weakness points such as the entire statistical quarter has the same level of P.T availability; in addition this methodology used one value of the average grad. Therefore, to be more precise, analysis can be carried out at a low scale such as parcels borders scale by make integration of cadastral data with network analysis. Average grad can also be calculated for each statistical quarter separately.
- P.T fixed route might branch to multiple sub-P.T fixe routes and a statistical quarter might have multiple P.T segments affecting it. Therefore, the methodology used for calculating frequency component of the LIPTA was based on weighted composite average frequency value. This value represents the frequency attribute of P.T service for the entire statistical quarter area. This makes it a good and an accurate method in the comparison between the statistical quarters.
- It is important to note that Z-scores (standard scores) for each statistical quarter in the study region were derived based on the P.T characteristics of that region only. Therefore, assigned levels of service availability may not share the quantitative characteristics of like statistical quarters in other regions. Level assignments simply indicate the P.T service intensity of a quarter in comparison to all other quarters of that specific region.
- Analyzing the accessibility disparity between different travel modes is recognized as an efficient way to assess sustainability of transport modes. In this study TTAI, which can be presented in simplified

graphical fashion is used to inform non-technical audiences about equity perspective of accessibility for transport modes. The index is based on door-to-door travel times between specific origins and destinations (O-D's) in the study area.

- The results illustrate that proposed LIPTA provides a suitable methodology for measuring P.T availability to urban area. However, the overall study results showed that, in general, the study area has good P.T service availability and there is a lack of service along the periphery of the study area; increasing service levels towards the CBD-area of the Nablus City. This requires taking remedial actions in P.T planning for peripheral areas.
- The results of TTAI showed that there is a gap between private car based and P.T (shared-taxi)-based accessibility for studied O-D's. This gap in accessibility levels poses substantial challenges for policy makers in equity perspective of using transportation services, and in shift orienting to use P.T service rather than using private car mode to ensure transportation long-term sustainability.

6.3 Indices Potential Application

Gauging and measuring the effectiveness of P.T availability is a tool critical to the evaluation of policy goals and P.T planning strategies. P.T availability analysis tools create an opportunity for municipalities and local agencies to improve P.T service while simultaneously constructing policy actions to encourage its use. The integration of land development policies, which favor P.T oriented development and increased provision of accessible and reliable

P.T services is a key policy action to encourage P.T ridership. Specifically, this research may be considered useful to all municipalities and Ministry of Transportation (MOT) in Palestine for various reasons. The use of the LIPTA has proven to be an effective example of a P.T availability tool that could potentially be utilized and recalibrated in this area for P.T planning purposes presently and in the future. The tool is successful for providing a visual spatial indication of service supply intensity and structure in Nablus City. Thus, this allows for the opportunity of municipalities and local agencies to view and assess the current P.T characteristics of the study area.

TTAI would provide an indication of the extent to which the determinants of private car and P.T use might be varied through policy actions to reduce private car dependency. For transport and land-use planning, the TTAI would illustrate the differences quantitatively to assist planners in prioritizing the routes with greatest potential for, and payoffs from, reducing private car dependency. Furthermore, this could guide the process of examining the relative values of service changes (such as improved P.T times, P.T priority schemes etc.) to determine which ones and to what extent they should be changed. In addition, it provides a wider perspective on the analytical process of modal shift estimation resulting from changes in service policy by clearly indicating the differences between services attributes for each mode. For decision-makers, the TTAI illustrates current services quality inequities in the transport system for important origin and destinations, and illustrate the results of monitoring the system and the proposed adjustments that may be appropriate.

Additionally, the conclusions of this research have several other policy applications. For example, the calculated two indices may be used by P.T developer to communicate and demonstrate the impacts that changes in funding may have on P.T operations and the P.T level of service. The P.T indices results provide a supplementary tool to be used in combination with measures that focus mainly on efficiency or performance.

6.4 Recommendations and Future Research

The study recommendations may help the MOT and local agencies in reviewing its regulations and policies regarding to P.T, and can motivate decision-makers and planners to set the proper regulations, plans, and policies.

Recommendations

- It is recommended that the MOT and local agencies should be taking into account the accessibility concept to improve the P.T services as part of a comprehensive short and long-term transport plan.
- The MOT and the municipalities should play a more active role in the planning, supervision, operation, and coordination of P.T services in order to arrive at efficient, reliable, and affordable P.T system.
- The MOT policy regarding granting P.T vehicle permits and the criteria of awarding these permits should be reviewed and take into consideration accessibility concept in the process of determining the number of P.T vehicles that operate on each P.T fixed route.
- It is recommended for Nablus Municipality to rely on the study results to identify ideal locations for P.T stops along a route, extend an existing route, identify new P.T routes, and expanding area coverage for existing P.T fixed routes.
- Nablus Municipality should also take remedial actions for regions that have a lack of P.T availability. These actions may include reallocation of existing P.T route to the expanded area coverage, merging some routes for a temporary period to increase frequency, and granting priority for P.T service especially at peak periods of the day to reduce P.T travel time and encourage using P.T mode rather than private car.
- To increase the accuracy of the methodology, some considerations may be take into account such as incorporating of a detailed pedestrian network dataset, non-residents population for each statistical quarter in the study area, gathering robust traffic count data and calculating

pedestrian crossing factor for each P.T stop in the study area, adding bus P.T mode and calculate TTAI to compare it with other transport modes.

Future Research

It is worth noting that the improvements applied to the LIPTA in this study create the potential for several future research initiatives.

- The index is capable of being applied in several diverse areas, and results provide a reasonable tool for making relative comparisons between urban areas with similar demographic characteristics.
- Assemblage of multiple data sets into a solitary collection allows for the opportunity of regional or nationwide analysis of P.T intensities.
- This research facilitates further study, which may be designed to track changes in P.T availability. These results can be used to determine how changing service levels influence residential movement, job opportunity, development patterns, etc.
- Comfort and convenience is an important P.T accessibility measure from costumer’s point of view, and this criterion can be expressed through the analysis of some quality of service. Therefore, incorporating this measure in future research to LIPTA as additional component makes it a more accurate index.
- Determining P.T demand (needed) distribution on time basis at statistical quarter level and comparing it with P.T availability level to identify amount of P.T gap is considered an important subject of research in the future.

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Appendix A:

Published Statistical Tables for Calculating Sample Size When Population Size is Known

Table 1. Sample Size for ±3%, ±5%, ±7%, and ±10% Precision Levels where Confidence Level Is 95% and P=.5.

Size of Population	Sample Size (n) for Precision (e) of:			
	±3%	±5%	±7%	±10%
500	a	222	145	83
600	a	240	152	86
700	a	255	158	88
800	a	267	163	89
900	a	277	166	90
1,000	a	286	169	91
2,000	714	333	185	95
3,000	811	353	191	97
4,000	870	364	194	98
5,000	909	370	196	98
6,000	938	375	197	98
7,000	959	378	198	99
8,000	976	381	199	99
9,000	989	383	200	99
10,000	1,000	385	200	99
15,000	1,034	390	201	99
20,000	1,053	392	204	100
25,000	1,064	394	204	100
50,000	1,087	397	204	100
100,000	1,099	398	204	100
>100,000	1,111	400	204	100

a = Assumption of normal population is poor (Yamane, 1967). The entire population should be sampled.

Source: (Yamane, 1967)

Appendix B:
Average Daily Frequency Data Collection and Calculations

Route Name :Al-Dahia/Al-Quds ST						
Total Number Of Permitted Vehicle : 40						
Ave. No. Of Trips Per Direction						
	Work Hours	To-Or-From	To-Or-From	To-Or-From	To-Or-From	Total
		Al-Quds ST	Al-Ain	Al-Dahia	Dahia-Al-Alia	
Major Route No.		**1.1**	**1.2**	**1.3**	**1.4**	
1	12	12	2	9	0	**23**
2	12	14	3	4	0	**21**
3	12	13	3	8	0	**24**
4	12	15	3	4	0	**22**
5	12	17	3	5	0	**25**
6	12	20	1	2	0	**23**
7	11	18	2	3	0	**23**
8	12.5	13	4	7	3	**27**
9	12.5	11	5	3	1	**20**
10	11.5	14	4	8	0	**26**
11	13.5	16	1	5	0	**22**
12	12	15	4	8	0	**27**
13	11	14	2	5	0	**21**
14	12	12	3	5	1	**21**
15	13.5	15	3	2	1	**21**
16	13	15	0	8	0	**23**
17	14	9	3	9	0	**21**
18	12	8	2	9	0	**19**
19	12.5	13	1	8	0	**22**
20	12	14	2	4	0	**20**
21	13	16	3	6	0	**25**
22	13	14	3	9	0	**26**
	Work Hours	To-Or-From	To-Or-From	To-Or-From	To-Or-From	Total
		Al-Quds ST	Al-Ain	Al-Dahia	Dahia-Al-Alia	
Major Route No.		**1.1**	**1.2**	**1.3**	**1.4**	
23	12.5	11	3	4	5	**23**
24	13	15	5	6	1	**27**
25	14	11	2	9	0	**22**
26	12.5	14	5	8	0	**27**
27	12	10	2	8	0	**20**
28	12	13	2	8	0	**23**
29	12	11	3	7	2	**23**

30	12	13	2	7	1	**23**
Total	**371**	**406**	**81**	**188**	**15**	
Average	**12.37**	**13.53**	**2.70**	**6.27**	**0.50**	**23.0 0**
Standard Deviation	**0.74**	**2.58**	**1.21**	**2.26**	**1.11**	**2.33**
Max	**14**	**20**	**5**	**9**	**5**	**27**
Min	**11**	**8**	**0**	**2**	**0**	**19**
Range	**3**	**12**	**5**	**7**	**5**	**8**
Average After Trim 5% of Outlier	**12.35**	**13.5**	**2.7**	**6.35**	**0.315**	
Average Daily Frequency (Veh/Day)		**540**	**108**	**254**	**12.6**	
Average Headway(min)		**1.37**	**6.86**	**2.92**	**58.81**	

Route Name: Balata/Iskan Rojeeb					
Total Number Of Permitted Vehicle : 89					
Ave. No. Of Trips Per Direction					
	Work Hours	**To-Balata**	**To-Or-From Iskan Rojeeb**	**From-Balata**	**Total**
Major Route No.		**2.1**	**2.2**	**2.1**	
Sub Route No.		**2.1.1**		**2.1.2**	
1	11	14	3	17	**34**
2	12	14	3	17	**34**
3	9	12	0	12	**24**
4	12	14	1	15	**30**
5	14	13	1	14	**28**
6	13	13	1	14	**28**
7	12	14	1	15	**30**
8	12	13	2	15	**30**
9	12	14	1	15	**30**
10	14	15	3	18	**36**
11	12	12	2	14	**28**
12	12	11	5	16	**32**
13	12	13	1	14	**28**
14	15	14	0	14	**28**
15	12	14	2	16	**32**
16	12	13	3	16	**32**
17	14	15	1	16	**32**
18	11	11	2	13	**26**
19	13	14	1	15	**30**
20	12	13	2	15	**30**
21	13	12	1	13	**26**
	Work Hours	**To-Balata**	**To-Or-From**	**From-Balata**	**Total**
			Iskan Rojeeb		
Major Route No.		**2.1**	**2.2**	**2.1**	
Sub Route No.		**2.1.1**		**2.1.2**	
22	12	11	0	11	**22**
23	11	10	1	11	**22**
24	12	11	2	13	**26**
25	11	9	1	10	**20**
26	10	8	2	10	**20**
27	11	9	1	10	**20**
28	10	10	0	10	**20**
29	12	9	1	10	**20**
30	12	11	1	12	**24**
31	11	11	0	11	**22**
32	11	10	1	11	**22**

33	10.5	11	1	12	**24**
34	11	12	0	12	**24**
35	12	12	1	13	**26**
Total	**415.5**	**422**	**48**	**470**	**940**
Average	**11.87**	**12.06**	**1.37**	**13.43**	**26.86**
Standard Deviation	**1.22**	**1.86**	**1.09**	**2.30**	**4.61**
Max	**15**	**15**	**5**	**18**	**36**
Min	**9**	**8**	**0**	**10**	**20**
Range	**6**	**7**	**5**	**8**	**16**
Average After Trim 5% of Outlier	**11.86**	**12.1**	**1.29**	**13.38**	
Average Daily Frequency (Veh/Day)		**1076.9**	**114.81**	**1190.82**	
Average Headway(min)		**0.66**	**6.20**	**0.60**	

Route Name: Asker/Masaken/Hijjawi College									
Total Number Of Permitted Vehicle : 101									
Ave. No. Of Trips Per Direction									
	Work Hours	**To-Old Asker**	**To-Or-From Masaken**	**To-Hijjawi college**	**To-New Asker**	**From-New Asker**	**From-Old Asker**	**From-Hijjawi college**	**Total**
Major Route No.		**3.1**	**3.2**	**3.3**	**3.4**	**3.4**	**3.1**	**3.3**	
Sub Route No.		**3.1.1**		**3.3.1**	**3.4.1**	**3.4.2**	**3.1.2**	**3.3.2**	
1	12	6	5	2	6	1	6	4	**30**
2	11	6	3	2	6	6	4	4	**31**
3	12	8	6	0	4	1	4	5	**28**
4	13	9	1	4	5	1	9	6	**35**
5	13.5	8	7	2	5	1	9	5	**37**
6	13	7	6	2	3	1	7	2	**28**
7	10	4	4	4	4	2	5	3	**26**
8	11	8	2	0	6	4	7	2	**29**
9	12.5	3	11	1	11	6	6	3	**41**
10	13	11	5	3	4	4	8	3	**38**
11	13	10	6	4	4	4	9	4	**41**
12	12.5	11	3	2	5	3	13	0	**37**
13	12.5	10	8	2	3	2	11	1	**37**
14	13.5	12	6	3	3	2	10	3	**39**
15	13	10	12	0	5	4	9	1	**41**
16	11	7	4	2	4	1	5	4	**27**
17	13.5	10	5	3	4	6	8	3	**39**
18	11	8	5	2	3	4	7	2	**31**
19	12	7	4	3	5	5	5	3	**32**
	Work Hours	**To-Old Asker**	**To-Or-From**	**To-Hijjawi**	**To-New Asker**	**From-New Asker**	**From-Old Asker**	**From-Hijjawi**	**Total**
			Masaken	**college**				**college**	
Major Route No.		**3.1**	**3.2**	**3.3**	**3.4**	**3.4**	**3.1**	**3.3**	
Sub Route No.		**3.1.1**		**3.3.1**	**3.4.1**	**3.4.2**	**3.1.2**	**3.3.2**	
20	11	8	5	3	3	4	6	4	**33**
21	10.5	7	4	2	4	2	8	2	**29**
22	11	6	5	4	4	5	5	3	**32**
23	11	7	6	3	3	4	4	4	**31**
24	10.5	6	5	2	4	5	4	3	**29**
25	10	5	4	3	4	2	4	4	**26**
26	11.5	9	3	3	3	3	8	3	**32**
27	11	9	5	2	2	3	7	2	**30**
28	10	7	4	0	5	4	5	3	**28**

29	11	9	2	2	4	3	7	3	**30**
30	12	10	3	3	2	4	8	1	**31**
31	10	8	0	2	4	4	5	3	**26**
32	11	9	4	3	2	3	7	2	**30**
33	11	7	5	0	6	5	4	2	**29**
34	10	6	4	2	4	4	5	1	**26**
35	11	7	5	3	3	4	5	3	**30**
36	10	9	3	1	4	3	7	2	**29**
37	11	8	5	2	3	4	5	2	**29**
38	11	9	6	1	3	3	5	4	**31**
39	11	8	8	3	2	4	5	3	**33**
40	10	5	4	4	3	2	4	3	**25**
Total	**458.5**	**314**	**193**	**89**	**162**	**133**	**260**	**115**	**1266**
Average	**11.46**	**7.85**	**4.83**	**2.23**	**4.05**	**3.33**	**6.50**	**2.88**	**31.65**
Standard Deviation	**1.05**	**1.74**	**2.10**	**1.09**	**1.00**	**1.14**	**2.29**	**1.07**	**4.42**
Max	**13.5**	**12**	**12**	**4**	**11**	**6**	**13**	**6**	**41**
Min	**10**	**3**	**0**	**0**	**2**	**1**	**4**	**0**	**25**
Range	**3.5**	**9**	**12**	**4**	**9**	**5**	**9**	**6**	**16**
Average After Trim	**11.42**	**7.88**	**4.69**	**2.25**	**3.92**	**3.3**	**6.33**	**2.86**	
5% of Outlier									
Average Daily		**795.88**	**473.69**	**227.25**	**395.92**	**333.3**	**639.33**	**288.86**	
Frequency (Veh/Day)									
Average Headway(min)		**0.86**	**1.45**	**3.03**	**1.74**	**2.06**	**1.08**	**2.38**	

Route Name: North Mount							
Total Number Of Permitted Vehicle : 26							
Ave. No. Of Trips Per Direction							
	Work Hours	To-Or-From-Mouta ST	To-Or-From	To-Or-From	To-Or-From	To-Or-From	Total
		/ Khaleh Aleman	Bigar ST	Abu Baker ST	Alrawda college	Manjarah Area	
Major Route No.		**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	
1	12.5	11	8	3	4	3	**29**
2	12.5	11	11	4	5	5	**36**
3	12.5	12	10	6	7	7	**42**
4	13	12	11	3	10	4	**40**
5	11	11	11	5	3	6	**36**
6	12	8	7	4	5	6	**30**
7	12	7	10	3	4	3	**27**
8	13	11	9	3	10	4	**37**
9	13	11	9	4	5	5	**34**
10	13	8	10	4	4	4	**30**
11	12	11	5	2	8	3	**29**
12	9	11	7	4	3	4	**29**
13	11.5	10	8	4	3	4	**29**
14	11	9	7	4	8	2	**30**
15	12	10	9	3	5	4	**31**
16	11	9	8	4	5	4	**30**
17	10	8	7	4	6	3	**28**
18	10	8	7	3	4	5	**27**
19	10	9	6	3	4	5	**27**
20	11	10	8	4	2	4	**28**
	Work Hours	**To-Or-From-Mouta ST**	**To-Or-From**	**To-Or-From**	**To-Or-From**	**To-Or-From**	**Total**
		/ Khaleh Aleman	**Bigar ST**	**Abu Baker ST**	**Alrawda college**	**Manjarah Area**	
Major Route No.		**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	
21	10.5	8	7	4	5	4	**28**
22	11	9	8	3	4	5	**29**
23	12	10	8	4	3	5	**30**
24	12	11	8	3	4	5	**31**
25	13	11	9	5	4	4	**33**

26	11	10	8	3	3	3	**27**
27	12	11	9	3	4	3	**30**
28	12	11	8	3	5	3	**30**
29	10	9	6	2	7	4	**28**
30	10	9	7	1	6	4	**27**
Total	**345.5**	**296**	**246**	**105**	**150**		
Average	**11.52**	**9.87**	**8.20**	**3.50**	**5.00**	**4.17**	**30.73**
Standard Deviation	**1.12**	**1.36**	**1.52**	**0.97**	**2.00**	**1.09**	**3.90**
Max	**13**	**12**	**11**	**6**	**10**	**7**	**42**
Min	**9**	**7**	**5**	**1**	**2**	**2**	**27**
Range	**4**	**5**	**6**	**5**	**8**	**5**	**15**
Average After Trim 5% of Outlier	**11.55**	**9.88**	**8.2**	**3.5**	**4.87**	**4.13**	
Average Daily Frequency(Veh/Day)		**256.88**	**213.2**	**91**	**126.62**	**107.38**	
Average Headway (min)		**2.70**	**3.25**	**7.62**	**5.47**	**6.45**	

Route Name: South Mount											
Total Number Of Permitted Vehicle : 35											
Ave. No. Of Trips Per Direction											
	Work Hours	**To-Or-From**	**To-Or-From**	**To-Or-From**	**To-Or-From**	**To-Or-From-Krom Ashour and**	**To-Or-From**	**To-Or-From**	**To-Or-From**	**To-Or-From**	**Total**
		10 St	**24 St**	**Fatayer ST**	**Weqai Area**	**Kshika ST and Khaleh Alamoud**	**Tawin Awsat ST**	**Al Basha ST**	**Al Dawai Area**	**Tell ST**	
Major Route No.		**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**5.6**	**5.7**	**5.8**	**5.9**	
1	12	5	6	8	2	4	5	6	1	4	**41**
2	12	5	8	6	1	5	3	4	3	5	**40**
3	13	4	9	5	4	5	6	5	1	4	**43**
4	12	5	7	8	0	4	4	4	0	3	**35**
5	11	6	7	5	1	3	3	3	2	4	**34**
6	12	6	8	6	2	5	5	5	1	2	**40**
7	12	6	7	5	3	4	4	4	3	5	**41**
8	13	7	8	6	4	4	6	6	0	0	**41**
9	11	5	9	5	2	2	2	5	2	4	**36**
10	12	5	8	4	3	3	4	5	1	2	**35**
11	11	6	8	6	2	3	3	3	3	1	**35**
12	10	4	7	8	3	4	2	2	2	3	**35**
13	11	4	8	5	2	3	3	3	1	2	**31**
14	12	5	4	5	3	5	4	2	3	4	**35**
15	13	6	5	5	2	4	5	2	2	3	**34**
16	11.5	5	8	7	2	3	4	2	0	5	**36**
17	12	5	8	8	3	2	3	3	1	3	**36**
18	13	5	10	7	3	3	4	1	4	4	**41**
19	12	4	8	6	1	2	3	4	3	5	**36**
	Work Hours	**To-Or-From**	**To-Or-From**	**To-Or-From**	**To-Or-From**	**To-Or-From-Krom Ashour and**	**To-Or-From**	**To-Or-From**	**To-Or-From**	**To-Or-From**	**Total**
		10 St	**24 St**	**Fatayer ST**	**Weqai Area**	**Kshika ST and Khaleh Alamoud**	**Tawin Awsat ST**	**Al Basha ST**	**Al Dawai Area**	**Tell ST**	
Major Route No.		**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**5.6**	**5.7**	**5.8**	**5.9**	
20	12	5	7	7	2	3	4	5	2	4	**39**
21	12	4	8	5	3	4	3	4	2	5	**38**
22	11	4	7	6	2	6	2	3	0	4	**34**
23	12	5	7	8	3	2	3	2	1	3	**34**
24	9	5	8	5	2	1	5	3	1	2	**32**
25	11	4	6	7	3	5	4	1	0	3	**33**
26	12	5	8	9	2	3	2	2	0	2	**33**
27	10	4	5	8	3	4	1	3	1	4	**33**
28	11	5	7	9	2	5	2	4	3	4	**41**

29	9	4	5	8	0	2	6	5	2	3	**35**
30	10	4	7	7	3	5	3	3	2	2	**36**
Total	**344.5**	**147**	**218**	**194**	**68**	**108**	**108**	**104**	**47**	**99**	**1093**
Average	**11.48**	**4.90**	**7.27**	**6.47**	**2.27**	**3.60**	**3.60**	**3.47**	**1.57**	**3.30**	**36.43**
Standard Deviation	**1.07**	**0.80**	**1.31**	**1.41**	**0.98**	**1.22**	**1.30**	**1.38**	**1.14**	**1.26**	**3.23**
Max	**13**	**7**	**10**	**9**	**4**	**6**	**6**	**6**	**4**	**5**	**43**
Min	**9**	**4**	**4**	**4**	**0**	**1**	**1**	**1**	**0**	**0**	**31**
Range	**4**	**3**	**6**	**5**	**4**	**5**	**5**	**5**	**4**	**5**	**12**
Average After Trim 5% of Outlier	**11.54**	**4.85**	**7.3**	**6.44**	**2.3**	**3.61**	**3.59**	**3.46**	**1.54**	**3.37**	
Average Daily Frequency (Veh/Day)		**169.75**	**255.5**	**225.4**	**80.5**	**126.35**	**125.65**	**121.1**	**53.9**	**117.95**	
Average Headway(min)		**4.08**	**2.71**	**3.07**	**8.60**	**5.48**	**5.51**	**5.72**	**12.85**	**5.87**	

Route Name: Rafedia/Academy							
Total Number Of Permitted Vehicle :178							
Ave. No. Of Trips Per Direction							
	Work Hours	To-Academy	From-Academy	To-Almraige ST-Rafedia Hospital Old Al-Quds Open University.	From-Rafedia Hospital	From- Old Al-Quds Open University	Total
Major Route No.		6.1	6.1	6.2	6.2	6.2	
Sub Route No.		6.1.1	6.1.2	6.2.1	6.2.2	6.2.3	
1	13.5	12	12	7	3	4	**38**
2	13	6	12	12	3	3	**36**
3	12	5	10	12	5	2	**34**
4	12.5	8	10	11	4	4	**37**
5	12.5	12	13	7	2	4	**38**
6	12	12	14	7	2	3	**38**
7	12.5	10	12	9	3	4	**38**
8	13	12	12	5	2	3	**34**
9	12	11	13	7	3	2	**36**
10	13	10	11	6	5	4	**36**
11	12	12	12	6	3	3	**36**
12	12.5	11	12	8	4	3	**38**
13	12	10	14	11	3	4	**42**
14	12	6	12	11	2	3	**34**
	Work Hours	To-Academy	From-Academy	To-Almraige ST-Rafedia Hospital	From-Rafedia	From- Old Al-Quds Open University	Total
				Old Al-Quds Open University.	Hospital		

Major Route No.		6.1	6.1	6.2	6.2	6.2	
Sub Route No.		6.1.1	6.1.2	6.2.1	6.2.2	6.2.3	
15	12	8	10	6	1	3	**28**
16	12	8	12	10	2	4	**36**
17	12	9	11	8	3	3	**34**
18	13	11	12	8	2	5	**38**
19	12	10	13	8	1	4	**36**
20	12.5	9	12	6	0	3	**30**
21	12	8	10	9	3	4	**34**
22	12	5	12	12	2	3	**34**
23	13	8	12	11	3	4	**38**
24	12.5	7	13	12	2	4	**38**
25	13	6	12	14	3	5	**40**
26	12	7	10	9	2	4	**32**
27	12	8	11	7	1	3	**30**
28	12	9	12	8	2	3	**34**
29	12	10	13	8	1	4	**36**
30	13	12	13	8	3	4	**40**
31	11	12	12	4	2	2	**32**
32	11	12	13	6	3	2	**36**
33	12	10	12	10	5	3	**40**
34	11	11	12	8	4	3	**38**
35	11	11	11	5	3	2	**32**
	Work Hours	**To-Academy**	**From-Academy**	**To-Almraige ST-Rafedia Hospital**	**From-Rafedia**	**From- Old Al-Quds Open University**	**Total**
				Old Al-Quds Open University.	**Hospital**		
Major Route No.		**6.1**	**6.1**	**6.2**	**6.2**	**6.2**	
Sub Route No.		**6.1.1**	**6.1.2**	**6.2.1**	**6.2.2**	**6.2.3**	
36	10	6	8	4	0	2	**20**
37	10.5	6	7	5	2	2	**22**

38	11	8	12	9	2	3	**34**
39	11	9	11	9	3	4	**36**
40	11	10	12	8	2	4	**36**
41	12	10	12	9	3	4	**38**
42	11	12	14	8	4	2	**40**
42	10	12	13	5	2	2	**34**
43	11	10	12	6	1	3	**32**
44	11	12	13	6	2	3	**36**
45	11	10	12	9	3	4	**38**
46	11	12	12	7	4	3	**38**
47	11	10	13	8	3	2	**36**
48	11	10	12	10	5	3	**40**
49	11	10	12	10	4	4	**40**
50	11	10	13	11	3	5	**42**
51	11	9	12	12	5	4	**42**
52	12	8	13	13	5	3	**42**
53	11	6	10	11	3	4	**34**
54	11	7	11	8	2	2	**30**
55	10	8	11	6	1	2	**28**
	Work Hours	**To-Academy**	**From-Academy**	**To-Almraige ST-Rafedia Hospital**	**From-Rafedia**	**From- Old Al-Quds Open University**	**Total**
				Old Al-Quds Open University.	**Hospital**		
Major Route No.		**6.1**	**6.1**	**6.2**	**6.2**	**6.2**	
Sub Route No.		**6.1.1**	**6.1.2**	**6.2.1**	**6.2.2**	**6.2.3**	
56	10	8	11	5	0	2	**26**
75	10	7	9	6	2	2	**26**
58	9	5	8	6	0	3	**22**
59	10	9	9	6	4	2	**30**
60	11	8	7	5	3	3	**26**
61	10	10	11	5	2	2	**30**
62	11	9	10	5	1	3	**28**
63	10	10	13	8	3	2	**36**

64	10	10	14	8	2	2	**36**
65	9	6	9	5	0	2	**22**
66	10	8	11	6	1	2	**28**
67	9	5	8	8	3	2	**26**
68	10	8	10	9	4	3	**34**
69	9	7	9	6	2	2	**26**
70	10	6	8	5	1	2	**22**
Total	**805**	**639**	**809**	**563**	**179**	**217**	**2407**
Average	**11.3 4**	**9.00**	**11.39**	**7.93**	**2.52**	**3.06**	**33.90**
Standard Deviation	**0.77**	**2.03**	**1.95**	**2.31**	**1.48**	**0.84**	**6.37**
Max	**13.5**	**12**	**14**	**14**	**5**	**5**	**42**
Min	**9**	**5**	**7**	**4**	**0**	**2**	**20**
Range	**4.5**	**7**	**7**	**10**	**5**	**3**	**22**
Average After Trim 5% of Outlier	**11.3 5**	**9**	**11.44**	**7.88**	**2.53**	**2.77**	**3.46**
Average Daily Frequency (Veh/Day)		**1602**	**2036.32**	**1402.64**	**450.34**	**493.06**	
Average Headway(min)		**0.43**	**0.33**	**0.49**	**1.51**	**1.38**	

Route Name: An-Najah University/Makhfia							
Total Number Of Permitted Vehicle :123							
Ave. No. Of Trips Per Direction							
	Work Hours	To-An-Najah University	From- An-Najah University	To-Makhfia	From-Makhfia	To-Or-From Teipa Homes (Jneed)	Total
Major Route No.		7.1	7.1	7.2	7.2	7.3	
Sub Route No.		7.1.1	7.1.2	7.2.1	7.2.2		
1	10	15	15	0	0	0	**30**
2	10	15	15	0	0	0	**30**
3	10	15	15	0	0	0	**30**
4	10	14	14	0	0	0	**28**
5	10	15	15	0	0	0	**30**
6	10	15	15	0	0	0	**30**
7	10	14	14	0	0	0	**28**
8	10	15	15	0	0	0	**30**
9	10	14	14	0	0	0	**28**
10	10	13	13	0	0	0	**26**
11	10	15	15	0	0	0	**30**
12	10	14	14	0	0	0	**28**
13	12	9	9	8	8	3	**37**
14	12	11	13	7	5	4	**40**
15	13	10	14	8	4	3	**39**
16	11	12	13	5	4	0	**34**
17	12	12	15	5	2	2	**36**
18	12	13	15	10	8	1	**47**
	Work Hours	To-An-Najah University	From- An-Najah University	To-Makhfia	From-Makhfia	To-Or-From Teipa Homes (Jneed)	Total
Major Route No.		7.1	7.1	7.2	7.2	7.3	
Sub Route No.		7.1.1	7.1.2	7.2.1	7.2.2		
19	12	3	6	15	12	8	**44**
20	12	11	14	10	7	0	**42**
21	12	16	18	4	2	2	**42**
22	11	6	8	9	7	3	**33**
23	13	4	6	15	13	4	**42**
24	14	10	13	10	7	2	**42**
25	10	7	7	0	0	3	**17**
26	12	6	8	10	8	3	**35**

27	13.5	3	6	15	12	3	**39**
28	12	11	12	3	2	0	**28**
29	13	7	8	10	9	1	**35**
30	12	15	16	6	5	3	**45**
31	13	5	6	8	7	4	**30**
32	14	12	15	9	6	3	**45**
33	13	12	14	7	5	2	**40**
34	12	11	12	8	7	1	**39**
35	13	13	14	6	5	3	**41**
36	11	14	14	4	4	2	**38**
37	12	13	13	3	3	1	**33**
38	13	15	15	3	3	4	**40**
39	10	15	15	2	2	3	**37**
	Work Hours	**To-An-Najah University**	**From- An-Najah University**	**To-Makhfia**	**From-Makhfia**	**To-Or-From Teipa Homes (Jneed)**	**Total**
Major Route No.		**7.1**	**7.1**	**7.2**	**7.2**	**7.3**	
Sub Route No.		**7.1.1**	**7.1.2**	**7.2.1**	**7.2.2**		
40	13	13	14	5	4	4	**40**
41	10	12	13	4	3	2	**34**
42	10	10	12	7	5	3	**37**
43	11	12	12	4	4	4	**36**
44	9	11	12	3	2	4	**32**
45	10	4	5	10	9	0	**28**
46	11	11	12	8	7	0	**38**
47	10	9	11	4	2	0	**26**
48	10	12	14	4	2	1	**33**
49	11	14	16	3	1	4	**38**
50	10	12	13	4	3	3	**35**
Total	**564.5**	**570**	**627**	**256**	**199**	**93**	**1745**
Average	**11.29**	**11.40**	**12.54**	**5.12**	**3.98**	**1.86**	**34.90**
Standard Deviation	**1.42**	**3.66**	**3.47**	**3.63**	**3.16**	**1.35**	**6.02**
Max	**14**	**16**	**18**	**15**	**13**	**8**	**47**
Min	**9**	**3**	**5**	**0**	**0**	**0**	**17**
Range	**5**	**13**	**13**	**15**	**13**	**8**	**30**
Average After Trim 5% of Outlier	**11.24**	**11.63**	**12.69**	**4.86**	**3.73**	**1.76**	**3.46**
Average Daily Frequency (Veh/Day)		**1430.49**	**1560.87**	**597.78**	**458.79**	**216.48**	
Average Headway(min)		**0.47**	**0.43**	**1.13**	**1.47**	**3.12**	

Route Name: Ain Camp /Majeen

Total Number Of Permitted Vehicle : 58

Ave. No. Of Trips Per Direction

	Work Hours	To_Ain Camp and Majeen	To-Al-Quds Open University	To-Or-From Zwata ST	To-Or-From Sekah-ST	From- Al-Quds Open University	From-Ain Camp and Majeen	To-Or-From-Malhes and Ain alsibian Area	Total
Major Route No.		**8.1**	**8.1**	**8.2**	**8.3**	**8.1**	**8.1**	**8.4**	
Sub Routeb No.		**8.1.1**	**8.1.2**			**8.1.3**	**8.1.4**		
1	13	12	3	6	3	4	11	3	**42**
2	12	10	3	6	3	5	8	3	**38**
3	13	12	1	10	5	1	12	2	**43**
4	13	12	4	6	5	5	11	2	**45**
5	12	10	1	9	4	3	8	3	**38**
6	12	12	3	6	2	3	12	3	**41**
7	13	12	2	8	8	2	12	1	**45**
8	11	10	0	7	8	0	10	3	**38**
9	14	7	5	8	12	5	7	0	**44**
10	12	10	0	11	4	0	10	4	**39**
11	13	8	4	8	3	4	8	3	**38**
12	12	10	2	8	5	3	9	4	**41**
13	12	10	3	9	4	3	10	2	**41**
14	11	9	3	7	3	3	9	3	**37**
15	10	10	2	6	5	2	10	2	**37**
16	11	10	3	7	4	3	10	1	**38**
	Work Hours	**To_Ain Camp and Majeen**	**To-Al-Quds Open University**	**To-Or-From Zwata ST**	**To-Or-From Sekah-ST**	**From- Al-Quds Open University**	**From-Ain Camp and Majeen**	**To-Or-From-Malhes and Ain alsibian Area**	**Total**
Major Route No.		**8.1**	**8.1**	**8.2**	**8.3**	**8.1**	**8.1**	**8.4**	
Sub Route No.		**8.1.1**	**8.1.2**			**8.1.3**	**8.1.4**		
17	12	12	2	8	3	2	12	1	**40**
18	11	12	1	6	3	3	10	4	**39**
19	13	12	4	8	1	4	12	2	**43**
20	14	10	5	9	2	5	10	3	**44**
21	12	11	2	7	3	2	11	2	**38**
22	12	11	2	9	3	2	11	2	**40**

23	10	10	3	5	3	1	12	3	**37**
24	10	12	1	5	3	1	12	3	**37**
25	11	12	0	6	6	0	12	2	**38**
26	10	10	2	6	3	3	9	3	**36**
27	10	9	1	6	6	2	8	2	**34**
28	11	12	2	6	1	3	11	1	**36**
29	10	10	3	9	0	4	9	1	**36**
30	10	8	4	7	3	3	9	2	**36**
Total	**350**	**315**	**71**	**219**	**118**	**81**	**305**	**70**	**1179**
Average	**11.67**	**10.50**	**2.37**	**7.30**	**3.93**	**2.70**	**10.17**	**2.33**	**39.30**
Standard Deviation	**1.24**	**1.41**	**1.38**	**1.51**	**2.36**	**1.47**	**1.51**	**0.99**	**2.98**
Max	**14**	**12**	**5**	**11**	**12**	**5**	**12**	**4**	**45**
Min	**10**	**7**	**0**	**5**	**0**	**0**	**7**	**0**	**34**
Range	**4**	**5**	**5**	**6**	**12**	**5**	**5**	**4**	**11**
Average After Trim 5% of Outlier	**11.62**	**10.59**	**2.35**	**7.24**	**3.76**	**2.72**	**10.22**	**2.35**	**1.54**
Average Daily Frequency (Veh/Day)		**614.22**	**136.3**	**419.92**	**218.08**	**157.76**	**592.76**	**136.3**	
Average Headway(min)		**1.14**	**5.12**	**1.66**	**3.20**	**4.42**	**1.18**	**5.12**	

Route Name: Al-Etehad						
Total Number Of Permitted Vehicle : 27						
Ave. No. Of Trips Per Direction						
	Work Hours	To-Arsad ST	To-Jeser ST	From-Arsad ST and Jeser ST	To-Or-From-Namsawi Asera ST and An- Najah Hospital	Total
Major Route No.		9.2	9.3	9.4	9.1	
1	12	12	4	16	12	**44**
2	13	9	11	20	11	**51**
3	11	12	10	22	5	**49**
4	10	8	7	15	11	**41**
5	13	12	10	22	11	**55**
6	12	11	5	16	11	**43**
7	12	11	12	23	5	**51**
8	13	12	10	22	7	**51**
9	14	9	11	20	10	**50**
10	12	8	10	18	10	**46**
11	11	12	7	19	8	**46**
12	12	10	10	20	8	**48**
13	12	10	11	21	8	**50**
14	12	8	12	20	7	**47**
15	12	8	10	18	10	**46**
16	12	8	12	20	8	**48**
17	12	10	11	21	6	**48**
	Work Hours	To-Arsad ST	To-Jeser ST	From-Arsad ST	To-Or-From-Namsawi	Total
				and Jeser ST	Asera ST and An- Najah Hospital	
Major Route No.		9.2	9.3	9.4	9.1	
18	12	11	10	21	7	**49**
19	12	12	10	22	5	**49**
20	11	10	9	19	8	**46**
21	12	11	10	21	8	**50**
22	13	12	11	23	4	**50**
23	13	10	12	22	7	**51**
24	13	10	12	22	6	**50**
25	12	12	10	22	5	**49**
26	12	11	9	20	8	**48**
27	10	9	13	22	5	**49**
28	11	13	10	23	5	**51**
29	11	14	10	24	3	**51**
30	11	15	12	27	1	**55**

Total	**358**	**320**	**301**	**621**	**220**	**1462**
Average	**11.93**	**10.67**	**10.03**	**20.70**	**7.33**	**48.73**
Standard Deviation	**0.91**	**1.83**	**2.03**	**2.49**	**2.67**	**3.04**
Max	**14**	**15**	**13**	**27**	**12**	**55**
Min	**10**	**8**	**4**	**15**	**1**	**41**
Range	**4**	**7**	**9**	**12**	**11**	**14**
Average After Trim 5% of Outlier	**11.94**	**10.59**	**10.2**	**20.7**	**7.41**	
Average Daily Frequency (Veh/Day)		**285.93**	**275.4**	**558.9**	**200.07**	
Average Headway(min)		**2.51**	**2.60**	**1.28**	**3.58**	

Route Name: Tamimi Buses							
Ave. No. Of Trips Per Direction							
	Work Hours	**To-Or-From South Mount**	**To-Or-From An-Najah University**	**To-Or-From Academy**	**To-Or-From Balata/Iskan Rojeeb**	**To-Or-From Al-Quds ST**	**To-Or-From Al-Quds Open University**
Major Route No.		**10.1**	**10.2**	**10.3**	**10.4**	**10.5**	**10.6**
Average Headway (min)		**60**	**15**	**15**	**30**	**30**	**15**
Avarage Daily Frequency (Veh/Day)	10	10	40	40	20	20	
	8.5						34

Route Name:Al-Waled Bus			
Ave. No. Of Trip Per Direction			
	Work Hours	**To-Or-From Iraq Tayeh/Water ST**	**To-Or-From Asker/Masaken**
Major Route No.		**11.1**	**11.2**
H.w(min)		**15**	**20**
Avarage Daily	**11**	**44**	**33**

Appendix C:

Detailed Travel Time Data Collected

Private Car Travel Time Data Collection and Calculation Sheet

Route Name: Masaken-Al-Quds Open University | **Time:7:20 Am**

Date: 10/11/2014 | **weather: sunlit**

Trail No.: 1 | **Distance: 8.700 Km**

No.	Check Points	Cumulative Travel Time (M:S)	Stop Time (Delay) (S)	Reason For Stop
Start	**Masaken**	0	0	0
			5	Pedestrian crossing
			15	Crossing Intersection
1	**Intersection at Asker Albalad mosque**	**3:50**		
			10	Congestion
			5	Pedestrian crossing
2	**Othman Mosque**	**5:23**		
			20	Crossing intersection
3	**East Intersection Cemetery**	**8:20**		
			5	Pedestrian crossing
4	**Al-Etehad Hospital**	**11:15**		
			15	Parking cars on two sides of street
			35	Crossing Intersection
5	**Asekah Intersection**	**14:35**		
End	**Al-Quds Open University**	16:55	110	
Total		**16.92 minutes**	**1.83 minutes**	

Private Car Travel Time Data Collection and Calculation Sheet				
Route Name: Masaken-Al-Quds Open University		**Time:7:15 Am**		
Date: 11/11/2014		**weather: sunlit**		
Trail No.: 2		**Distance: 8.700 Km**		
No.	**Check Points**	**Cumulative Travel Time (M:S)**	**Stop Time (Delay) (S)**	**Reason For Stop**
Start	**Masaken**	0	0	0
			10	Crossing Intersection
1	**Intersection at Asker Albalad mosque**	**3:35**		
			15	Congestion
2	**Othman Mosque**	**5:00**		
			20	Crossing intersection
3	**East Intersection Cemetery**	**8:00**		
			10	Pedestrian crossing
4	**Al-Etehad Hospital**	**11:00**		
			15	Parking cars on two sides of street
			20	Crossing Intersection left
5	**Asekah Intersection**	**14:50**		
			10	Pedestrian crossing
End	**Al-Quds Open University**	15:25	100	
Total		**15.42 minutes**	**1.67 minutes**	

Private Car Travel Time Data Collection and Calculation Sheet

Route Name Masaken-Al-Quds Open University

Time:7:20 Am

Date: 12/11/2014

weather: sunlit

Trail No.: 3

Distance: 8.700 Km

No.	Check Points	Cumulative Travel Time (M:S)	Stop Time (Delay) (S)	Reason For Stop
Start	**Masaken**	0	0	0
			10	Pedestrian crossing
			15	Crossing Intersection
1	**Intersection at Asker Albalad mosque**	**3:10**		
			15	Congestion
2	**Othman Mosque**	**5:30**		
			20	Crossing Intersection
3	**East Intersection Cemetery**	**7:55**		
			10	Pedestrian crossing
4	**Al-Etehad Hospital**	**11:20**		
			20	Parking cars on two sides of street
			30	Crossing Intersect left
5	**Asekah Intersection**	**14:35**		
			10	Pedestrian crossing
			10	Stop sign
End	**Al-Quds Open University**	16:10	140	
Total		**16.17 minutes**	**2.30 minutes**	

Private Car Travel Time Data Collection and Calculation Sheet

Route Name: Masaken-Al-Quds Open University **Time:7:17 Am**

Date: 26/11/2014 **weather: sunlit**

Trail No.: 4 **Distance: 8.700 Km**

No.	Check Points	Cumulative Travel Time (M:S)	Stop Time (Delay) (S)	Reason For Stop
Start	**Masaken**	0	0	0
			15	Crossing Intersection
1	**Intersection at Asker Albalad mosque**	**2:50**		
2	**Othman Mosque**	**4:55**		
			15	Crossing intersection
			10	Pedestrian crossing
3	**East Intersection Cemetery**	**7:55**		
			10	Pedestrian crossing
4	**Al-Etehad Hospital**	**10:50**		
			20	Parking cars on two sides of street
			25	Crossing Intersection left
5	**Asekah Intersection**	**13:50**		
			10	Pedestrian crossing
			15	Stop sign
End	**Al-Quds Open University**	15:35	120	
Total		**15.58 minutes**	**2.00 minutes**	

Private Car Travel Time Data Collection and Calculation Sheet

Route Name: Masaken-Al-Quds Open University | **Time:7:22 Am**

Date: 1/12/2014 | **weather: sunlit**

Trail No.: 5 | **Distance: 8.700 Km**

No.	Check Points	Cumulative Travel Time (M:S)	Stop Time (Delay) (S)	Reason For Stop
Start	**Masaken**	0	0	0
			10	Crossing Intersection
1	**Intersection at Asker Albalad mosque**	**2:35**		
			20	Congestion
2	**Othman Mosque**	**5:25**		
			10	Crossing intersection
3	**East Intersection Cemetery**	**7:55**		
			10	Pedestrian crossing
4	**Al-Etehad Hospital**	**10:30**		
			20	Crossing Intersection left
5	**Asekah Intersection**	**13:35**		
			10	Stop sign
End	**Al-Quds Open University**	14:55	80	
Total		**14.92 minutes**	**1.33 minutes**	

Private Car Travel Time Data Collection and Calculation Sheet

Route Name: Al-Dahia-Nablus Health Directorate **Time:7:55Am**

Date: 10/11/2014 **weather: sunlit**

Trail No.: 1 **Distance: 6.800 Km**

No.	Check Points	Cumulative Travel Time (M:S)	Stop Time (Delay) (S)	Reason For Stop
Start	**Omhat Almoamenen Mosque**	0	0	0
			5	Parking a car in front
			5	Stop Sign
1	**Intersection with Faisal ST**	**1:55**		
			12	Crossing Intersection
			5	Crossing median to transfer
2	**Education Directorate Intersection**	**3:50**		
			5	Crossing intersection
			10	Parking cars on two sides of street
			8	Pedestrian crossing
3	**NEDCO**	**8:30**		
			5	Pedestrian crossing
			10	Parking a car in front
			5	Congestion
4	**Intersection behind An-Najah University**	**12:00**		
			10	Crossing Intersection
			10	Impedance by truck
End	**Nablus Health Directorate**	14:52	90	
Total		**14.87 minutes**	**1.5 minutes**	

Private Car Travel Time Data Collection and Calculation Sheet				
Route Name: Al-Dahia- Nablus Health Directorate			**Time:7:50Am**	
Date: 11/11/2014			**weather: sunlit**	
Trail No.: 2			**Distance: 6.800 Km**	
No.	**Check Points**	**Cumulative Travel Time (M:S)**	**Stop Time (Delay) (S)**	**Reason For Stop**
Start	**Omhat Almoamenen Mosque**	0	0	0
			5	Pedestrian crossing
			5	Stop Sign
1	**Intersection with Faisal ST**	**2:00**		
			20	Crossing Intersection
2	**Education Directorate Intersection**	**4:35**		
			15	Crossing intersection
			20	Parking cars on two sides of street
3	**NEDCO**	**8:55**		
			10	Pedestrian crossing
4	**Intersection behind An-Najah University**	**12:20**		
			13	Crossing Intersection
End	**Nablus Health Directorate**	13:30	88	
Total		**13.50 minutes**	**1.46 minutes**	

Private Car Travel Time Data Collection and Calculation Sheet

Route Name: Al-Dahia-
Nablus Health Directorate **Time:7:48Am**
Date: 12/11/2014 **weather: sunlit**
Trail No.: 3 **Distance: 6.800 Km**

No.	Check Points	Cumulative Travel Time (M:S)	Stop Time (Delay) (S)	Reason For Stop
Start	**Omhat Almoamenen Mosque**	0	0	0
			5	Stop sign
1	**Intersection with Faisal ST**	**1:50**		
			20	Crossing Intersection
			5	Crossing median to transfer
2	**Education Directorate Intersection**	**4:00**		
			20	Crossing intersection
			15	Parking cars on two sides of street
			5	Pedestrian crossing
3	**NEDCO**	**9:00**		
			5	Pedestrian crossing
4	**Intersection behind An-Najah University**	**11:50**		
End	**Nablus Health Directorate**	13:00	75	
Total		**13.00 minutes**	**1.25 minutes**	

Private Car Travel Time Data Collection and Calculation Sheet

Route Name: Al-Dahia-
Nablus Health Directorate — **Time:7:58Am**
Date: 26/11/2014 — **weather: sunlit**
Trail No.: 4 — **Distance: 6.800 Km**

No.	Check Points	Cumulative Travel Time (M:S)	Stop Time (Delay) (S)	Reason For Stop
Start	**Omhat Almoamenen Mosque**	0	0	0
			5	Pedestrian crossing
1	**Intersection with Faisal ST**	**1:55**		
			25	Crossing Intersection
2	**Education Directorate Intersection**	**3:25**		
			20	Crossing intersection
			10	Parking cars on two sides of street
			5	Pedestrian crossing
3	**NEDCO**	**8:50**		
			6	Pedestrian crossing
			10	Parking a car in front
			10	Congestion
4	**Intersection behind An-Najah University**	**12:00**		
			9	Crossing Intersection
End	**Nablus Health Directorate**	14:15	100	
Total		**14.25minutes**	**1.67 minutes**	

Private Car Travel Time Data Collection and Calculation Sheet

Route Name: Al-Dahia-
Nablus Health Directorate **Time:7:55Am**
Date: 1/12/2014 **weather: sunlit**
Trail No.: 5 **Distance: 6.800 Km**

No.	Check Points	Cumulative Travel Time (M:S)	Stop Time (Delay) (S)	Reason For Stop
Start	**Omhat Almoamenen Mosque**	0	0	0
			5	Pedestrian crossing
1	**Intersection with Faisal ST**	**2:00**		
			25	Crossing Intersection
			5	Crossing median to transfer
2	**Education Directorate Intersection**	**4:00**		
			30	Crossing intersection
			5	Pedestrian crossing
3	**NEDCO**	**8:45**		
			10	Parking cars on two sides of street
4	**Intersection behind An-Najah University**	**12:10**		
End	**Nablus Health Directorate**	13:55	80	
Total		**13.92minutes**	**1.33 minutes**	

Shared-Taxi Travel Time Data Collection and Calculation Sheet

Route Name: Masaken-Al-Quds Open University **Time:7:25 Am**
Date:17/11/2014 **weather: cloudy**
Trail No.: 1 **Distance:5.00/3.400 KM**

No.	Check Points	Cumulative Travel Time (M:S)	Stop Time (Delay) (S)	Reason For Stop
Start	**Masaken**	0	0	0
			20	Pedestrian crossing
			15	Congestion
			10	Passenger boarding
1	**Al-Ghawi Intersection**	**5:30**		
			12	Pedestrian crossing
			25	Congestion
2	**Intersection with Faisal ST**	**7:35**		
			10	Crossing Intersection
			23	Passenger alighting
			30	Signal sign
3	**Mercy Clinic**	**9:50**		
			25	Passenger boarding
			15	Passenger aligning
			70	Signal sign
			30	Congesting
End	**CBD**	**14:48**	**285**	
Sub-Total		**14.80 minutes**	**4.75 minutes**	
Start	**Internal P.T Service Complex**	0	0	
			10	Congesting
			25	Stop sign
			15	Stop sign
1	**AL-Salam Mosque**	**2:55**		
			30	Signal sign

			15	Passenger alighting
			10	Pedestrian crossing
			15	Congesting
2	**Majeen/Zwata Intersection**	**5:50**		
			20	Passenger alighting
			10	Pedestrian crossing
			12	Stop sign
End	**Al-Quds Open University**	**8:55**	**162**	
Sub-Total		**8.92 minutes**	**2.7 minutes**	
Total		**23.72**		

Shared-Taxi Travel Time Data Collection and Calculation Sheet

Route Name: Masaken-Al-Quds Open University

Date:18/11/2014

Time:7:20 Am

weather: sunlight

Trail No.:2

Distance: 5.00/3.400 KM

No.	Check Points	Cumulative Travel Time (M:S)	Stop Time (Delay) (S)	Reason For Stop
Start	**Masaken**	0	0	0
			10	Pedestrian crossing
			15	Congesting
			12	Passenger boarding
1	**Al-Ghawi Intersection**	**5:00**		
			5	Pedestrian crossing
			20	Congesting
2	**Intersection with Faisal ST**	**7:20**		
			10	Crossing Intersection
			25	Passenger boarding
			25	Passenger alighting
3	**Mercy Clinic**	**9:10**		
			29	Passenger alighting
			40	Signal sign
			65	Signal sign
End	**CBD**	**13:30**	**256**	
Sub-Total		**13.50 minutes**	**4.27 minutes**	
Start	**Internal P.T Service Complex**	0	0	
			15	Stop sign
			10	Congesting
			10	Stop sign
1	**AL-Salam Mosque**	**2:46**		
			27	Congesting
			15	Passenger alighting

			10	Pedestrian crossing
2	**Majeen/Zwata Intersection**	**5:25**		
			15	Passenger alighting
			10	Pedestrian crossing
			20	Passenger alighting
			12	Stop sign
End	**Al-Quds Open University**	**8:37**	**144**	
Sub-Total		**8.62 minutes**	**2.4 minutes**	
Total		**22.12**		

Shared-Taxi Travel Time Data Collection and Calculation Sheet

Route Name: Masaken-Al-Quds Open University
Date:19/11/2014
Trail No.: 3
Time:7:20 Am
weather: sunlight
Distance:5.00/3.400 KM

No.	Check Points	Cumulative Travel Time (M:S)	Stop Time (Delay) (S)	Reason For Stop
Start	**Masaken**	0	0	0
			15	Pedestrian crossing
			15	Passenger boarding
			10	Passenger boarding
1	**Al-Ghawi Intersection**	**4:50**		
			12	Pedestrian crossing
			20	Congesting
2	**Intersection with Faisal ST**	**6:50**		
			10	Crossing Intersection
			25	Passenger alighting
3	**Mercy Clinic**	**8:55**		
			25	Passenger boarding
			20	Signal sign
			35	Signal sign
			75	Signal sign
End	**CBD**	**13:54**	**262**	
Sub-Total		**13.90 minutes**	**4.37 minutes**	
Start	**Internal P.T Service Complex**	0	0	
			20	Congesting
			30	Signal sign
			25	Stop sign

			10	Stop sign
1	**AL-Salam Mosque**	**2:55**		
			20	Passenger alighting
			25	Congesting
			10	Pedestrian crossing
2	**Majeen/Zwata Intersection**	**5:30**		
			20	Passenger boarding
			10	Pedestrian crossing
End	**Al-Quds Open University**	**9:06**	**170**	
Sub-Total		**9.10 minutes**	**2.83 minutes**	
Total		**23.00**		

Shared-Taxi Travel Time Data Collection and Calculation Sheet

Route Name: Masaken-Al-Quds Open University | **Time:7:15 Am**

Date:24/11/2014 | **weather: cloudy**

Trail No.: 4 | **Distance:5.00/3.400 KM**

No.	Check Points	Cumulative Travel Time (M:S)	Stop Time (Delay) (S)	Reason For Stop
Start	**Masaken**	0	0	0
			10	Pedestrian crossing
			20	Passenger boarding
1	**Al-Ghawi Intersection**	**4:35**		
			15	Passenger boarding
			35	Congesting
2	**Intersection with Faisal ST**	**7:00**		
			10	Crossing Intersection
			20	Passenger boarding
			30	Congesting
3	**Mercy Clinic**	**8:30**		
			25	Passenger alighting
			20	Pedestrian crossing
			25	Passenger alighting
			72	Signal sign
End	**CBD**	**14:36**	**282**	
Sub-Total		**14.60 minutes**	**4.70 minutes**	
Start	**Internal P.T Service Complex**	0	0	
			10	Congesting
			30	Signal sign

			25	Stop sign
1	**AL-Salam Mosque**	**3:00**		
			25	Congesting
			20	passenger alighting
			15	Pedestrian crossing
2	**Majeen/Zwata Intersection**	**5:50**		
			15	Passenger alighting
			10	Pedestrian crossing
			20	Passenger boarding
			15	Stop sign
End	**Al-Quds Open University**	**8:37**	**185**	
Sub-Total		**9.80 minutes**	**3.08 minutes**	
Total		**24.4**		

Shared-Taxi Travel Time Data Collection and Calculation Sheet

Route Name: Masaken-Al-Quds Open University **Time:7:30 Am**

Date:25/11/2014 **weather: cloudy**

Trail No.: 5 **Distance:5.00/3.400 Km**

No.	Check Points	Cumulative Travel Time (M:S)	Stop Time (Delay) (S)	Reason For Stop
Start	**Masaken**	0	0	0
			30	Pedestrian crossing
			20	Passenger boarding
			15	Congestion
1	**Al-Ghawi Intersection**	**5:35**		
			30	Congesting
			20	Passenger boarding
2	**Intersection with Faisal ST**	**7:50**		
			30	Crossing Intersection
			20	Passenger alighting
			35	Signal sign
3	**Mercy Clinic**	**9:45**		
			30	Passenger alighting
			20	Pedestrian crossing
			35	Signal sign
			65	Signal sign
End	**CBD**	**15:18**	**350**	
Sub-Total		**15.30 minutes**	**5.83 minutes**	
Start	**Internal P.T Service Complex**	0	0	
			10	Congesting
			35	Signal sign

			15	Stop sign
1	**AL-Salam Mosque**	**3:10**		
			15	Congesting
			20	Passenger alighting
			10	Pedestrian crossing
			17	Passenger boarding
2	**Majeen/Zwata Intersection**	**6:00**		
			15	Passenger alighting
			10	Pedestrian crossing
			20	Passenger alighting
			10	Stop sign
End	**Al-Quds Open University**	**8:37**	**177**	
Sub-Total		**9.40 minutes**	**2.95 minutes**	
Total		**24.7**		

Shared-Taxi Travel Time Data Collection and Calculation Sheet

Route Name: Al-Dahia- Nablus Health Directorate
Date: 17/11/2014
Trail No.: 1
Time:8:05 Am
weather: cloudy
Distance:3.600/3.200 Km

No.	Check Points	Cumulative Travel Time (M:S)	Stop Time (Delay) (S)	Reason For Stop
Start	**Omhat Almoamenen Mosqu**	0	0	0
			8	Pedestrian crossing
			10	stop Sign
1	**Intersection with Faisal ST**	**2:30**		
			25	Crossing Intersection
			5	Crossing median to transfer
			25	passenger boarding
2	**Mercy Clinic**	**6:45**		
			25	passenger alighting
			30	Signal sign
			50	Signal sign
End	**CBD**	**11:00**	**178**	
Sub-Total		**11.00 minutes**	**2.97 minutes**	
Start	**Internal Service Complex**	0	0	
			10	Pedestrian crossing
			25	Signal sign
			30	Signal sign
1	**South cemetery**	**4:00**		
			15	Passenger alighting
			10	Crossing Intersection to left
2	**Intersection behind An-Najah University**	**6:05**		
			10	Passenger alighting
			5	Parking car in front
End	**Nablus Health Directorate**	**8:30**	**105**	
Sub-Total		**8.50 minutes**	**1.75minutes**	
Total		**19.5**		

Shared-Taxi Travel Time Data Collection and Calculation Sheet				
Route Name: Al-Dahia- Nablus Health Directorate Date: 18/11/2014 Trail No.: 2			**Time: 8:00 Am weather: sunlight Distance:3.600/3.200 KM**	
No.	**Check Points**	**Cumulative Travel Time (M:S)**	**Stop Time (Delay) (S)**	**Reason For Stop**
Start	**Omhat Almoamenen Mosqu**	0	0	0
			5	Parking car in front
			5	Stop Sign
1		**2:20**		
	Intersection with Faisal ST		15	Crossing Intersection
			5	Crossing median to transfer
			20	Passenger boarding
			15	Passenger alighting
2		**6:05**		
	Mercy Clinic		29	Passenger boarding
			36	Signal sign
			30	Signal sign
End		**10:21**	**160**	
Sub-Total	**CBD**	**10.35 minutes**	**2.67 minutes**	
Start		0	0	
	Internal Service Complex		5	Parking car in front
			10	Congesting
			23	Signal sign
1		**3:02**		
	South cemetery		22	Congesting
			15	Passenger alighting
			10	Crossing Intersection to left
2	**Intersection behind An-Najah University**	**5:40**		
			13	Passenger alighting
End		**8:10**	**98**	
Sub-Total	**Nablus Health Directorate**	**8.16 minutes**	**1.63 minutes**	
Total		**18.51**		

Shared-Taxi Travel Time Data Collection and Calculation Sheet				
Route Name: Al-Dahia- Nablus Health Directorate			**Time:7:55 Am**	
Date: 19/11/2014			**weather: sunlit**	
Trail No.: 3			**Distance:3.600/3.200 KM**	
No.	**Check Points**	**Cumulative Travel Time (M:S)**	**Stop Time (Delay) (S)**	**Reason For Stop**
Start	**Omhat Almoamenen Mosqu**	0	0	0
			5	Stop Sign
			10	Passenger alighting
1	**Intersection with Faisal ST**	**1:55**		
			15	Crossing Intersection
			5	Crossing median to transfer
			10	Pedestrian crossing
			15	Congesting
2	**Mercy Clinic**	**6:00**		
			30	Passenger boarding
			25	Signal sign
			70	Signal sign
End	**CBD**	**11:27**	**185**	
Sub-Total		**11.45 minutes**	**3.08 minutes**	
Start	**Internal Service Complex**	0	0	
			10	Pedestrian crossing
			30	Signal sign
			40	Signal sign
1	**South cemetery**	**5:00**		
			15	Passenger alighting
			20	Crossing Intersection to left
2	**Intersection behind An-Najah University**	**6:20**		

			15	Passenger alighting
End	**Nablus Health Directorate**	**9:12**	**130**	
Sub-Total		**9.20minutes**	**2.17 minutes**	
Total		**20.65**		

Shared-Taxi Travel Time Data Collection and Calculation Sheet				
Route Name: Al-Dahia- Nablus				
Health Directorate			**Time:7:55 Am**	
Date: 24/11/2014			**weather: cloudy**	
Trail No.: 4			**Distance:3.600/3.200**	
No.	**Cheak Points**	**Cumulative Travel Time (M:S)**	**Stop Time (Delay) (S)**	**Reason For Stop**
Start	**Omhat Almoamenen Mosqu**	0	0	0
			15	Parking car in front
			10	Stop Sign
			10	Pedestrian crossing
1	**Intersection with Faisal ST**	**2:45**		
			30	Crossing Intersection
			20	Passenger boarding
			25	Signal sign
2	**Mercy Clinic**	**6:57**		
			20	Passenger alighting
			25	Signal sign
			43	Signal sign
End	**CBD**	**11:48AM**	**198**	
Sub-Total		**11.80 minutes**	**3.3 minutes**	
Start	**Internal Service Complex**	0	0	
			10	Congesting
			23	signal sign
1	**South cemetery**	**4:45**		
			22	Congesting
			25	Crossing Intersection to left
2	**Intersection**	**5:55**		

	behind An-Najah University			
			20	Passenger alighting
			15	Passenger boarding
End	**Nablus Health Directorate**	**8:55**	**115**	
Sub-Total		**8.92minutes**	**1.92 minutes**	
Total		**20.72**		

Shared-Taxi Travel Time Data Collection and Calculation Sheet

Route Name: Al-Dahia- Nablus Health Directorate

Time: 8:05 Am

weather: cloudy

Date: 25/11/2014

Trail No.: 5

Distance:3.600/3.200

No.	Check Points	Cumulative Travel Time (M:S)	Stop Time (Delay) (S)	Reason For Stop
Start	Omhat Almoamenen Mosqu	0	0	0
			10	Pedestrian crossing
1	Intersection with Faisal ST	2:00		
			20	Crossing Intersection
			5	Crossing median to transfer
			20	Passenger boarding
2	Mercy Clinic	5:53		
			25	Passenger alighting
			20	Signal sign
			30	Signal sign
End	CBD	10:55	130	
Sub-Total		10.92 minutes	2.17 minutes	
Start	Internal Service Complex	0	0	
			5	Pedestrian crossing
			30	Signal sign
1	South cemetery	4:20		
			22	Congesting
			10	Crossing Intersection to left
2	Intersection behind An-Najah University	5:38		
			15	Passenger alighting
End	Nablus Health Directorate	8:18	107	
Sub-Total		8.30 minutes	1.78 minutes	
Total		19.22		

جامعة النجاح الوطنية
كلية الدراسات العليا

امكانية الوصول للنقل العام وفجوة الخدمة- مدينة نابلس

إعداد
خليل جابر احمد قيسي

إشراف
د. خالد الساحلي

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

2015

امكانية الوصول للنقل العام وفجوة الخدمة- مدينة نابلس

إعداد

خليل جابر احمد قيسي

إشراف

د. خالد الساحلي

الملخص

أكد الاهتمام المتزايد في التنمية المستدامة على أهمية مفهوم "إمكانية الوصول" كمؤشر رئيس لتقييم تحسينات النقل العام. حتى الوقت الراهن، تعتبر عملية قياس إمكانية الوصول إلى خدمات النقل العام في فلسطين محدودة، ولم يكن لدى الهيئات المحلية أي مقياس محدد أو دقيق لتقييم إمكانية الوصول لخدمات النقل العام. تقدم هذه الدراسة منهجاً وطريقة قياس مقترحة لعملية تقييم إمكانية الوصول لخدمات النقل العام التي تعمل ضمن خطوط ثابتة داخل المدينة (مدينة نابلس).

أظهرت الدراسات السابقة أن هناك نوعان رئيسان مختلفان من الأبحاث ذات العلاقة في إمكانية الوصول لأنظمة النقل العام. يعالج النوع الأول من الأبحاث قياس إمكانية الوصول لأنظمة النقل العام، أما النوع الثاني فإنه يعالج قياس الوصول إلى أهداف الرحلات (Destination) من خلال استعمال نظام النقل العام. إن الهدف الرئيس من هذه الأطروحة هو دراسة هذين النوعين من الأبحاث من خلال تطوير اثنين من المؤشرات ليعكسا مستوى إمكانية الوصول لكل نوع منها، وهذان المؤشران هما: الأول- مؤشر توفر خدمة النقل العام المحلي (LIPTA)، أما الثاني- فهو مؤشر إمكانية الوصول عن طريق زمن الرحلة (TTAI).

ترتكز منهجية هذه الدراسة بشكل رئيس على الطرق الكمية والتحليلية مستخدمة البيانات التي تم جمعها وكذلك المسح الميداني لعدد رحلات خدمة النقل العام، وأيضا عن طريق استعمال بيانات زمن الترحال الميدانية، حيث تم استخدام برنامج نظم المعلومات الجغرافية (GIS) في التحليل وعرض

النتائج، ويتضح ذلك من خلال استعمال التحليل الشبكي لقياس التغطية المكانية لخدمة النقل العام وذلك بناء على مسافة المشي الفعلية على شبكة الطرق المعدة للمشاة.

أظهرت نتائج هذه الدراسة بشكل واضح أن المؤشرات المقترحة تزود منهجية دراسة ملائمة لقياس وتقييم إمكانية الوصول للنقل العام في المناطق الحضرية، حيث أكد المؤشر الأول على أن خدمات النقل العام في منطقة الدراسة متوفرة بصورة جيدة بشكل عام، كما أنه يوجد نقص في هذه الخدمات على طول المناطق المحيطة في منطقة الدراسة، ومن ناحية أخرى أظهر المؤشر الثاني أن هناك فجوة في إمكانية الوصول ما بين استعمال وسائل النقل العام والسيارات الخاصة للمناطق المدروسة.

توصي هذه الدراسة أنه يجب على وزارة النقل والمواصلات كما على الهيئات المحلية أن تأخذ بالاعتبار مفهوم "إمكانية الوصول" لتحسين خدمات النقل العام كجزء من خطتها الشاملة (طويلة وقصيرة المدى)، كما توصي الدراسة بلدية نابلس بالاعتماد على نتائج هذه الدراسة لدعم بعض السياسات التي تعمل على تشجيع استخدام النقل العام كنظام مواصلات بديل