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The Utilization of Geomatics Techniques for Analysis of Urban Areas Transportation Network

A Thesis
Submitted to the Building and Construction Engineering Department of the University of Technology in a Partial Fulfillment of the Requirements for the Degree of Master of Science in Geomatics Engineering.

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بِسْمِ اللّهِ الرَّحْمنِ الرَّحِيمِ

﴿وَمَا تَوْفِيقِي إِلَّا بِاللَّهِ عَلَيْهِ تَوَكَّلْتُ وَإِلَيْهِ أُنِيبُ﴾

صدق ألله العلي العظيم

سورة هود أية (٨٨)

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Khaldoon Talib Falih

2016

الاهداء

يقوم الوطن لينحني إجلالاً لأرواح أبطاله، وتغيب الشمس خجلاً من تلك الشموس.

..... شهداء العراق

إلى من صلى ودعا~ ونزلت دمعته بحرقة لأجلي~ اطال الله في عمره

..... جدي العزيز

إلى من كلله الله بالهيبة والوقار ~ إلى من علمني العطاء بدون انتظار

..... والدي العزيز

إلى ملاكي في الحياة التي كان دعائها سر نجاحي وحنانها بلسم جراحي

..... والدتي العزيزة

إلى من بهم أكبر وعليهم أعتمد ~ إلى شمعة متقدة تنير ظلمة حياتي

..... أخوتي وقرة عيني

إلى رفيقة دربي التي سارت معي نحو الحلم خطوة بخطوة

..... زوجتي العزيزة

خلدون

ABSTRACT

Al-Nasiriyah City suffers from traffic congestion in different spots. The reasons behind that are: high population density, small road network, concentration of local and international institutions of Al-Nasiriyah City. Therefore, there is a need for scientific-foundations for transportation planning in order to evaluate the existing situation of Al-Nasiriyah transportation system and the experience of future development scenarios of transportation system and land use. Most of the development processes that are applied to Al-Nasiriyah faced many challenges in the conventional travel demand forecasting process such as: the absence of previous transportation planning studies and lack of traffic data so that was necessary to make a traffic count through the Mobile Speed Safety System (MSSS) device and also questionnaires on traffic, to obtain data that can be adopted as the basis for travel demand forecasting process.

Given this context, the main objectives of this research are analyzing the existing traffic situation of Al-Nasiriyah City based on a reliable traffic count, modelling and building the road network of Al-Nasiriyah City using a suitable transportation planning software.

According to the study area, (O-D) matrix (Original – Destination) has been developed and built using traffic count in addition to estimating and evaluating the traffic flow and network performance based on the selected process.

The methodology of the research is based on two levels of evaluation of Al-Nasiriyah transportation system, it selects the best route between various stations by using a techniques (Arc GIS 10.3), and network level where TransCAD software. The results of data collection and analysis show that the morning peak period is from 7:00 a.m. to 8:00 a.m. The highest peak hour of traffic flow is [4585.7 pcu/hr] at the northern

entrance for Nasiriyah city Baghdad entrance (EX1), as for intersections the value amounted to [3874.3 pcu/hr] in Al-Bahoo intersection in city center. Using TransCAD software a traffic assignment was made for the (Stochastic User Equilibrium) and (System Optimum) Assignment, Models for assignment and distribution of the traffic in Al-Nasiriyah road network are built, the results of two models were nearly convergent and there is a small improvement in the work of road network by using the system optimum model. The results show that there is a great imbalance in the city center for increasing congestion and lack of services where the percentage (v/c) is greater than or equal to one and this is proven by counting the traffic that clarified the large traffic flow in these regions and gradually the (v/c) to rest of the network. The Presentation of proposals concerning improving each of (road system, car parking, major intersections of the city) through choosing five major intersections to improve, the more congestion is Al-Bahoo intersection, where the percentage (v/c) is about 1.331 and this ratio is relatively large. Proposals suggested are: Signalized (2-phase), U-turns 100m from intersection on dedicated lane, Prohibition of HGVs during daytime, Additional lanes (all approaches), that improve the v/c ratio by 0.70.

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LIST OF ABBREVIATIONS

Symbol	Meanly
AHP	Analytic Hierarchy Process
ATC	Area Traffic Control
ESRI	Economic and Social Research Institute
GCP	Ground Control Points
GIS	Geographic information system
GIS-T	Geographic information system Transportation
GPS	Global positioning system
HCM	Highway Capacity Manual
HCS	Highway Capacity Software
HGV	Heavy goods vehicles
IPG/GDL	Iraqi Planners Group with Garsdale Design Limited.
LOS	Level of service
MCDM	Multiple Criteria Decision Making
MSSS	Mobile speed safety system
O-D	Origin-Destination

Symbol	Meanly
RMS	Root Mean Square
SOA	System Optimum Assignment
SUE	Stochastic User Equilibrium
TAZ	Traffic Analysis Zone
TOPSIS	Technique for Order Preference by Similarity to Ideal Solution
UNHCR	United Nations High Commission for Refugees
UTM	Universal Transverse Mercator
UTP	Urban Transportation Planning
V/C	Volume to Capacity Ratio
WGS 84	World Geodetic System in 1984
$\boldsymbol{\varepsilon}$	(Eta) Index
$\boldsymbol{\gamma}$	(Gamma) Index
$\boldsymbol{\alpha}$	(Alpha) Index
$\boldsymbol{\beta}$	(Beta) Index

Chapter One
Introduction

1.1 General

The purpose of transportation is to provide a mechanism for the exchange of goods, information, and to support economic improvements for society. Transportation provides the means to travel for purposes of employment, exploration, personal fulfillment and is a necessary condition for human activities, such as commerce, recreation, and defense (Hoel, et. al., 2011). The congestions have several causes, such as an increase of traffic, which is the inevitability results for increases of population, number of vehicles and equipment. The poor condition of the infrastructure uses the individual transport rather than mass transport. Lastly the existence of services and government centers especially those that deal directly with the public, leads to the state of congestion**,** (AL-Emam, 2004).

Determining the level of service (LOS) for urban street is very important, as the first step of analysis procedure. This affects the planning, design, and operational phase of transportation projects as well as the allocation of limited financial resources among competing transportation projects**,** (Mohapatra, 2012).

This thesis is the first attempt at that plan and utilizes a two-level approach to determine the best combination of evaluation and enhancement of urban street network in Al-Nasiriyah city. This study focuses on the urban street including arterials, collectors, and intersection. With the scientific progress, there are number of applications such as Mobile Speed Safety System (MSSS), Geographic Information System (GIS) and TransCAD Ver.4.5. MSSS receivers can record the location

and speed automatically at a regular sampling period, consequently. Only one technician is required in the vehicle to determine information for the Transportation Network.

Fortunately, GIS and TransCAD can be used for this purpose, with adding advantages that the resulting travel time data can be entered directly into existing geographic databases (Ibid, 2012). This software is the fastest growing in many fields of transportation because it is the ideal information management and analysis tool. Descriptive information in one database with place, analysis ability which presents the simulation of the new suggestions and planning projects with results of this study.

1.2 Problem Definition

Al Nasiriyah city and many other Iraqi cities do not have published comprehensive studies on transportation planning, or plans for traffic management taking into account the annual growth in population. The number of population is now about 1616226 persons in ThiQar province. The expected number will increase up to 3.5 million in 2030. The result is increasing in demand for transport services, which currently suffer of very poor conditions. The recent urban roads network badly suffers of many problems such as low speed, increasing congestion, long time of travel, the low level of services, increase the level of accident rates, poor road network management, as a whole in the absence of studies on the overall level of each city. Most of the traffic studies are still dealing with individual cases without the existence of a comprehensive strategy to deal with transportation problems. For this reason, the urban road network is used to increase efficiency that can be achieved through the flow of traffic sound management and this requires a great deal of travel times, travel speed and data delay.

Research recently conducted on the feasibility of using geographic information system (GIS) software and TransCAD techniques, and for the first time the use of Mobile Speed Safety System (MSSS). The MSSS is about a device using for the completion of the data collection process and identifying peak times, then analyze this using the software that mentioned above. As a result, the apparent lack of available transportation system data and dispersion prompting to do a complete database of the transport system. This will lead to facilitate decision-making, and the analysis and development of the transport network operation.

1.3 Objectives of This Study

The objective of this research is to evaluate Al-Nasiriyah city transportation system by applying a transportation planning process and mitigate the challenges mentioned above. The main objectives are:

1- Gathering information pertaining to the transportation system in Al-Nasiriyah city because of the large dispersion in this system during current period to facilitate the tasks of the decision-makers for the development of transportation network.
2- Analyzing the existing traffic situation of Al-Nasiriyah City based on a reliable traffic count.
3- Modelling and building the road network of Al-Nasiriyah City using a suitable transportation planning software.
4- Calculating the expected traffic volumes on each highway segment and assigned trips for each O-D pair to the shortest path from each origin to all destinations then determine the actual links that will be used in the highway network based on the highway traditional traffic capacity.
5- Preparing traffic data base including as follows:

- Vehicles movements' survey on both external and internal ambits.
- Count and classify vehicles on the internal road network.
- Trip time survey.
- Parking survey.
- Roads condition survey.
- Intersections survey.

1.4 Methodology of Work

The methodology of this research consists of five stages as the following:

- The first is to clarify the existing transport network in the city and the types of roads included in this network, and also the extent of the effect distance the rest of the cities for the study area.
- While the second stage was conducted surveys of traffic on the ground. This stage consists of 11 traffic surveys for the city of Nasiriyah.
- The third stage includes the presentation of the services in the network and global standards which have been developed land requirements for these services, including the roads.
- The fourth and fifth stages has performed an analysis by using (GIS , TransCAD) that shows the results and evaluation, then was the presentation of proposals for the development of the network as shown in Figure (3-1).

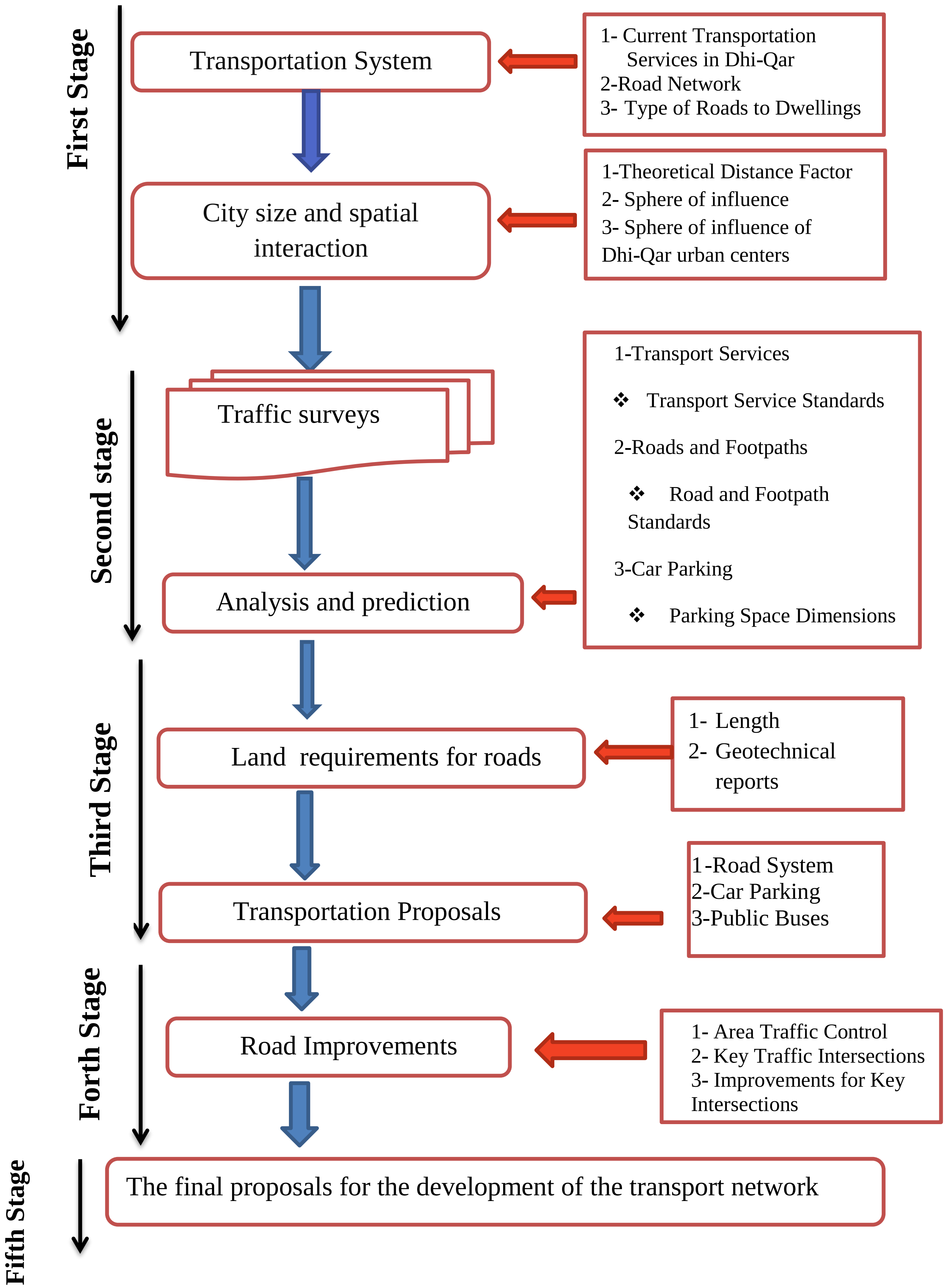

Fig.(1-1): Flow chart explaining the methodology of the work

1.5 Scope of the Thesis

This thesis is divided into six chapters as explained briefly here:

Chapter One gives an introduction to urban transportation planning and the problems related to Al-Nasiriyah city due to urbanization and motorization. The importance of implantation of comprehensive urban transportation planning is necessary.

Chapter Two is concerned with the review of previous literatures on the urban transportation planning process, implementation of GIS in travel demand modeling, optimization methods and urban transport modes.

Chapter Three illustrates the comprehensive information as the location and demographic statistics of the Al-Nasiriyah city as well as the work has been planned to study which partitioned into stages. Then describe the situation transport network in the city. Later, there was collected transport information completely about the city through field work.

Chapter Four shows the basic requirements for transport services. The database has been built in GIS program to find the best paths between roads depending on the origin and destination of each trip, and also the level of network performance ratios is evaluated depend on the area and population, and some other indicators.

Chapter Five explains O-D matrix calculated for transportation network and use the TransCAD for implement traffic assignment to network by using two methods and the result is shown in maps and tables.

Chapter Six presents the conclusions and recommendations on the necessary measures for the future transportation alternative scenarios.

Chapter Two

Literature Review

2.1 General

This chapter is a review of Urban Transportation Planning Process (UTPP) in addition to previous studies which are concerned with analysis transport networks, identifying problems and offering solutions to networks. Also it discusses the fundamentals of the analysis process, including the demand for travel, the types of trips and some engineering programs that used for this purpose of modeling.

2.2 Background of Urban Transportation Planning (UTP)

Urban transportation planning includes evaluation and selection of the best and fastest way which contains the current transit facilities and future expectations taking into consideration the other cities that occur during the planning period developments. It includes two types of planning.

The first includes short-term and focuses on projects that define the plans that can be implemented within 1-3 years and aims of these projects that provide better management of public utilities, which makes it better than before. The second includes the long-term, which aims to transport development in the long term and are planning this building for over 20 years,(Garber and Hoel, 2010).

The transportation planning process is proposed to be comprehensive through the gathering, investigation and discussion of relevant data related with current conditions and the growth back ground. The purpose is to determine goals and aims, of the 'existing movements patterns' in the city and to predict the future demand patterns either (Banister, 2002).

The transportation planning process is involved in the assessment of the level of performance of the transport network in the city, and has an important role in the design and determines which service facilities this operation including (major streets, highways, service corridors, the main lines of other transportation ways), Figure (2-1) shows the effect of transportation planning process on the shape of city,(Southern, A. 2006).

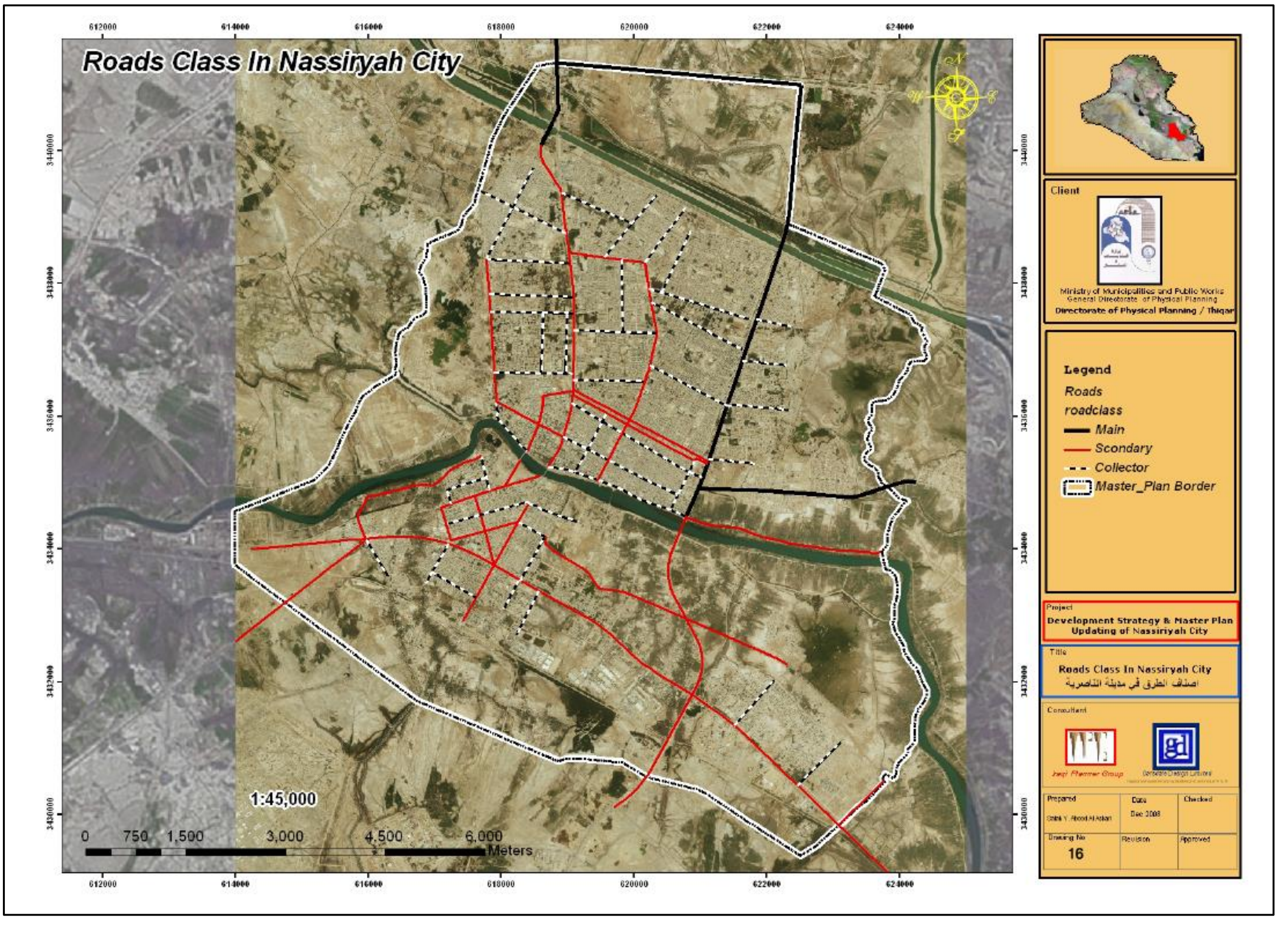

Fig.(2-1): Roads class in Nasiriyah city

Urban transportation planning involves the evaluation and selection of highway or transit facilities to serve present and future land uses. For example, the construction of a new shopping center, airport, or convention center will require additional transportation services. Also, new residential development, office space, and industrial parks will generate additional traffic, requiring the creation or expansion of roads and transit services.

The process must also consider other proposed developments and improvements that will occur within the planning period. The urban transportation planning process has been enhanced through the efforts of the Federal Highway Administration and the Federal Transit Administration of the U.S. Department of Transportation by the preparation of manuals and computer programs that assist in organizing data and forecasting travel flows. Urban transportation planning is concerned with two separate time horizons. The first is a short-term emphasis intended to select projects that can be implemented within a one- to three-year period. These projects are designed to provide better management of existing facilities by making them as efficient as possible. The second time horizon deals with the long-range transportation needs of an area and identifies the projects to be constructed over a 20-year period,(Ibid,2010). Urban transportation planning is the process which leads to decisions on transportation policies for long range planning. In this process, planners develop model about the impacts of adding alternative transportation polices, like transit route changes, new highways or adding new metro line. This planning process support decision makers (officials) in their selection of transportation policies,(Federal highway administration, 2010). The diagram in Figure (2-2) shows the relationship of major planning activities.

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Fig.(2-2): Major Four Step Model

2.3 GIS Definition and Applications

2.3.1 General Introduction to GIS

Sun et. al. (2005) the main develop a multimedia inventory system for the intersections on the highway system maintained by Department of Transportation (DOT) in one of its districts. The objectives of this study are to display-signalized intersections on the GIS street map, develop efficient data collection and processing methods, integrate multiple sources of data in GIS, and provide relevant information on signalized intersections in GIS format. Geographic Information System integrates information in a way that helps to understand and find solutions to problems. Data about real-world objects is stored in a database and dynamically linked to a screen map, which displays graphics representing real-world objects. When the data in the database was changed, the map is updated to reflect the changes, GIS can provide information on the subject, which was used in which, for example, in the transportation provides information pertaining to (traffic congestion, intersections and performance, choose the most appropriate route, traffic accidents).

2.3.2 Application of GIS in Transportation Planning

2.3.2.1 General Transportation Planning in GIS

Yang et al. (2003) presented integrate traffic demand analysis and engineering design into a package, which can optimize the spatial location and alignment of a constructed highway in road network,(Tae-Ho et al. 2008) presented the route location method by applying decision support system (AHP) and GIS. They developed program to evaluate suitability of current routes by applying the Analytic Hierarchy Process (AHP) based-GIS,(Avram et al. ,2010). Dealt with the utilization of GIS that allows the coordination and optimization of urban road traffic and of the way the inhabitants of the city and experts in territorial planning perceive

it,(Olowosegun et al. ,2012) applied a (GIS) tools in the published report to present the appropriateness of the location of bus stops, stop elevation and spacing evaluation in the study area.

Hu Weiping, Wu Chi (2008) the road network has a key role in the spatial distribution in the cities. And it has a key role in the transport and the effect shown by the economic and social activity in the city, so there have been many studies on road networks hold because of their importance. Therefore, the study indicates the first, the study of the concept of access through the best and the least distance and some methods of evaluation of networks. Then use method spatial analysis to assess the level networks using geographical information systems and networks focus in evaluating the strength of connectivity within the network, the shortest time for trips between the origin and destination. Therefore they have relying on several indicators, including building a model in detail expresses the city, taking into consideration the old models designed. On the basis of it was chosen as a model of Foshan City to the study, it was tested using the models of urban road network data and also the further development of models was discussed to assess the possibility of access and building the optimal model and its applicability to Foshan City as shown in Figure (2-3) and Figure (2-4).

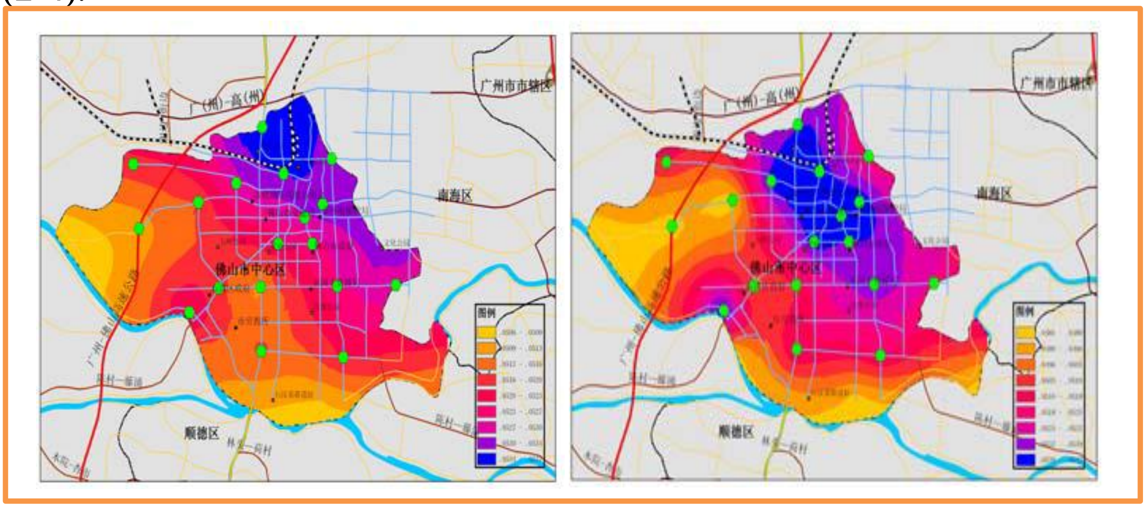


Fig.(2-3): Shortest travel time value interpolation chart (Ibid,2008)

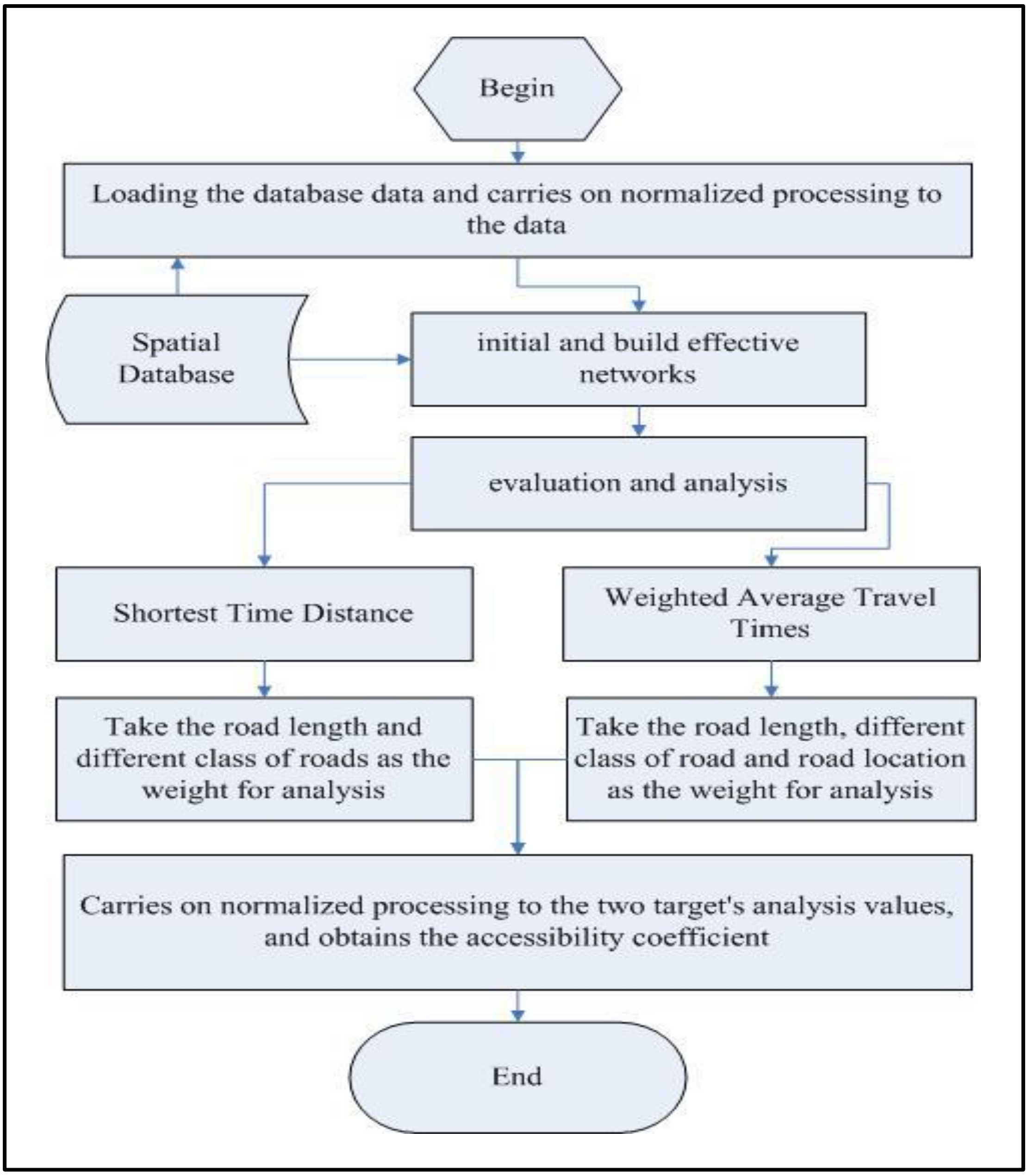


Fig.(2-4): Road network accessibility evaluation flowchart

The road network evaluation system: This study takes the central region of Foshan city in China as an example, the road data of (2008) were used in the test. The nodes (the green dots) distribution is shown in Figure (2-5). Based on GIS spatial analysis methods, we built a weighted and normalized index to value the accessibility of road nodes. In the sample test of Foshan city, the results show that the index can explain the true situation of road network's accessibility

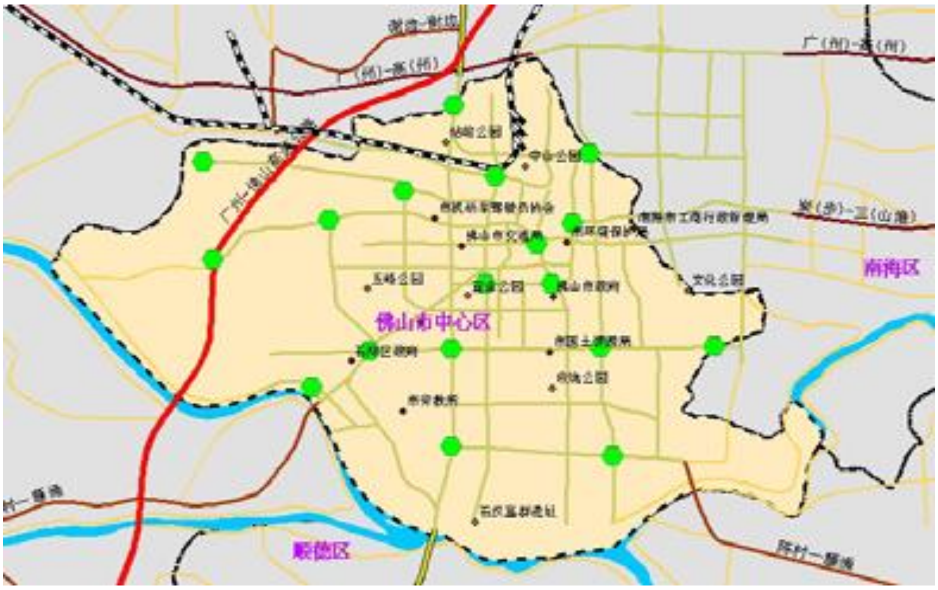


Fig.(2-5): Sample nodes' location in Foshan city

2.3.2.2 Arc GIS Network Analyst

Arc GIS Network Analyst is one of GIS software applications in the process of spatial analysis of networks that provide selecting the best route, finding service areas and accessibility to them and finding the paths concerning origin and destination etc. This tool works depending on a sophisticated model built into GIS. The availability of this tool forms tracks and also digital tables' data for these routes.

With this tool, the program uses an algorithm that finds the shortest path for roads; this algorithm was developed by Dijkstra in 1953. This algorithm reduces the time, expense and necessary effect to find the optimal path. Where the balance of working through the track closest to calculate the optimal path, which can be controlled mathematically, algorithm breaks the network into nodes (where lines join, start or end) and paths between such nodes are represented by lines. In addition, each line has an associated cost representing the cost (price) of each line needed to reach a node, (Abood, 2013).

It is the network analysis process of the most important functions that GIS can carry out with high efficiency. Because the movement of people and their movements and distribution of goods, services and energy is through road networks infrastructure, the shape and the efficiency of these networks determine significantly the level of people's lives and significantly affect the fairness of the distribution of services, and provide practical networking different means analysis for the study of any network and determine the extent of the impedance of each part of the process traffic and to express it in a digital image, and then the process of dealing with that network begins through a series of commands are known spatial commands which that calculate the desired routes and display them to the user in Concept, (saber H. ,2012).

2.3.3 Optimization Methods

GIS-based optimization analysis is a process that combines and transforms spatial data into a resultant decision. The optimization procedures are decision rules which define a relationship between the input and an output data. There are many ways in which optimization can be developed such as AHP, Genetic Algorithm, etc.

The optimization model presents the locations of stations for route of an on-ground rail transit using various objective functions of demand and cost as they affect the design of transit alignment. Station locations were optimized using a developed Genetic Algorithm (GA) based on a GIS database,(Sutapa Samanta et al, 2010).

Denis (1997) the present study was conducted to find the best ways to access independent paths, find any aimed up to one position, for every position we need to track different from neighboring paths and the best ways to find these pathways as the process is done entirely manually. Therefore, this study has developed multiple strategies to find those paths

and using modern methods, including the use of geographic information systems. The study applied is based on the Monte Carlo approach to compare the resulting application of these methods to forest areas and on the basis that the solutions found this study offer the possibility of finding new solutions and other ways are different by 80% from what it, anywhere to prove the applicability of automated design for the first networks process.

2.4 Transportation Network Design

Network design is one of the most important encountered classes of optimization problems, (Ahuj et. al. 1993). It is a field in graph theory and optimization. A lot of optimization problems in network design come directly from everyday practice in engineering and management: determining the shortest paths in traffic or communication networks, maximal flows, or shortest tours, planning connections in traffic networks, coordinating projects, solving supply and demand problems, (Mitsuo Gen et. al. ,2008).

Network is used to describe a structure that can be either physical (e.g., streets and intersections or telephone line etc.) or conceptual (e.g., information lines and people, affiliation relationships and television stations, etc.). Each of these networks includes two types of elements: a set of points (node) and a set of line (edge) connecting these points,(Yosef Sheffi, 1985).

Result from this urban public transport is the public welfare undertakings for urban economic development and people’s life. It also considers the degree of the statement of modernity in the city. This study is provided to the transport network and how the maintenance of the road network in real-time data and the main features are as follows, separation of road layer and route layer separation, and route display doesn’t rely on road net, route site

generated by assigning the location of the axis of the station and the geological nature of the route chosen, line generation algorithm is independent of any line and is only related to site and the nature of the road it can control the Network Properties, such as deleting, addition or modification to the routes, and also processing and improving the geographical information systems data in the basic network of roads. There is the possibility to store the data or modifications and management of any integrated management of a transfer system in cities. The system has good expansibility, which will better serve urban public transportation GIS and foster urban development,(Wen Zeng et al. 2010).

Khazaal (2005) Made a study to determine the characteristics of the paved road network in the province of Erbil in 2005, by answering the following questions blindness (To what extent realized the degree of contact between the urban settlements, What is the correlation and interdependence between urban settlement, Where centralization is realized or moderation in the network, What is the turning roads Index)

Applying theoretical graphic indicators appeared showing through the application of evidence that all urban settlements in the governorate associated with the path of one of the refer to provide a degree of connectivity and therefore lack the isolation of these Settlements for each other. At the level of the districts appeared disparity where the degree of connectivity is weak as a result of the topography of the region Also shows that the network is not a centralized top-class although the settlement Arbil Occupied center stage in direct contacts and followed to a lesser extent 6 other settlements.

Network design is one of the most important encountered classes of optimization problems, (Ahuj et al, 1993). It is a field in graph theory and optimization. A lot of optimization problems in network design come

directly from everyday practice in engineering and management: determining the shortest paths in traffic or communication networks, maximal flows, or shortest tours; planning connections in traffic networks; coordinating projects; and solving supply and demand problems,(Mitsuo et. al. 2008).

2.5 Travel Demand Modeling

2.5.1 General Introduction

Travel demand is expressed as the number of persons or vehicles per unit time that can be expected to travel on a given segment of a transportation system under a set of given land-use, socioeconomic, and environmental conditions. Forecasts of travel demand are used to establish the vehicular volume on future or modified transportation system alternatives. The methods for forecasting travel demand can range from a simple extrapolation of observed trends to a sophisticated computerized process involving extensive data gathering and mathematical modeling. The travel demand forecasting process is as much an art as it is a science. Judgments are required concerning the various parameters–that is, population, car ownership, and so forth–that provide the basis for a travel forecast. The methods used in forecasting demand will depend on the availability of data and on specific constraints on the project, such as availability of funds and project schedules this is shown in Figure (2-6) ,(Ibid 2010).

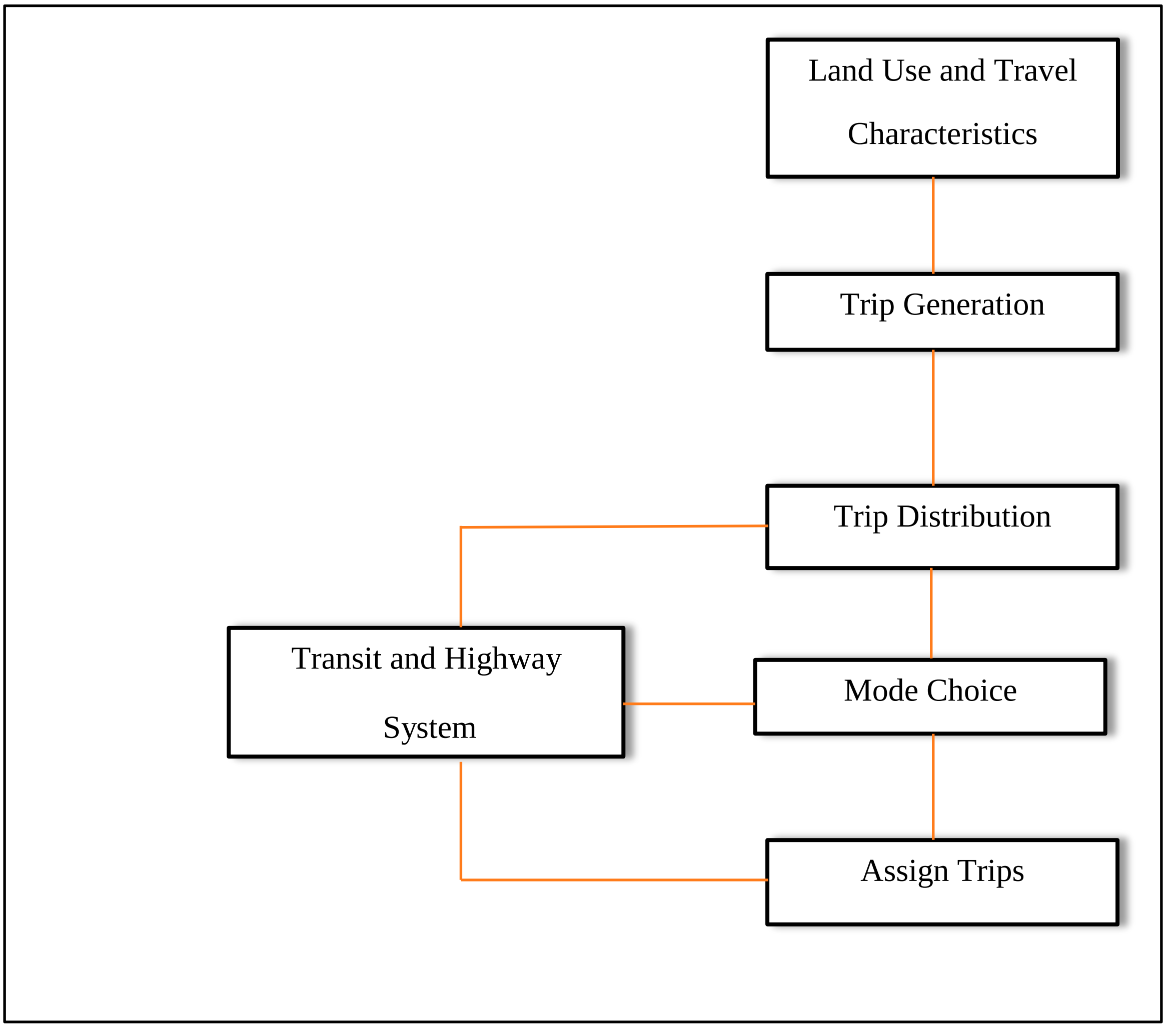


Fig.(2-6): Travel Forecasting Process,(Ibid 2010).

Travel demand modeling studies are essential for the design of transportation facilities and services, and also for planning, investment, and policy development The objective of this study is to develop and apply predicted models for each phase of travel demand forecasting process for Al-Amarah city that include the social economic, location, and land-use characteristics in addition to the road network database. By using the (Stochastic User Equilibrium) and (System Optimum) Assignment Models for assignment the traffic in Al-Amarah road network for the base and target year of the study, the results of two models nearly were convergent

and there is a small improvement in the work of road network by using the system optimum model this method as shown in Figure (2-7) (Qasim G. ,2015).

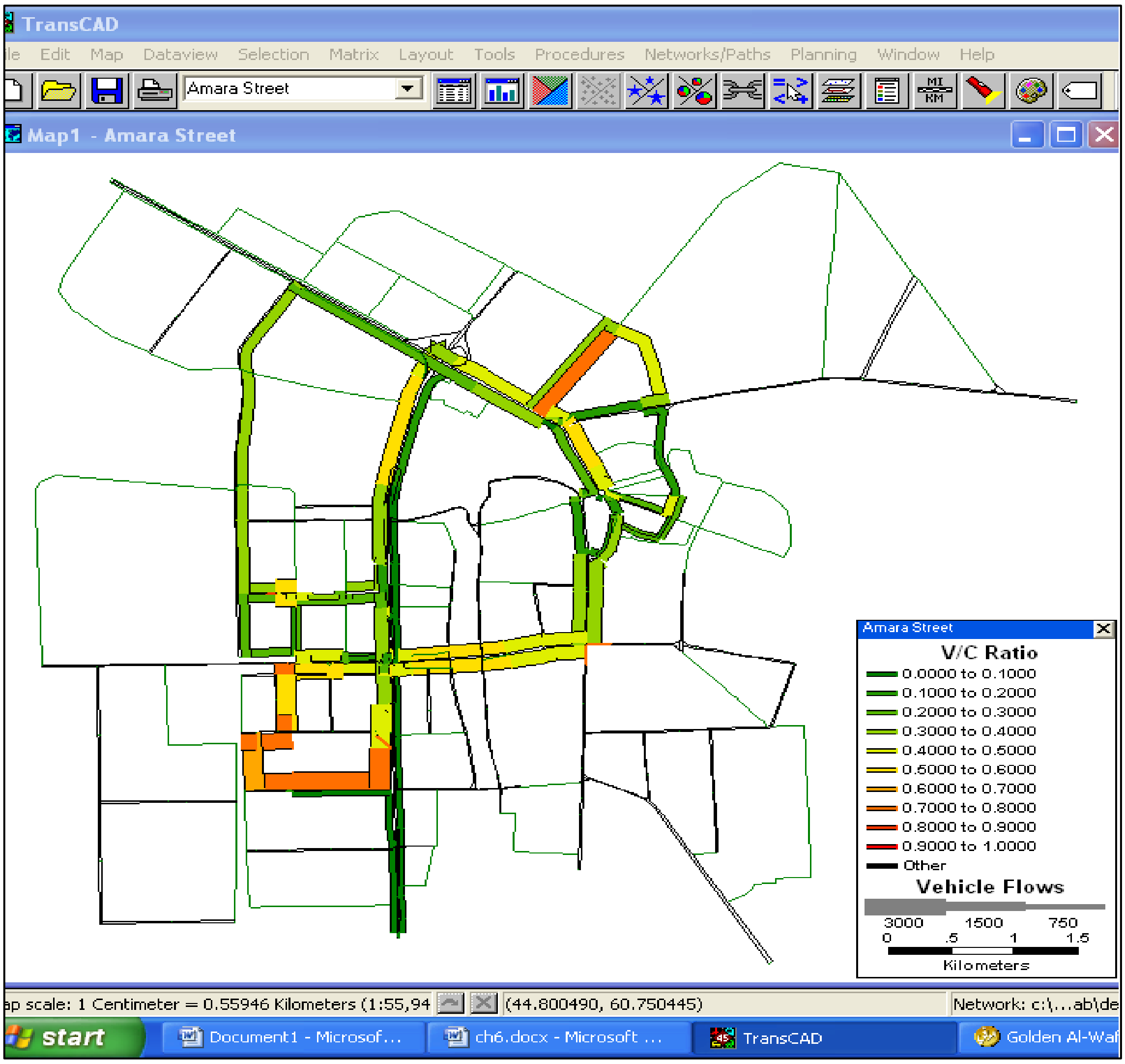


Fig.(2-7): Stochastic User Equilibrium Assignment Model Result (Ibid, 2015)

2.5.2 Travel Forecasting Process

Several analytical methods are used to complete transportation studies or prepare transportation plans; travel demand modeling is just one of them. The most commonly used methodology for travel demand

modeling is the four step process that considers generation, distribution, mode choice, and route assignment of trips,(Desai et. al., 2011).

Forecasting can be summarized in a simplified way by indicating the task that each step in the process is intended to perform this process as shown in Figure (2-8), (Ibid, 2010)

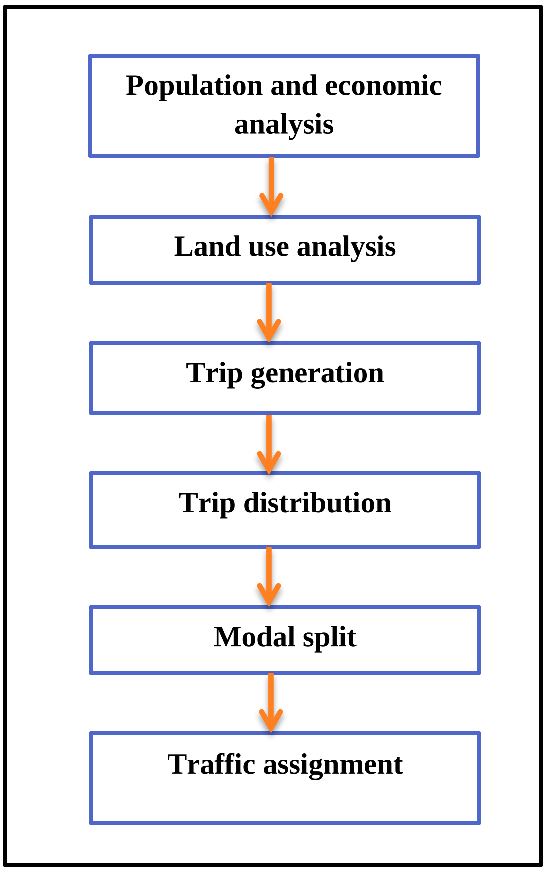


Fig.(2-8): Steps in the Travel Forecasting Process

(Ibid, 2010)

2.5.2.1 Land Use and Travel Characteristics

The process of determining the transport investments are by finding out appropriate activities for transport infrastructure and modern activities in locations that enable the management of the transport process in addition to the land use can affect the amount of travel and geographic nature also

and finding ways relative to attract travelers and find different ways to travel ,(Al-Hasani, 2010).

2.5.2.2 Trip Generation

Trip generation is the process of determining the number of trips that will begin or end in each traffic analysis zone within a study area. Since the trips are determined without regard to destination, they are referred to as trip ends. Each trip has two ends, and these are described in terms of trip purpose Trip generation analysis has two functions: (1) to develop a relationship between trip end production or attraction and land use and (2) to use the relationship to estimate the number of trips generated at some future date under a new set of land use conditions, (Ibid, 2010)

2.5.2.3 Trip Purpose

Trips are classified into several different types depending on the type and purpose necessary allotted to each trip. Home-based trips are further classified based on their purpose into work, shopping, school, person business, social and recreational. The return to home will also consider home-based trips or simply, home-based trips can be one of the following: ,(Bruton, 1985).

1. From home to work.
2. From home to education.
3. From home to shop.
4. From home to social/recreational.
5. From home to other.
6. From work to home.
7. From education to home.
8. From shop to home.
9. From social/recreational to home.
10. From other to home.

Examples of non-home-based trips are trips between work and shop and business trips between two places of employment.

Also, trips classified according to their origins and destinations within the external cordon line of the study area into,(Khisty and Lall, 1998):

- External / External trips; origins and ends outside the external cordon line of study area.
- External / Internal trips; origins outside the external cordon and ends inside the external cordon line of the study area.
- Internal / External trips; origins inside the external cordon line and ends outside the external cordon line of the study area.
- Internal / Internal trips; origins and ends inside the external cordon line of the study area.

2.5.2.4 Trip Distribution

Trip distribution analysis is the process in which trips originating in one zone are distributed to the other zones in the study area. Trip distribution methods have developed in the last two decades from a total reliance on growth factor techniques to the wide use of interactive travel models ,[Federal Highway Administration, 2010].

Trip distribution is a process by which the trips generated in one zone are allocated to other zones in the study area. These trips may be within the study area (internal-internal) or between the study area and areas outside the study area (internal-external),(Ibid, 2010).

2.5.2.5 Gravity Model

The gravity model is the most broadly utilized and documented for trip distribution, which considers that the number of trips between each pair of zones is directly proportional to the number of trip produced from and attracted to each pair of zones and inversely proportional to the required

travel time for trip between each pair of zones,(Martin and McGuckin, 1998).

Mathematically, the gravity model is expressed as

$$T_{ij} = P_i * \frac{A_j F_{ij} K_{ij}}{\sum_{j=0}^{n} A_j F_{ij} K_{ij}} \dots\dots (2-1)$$

where :

T_{ij} Number of trips from zone i to zone j,

P_iNumber of trip productions in zone I,

A_j Number of trip attractions in zone j,

F_{ij} Friction factor relating to spatial separation between zone i to zone j

K_{ij} Trip distribution adjustment factor between zone i to zone j.

2.5.2.6 Mode Choice

The choice of selection of transport mode for travel is the most important issue in transport planning because public transport plays an important role in policy making ,(Ortuzar and Willumsen, 1994). A selection of one mode among the alternative travel modes is depended on experience and on some views about the most modes widely used among the available modes (Jadranka, 2003). *Mode choice* is that aspect of the demand analysis process that determines the number (or percentage) of trips between zones that are made by automobile and by transit. The selection of one mode or another is a complex process that depends on factors such as the traveler's income, the availability of transit service or auto ownership, and the relative advantages of each mode in terms of travel time, cost, comfort, convenience, and safety,(Ibid, 2010).

Chatterjee and Venigalla (2011) explained factors that may affect trip maker’s by selecting a specific transportation mode for a trip as follows:

- Trip Makers Characteristics
- Trip Characteristics
- Transportation Systems Characteristics

2.5.2.7 Traffic Assignment

The final step in the transportation forecasting process is to determine the actual street and highway routes that will be used and the number of automobiles and buses that can be expected on each highway segment. The procedure used to determine the expected traffic volumes is known as traffic assignment . Since the numbers of trips by transit and auto that will travel between zones are known from the previous steps in the process, each trip O-D can be assigned to a highway or transit route. The sum of the results for each segment of the system results in a forecast of the average daily or peak hour traffic volumes that will occur on the urban transportation system that serves the study area (Ibid, 2010).

Traffic assignment is distributing trips along routes between each origins and destinations in transportation networks. It is the last step in the four step transportation forecasting model. Each number of trips from origin to destination must be assigned to the available routes connecting the pair of nodes. Traffic assignment establishes the traffic flow patterns and analyzes congestion points.TransCad supports a wide variety of assignment methods encountered in transportation planning practice,(Mathew and Krishna Rao,2006)

These models are as follows:

1- All-or-Nothing Assignment (AoN)
2- STOCH Assignment
3- Incremental Assignment
4- Capacity Restraint

5- User Equilibrium (UE)
6- Stochastic User Equilibrium (SUE)
7- System Optimum

This study addressed the quantitative analysis of roads paved in the county side between urban centers in the province of Maysan. The study aims to analyze quantitatively road network "in Maysan province, as well as" knowledge of the effectiveness of the network and the intensity and the degree of association and efficiency in the ease of access. The study focused on the quantitative analysis of several indicators was heavily urban network and the contract and cornering index and degree of centralization and threading as well as accessibility. The city of Amarah was ranked first in all quantitative indicators mentioned above as they represent the county and its acquisition of most of the administrative institutions and economic and service, while came a city on the western Mattresses recent and all quantitative indicators also "being a City peripheral. Then ended the study findings and proposals,[**Jurani.2014**].

2.6 TransCAD Aplication

Asmael (2015) the increase in using private share leads to congestion and gets worse, leading to bus trip time increases, and adverse impacts on the comfort of passengers. For this reason and to assist the local related agencies to figure out this problem, urban rail mass transit like Metro is proposed as a case study in the form of attractive and effective strategy to reduce traffic congestion in cities with high levels of demand and congestions like Baghdad throughout the prediction and selection of the optimal alternative based on Multi Criteria Decision Making (MCDM) in transportation planning. The local transportation network facilities are analyzed using GIS application by the aid of (Trans CAD) software. Moreover, an optimal metro route alternative an optimization technique is

predicted by using Analytical Hierarchal Process (AHP) and TOPSIS methods. Based on the collected traffic data, O-D matrix is estimated. In addition, Peak hour ridership on metro routes in 2014 is found to be 30000 passenger per hour per direction and peak hour ridership on metro routes in 2035 reached 50000 passengers per hour per direction. On the other hand, it is concluded that travel demand on alternative route 1 equals 310000 and 600000 trip per day in two directions, while, load on alternative route 2 equals 360000 and 720000 trip per day in 2014 and 2035, respectively, the result of this study as shown in Figure (2-9) .

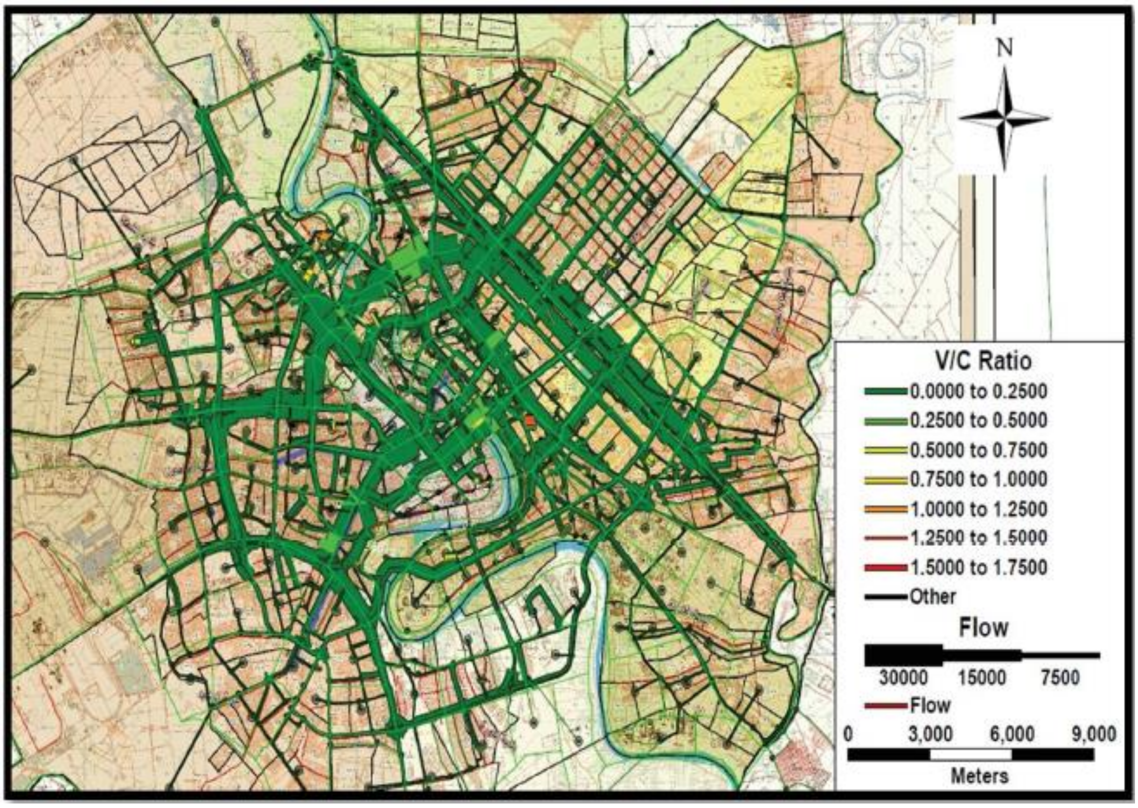


Fig.(2-9): Assignment Results of Vehicle Flow

(Asmael, 2015)

Chapter Three

Methodology and Experimental Work

3.1 General

This chapter gives a general description of the study area which includes all aspects: including geographic and economic importance of the region. These data were collected for Al-Nasiriyah city. In addition, it has the inclusion of statistical data and population distribution of the city because they have an important role in the analysis of transport networks process. It displayed the methodology of this study that was composed of several stages. Also it clarifies the reality of the existing road network in the city through direct surveys and questionnaires.

3.2 Study area

3.2.1 Location

Thi-Qar governorate extends from Waist in the north, to Basra in the south, to Mesian governorate, east to Al-Muthana, west in Iraq area and zone (38 N) according to UTM (Universal Transverse Mercator) geographic coordinate system . Local study region extends between latitude (30°40' 00" to 32° 00' 00") north and longitude (45°40' 00" to 47°10' 00") east, The area of Dhi-Qar is (12900 sq. km) representing 3% of the total area of Iraq. Most of it is very fertile producing various agricultural crops. The governorate is famous for its Marsh area (Haur Al-Hammar) and is important to the tourism industry. It could be said, therefore, that the governorate has economic importance in terms of agricultural and tourism potential, the latter including both natural and historical/archaeological tourism,(COSIT2005).

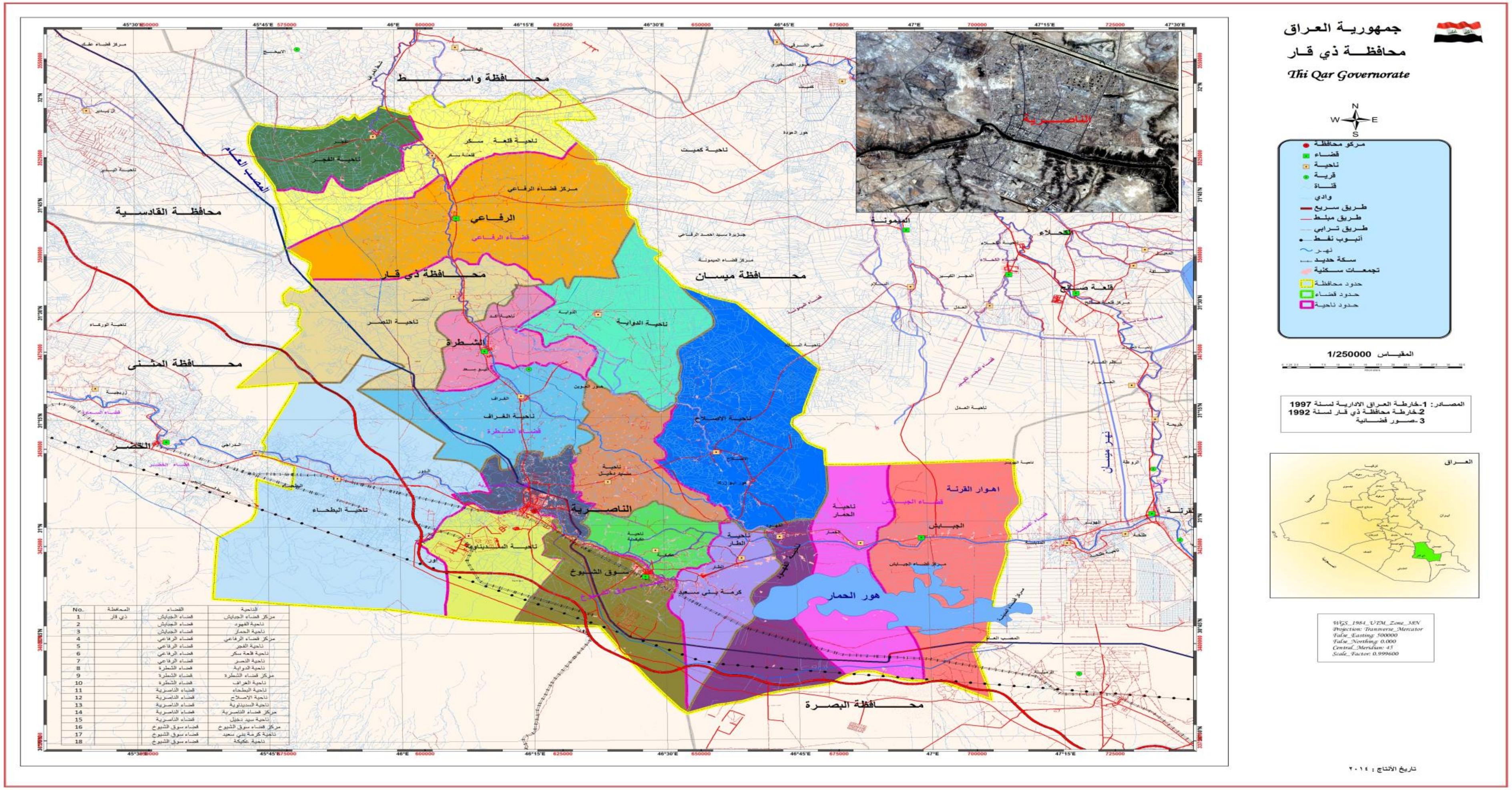


Fig.(3-1): The map of Thi-Qar Governorate

3.2.2 Geographic Characteristics

Generally, the topography of Thi-Qar is flat. The Euphrates River, Shatt Al-Gharraf and four other irrigation canals pass through the governorate.

3.2.3 Climate

The climate of Dhi-Qar is generally warm and dry in summer , moderately cold and rainy in winter. The temperature begins to increase at the beginning of May reaching 42.8 C° in July then decreases gradually from September. The prevailing wind is from the north-west and carries dust from the western desert and with the dusty weather lasting many days. The average rainfall ranges between 150-180 mm annually.

3.2.4 Administrative Divisions

Thi-Qar governorate is divided into five Qada. In turn, each Qada is divided into smaller units called Nahiya as shown in Table (3-1)and Figure(3-2).

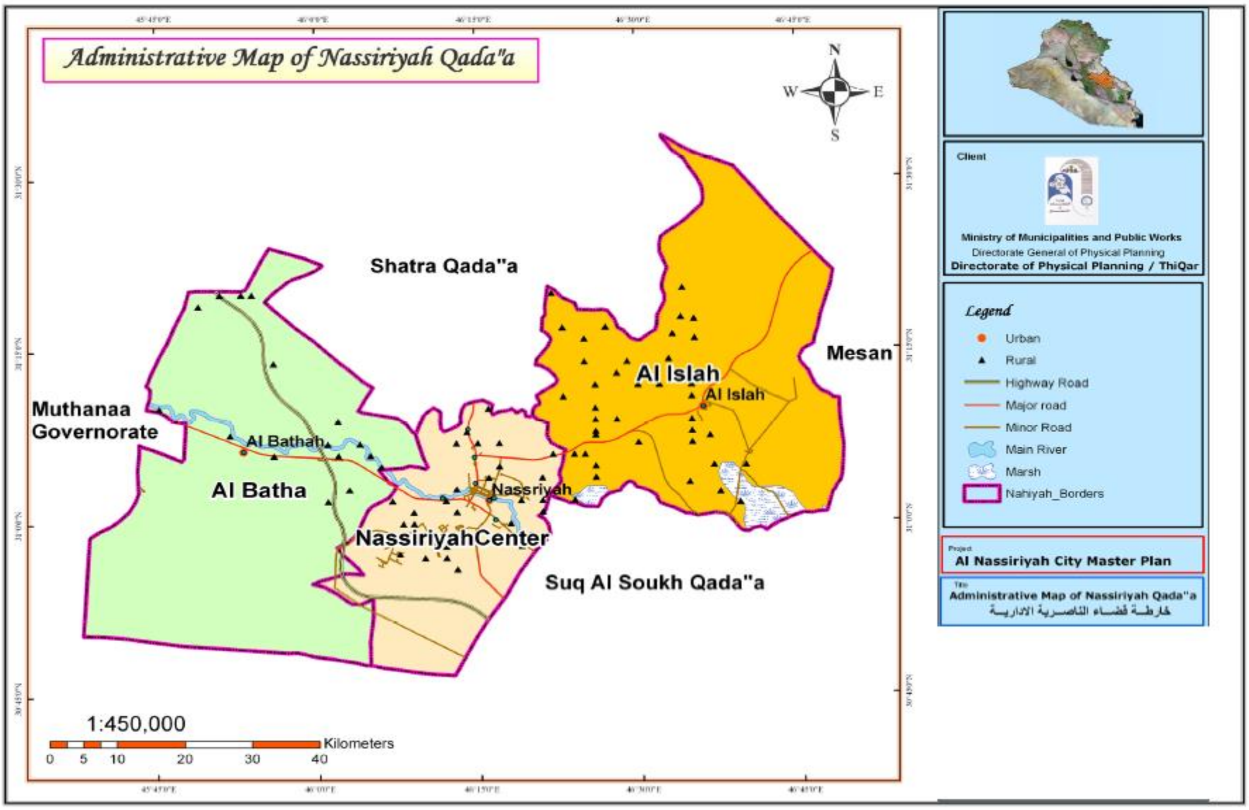


Fig.(3-2): Administrative Unit of Nasiriyah city

Table (3-1): Areas of Administrative Units in 2003

Administrative Unit	Area (Sq.Km)
Al Nasiriyah Qada Centre	1277
Al Islah Nahiya	1104
Al Bathaa Nahiya	1868
Sayid Dakhil Nahiya	295
Subtotal	4149
Al Rifaai Qada Centre	1345
Kalaat Sukkar Nahiya	514
Ennasr Nahiya	908
Alfajr Nahiya	433
Subtotal	3300
Suk Shoyukh Qada Centre	285
Al Akika Nahiya	7
Karmat Bani Said Nahiya	474
Al Fadliya Nahiya	615
Attar Nahiya	1
Subtotal	1382
Al Jabayish Qada Centre	1062
Al Hammar Nahiya	681
Al Fouhoud Nahiya	590
Subtotal	2333
Al Shatra Qada Centre	384
Adouaya Nahiya	737
Al Gharraf Nahiya	623
Subtotal	1744
Total Area of Governorate	12900

3.3 Population

3.3.1 Population Structure

The total population of Thi-Qar was estimated to be (1616226 in 2010). Table (3-2) shows the population distribution by administrative units deeply of Qada and Nasiriyah classify into males – females, and urban – rural. The male / female classifying is almost identical at 51% for males and 49% for females. The spatial distribution of population, as concluded from the Table (3-3), indicates that Nasiriyah Qada represents the first rank at approximately 36% of the total population, followed by Al Shatra in second and Al Rifaai in third with 22% and 20% respectively. Suk Shoyukh ranks fourth with 15%, and fifth and lowest is Al Jabayish with approximately 4% of the total population.

3.3.2 Urban Population

Population estimates for the year 2010, as shown in Table (3-2), indicate that Nasiriyah Qada attracts about half of the total urban population of the governorate (436000), with Al Shatra, Al Rifaai, Suk Shoyukh and Al Jabayish coming second, third, fourth and fifth respectively. It is obvious that Nasiriyah as the major Qada is including Nasiriyah city, which absorbs most of the investment. That is why population and labour forces concentrate here. This phenomenon is an established fact in the development process in general and regional processes in particular, since population concentration in an area is a function of the spatial allocation of investment.

Table (3-2): Population estimates **(**COSIT 2010).

Qada	Nahiya	Urban			Rural			Total		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Al Nasiriyah	Qada Centre	200559	197044	397603	22714	22512	45226	223273	219556	442829
	Al Islah	4652	4599	9251	14629	14477	29106	19281	19076	38357
	Al Bathaa	9117	9207	18324	11350	11812	23162	20467	21019	41486
	Sayid Dakhil	5388	5428	10816	21080	21548	42628	26468	26976	53444
Qada Total		219716	216278	435994	69773	70349	140122	289489	286627	576116

3.3.3 Population Density

One of more measurements of spatial population distribution is the overall and urban density. For purposes of analysis, it is assumed here that the Qada center is entirely urban. This assumption is realistic because Qada centers are, by municipal legislation, considered to be urban see Table **(3-1)**.

Table (3-3): Population density by Qada **(**COSIT 2010).

Qada	Population		Area Sq. Km		Population Density (person/ Sq. Km)	
	Qada Centre	Total	Qada Centre	Total	Qada Centre	Total
Nasiriyah	442829	576116	1277	4494	347	128
Al Rifaai	12453	325638	1745	3300	8	99
Suk Shoyukh	94752	247874	285	1374	333	180
Al Jabayish	25916	62357	1062	2333	24	27
Al Shatra	187172	354922	384	1744	487	204

Table (3-3) shows the relationship between the population of each "Urban Center" and the area of that center, in other words, it reflects the density. The ratio as calculated for the urban population of the Qada center to its urban area and the total population of the Qada to its total area (over all density).

• Dividing population of Qada center by area of each center gives urban density.

• Dividing total population of the Qada by its area, gives overall density.

According to this indicator, Al Shatra Qada represents the first rank in both urban density and overall density with (487) persons per sq. km and (204) persons per sq. km, while Suk Shoyukh comes second, Nasiriyah third and Al Jabayish last with the lowest density. The reason behind this is the variation in the area. A larger area which will be a lower density. This is true with regarding to the Nasiriyah area which is equal to three times to the area of Al Shatra Qada, while has a lower density in comparison with other Qada.

In physical planning, density and the net or overall residential density, all of them represent crucial factors in determine the carrying capacity of the area of the city. Density also helps to determine the extent of the city expansion

3.3.4 Population Projection

Obtaining a long term forecast, up to the years 2020 and 2030, the annual population growth rate for Thi-Qar should be first estimated. To obtain a forecast for this period, as shown in Figures (3-5) and Table (3-3) which take population of the base year 1997 as 1,184,796 and for 2008 as 1,666,932. The following equation is applied:

$$Pt = P_o e^{r\,t} \text{ .... (3.1)}$$

where:-

t = time period (e.g.: 1, 2, 3,…)

r = annual growth rate

Pt = population in a time (t)

P_o = population at t = 0 (original population).

$$r = [\, ln\, (Pt / P_o)] / t] \text{ .... (3.2)}$$

When using example:

The annual growth rate for the period (1997-2008) = 3.1%

Given the estimated population in 2008 and assuming the annual growth rate is fixed at 3.1%,

a. The estimated population in 2020 is 2,419,199

b. The estimated population in 2030 is 3,299,639

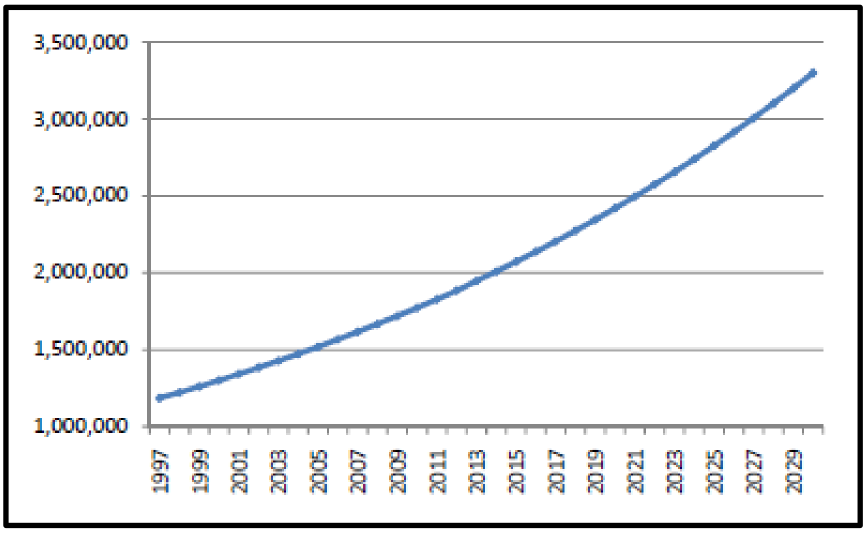


Fig.(3-3): Population projected increase in Dhi-Qar 1997-2030

3.4 Transportation System

The demand for transport has increased considerably as Thi-Qar has developed over the past few decades. The transportation system is a road based system, but also has railway lines. Travel patterns within the central part of Thi-Qar are focused on Nasiriyah which provides strong links and good services between Nasiriyah and the other Qada centers, Al Shatra, Al Rifaai, Suk Shoyukh and Al Jabayish, which are not available locally. There are also many commuters. (UNHCR, 2006).

Generally in Iraq and Dhi-Qar in particular, road networks comprise three classes of roads:

- Primary roads: these connect main towns and governorates, they carry mostly long- distance traffic that is either generated in the towns or collected from the rural areas by the secondary and local roads.
- Secondary roads: these connect small towns and groups of villages and link these areas into the primary road network.
- Local roads: these connect the more lightly-populated rural areas into the secondary and primary road network. They also provide access to individual plots such as farms and homes, usually these roads are unpaved or poorly paved.

3.4.1 Current Transportation Services in Dhi Qar

Roads means are the most common form of transportation in Thi-Qar governorate, for example taxis, buses and trucks, though boats are also used between Al Jabayish and Nasiriyah.

The main roads in Thi-Qar governorate are in a state of disrepair and roads in the rural areas are predominantly unpaved. The maintenance of

rural roads usually falls to local communities and Qada councils, who have limited funds for repair.

The Basrah-Baghdad railway runs through Thi-Qar stopping at Suk - Shouyukh and Nasiriyah , but only runs as far as Hilla, in Babel governorate, due to the current security situation. The railway is subject to ongoing repair work, but still provides freight and passenger services as shown in Figure (3-4), (UNHCR, 2006).

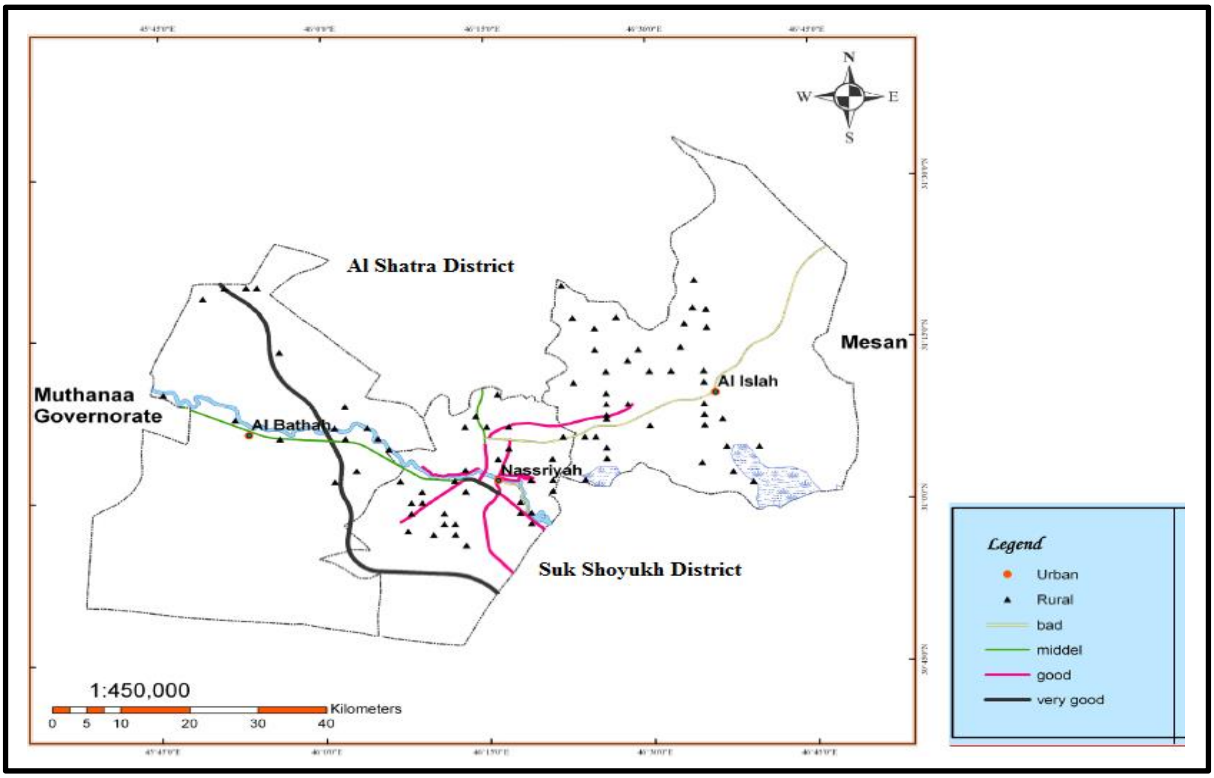


Fig.(3-4): Condition of roads in Qada Nasiriyah

3.4.2 Road Network

- The international Iraqi expressway is a highway which links all southern governorates with Baghdad and links Iraq with Jordan and Syria via Anbar governorate. It also links Dhi-Qar with Basrah and the middle Euphrates governorates.

-Primary road network:-

There are four main roads which link Nasiriyah with the other four Qada centers.

- ❖ The distance between Nasiriyah and Suk- Shoyukh is the shortest at 27 km.
- ❖ Al Shatra is second at 40 km .
- ❖ Al Jabayish and Al Rifaai are furthest at 73 km and 77.2 km respectively.
- ❖ Other local roads include ,(IPG/GDL 2008):

1-Nasiriyah – Ur (recently paved, single carriageway, with no proper shoulders).

2- Nasiriyah - Bathaa (moderate condition).

Parts of these two roads run parallel to the Nasiriyah-Bathaa railway.

3- Nasiriyah - Suk Shoyukh (moderate single carriageway with no proper shoulders).

4-Nasiriyah - Sayid- Dakhil (dual carriageway, well paved with no traffic signs, part of the road currently damaged due to wars and conflicts)

3.4.3 Type of Roads to Dwellings

The Iraq living condition survey of 2004 , carried out by the UNDP to assess the development process in Iraq, has used criterion which measures the extent of the provision of transport to dwellings in all parts of Dhi Qar. The report provided the percent of all households as follows, see Table (3-4),(Report of UNDP ,2004).

Table (3-4): Types of roads in Nasiriyah city

Type of road	% of the urban road network	% of the total road network
Paved	43	17
Partially paved	14	13
Gravel road	04	04
Dirt road	38	66
Other types	01	00

- In conclusion it might be safe to say that Thi-Qar is moderately provided with efficient roads, but the population is poorly provided with transportation facilities

3.5 City Size and Spatial Interaction

The current unbalanced urban hierarchy in Dhi- Qar has extended the sphere of influence of Nasiriyah, to the detriment of almost all other Qada and Nasiriyah. In other words, Nasiriyah's market dominates all other small urban markets, in that the spatial interaction between Nasiriyah and all other urban centers and rural villages occurs continuously in the interest of the regional capital, due to its superiority over almost all other urban and rural centers. Nasiriyah actually exerts polarization effects as a single pole in the governorate,(Zipf, G, 1984).

Lack of numerical data about commercial transportation or number of trips made between urban centers and Nasiriyah make it difficult to quantify spatial interaction. This is an issue with the model itself as many commentators have pointed out.

Existing interaction could be envisaged by measuring the number of trips made with regard to population size. For example, if Nasiriyah is destination 'j', trips originated from center is 'i' and accepting the cost and

time of travel is nil, therefore the number of trips made by everybody from a particular location i.e.: Al Shatra, would be:-

$$Pj / P \quad \ldots\ldots(3.3)$$

Where:-

Pj= population of destination

P= total population of the governorate

Numerically:

$$400{,}000/1{,}700{,}000 = 0.24$$

(It can be calculated in relation to Nasiriyah city)

This means that 24% of trips made by everyone in all cities of Thi-Qar will be made to Nasiriyah. This percentage represents not only the percentage of total number of trips made annually to Nasiriyah by one single person in one specific area, but also represents the ‘trend of travel’ of all populations of other centers, since they are all identical and there is ‘nil’ time or cost of travel. Based on such assumptions the trips made by the population of each Qada can be estimated simply by multiplying its population size by a "constant variable" 0.24, as shown in Table (3-5).

Table (3-5): Estimated urban trips for Thi-Qar Qada

Urban center	Population size (person)	Annual trips (person /year)
Al Shatra	172,000	41,000
Al Rifaai	137,000	33,000
Al Jabayish	43,000	10,000
Suk Shoyukh	22,000	5,000

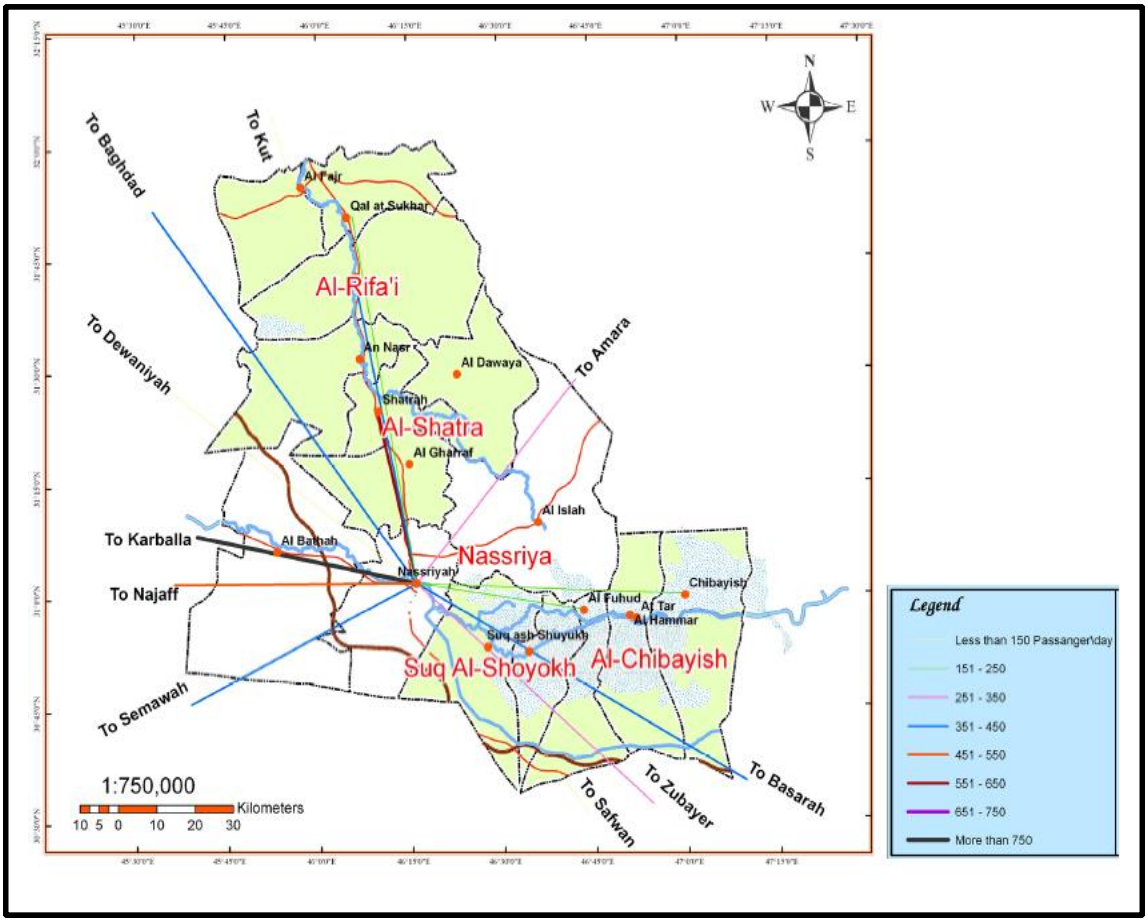


Fig.(3-5): Spatial interaction of Al- Nasiriyah city extracted from satellite image (Quick bird resolution 50 cm) using Arc GIS 10.3

3.5.1 Theoretical Distance Factor

Distance is an aspect of interaction based on special interaction and the interaction between cities is determined using the distance factor which can be established by

$$I = P_1 P_2 / D \quad \ldots\ldots(3.4)$$

I = 400 x 137 / 77

P1 = population of Nasiriyah

P2 = population of Al Rifaai

D = distance, in kilometers, between two cities

Therefore: I = 893

As another example, the interaction between Al Shatra and Al Rifaai would be:

I = 172 x 137 / 37 = 631

These examples show that the interaction between Nasiriyah and Al Rifaai is 1.4 times the interaction between Al Shatra and Al Rifaai despite the distance between the former being 2.5 times the distance between the latter. If the same approach is applied to identifying the interaction between Nasiriyah, Suk Shoyhuk and Al Jabayish, the result would show that Nasiriyah influences Suk Shoyhuk 2.5 times more than Al Jabayish.

3.5.2 Sphere of Influence

The population size of a city and the distance separating it from other centers are two factors that affect a city’s sphere of influence, the latter decreasing with distance. Therefore in an urban system with a number of cities, the greater the city size, the greater the spatial sphere of influence it will have, but there will also be areas where these spheres of influence

overlap and interact with each other (E1,E2) as shown in Figure (3-6), (Zipf. G. 1984).

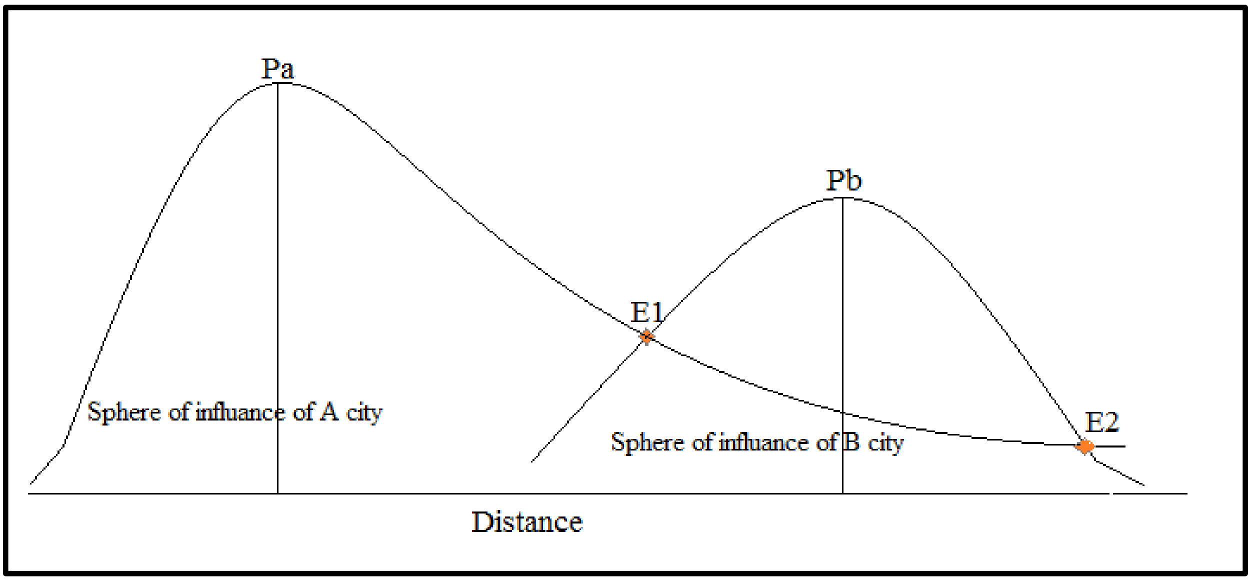


Fig.(3-6): Sphere of Influence showing the effect of the distance between cities

By identifying the spheres of influence of major centers in Dhi Qar, Nasiriyah's sphere of influence is obviously the greatest, as demonstrated by Figure (3-6) Sphere of Influence.

3.5.3 Sphere of Influence of Thi-Qar Urban Centers

It should be admitted at the outset, that the lack of numerical data about 'flows' - whether commercial transactions, trips, telephone calls, etc., makes it extremely difficult to identify spheres of influence of urban centers in the governorate, namely the Qada centers. The extent of services provided by centers reflects the relative position of a place with respect to other places.

Every type of center serves a particular function within a specific area, such as administration, health care, shopping and recreation. The sum total of spheres of influence of all the main services in a settlement represents the sphere of influence of the settlement itself. The sphere of influence of a

settlement usually increases with an increase in the size of that settlement. Yet its influence, as a form of spatial interaction, decreases with distance. Mathematically this could be re-phrased as follows: flows are a function of the attributes of the location's origin, for example for any Qada or center, the attributes of the location of destination and the distance between the starting location and the final destination.

The general formulation of the spatial interaction model is as follows:

$$T_{ij} = F\,(V_i, W_j, S_{ij}) \quad \ldots\ldots(3.5)$$

where:-

• T_{ij} = interaction between location 'i' (origin) and location 'j' (destination), its units of measurement are varied and can involve people, tons of freight, traffic volume, etc. It also relates to a time period such as interactions by the hour, day, month or year.

• V_i = attributes of the location of origin 'i'. Variables often used to express these attributes are socioeconomic in nature, such as population, number of jobs available, industrial output or gross domestic product.

• W_j = attributes of the location of destination 'j'. It uses similar socio-economic variables as the previous attributes.

• S_{ij} = attributes for separation between the location of origin 'i' and the location of destination 'j', also known as transport friction. Variables often used to express these attributes are distance, transport cost or travel time.

3.6 Mobile Speed Safety System (MSSS)

The SENSYS MSSS II (Mobile Speed Safety System) basic work depends on the vehicle by sensing the radar beam launched by the device as shown in Figure (3-7).The device has a wide radar unit that able to capture more of the vehicle at one time. The depth of these rays launched by MSSS is about 150 meters. Device supports in its work to determine the speed and distance on the Doppler cone and track vehicles moving inside this cone as illustrated in Figure (3-8). Preparation device is a complex system. It does not need to complicated settings because it set up by computer. There are several types of these devices: mobile type and fixed type regarding to the performance of the device in monitoring place. The device has a high accuracy and speed in monitoring to get ideal solution to rid of the traditional methods in determining the characteristics of the different vehicles that require completing the process that evaluates private transportation networks, (SENSYS® Traffic, 2015)

Fig.(3-7): Mobile Speed Safety System (MSSS)

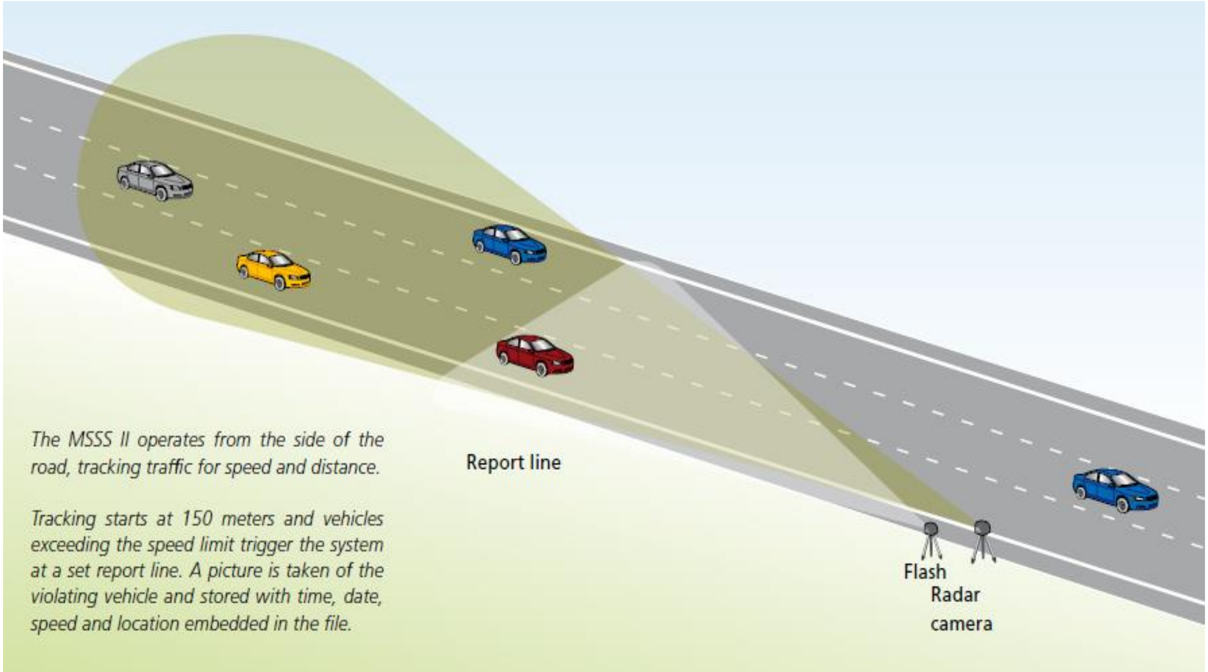


Fig.(3-8): Cone Doppler to determine the speed of the device

3.6.1 Features and Benefits of MSSS

- Providing digital images with very high resolution
- Continuity and very high speed during the monitoring process
- Providing information about travel time, date, location, vehicle speed, speed limit
- Using Senses' unique multi-tracking radar
- Having the ability to monitor 20 frames per second to more than one vehicle
- During the monitoring it shows the line speed limit and provides us with complete report after monitoring.

3.7 Traffic Surveys

The second stage includes the process of conducting surveys of traffic for all the city of Nasiriyah has this combination using modern devices differently from the past because the devices uses the principles of remote sensing system using radar in these devices.

The surveys will be as follows:-

1-External traffic outlet for Al-Nasiriyah city

2- Type of external traffic flow

3- The purpose of external traffic trip

4- Traffic load for the external traffic flow of city

5- The internal road net for city

6- City center traffic volume

6- Origen and destination for trips through city center

7- Type of traffic flow of the city center for Nasiriyah

8- The purpose of city center traffic trip

9- Traffic intersection

10-Pedestrian movement

11- Car parking (Areas and Location)

3.7.1 External Traffic Outlet for Al-Nasiriyah City

Al-Nasiriyah city has a six main entrance link it with the traffic came out of the city , represented by the traffic from the hinterland and the traffic from the Dhi-Qar Qada and areas as it is the administrative center of the province , besides the traffic came from the province around because it's the node of main way through the south region of Iraq. The first entrance is from north-east or is known as Baghdad entrance EX1 which is the connection axis of the city traffic with the traffic came from the north and the middle of Iraq as provinces of Baghdad Diyala and Wasit. And the second entrance is the north-west EX2 which is the connection axis of the city traffic with the traffic of its region hinterland as Sayid-Dakhil area , while the third and fourth entrances EX3 ,EX4 successively make the same traffic function for the second entrance by connecting the city with the traffic coming from Ur Nahiya and Suk Shoyukh .(Figure 3-9)

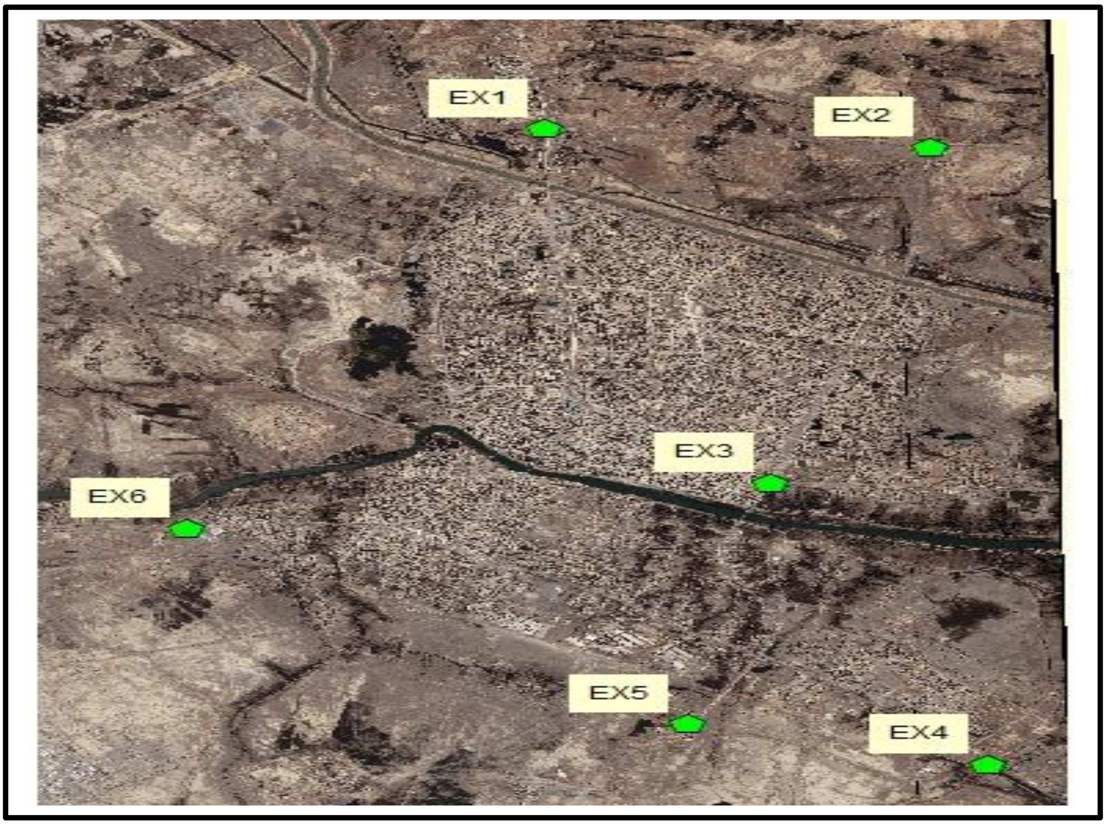


Fig.(3-9): Satellite image (Quick bird resolution 50 cm) showing the External entrances Stations in Nasiriyah city

The fifth entrance (EX5) represents the traffic connection axis of Al Nasiriyah city with Al Basra province, but the last and sixth entrance EX6 link Al Nasiriyah city with AL-Muthannah province.

From that, the city having three very important gates, this importance coming on the national level through considering Nasiriyah city its transportation node between north and middle of Iraq within southern parts, where the entrance (Ex2, Ex3,Ex4) is regional movements nodes.

3.7.2 External Traffic

Through direct monitoring of the movement of vehicles on the main entrances using the device (MSSS) has been gathering data as shown in Table (3-6) and Figure (3-10) and (3-11,12) , it is found that the more substantial volume of traffic enters the city through Baghdad entrance that represents the main axis movement for the traffic which comes from Baghdad city towards Al Basra province through Al Basra entrance EX5 that has the more substantial volume of traffic leaving Al Nasiriyah city . From the above mentioned , we can account the outlet traffic volume in the city about 50% from the whole external traffic coming from north to the south of the city .

Table (3-6): Distribution traffic volume by city entrance

Highway Entrance of Al Nasiriyah city	Traffic Volume (veh./ day)		
	Out to	In to	Total
EX1	7475	18585	26060
EX2	4477	4344	8827
EX3	3427	3875	7302
EX4	9360	9090	18450
EX5	9843	6304	16147
EX6	5673	10146	15819

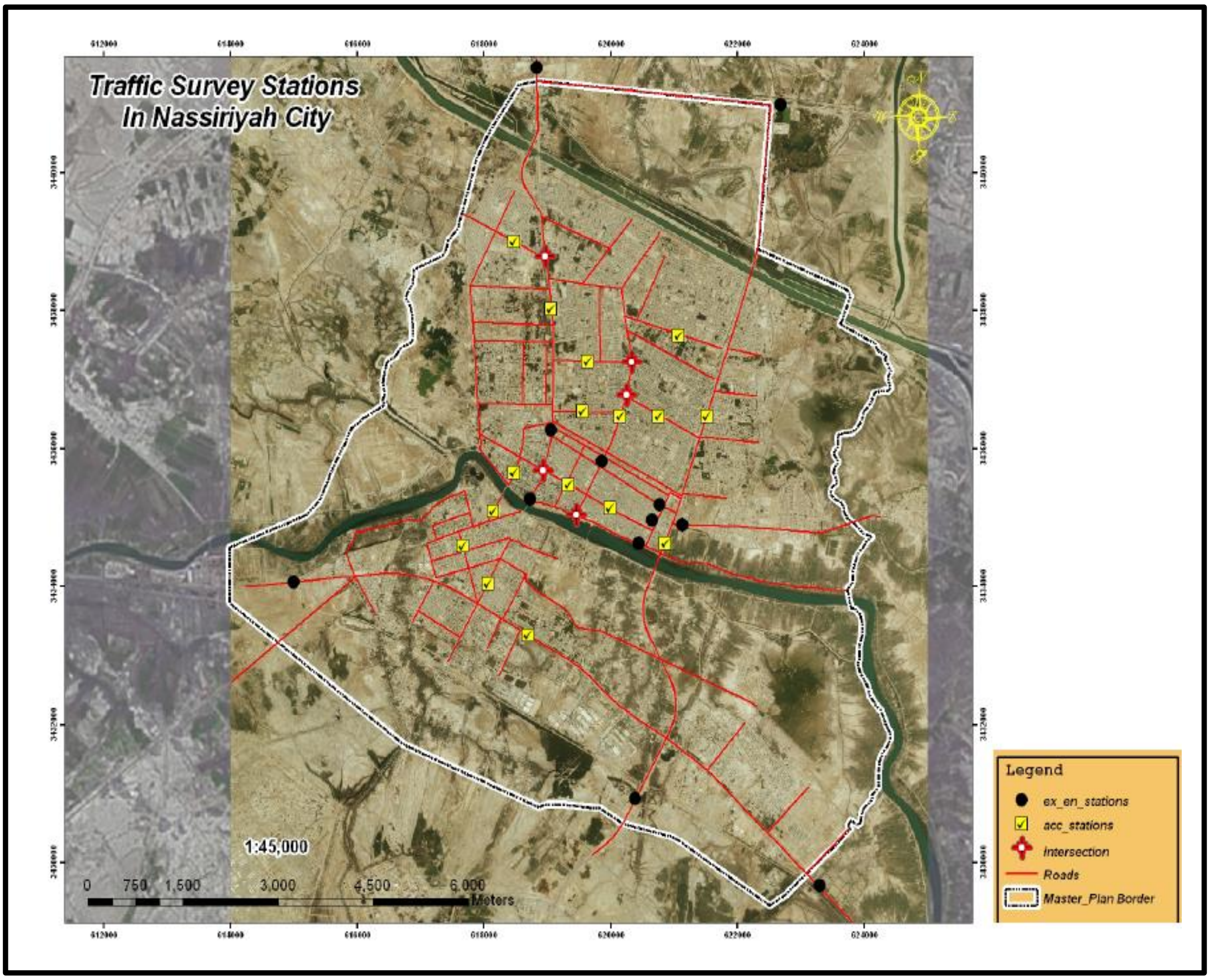


Fig.(3-10): Traffic Survey Stations in Nasiriyah city

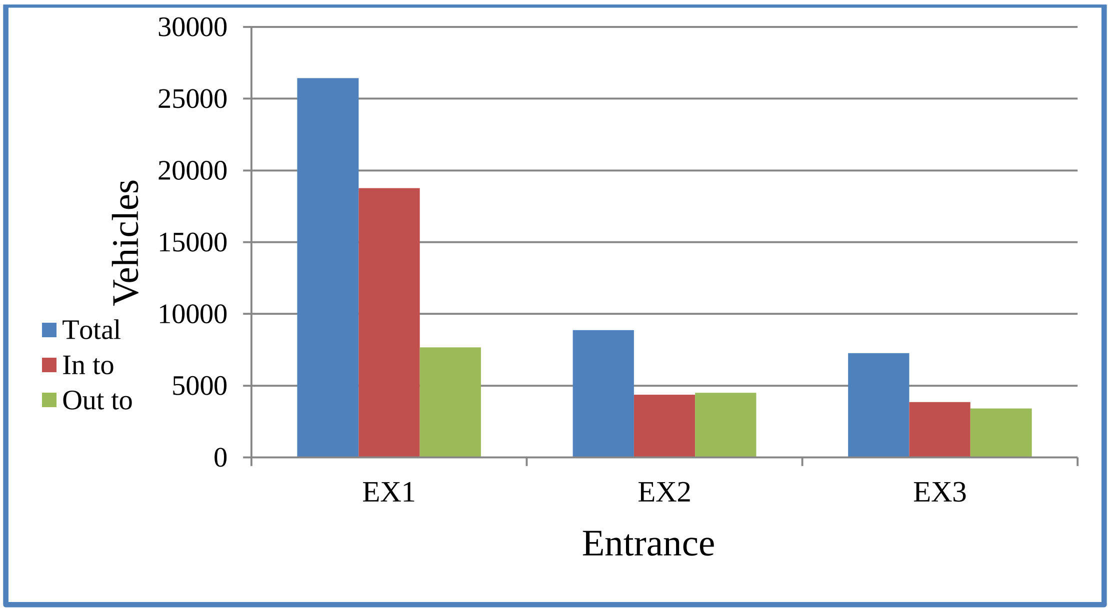


Fig.(3-11): Distribution of traffic volume by city entrance (EX1,EX2,EX3)

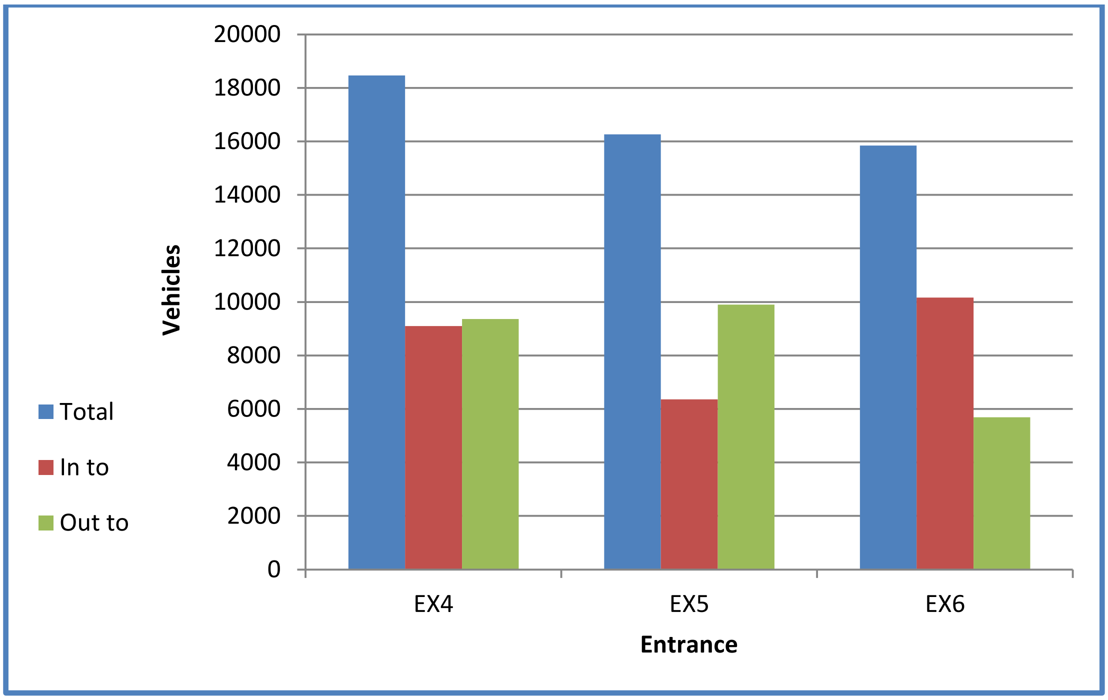


Fig.(3-12): Distribution of traffic volume by city entrance (EX4,EX5,EX6)

3.7.3 Type of Traffic Composition External Traffic Flow

Determination of the types of vehicles entering and leaving the city to the monitoring of vehicles, the process was conducted using a device (MSSS) and the collected data are shown in Table (3-7) and Figures (3-13 , 3-14) that the most kind of vehicle forming the external traffic flow which get is into the city is the private small cars ,followed by the taxis then the mini buses ratios successively (25% ,13%, 17%) from the whole volume of traffic flow getting into the city .

On the other hand, it's found the private small cars became in first state for the vehicles leaving the city, after them the mini buses, then the light vehicles in ratios 26%, 17%, 14% from the whole traffic flow leaving the city. As a result, the private small cars represent the basic component of the external traffic of the city , after them the mini buses , then the light

vehicles, (26%, 17%,12%) from the whole external traffic flow of Al-Nasiriyah city.

Table (3-7): Distribution of external traffic by vehicle type

Entrances		passenger car(veh.)	Bus vehicle(veh.)	Van car(veh.)
EX1	In	8509	5469	4739
	Out	2897	2057	2706
	Total	11406	7526	7499
EX2	In	1484	861	2028
	Out	1787	1006	1713
	Total	3271	1867	3741
EX3	In	2310	475	1075
	Out	1803	530	1080
	Total	4113	1005	2155
EX4	In	4053	2444	2601
	Out	3146	2748	3466
	Total	7199	5192	6067
EX5	In	1583	1478	3298
	Out	2565	3035	4298
	Total	4148	4513	7596
EX6	In	6747	2234	1179
	Out	3290	1117	1279
	Total	10037	3351	2458

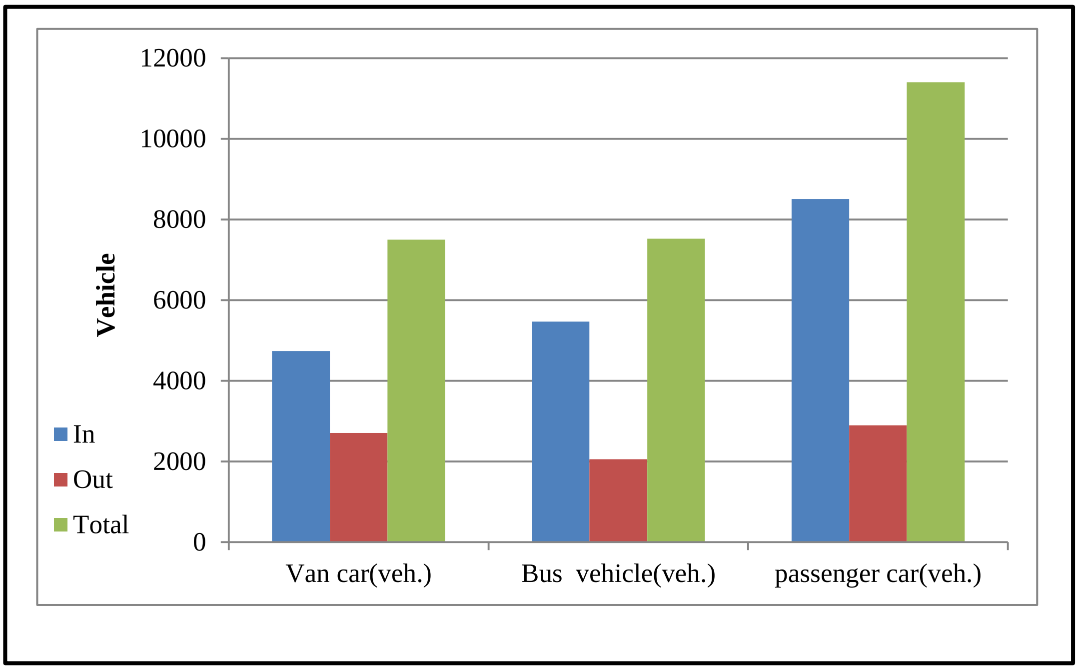


Fig.(3-13): Distributed external traffic by vehicle type from(EX1)

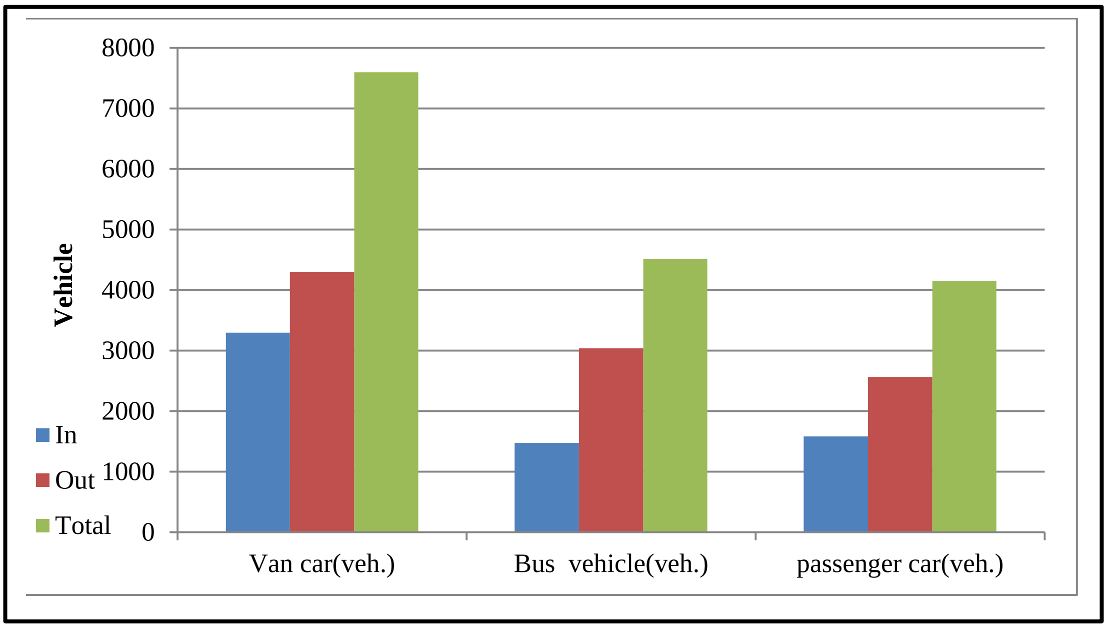


Fig.(3-14): Distributed external traffic by vehicle type from(EX2)

- Other forms of the other entrances are presented in Appendix B

3.7.4 The Purpose of External Traffic Tripe

Samples of the questionnaire were Collected from the entrance to the city in order to know the purpose of the trip to determine the most trend areas it, The trip purpose for the private job was dominant on the trips distribution type in Al Nasiriyah city concerning the external traffic flow from and to the city through its main entrances, and it was somewhat balanced, followed by the purpose for governmental work, then for shopping, See Table (3-8) and Figures (3-17)- (3-20). Also was noticed repeating of the trip for (other) the high ratio for the external traffic towards the city through Baghdad entrance, Sayid-Dakhil entrance, and Sdenawia entrance, due to the existing military base belong to the Ministry of Defense , and the general security situation prevents the travelers from saying the honest information about their trip destination and purpose

Table (3-8):) Distribution of traffic in city through city entrances according to purpose of trips for Entrances

Entrances / purpose	EX1			EX2			EX3			EX4			EX5			EX6		
	In%	Out %	Total %	In%	Out %	Total %	In%	Out %	Total %	In %	Out %	Total %	In %	Out %	Total %	In %	Out %	Total %
Home	2.3	4.4	6.7	3.4	2.1	5.5	6.7	3.7	10.4	5.1	17.1	22.2	0.9	14.3	15.2	10.5	0.7	11.2
Governmental	5.4	2.0	7.4	4.5	15.4	19.9	8.3	10.7	19	3.4	9.9	13.3	17.0	12.1	29.1	29.1	14.3	43.4
Shopping	2.9	23.4	26.3	13.6	15.4	29.0	4.2	10.5	14.7	1.7	0.0	1.7	22.6	18.2	40.8	10.1	9.5	19.6
Recreation	4.8	0.0	4.8	3.6	7.7	11.3	3.4	0.0	3.4	6.2	0.0	6.2	11.3	3.0	14.3	2.8	1.6	4.4
Private job	34.7	42.4	77.1	12.7	57.7	70.4	40.1	39.2	79.3	31.0	61.7	79.2	41.5	25.8	67.3	40.8	68.3	109.1
Education	16.5	4.5	21	0.9	0.0	0.9	8.7	4.5	13.2	11.3	7.3	18.6	5.7	1.5	7.2	0.6	6.3	6.9
Others	33.9	23.1	57	59.1	3.8	62.9	28.8	31.2	60	48.2	15.6	58.8	1.9	24.2	26.1	3.4	2.2	5.6

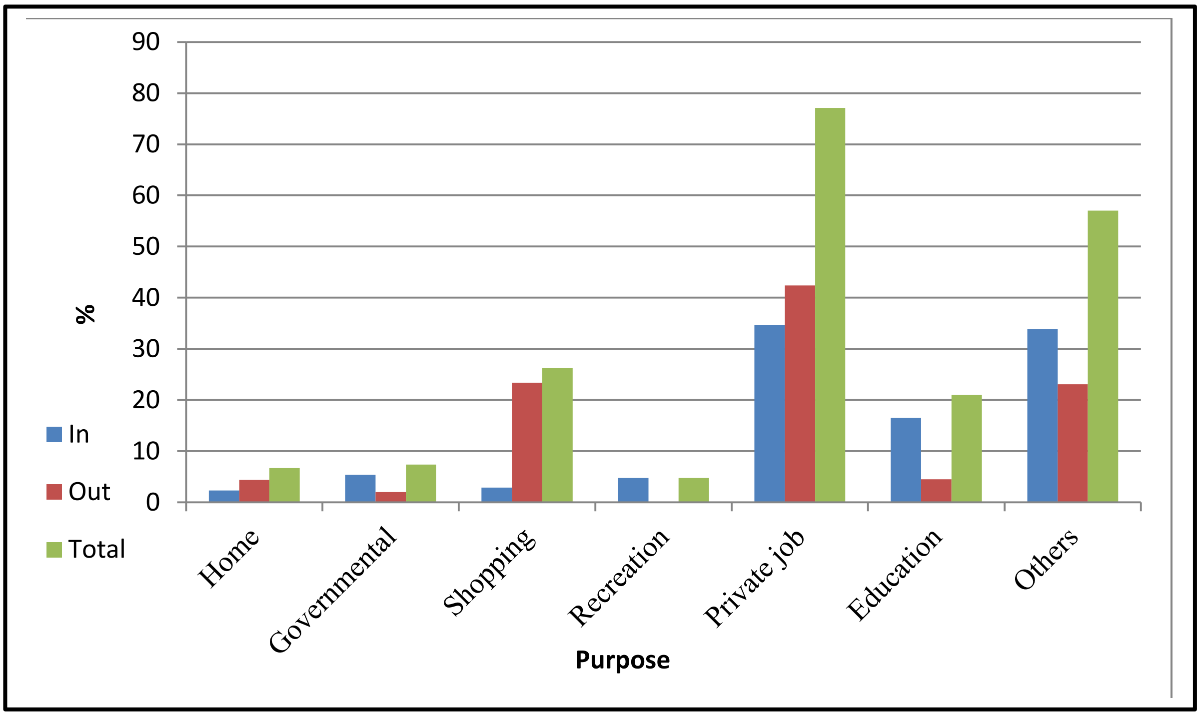


Fig.(3-15): distribution of traffic in city through city entrance due to trip purpose through EX1

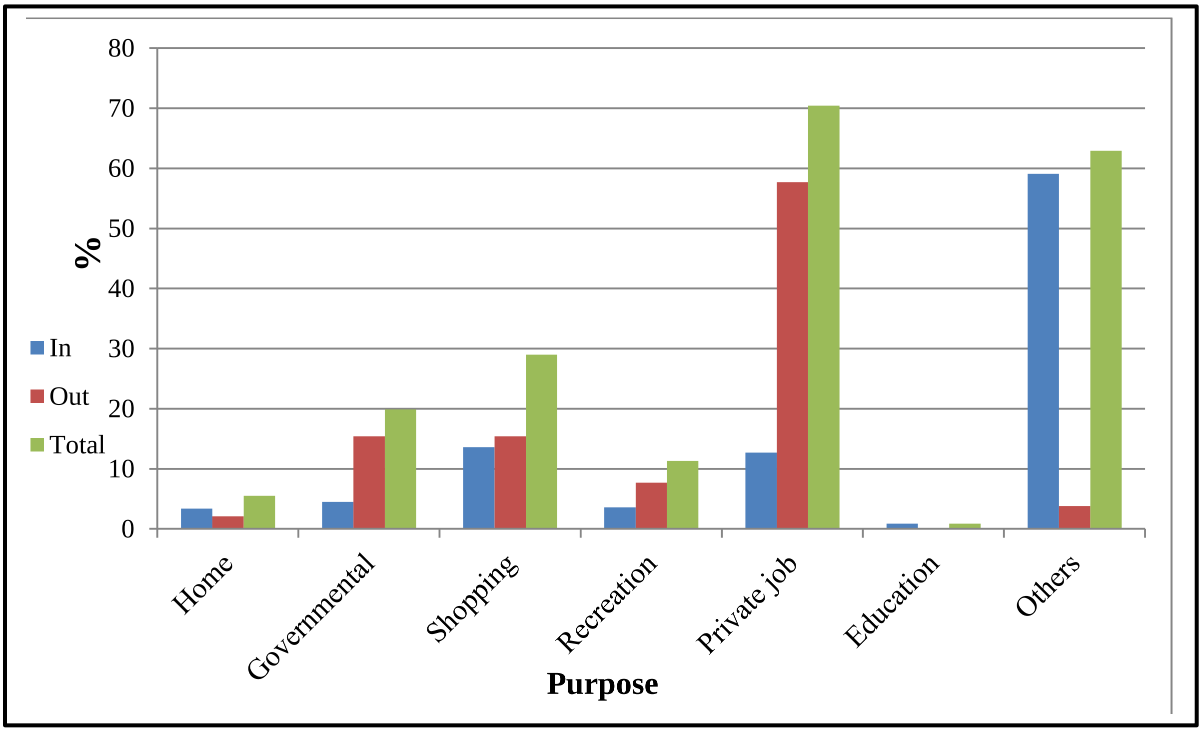


Fig.(3-16):distribution of traffic in city through city entrance due to trip purpose through EX2

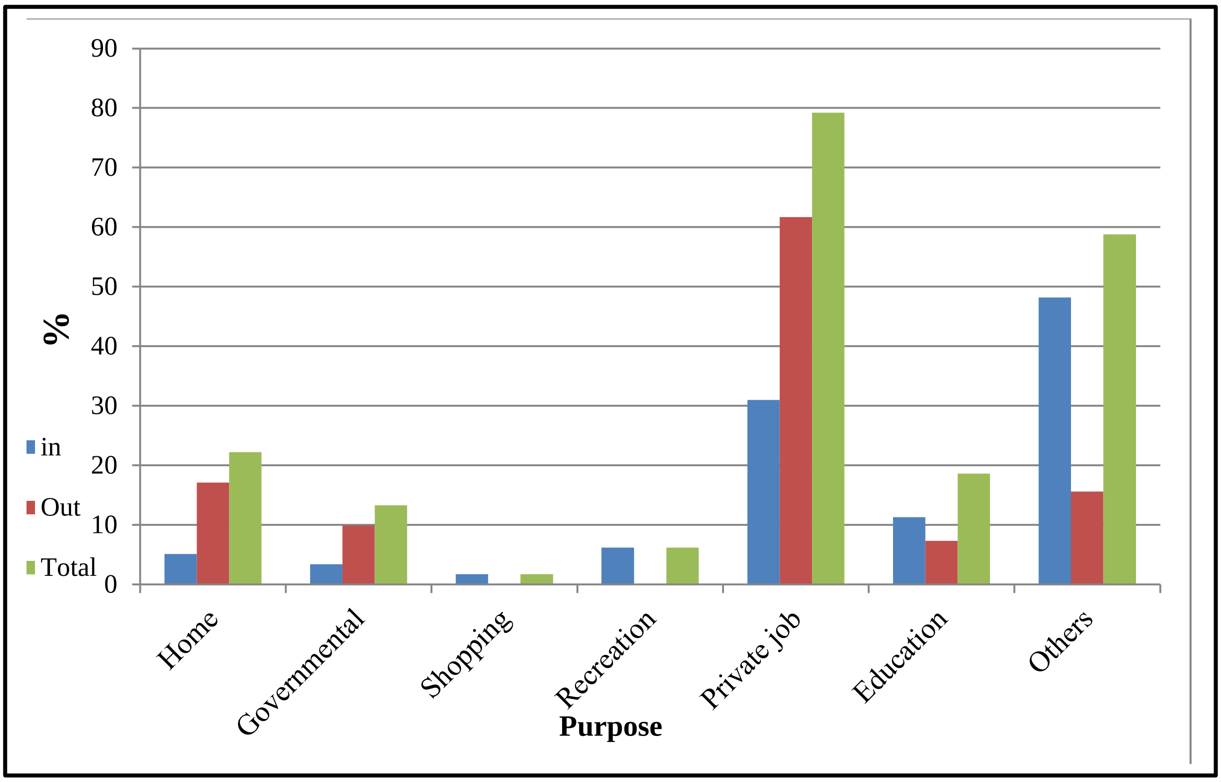


Fig.(3-17): Distribution of traffic in city through city entrance due to trip purpose through EX4

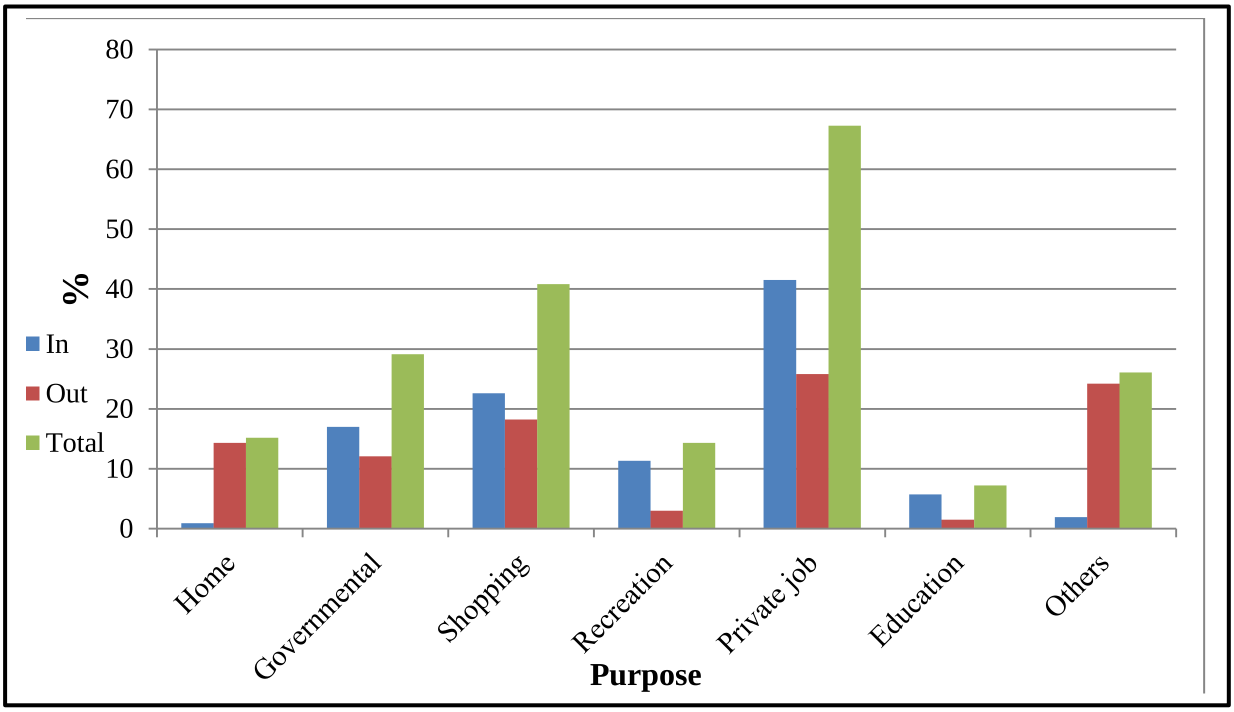


Fig.(3-18):distribution of traffic in city through city entrance due to trip purpose through EX5

3.7.5 Traffic Load for the External Traffic Flow of Al-Nasiriyah City

The number of vehicles monitored on several days each entrance were observations recorded per hour using the device MSSS , and then average of these observations is shown in Tables (3-10), (3-11) and Figures (3-19), (3-20), (3-21).

Table (3-10): Peak hour to external traffic through city entrances

	EX1			EX2			EX3			EX4		
Hours	Out (veh.)	In (veh.)	Total (veh.)	Out (veh.)	In (veh.)	Total (veh.)	Out (veh.)	In (veh.)	Total (veh.)	Out (veh.)	In (veh.)	Total (veh.)
6-7	390	850	1240	260	390	650	121	280	401	1291	641	1932
7-8	325	2785	3110	345	415	760	170	510	680	773	869	1642
8-9	393	2520	2913	322	552	874	325	610	935	1072	1228	2300
9-10	400	2090	2940	340	319	659	290	580	870	590	931	1521
10-11	440	1970	2410	368	275	643	395	356	751	880	1071	1951
11-12	616	1250	1866	371	362	733	353	222	575	915	679	1549
12-01	760	1271	2031	445	420	865	298	193	491	869	540	1409
1-2	1058	1515	2572	386	320	706	248	186	434	652	733	1385
2-3	1320	1730	3050	440	490	930	325	231	556	755	780	1535
3-4	1187	1173	2360	459	440	899	484	285	569	478	532	1010
4-5	465	1050	1515	477	260	737	320	250	570	707	513	1220
5-6	253	800	1053	280	91	371	302	168	470	401	595	996

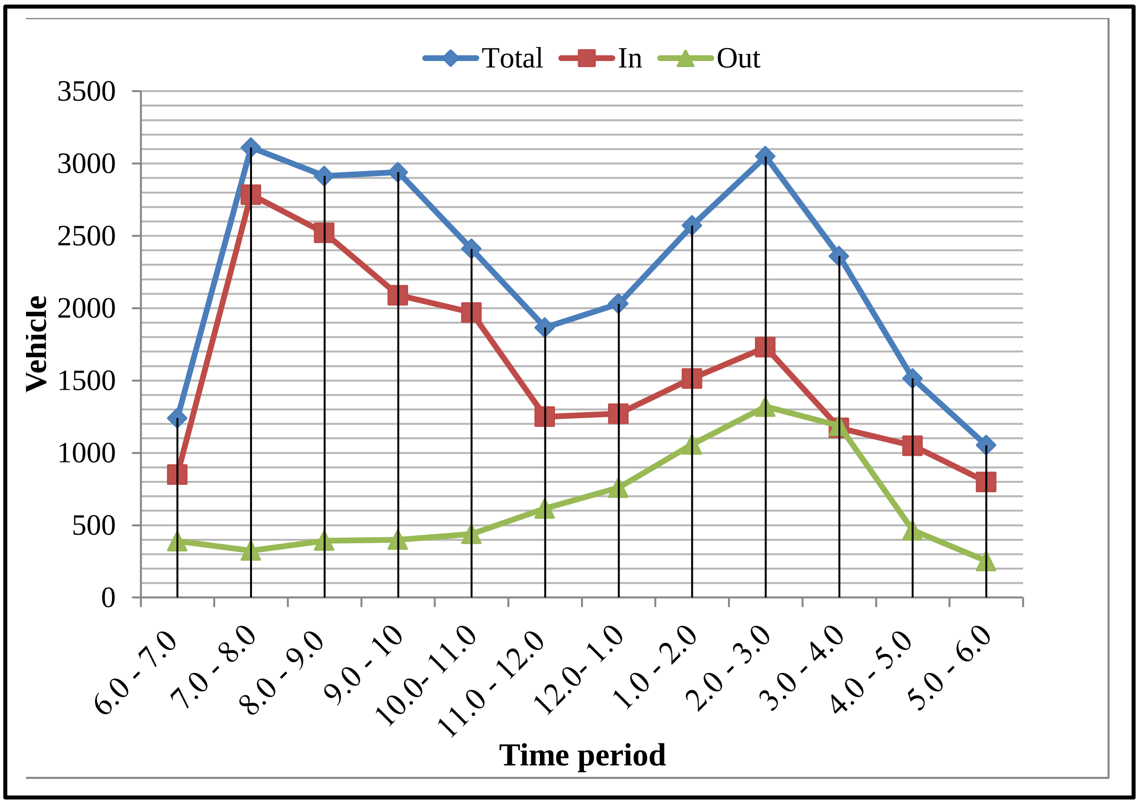


Fig.(3-19): Peak hour to traffic volume through (EX1) entrance

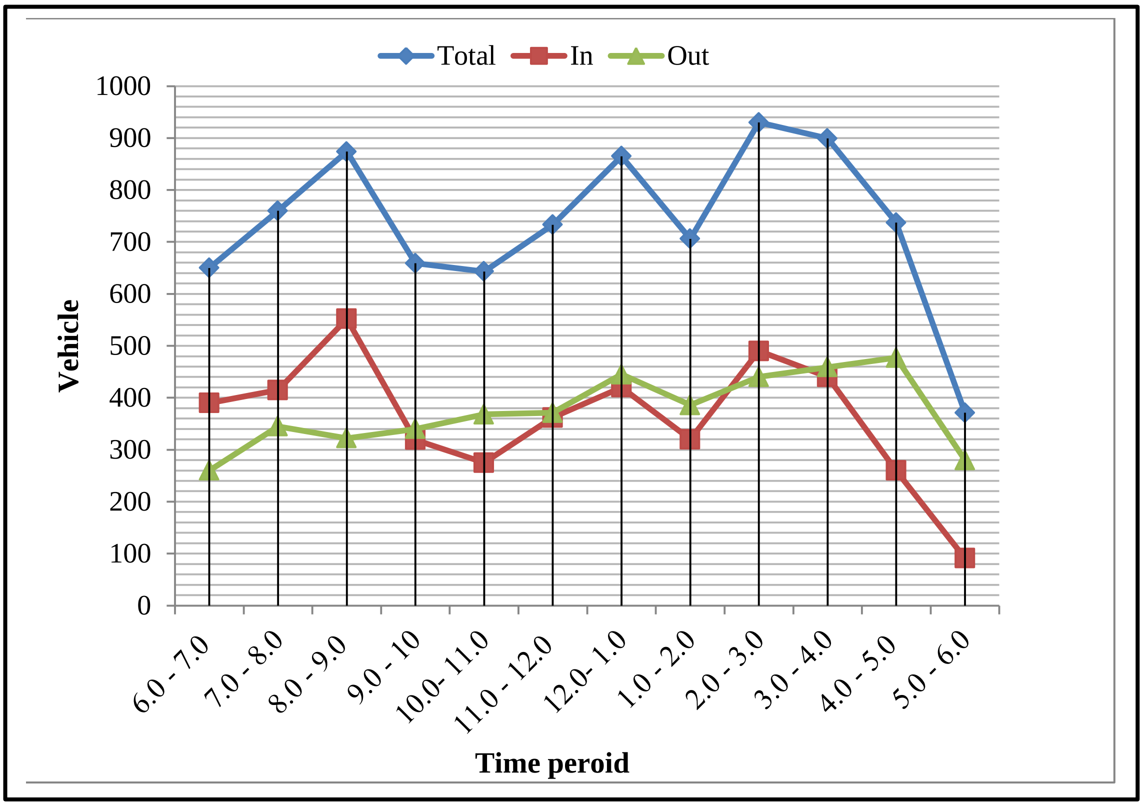


Fig.(3-20): Peak hour to traffic volume through (EX2) entrance

Table (3-11): Peak hour to external traffic through city entrances for (EX5,EX6)

	EX5			EX6		
Hours	Out (veh.)	In (veh.)	Total (veh.)	Out (veh.)	In (veh.)	Total (veh.)
6-7	539	575	1114	289	293	582
7-8	945	531	1476	653	389	1042
8-9	1200	520	1720	661	1158	1819
9-10	1185	510	1695	689	914	1603
10-11	1099	602	1701	581	1024	1605
11-12	749	539	1288	614	976	1590
12-01	1058	674	1732	491	778	1269
1-2	565	471	1036	417	815	1232
2-3	708	548	1256	307	825	1123
3-4	865	395	1260	385	893	1278
4-5	542	639	1181	325	1570	1895
5-6	303	385	688	265	516	781

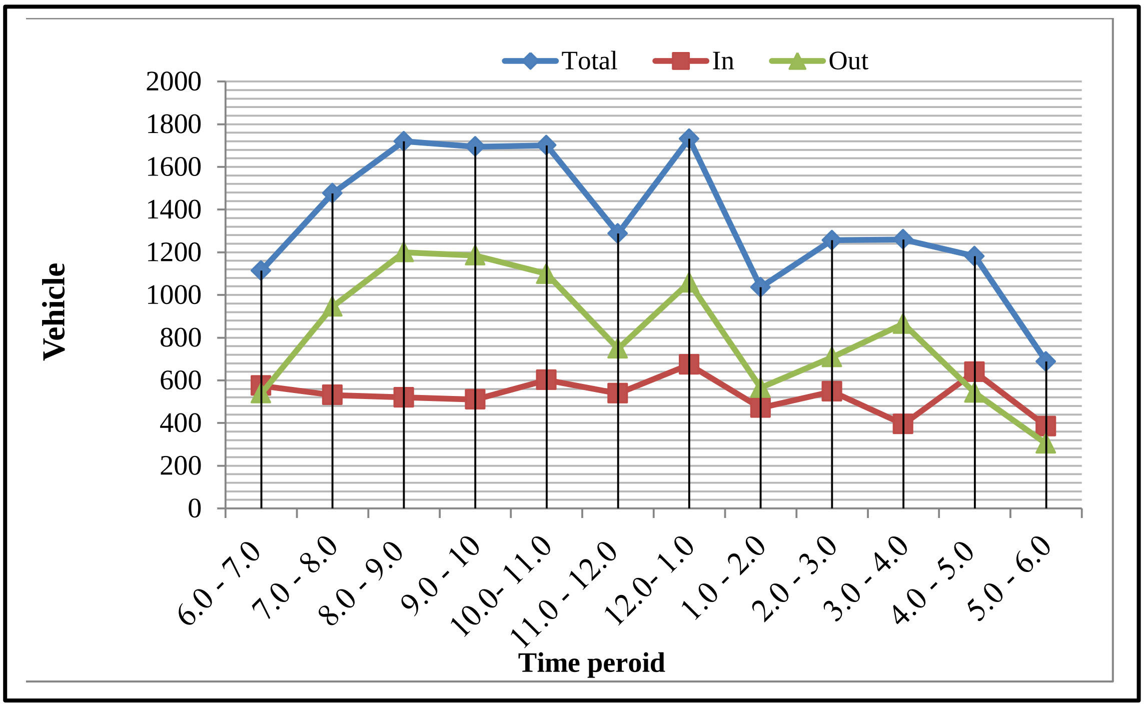


Fig.(3-21): Peak hour to traffic volume through (EX5) entrance

The peak period for the traffic flow to AL Nasiriyah city is determined through its main entrances (8 – 9) in the morning , and any other peak period has been noticed during the time survey which took twelve hours, and the same peak period is determined for all external traffic through city main entrances see Table (3-10),(3-11).

While a little differences were found between traffic peak period for traffic flow through city main entrances , for the two regional entrances EX2, EX4, did not record any variation in peak period through the time survey for the vehicle traffic, but the third regional entrance EX3 determined the time (8:00 – 9:00) in the morning as a peak period for the traffic flow for the vehicles entering the city.

For the entrances that have the traffic come from the around provinces , variations of the peak were determined periods , for Baghdad entrance (8:00-9:00) in the morning as a peak period for the traffic entering the city, and (2:00 - 3:00)afternoon as a peak period for the traffic leaving the city. Al Basra entrance record (8:00 – 9:00) in the morning as a peak period for the traffic leaving the city, and (4:00 – 5:00) in the afternoon as a peak period for the traffic entering the city for Al Samawa entrance ,see Figures (3-19) ,(3-20),(3-21).

* Other figures of the other entrances are presented in Appendix B

3.7.6 The Internal Road Network for Al-Nasiriyah City

The internal road net for AL Nasiriyah city is distinguished by its expansion and street's wideness and quantity of connection nodes and linkages. It is found 59% of these streets net are highway urbanization between the city and cities and urban centers surrounding see Figure (3-22). But it misses 36% services and does not have water drainage , 23%

does not have middle island , also 15% the pavement street vary between middle and bad pavement This show in Figures (3-23) and Table (3-12).

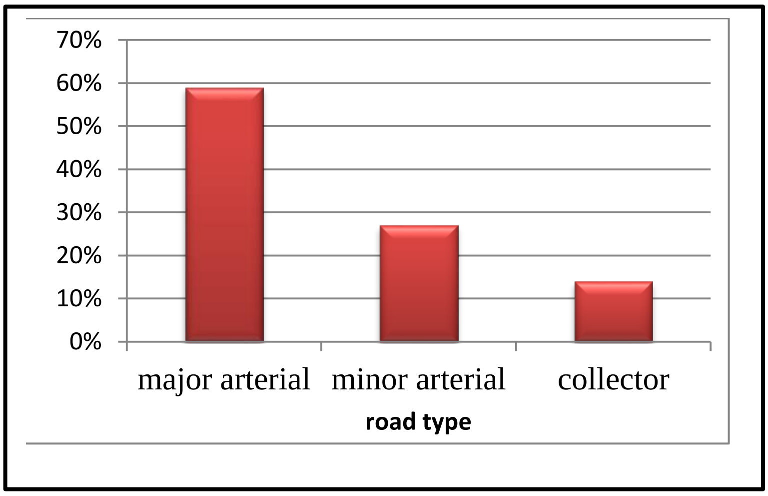


Fig.(3-22): Roads class in Nasiriyah city

- The figure is based on the views of some streets sites to determine the extent of the streets to rain water drainage efficiency.

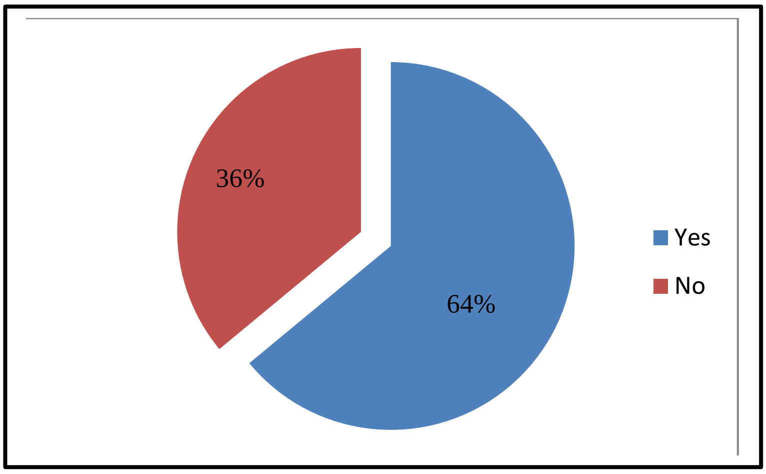


Fig.(3-23): Available of rain drainage in road network

Table (3-12): Roads network structure for some streets in Nasiriyah city

Surface	Structure State	Roads Class	Lane No.	Island Surface	Rain Network
asphalt	Very good	Major arterial	3	Concrete	yes
asphalt	Very good	Major arterial	3	Concrete	yes
asphalt	mid	Minor arterial	3	Without	no
asphalt	Good	Minor arterial	2	Concrete	yes
asphalt	Good	Major arterial	2	Concrete	no
asphalt	Good	Minor arterial	2	Concrete	Yes
asphalt	mid	Minor arterial	2	asphalt	Yes
asphalt	bad	Minor arterial	1	asphalt	No
asphalt	Very good	Minor arterial	2	asphalt	Yes
asphalt	Good	Major arterial	2	asphalt	Yes
asphalt	Good	Collector	3	Without	No
asphalt	Good	Collector	2	asphalt	Yes
asphalt	Good	Major arterial	3	Without	no
asphalt	Very good	Major arterial	3	asphalt	Yes
asphalt	Good	Major arterial	3	Concrete	Yes
asphalt	Good	Major arterial	2	Concrete	no
asphalt	Mid	Major arterial	2	asphalt	Yes
asphalt	Bad	Major arterial	2	Without	Yes
asphalt	Bad	Major arterial	2	Without	Yes
asphalt	Very good	Major arterial	3	Concrete	Yes
asphalt	Good	Minor arterial	1	asphalt	no
asphalt	Very good	Major arterial	3	Concrete	Yes
asphalt	Bad	Minor arterial	2	asphalt	no
asphalt	Bad	Minor arterial	2	asphalt	no
asphalt	Mid	Minor arterial	2	Without	no
asphalt	Good	Major arterial	2	Without	no
asphalt	Mid	Collector	2	asphalt	Yes
asphalt	Mid	Collector	3	Without	no
asphalt	Good	Collector	2	Concrete	Yes

3.7.7 City Center Traffic Volume

The most important points in a position were chosen to control the surveys to the center of the city where these points distributed as shown in the Figure (3-24). These points are five stations were observed surveys using MSSS device.

Fig.(3-24): Satellite image (Quick bird resolution 50 cm) illustrating Locations of observing points in the city center

The major traffic flow getting into the Al-Nasiriyah city is through the internal zone station EN2, in Figure (3-24) which explains the internal zone stations for the traffic survey around the city center specially concerning the passing traffic leaving the center to the other areas, and Table (3-13), and Figure (3-25) show the traffic flow . From all of that , it is found that the city center generating more attraction than with ratio

21%, also the traffic flow leaving the city center is about 61% of the whole traffic flow passing the city center of AL Nasiriyah city.

Table (3-13): Traffic flow through city center

Observing points	Out of center (veh.)	To center (veh.)	Total (veh.)
En1	6308	6267	12575
En2	24640	1106	35705
En3	5433	3406	8839
En4	7272	5221	12493
En5	4090	4857	8957

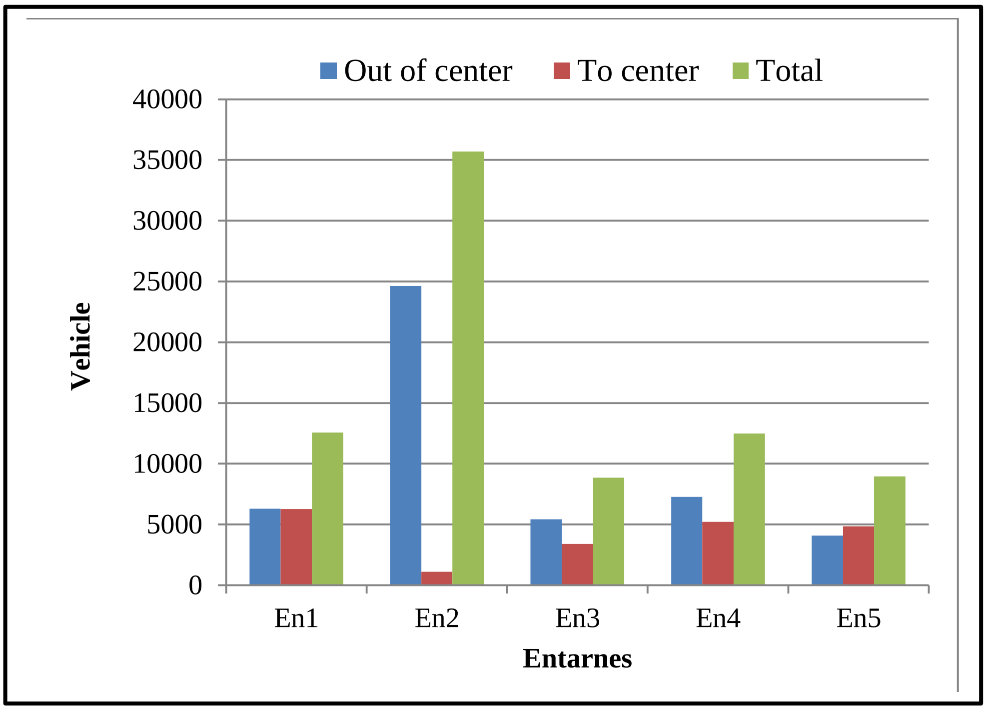


Fig.(3-25): Distribution of traffic flow towards city center

3.7.8 Origin and Destination for Trip Through City

Movement style is explained through observing points in Figure (3-26), traffic is divided into three parts, the first is the movement generated and attracted to regional remote areas of the city, which includes all areas under the influence of Nasiriyah areas is represented in the administrative boundaries of the city of Nasiriyah, the second is the traffic cames from the other administrative units of Dhi-Qar province and the third is comes from traffic outside the province.

The traffic flow for the city center is distinguished by fact that most trips destinations and sources are from and to the city hinterland, that explains the exiguity of the passing traffic through city center due to the existing highways around the city center that directly connect the main entrances of the city . See Tables (3-14) , (3-15) and Figure (3-26).

Table (3-14): Distribution of trips towards city center due to origin and destination through each station

	En1%		**En2%**		**En3%**		**En4%**		**En5%**		**Total%**	
	origin	destination	origin	destination	origin	destination	origin	destination	origin	destination	origin	destination
Region	81.5	87.9	64.8	87.3	96.8	90.4	76.2	95.2	92.6	96.3	82.0	91.1
Inside governorate	18.5	12.1	21.1	4.2	3.2	9.6	19.0	2.4	7.4	3.7	13.9	6.9
Outside governorate	0.0	0.0	14.1	8.5	0.0	0.0	4.8	0.0	0.0	0.0	4.1	2.0
	100	100	100	100	100	100	100	100	100	100	100	100

Table (3-15): Distribution of trips towards city center due to origin and destination to all city

	En1%		**En2%**		**En3%**		**En4%**		**En5%**		**Total%**	
	origin	destination	origin	destination	origin	destination	origin	destination	origin	destination	origin	destination
Region	21.9	20.9	19.0	22.3	25.2	23.7	13.2	14.4	20.7	18.7	100	100
Inside governorate	29.3	38.1	36.6	14.3	4.9	33.3	19.5	4.8	9.8	9.5	100	100
Outside governorate	0.0	0.0	83.3	100	0.0	0.0	16.7	0.0	0.0	0.0	100	100

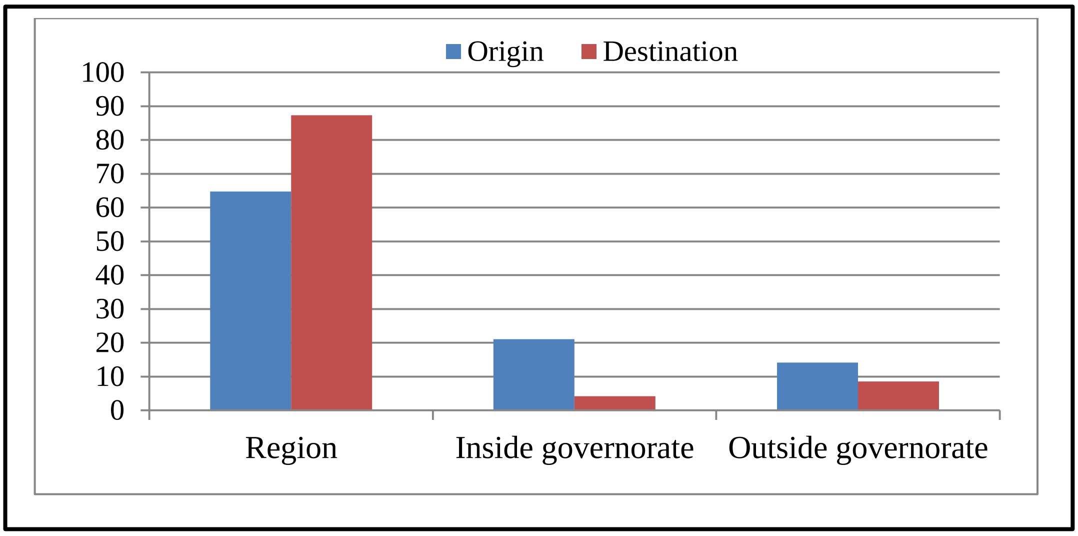


Fig.(3-26): Distribution of trips towards city center due to origin destination through station (En2)

- Other forms which illustrate the entrances are found in Appendix B

3.7.9 Type of Traffic Composition Internal Traffic Flow

Most ratios of vehicle type were nearly kindred and steady through the traffic flow passing every station from the internal zone stations around AL Nasiriyah city center , and the major part is for the saloon private cars with 51% of the passing vehicles in the city center, and about the same ratio for the vehicles leaving the center 50% , followed by the taxis 14% of all the vehicles traffic flow, but the mini buses recorded 13% of the vehicles traffic flow getting into the center , and 19% for the vehicles leaving the center , totally its forms around 16% of the whole volume vehicles traffic flow for the city center , this is shown Table (3-16), and Figure (3-27) and (3-28).

Table (3-16): Distribute internal traffic volume by vehicle type .

Entrances		passenger car(veh.)	Bus vehicle (veh.)	Van car (veh.)
En1	To center	4640	737	890
	Out of	5474	552	282
	Total	10114	1289	1172
En2	To center	8565	1691	810
	Out of	16181	6913	1546
	Total	24746	8604	2356
En3	To center	4075	858	500
	Out of	6711	1153	975
	Total	3306	937	978
En4	To center	4494	1549	1229
	Out of	7800	2486	2207
	Total	2125	1680	1062
En5	To center	2289	1219	582
	Out of	4414	2899	1644
	Total	21272	5340	4215

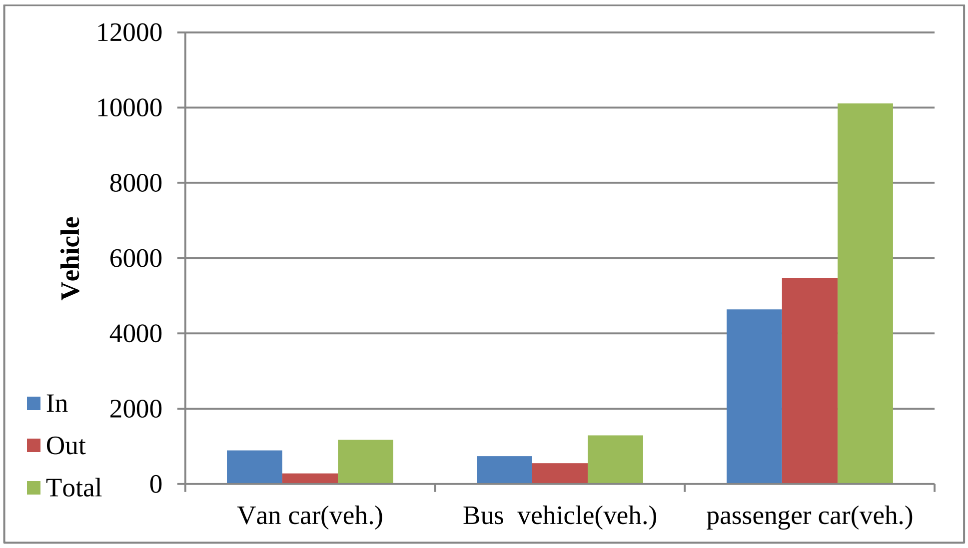


Fig.(3-27): Distribution of vehicles in traffic volume throw internal cordon station (En1)

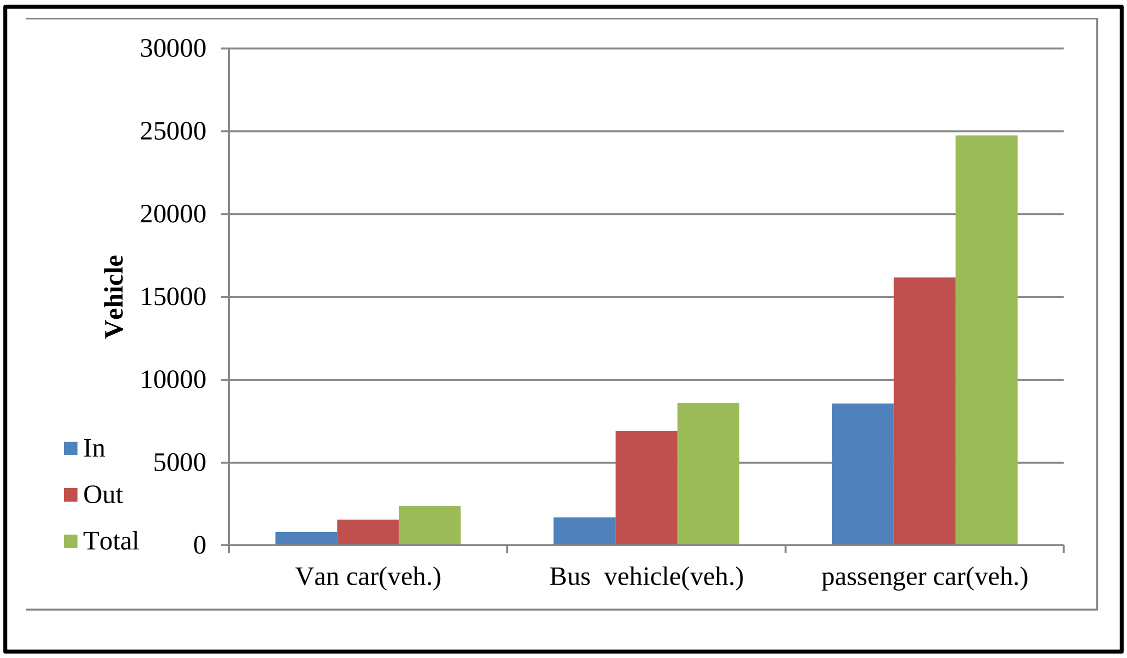


Fig.(3-28): Distribution of vehicles in traffic volume throw internal cordon station (En2)

3.7.10 The Purpose of City Center Traffic Trip

The city center is distinguished by concentration of trading and business activities , so it is natural to find the biggest purpose ratio the private work purpose, Table (3-17) then the trip purpose was for shopping which represents, the most important activities Figure (3-31).

Table (3-17): Traffic flow proportion through city center according to trip purpose

Stations / Type purpose	En1			En2			En3			En4			En5		
	In%	Out%	Total%	In%	Out%	Total%	In%	Out%	Total%	In%	Out%	Total%	In%	Out%	Total%
Home	6.1	5.4	11.5	2.8	30.4	33.2	4.8	7.2	12	3.6	1.7	5.3	1.9	1.4	3.3
Governmental	9.1	7.8	16.9	11.3	19.6	30.9	9.5	7.2	16.7	4.9	13.8	18.7	3.7	8.5	12.2
Shopping	34.8	7.8	42.6	29.6	5.4	35	11.1	13.4	24.5	33.1	27.6	60.7	9.1	4.2	13.3
Recreation	6.1	4.2	10.3	4.2	5.4	9.6	6.3	8.2	14.5	7.3	13.8	21.1	2.8	1.2	4
Private job	40.9	54.4	95.3	40.1	30.4	70.5	36.5	36.1	72.6	43.5	37.9	81.4	60.4	22.5	82.9
Education	1.5	1.6	3.1	5.6	5.4	11	6.3	5.2	11.5	7.1	1.7	8.8	3.6	2.8	6.4
Others	1.5	18.8	20.3	6.4	3.6	10	25.4	22.7	48.1	2.4	3.4	5.8	18.5	59.4	77.9

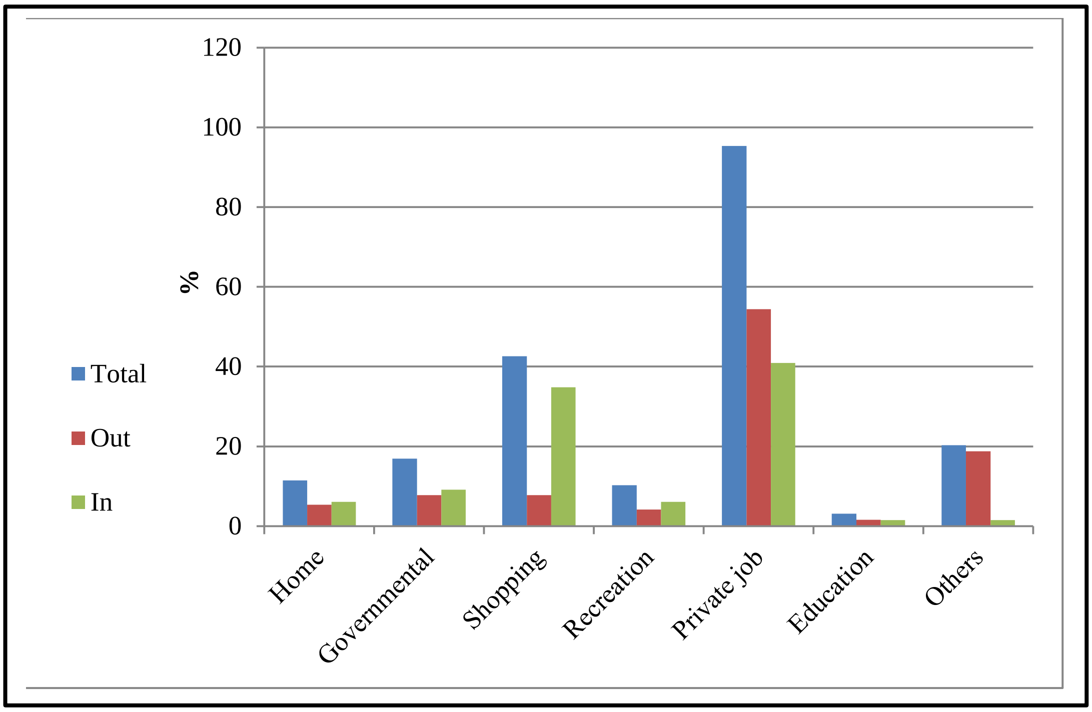


Fig.(3-29): Trips purpose through internal survey station (En1)

3.7.11 Traffic Intersection

Al- Nasiriyah city contains fourteen 14 traffic intersections , these are just dual and trio, there are no quadruple or different levels intersections , most of which were designed and studied according to the traffic flow, five of largest effective intersections that has been not designed studied before have been determined for surveys , Figure (3-30) shows the composition between the traffic volume in each intersection , and Figure (3-31) shows the spatial distribution of these intersections.

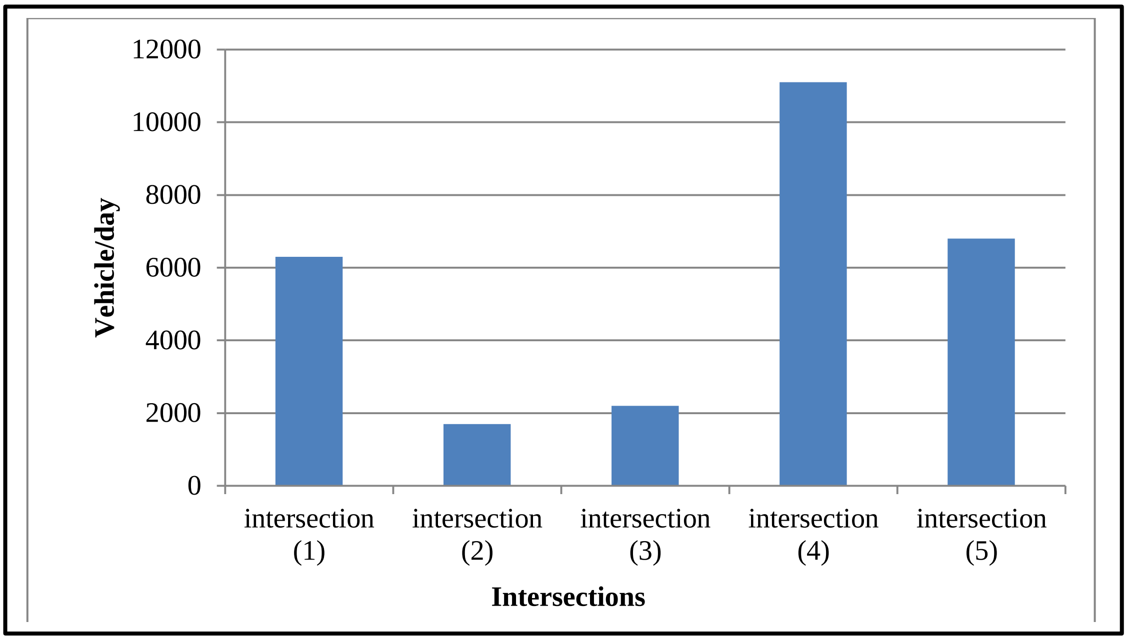


Fig.(3-30): Traffic volume in intersections of Nasiriyah city

Fig.(3-31): Satellite image (Quick bird resolution 50 cm showing the Spatial distribution of traffic volume in city intersections

3.7.12 Pedestrian Movement

The survey of pedestrian station flowing into the city center of AL Nasiriyah city has been determined by eight 8 survey stations ,see Figure (3-32) . It has been noticed that the major ratio for the pedestrian movement is through stations (5,6) , while station 6 recorded 70%, 57% of the whole volume for male and female successively, followed by station 5 with ratio 17%, 18% of the whole volume for male and female successively, see Table (3-18).

Fig.(3-32): Satellite image (Quick bird resolution 50 cm) illustrating Pedestrian survey stations

Table (3-18): Distribution pedestrians on survey stations

station	male	% male	Female	% Female
1	1582	3	498	1
2	1891	4	716	2
3	1572	3	818	2
4	393	1	257	1
5	9097	17	5842	18
6	30618	57	23347	70
7	4371	8	1001	3
8	3950	7	1039	3
Total	53474	100	33518	100

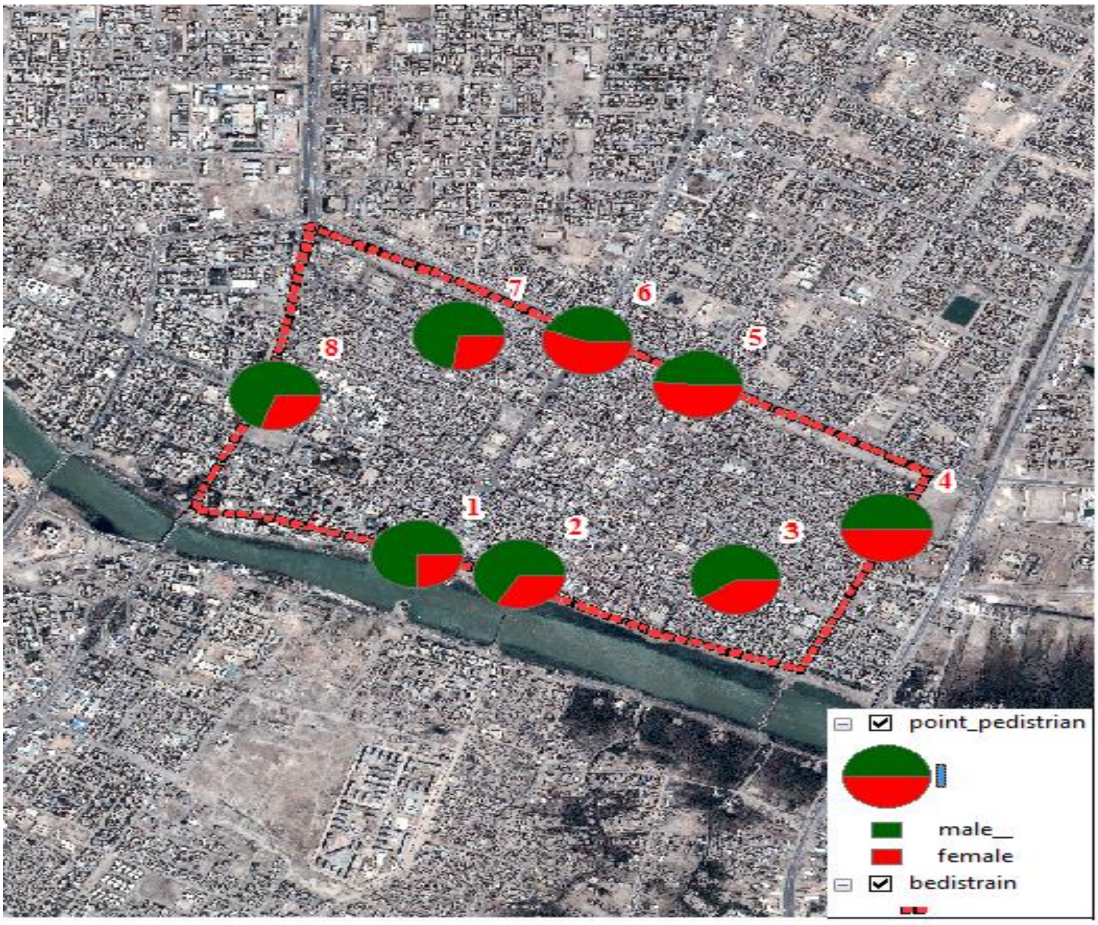


Fig.(3-33): Spatial distribution of pedestrian in Nasiriyah city

Figure (3-33) shows the spatial distribution for the pedestrian movement ,we can see the higher ratio of the male movement through station 7 , generally the male pedestrian movement is higher than female pedestrian movement , and the higher ratio to leave the pedestrian is through station 5 due to the internal transportation garage in the city , while there is equality for the enter and exit of pedestrian movement at stations (6,7) , but in the other survey station the entry of pedestrian movement is more than exiting of pedestrian movement. The most prominent purpose for the pedestrian movement is the work with ratio 57% from the whole volume of pedestrian movement , followed by (other) trip purposes with ratio 25% , then the shopping purpose with ratio 13% from the whole pedestrian movement.

Chapter Four

Analysis and GIS Result

4.1 General

This chapter will display service requirements for roads, which include ,filling stations, preparing a satellite image accuracy of (50) cm, correcting them, drawing network roads by using GIS and the preparation of the full data of the network includes the length of the road base; the time taken to end trip; speed and width of the road. After that it is conducting the analysis by using GIS.

4.2 Transport Services (Standards)

Transport service standards covered petrol filling stations and bus facilities, but few standards were found in the Iraqi documents. The transport service standards reviewed were arranged into categories of size and catchment population. The proposed standards seek to give adequate provision of public transport services to all catchment levels. Bus stops will have no specific allocation and will depend on a combination of bus route and road type. Bus stations at the local/town level as well as the regional/city level are expected to ensure that bus stops are concentrated in one area near regional/city/town centers. A taxi rank category is provided and is expected to be located at the local level near to the shopping centers and bus stations. This will ensure a more comprehensive and integrated transport network. Petrol filling station standards as a category are also proposed to comply with modern regional and international standards. The proposed standards comply with Iraqi and international standards. Highway service station standards are guidance

only and should be sized and located in accordance with the relevant highway authority guidance. For these services of global standards are listed in Table (4-1), (IPG/GDL ,2008).

Table (4-1): Transport Service Standards (IPG/GDL ,2008)

Category	Sub-category	Plot Size (M^2)	Indicative Catchment
Public Transport (Bus)	Station City Terminus Garage/Depot	2500 5000 15000	City Quarter City
Public Transport (Taxi)	Taxi Rank	2500	Quarter
Petrol Filling Station	Large Medium Small	2500 1400 5000	City Quarter Neighborhood
Other roadside services	Highway service station	45000	City

4.3 Roads and Foot Routes (Standards)

There are many different road classifications and a variety of hierarchies in the reviewed documents. All road categories broadly fitted into three categories which can be described as Primary, Secondary and Tertiary, with highways the primary long distance road network and access and local roads being at the bottom of the scale. Depending on the road type foot Routes are also included in the road hierarchy, however within the various urban hierarchies there are also pedestrian routes not associated with the road network. The proposed road standards respect existing Iraqi standards, Table (4-2) shows that these standards will depend in analysis , as well as taking into account current international standards where applicable. Carriageway widths and numbers of lanes

should be reviewed on a constant basis by traffic flow and condition surveys by the authority responsible for highways within Nasiriyah. This is to ensure that road capacity is not exceeded and that highway safety is not impaired. Separate foot Route standards have also been included to ensure an adequate variety of transport methods at a neighborhood and local level. Car ownership is on the rise in Iraq and without heavy investment in the total travel infrastructure traffic congestion will be get worse unless adequate provision of alternative transport is provided. The provision of foot Routes and cycle ways allows for local car traffic to be alleviated. This type of network is also required to be integrated at the neighborhood and local level with schools, health centers and mosques to ensure that road trips are limited to medium and longer journeys, (IPG/GDL ,2008).

Table (4-2): Road and Footpath Standards (IPG/GDL ,2008).

Category	Sub-category	Right of Way Width (m)	Service Area
Primary	Urban Arterial Road Urban Arterial Road in Residential Highway in rural areas	55 33-50 50	City City N/A
Secondary	Local Distributor (Industrial) Local Distributor (Residential) Highway in Rural Areas	30 20 13.52	Quarter City N/A
Tertiary	Access Road (Industrial) Access Road (Residential)	20 15	Neighborhood Neighborhood
Foot Route Foot Route/Cycle way		2.5 3.5	Neighborhood Quarter

4.4 Land Requirement Roads

The second area where the calculation of land is made by means of standards will not work in that of roads and access are within urban areas. What is needed here is an understanding of the land actually required to accommodate roads and access for different urban housing layouts. Therefore we have studied typical neighborhoods of Shuhada in Nasiriyah shown in Figure (4-1) to calculate the ratio of different types of roads to the number of plots served (road length/plot).

This procedure has been used very successfully for projects in other places and we have to do on the results of this process to the urban area in Nasiriyah to those found in other countries in the region. The results are shown in Table (4-4) and these methods which have lengths in the plot are used as evidence in a subsequent calculations of region of the needs of the territory. But we do not consider that the residential neighborhoods in the future should be able to use economies and be less wasteful approach for analysis.

Fig.(4-1): Nasiriyah Shuhada Neighborhoods drawing on satellite image Quick bird with Resolution (50 cm)

Table (4-3): Land use Analysis of Existing Neighborhoods

Category	Number	Road width (m)	Road Length (m)	Area(m^2)	Built-up area	Road Length / Plot (m)
Residential	**3544**	—	—	708807	53.0%	—
Car Parks	**3**			6664	0.5%	
Commercial	**1**			316	0.0%	
Designed	**4**			10293	0.8%	
Education	**10**			48302	3.6%	
Health Care	**1**			2689	0.2%	
Open Space	**35**			223735	16.7%	
Religious	**3**			1819	0.1%	
Unauthorized	**3**			44208	3.3%	
Utilities	**1**			2172	0.2%	
Subtotal	**3,605**			**1,049,005**	**78.5%**	
Road						
Arterial	—	40	572	—	1.7%	0.16
Distributor		20	1910		5.7%	0.54
Local		15	5043		3.8%	1.42
Access		10	27626		10.3%	7.80
Subtotal				**287,850**	**21.5%**	
Totals	**3,605**			**1,336,855**		
Plot Size	**200 m^2 average**					

4.5 Images Pre-Processing

Pre-processing of the images is required in order to suppress unwanted distortions or enhance some image features important for further processing.

Remotely sensed image data are, in fact, representations of the irregular surface of the Earth and therefore need to be georeferenced.

In the present study georeferentiation was performed by means of the

image-to- image method as Quick Bird 2009, which was selected as the reference image, was already georeferenced .By means of this technique it was possible to make use of the Quick Bird 2014.

To perform this operation the first step was the identification of Ground Control Points (GCPs) as shown in Table (4-5), which are specific pixels in an image for which the output map coordinates are known. GCPs consist of two E,N pairs of coordinates:

i) Source coordinates or data file coordinates in the image being rectified (Quick Bird 2014)

ii) Reference coordinates or coordinates of the reference image to which source image is being registered (Quick bird 2009)

Accurate GCPs are essential for an accurate georeferentiation. From the GCPs, in fact, the georeferenced coordinates for all other points in the image are extrapolated. A set of (20) GCPs was selected throughout the scenes for the georeferentiation of the images, in a dispersed way including the intersection of roads, rivers, buildings and avoiding landmarks that can vary during time Figure (4-2).

Table (4-4): coordinate of Some of ground control points in Nasiriyah city use for image processing

Point	E (Easting) m	N (Nothing) m	Z (Elevation) m
CP1	618902.391	3435684.359	6.217
CP2	618928.267	3435594.745	6.246
CP3	618863.136	3435510.992	6.389
CP4	618837.141	3435727.310	5.744
CP5	618762.929	3435816.578	5.967
CP6	618652.991	3435839.063	6.234
CP7	619251.568	3435523.050	5.714

Point	E (Easting) m	N (Nothing) m	Z (Elevation) m
CP8	916135.755	3435602.206	5.852
CP9	619012.118	3435650.454	5.738
CP10	618981.312	3435771.239	5.535
CP11	618990.766	3435899.987	5.464

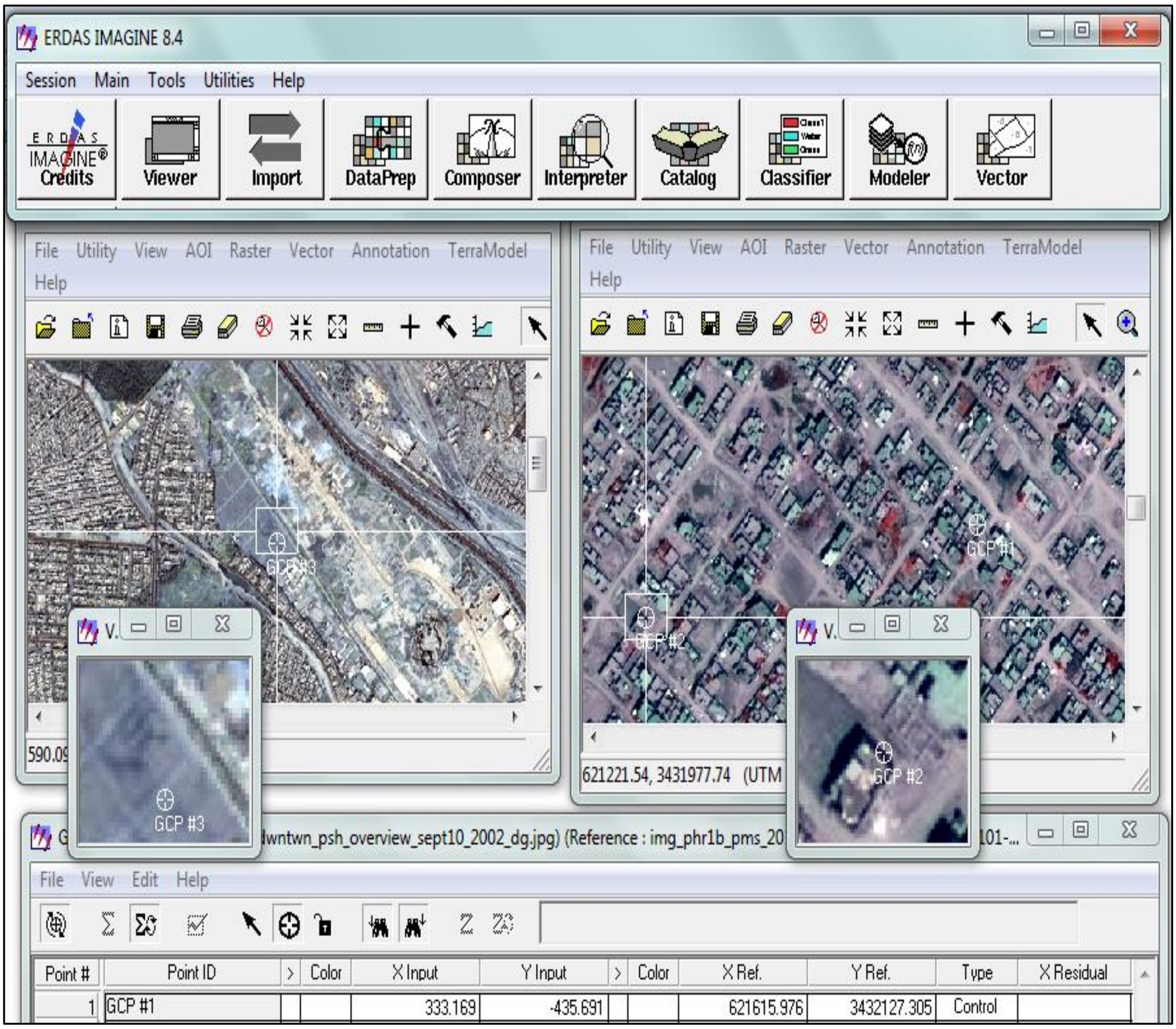


Fig.(4-2): Georeferentiation of (Quick bird 2009) to (Quick bird 2014).

The second step for the georeferentiation was the use of polynomial equations in order to convert source file coordinates to georeferenced map coordinates. The selection of the polynomial equation depends upon the distortion in the imagery, the number of GCPs used and their

locations relative to one another. The degree of complexity of the polynomial is expressed as the order of the polynomial. The order is simply the highest exponent used in the polynomial. RMS was 0.43 pixels for Quick Bird 2014.

4.6 GIS Implementation in Transportation Planning

It was creating a model of route analysis in GIS illustrates process of selecting the best route in several cases. Creating a modeling for finding the fastest route is to evaluate the network in many factors by using GIS shown in the Figure (4-3).

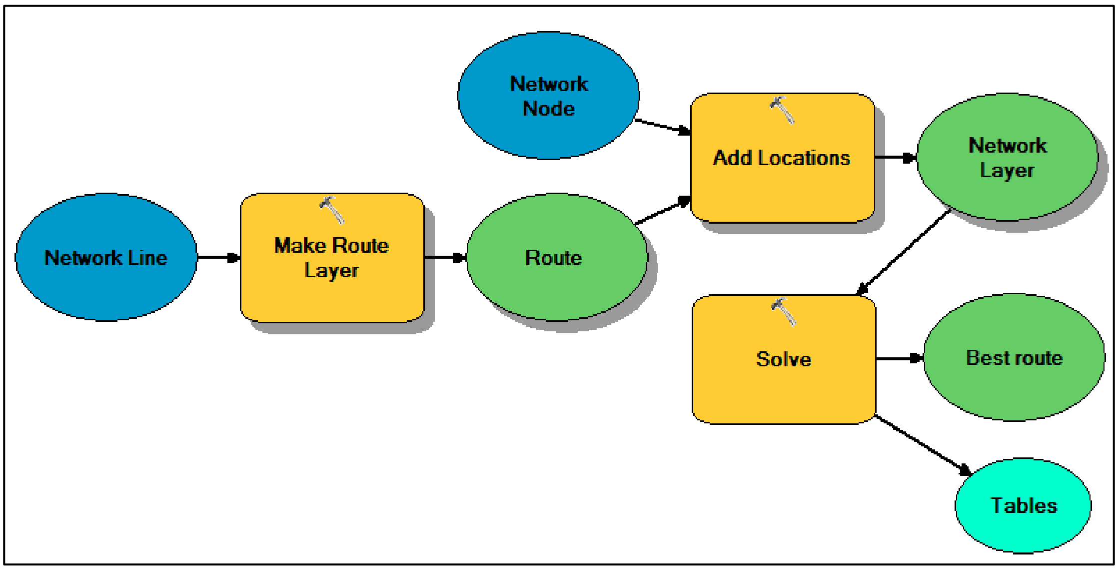


Fig.(4-3): Modeling for finding the fastest route to evaluate the network in many factors by using GIS

4.6.1 Preparing the Shape Files of Road Network

To execute the traffic assignment analysis, it was necessary to prepare the shape files of the road network; these shape files were built by observing the satellite image, the master plan map of Al-Nasiriyah city shown in Figures (4-4),(4-5) and Table (4-5), lists the collected data.

By Arc Catalog program three shape files were built of road network, these included (links, nodes and zones or polygon) as shown in Figure (4-6).The links and bridges layer was represented as polyline feature .These shape file include 1523 links which represent the main, collector, and local roads, bridges and overpasses of Al-Nasiriyah city as shown in Figure (4-7), Figure (4-8) represents the nodes and intersection layers as point feature which include 1232 nodes.

Table (4-5): The Satellite imagery specifications

Product Type:	**Standard**	**Product Option:**	**Natural Colour**
Bit Depth:	8	File Formal:	Geo TIFF
Tiling:	No	Map Projection:	UTM
Delivery Method:	DVD	UTM Zone:	38N
License Type:	Single	Datum:	WGS84
Quick Bird Standard Imagery 4-band pansharpend, radiometically corrected, sensor corrected, and mapped a geographic projection, RMSE 14 meters, resolution 0.5 meters, acquisition data ** is for 2014 or newer for the 18 major cities in Iraq. Up to 20% cloud cover for new imagery			

Fig.(4-4): Satellite Image of Al-Nasiriyah City [2014].

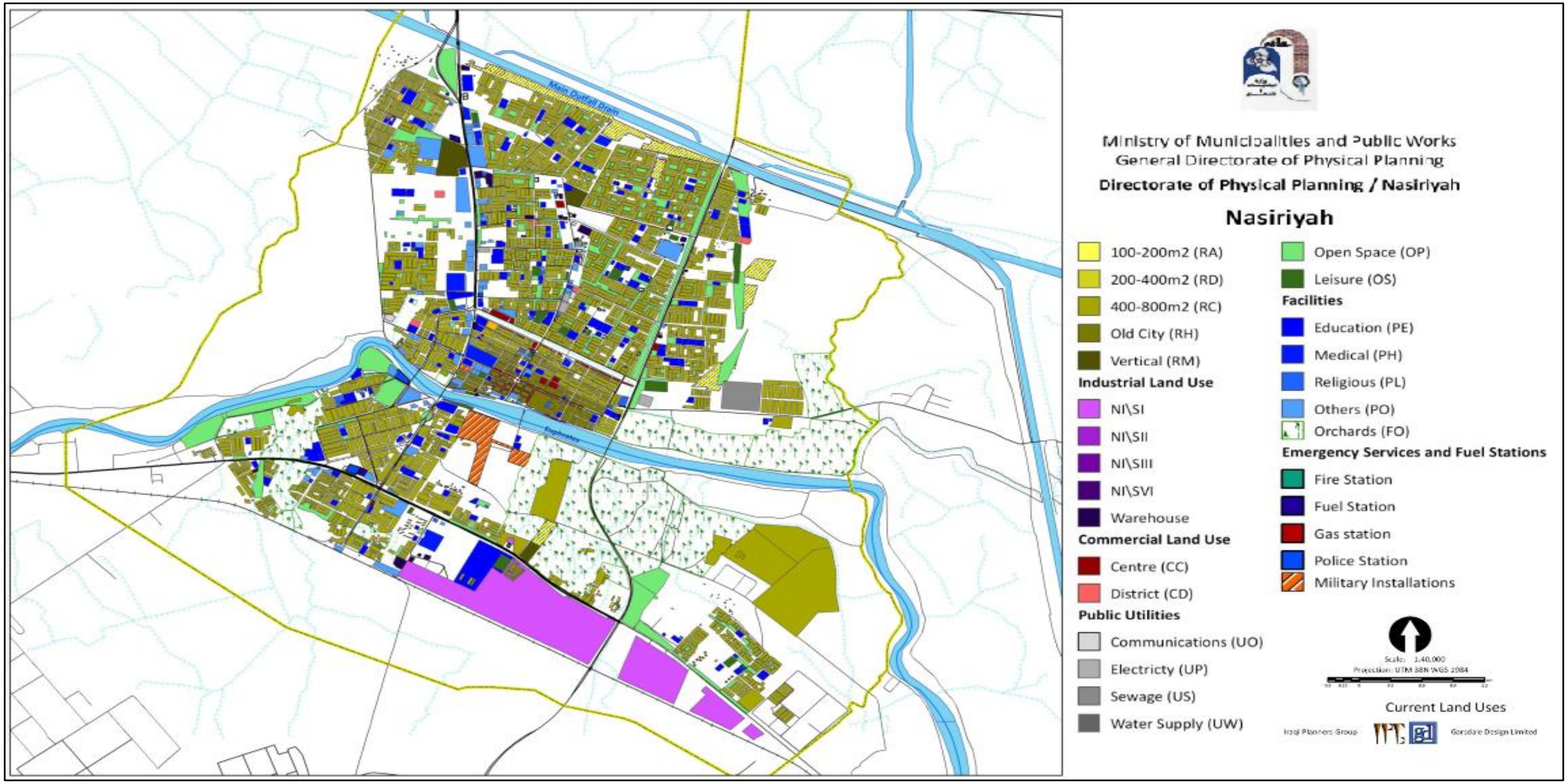


Fig.(4-5): Master Plan Map of Al- Nasiriyah City

(Directorate of AL- Nasiriyah City Municipality)

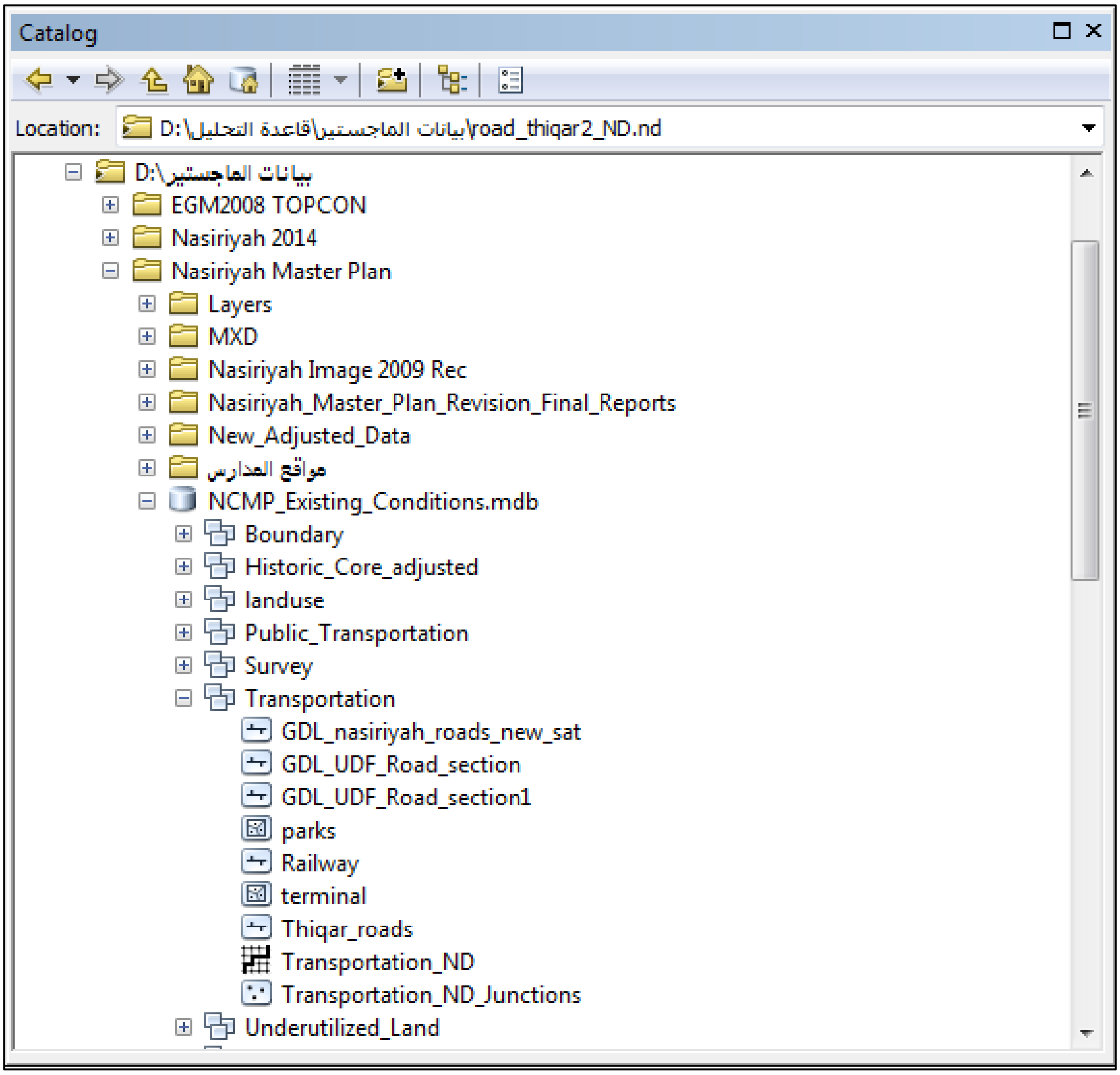


Fig.(4-6): Building Layers of Road Network for Study Area by Arc Catalog Program

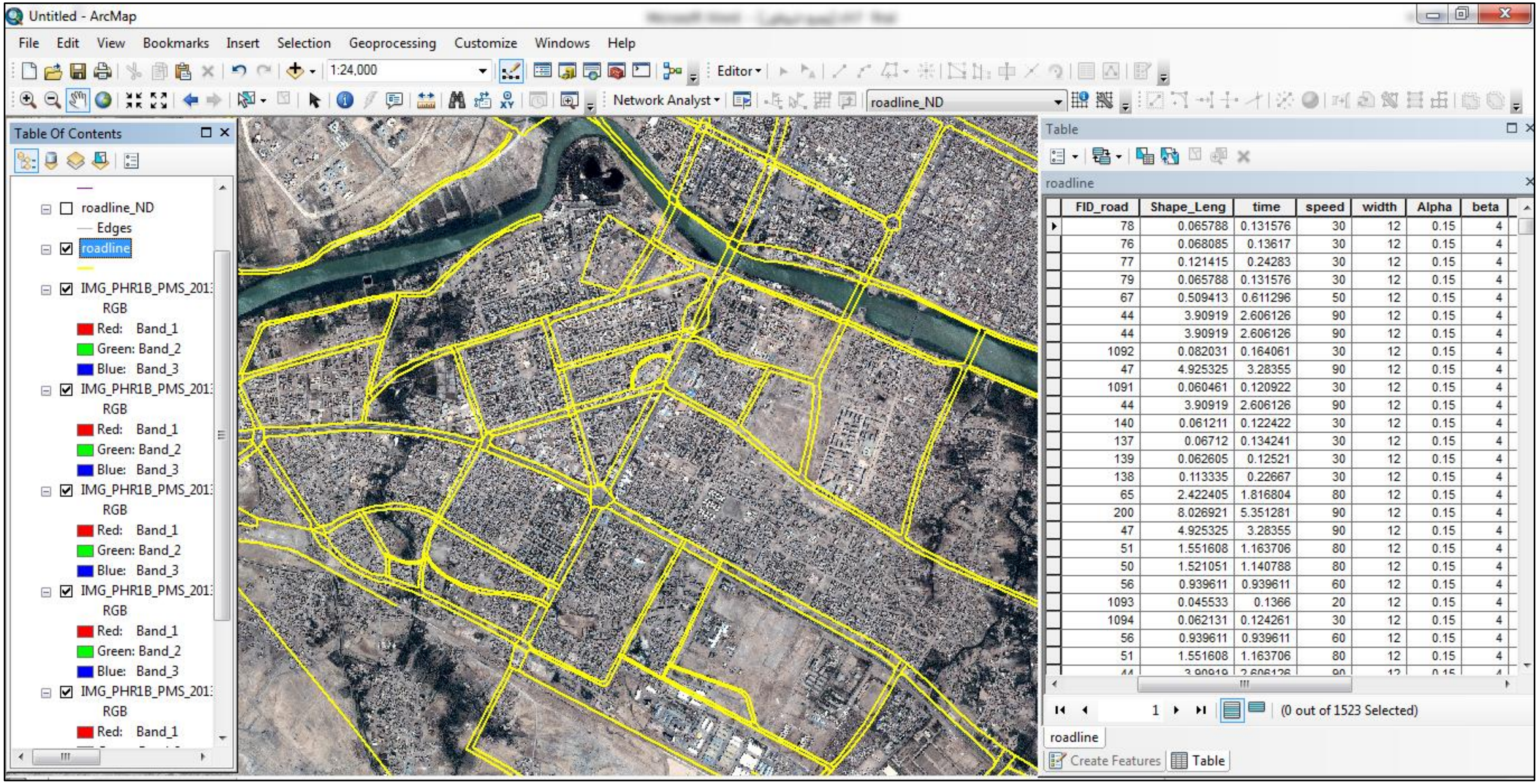


Fig.(4-7): Layer of Links of Al-Nasiriyah Road Network

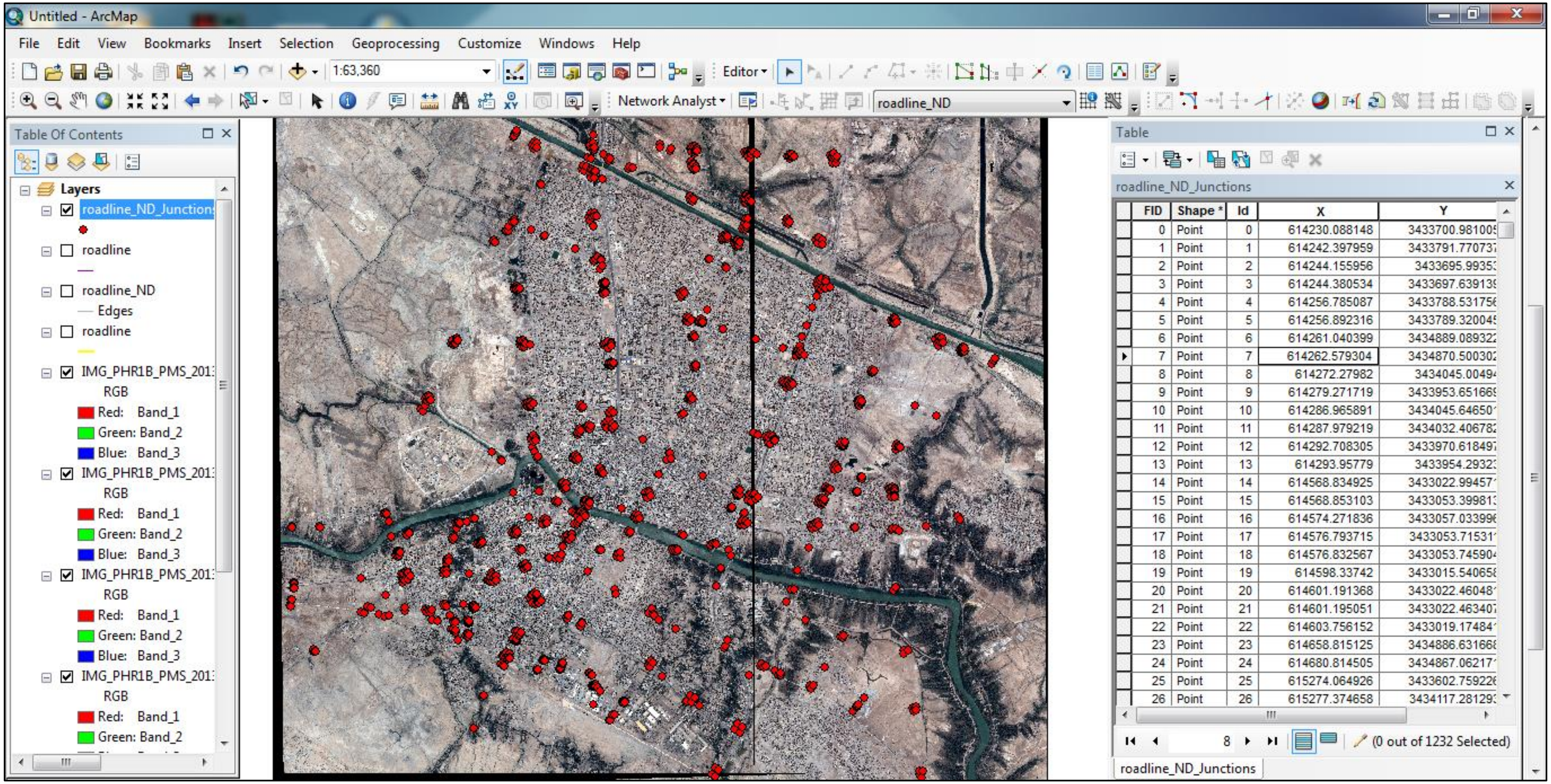


Fig.(4-8): Layer of Nodes and Intersections of Al-Nasiriyah Road Network

4.6.2 Applying the Network Topology to the Layers of Road Network

After data collection, link layers, it must be applied to the topology graphs. It aims is to modify topology and calendar databases and correct their errors resulting from the drawing through the organization of the laws and rules set and it made the correction process by topology of data on the level of data set, and are not at the level of classes which must be the class to be the work of a topology within data set not taken any action on the topology classes shape file type.

1- Deleting duplicate lines,
2- Erase short objects,
3- Break crossing objects,
4- Extend undershoots,
5- Snap clustered nodes,
6- Dissolve pseudo nodes,
7- Erase dangling objects,
8- Simply objects and,
9- Remove zero length objects.

In this study, a topology network was built by Arc catalog program. The topology was applied to the layer of links with two conditions (must be single part, must not self-intersection and must not have dangles); also the topology applied to the layer of zones with two conditions (must not overlap and must not have gap). The result of the summation of errors in drawing after applying topology network must be equal to zero, This is demonstrated in Figure (4-9).

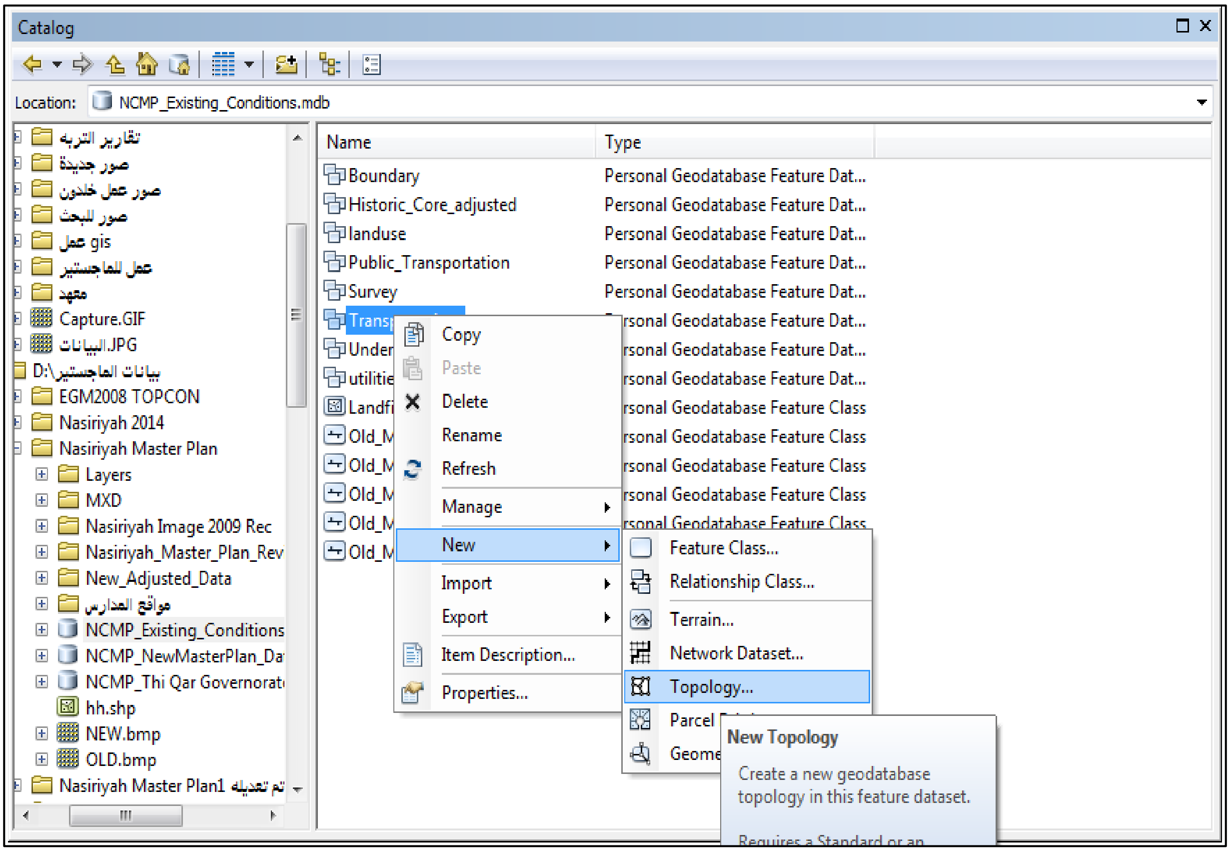


Fig.(4-9): Creation of topology in Arc catalog program

4.7 Preparing the Data Base of Road Network

After collecting the database for each shape file, that data was inserted and was organized by Arc GIS 10.3 program for connecting with these layers to execute the ArcGIS Network Analyst

4.7.1 Data Base of Links Shape File

The database of Al-Nasiriyah road network was taken from the Directorate of AL-Nasiriyah Municipality (GIS unit) while the others were obtained by observation or measuring them. Mainly three types of attribute data were collected. The First data were descriptions attributes, which give the descriptions like roads (length, width, number of lane, speed limit, and capacity etc.), the Second data was cost attributes, which play the essential role in the analysis of road to find the optimal route location, the cost of length of road in meters and cost of time (drive time)

in minutes. Finally, third was the restriction attributes, which also have the main role accompanying cost attributes. This attribute data include restriction values like one-way and no entry road (closed road). Table (4-7) shows part of these attributes.

Table (4-6): Part of Data Set of Links Attributes

ID	Link Id	One Way	Length (m)	Time (min)	Speed (km/hr)	Link width (m)	Capacity (pcph)	Dir.
1	78	FT	65.788	0.131576	30	12	5484	1
2	77		68.085	0.13617	30	12	5484	1
3	671	FT	121.415	0.24283	30	12	5484	1
4	55	FT	65.788	0.131576	30	12	4113	0
5	621	FT	509.413	0.611296	50	10	5484	1
6	841		3.909.19	2.606126	90	12	5484	0
7	128		3.909.19	2.606126	90	12	5484	0
8	137	FT	82.031	0.164061	30	10	5484	1
9	139		4925.325	3.28355	90	12	4113	1
10	4432	FT	60.461	0.120922	30	9	4113	0
11	241		3909.19	2.606126	90	10	5484	1
12	514		61.211	0.122422	30	12	5941	0
13	33	FT	67.12	0.134241	30	12	4113	0
14	461	FT	62.605	0.12521	30	12	5484	1
15	681	FT	113.335	0.22667	30	9	4113	1
17	76		2422.405	1.816804	80	12	5941	1
18	751		8026.921	5.351281	90	12	5941	1
19	312	FT	4925.325	3.28355	90	10	5484	1
20	157	FT	1551.608	1.163706	80	10	5484	0
21	221		1521.051	1.140788	80	10	5484	0
22	157		939.611	0.939611	60	10	5941	0
23	113	FT	45.533	0.1366	20	9	4113	1
24	684	FT	62.131	0.124261	30	9	4113	0
25	719	FT	939.611	0.939611	60	12	5484	1

4.7.2 Data Base of Nodes Shape File

The database of nodes layer contained the number and the geographic coordinate of nods (E and N). Example of these attribute is stated in Table (4-7), these were inserted in the attributed table of nodes layer. The attribute of nodes is necessary in network analysis and traffic assignment of road network for the study area, And Figure (4-10) illustrates all Network for Nasiriyah city.

Table (4-7): Part of Nodes and Intersections Attributes

ID	(E) Coordinate (m)	(N) Coordinate (m)
1	614230.088148	3433700.98101
2	614242.397959	3433791.77074
3	614244.155956	3433695.99353
4	614244.380534	3433697.63914
5	614256.785087	3433788.53176
6	614256.892316	3433789.32004
7	614261.040399	3434889.08932
8	614262.579304	3434870.5003
9	614272.27982	3434045.00494
10	614279.271719	3433953.65167
11	614286.965891	3434045.6465
12	614287.979219	3434032.40678
13	614292.708305	3433970.6185
14	614293.95779	3433954.29323
15	614568.834925	3433022.99457

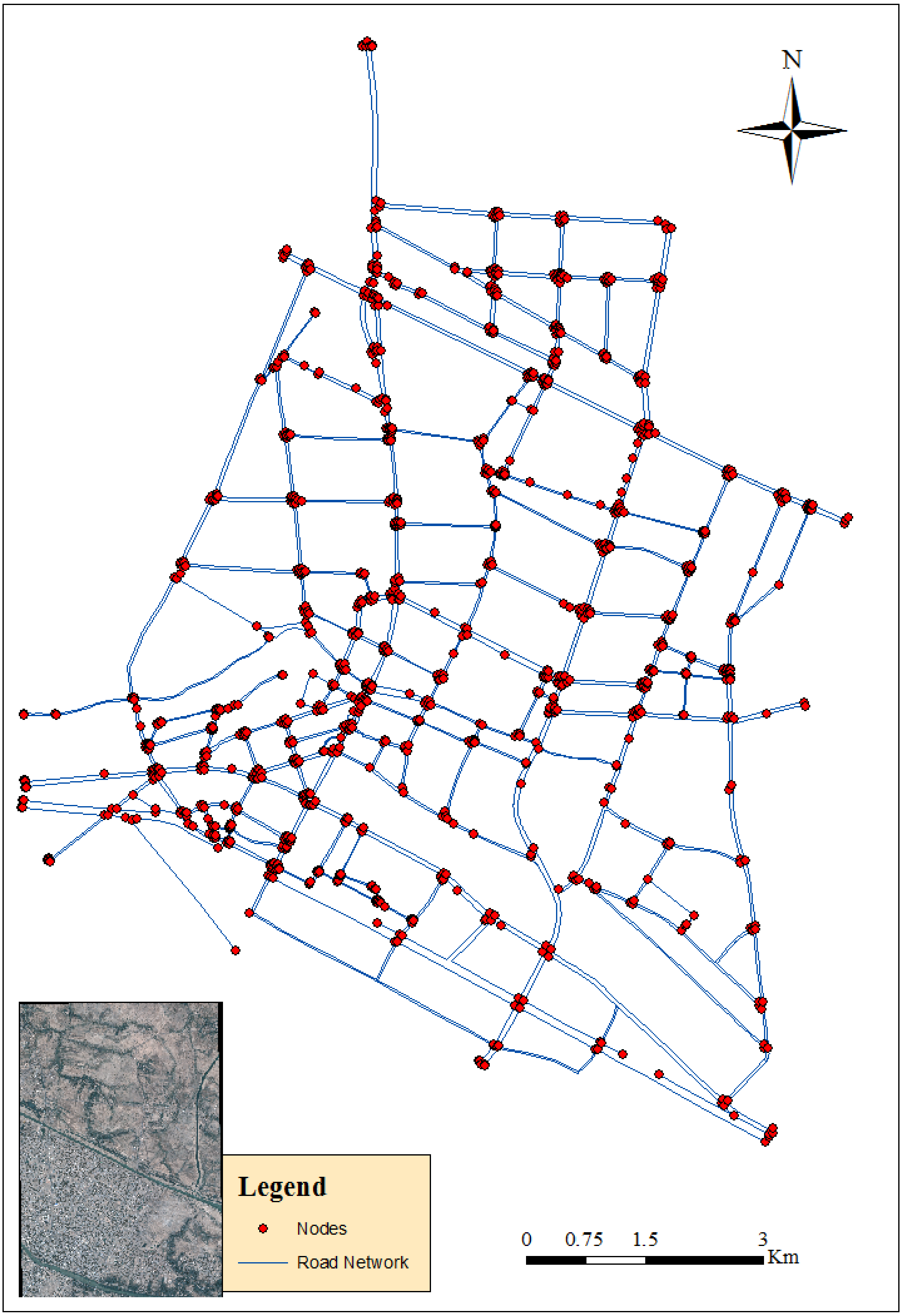


Fig.(4-10): The Reduced Road Network of Al-Nasiriyah City (Topological Diagram).

4.7.3 Data Base of Zone Shape File

The database of the zone that was inserted in the attribute table of zones layer contained; the number of zone, land use of zone ,etc. These were taken from the master plan map of Al-Nasiriyah city. In addition the population was taken from the Directorate of AL-Nasiriyah Statistics. it is a database of all uses of the land in the city and work schedules description of each one and uses as shown in Figure (4-11).

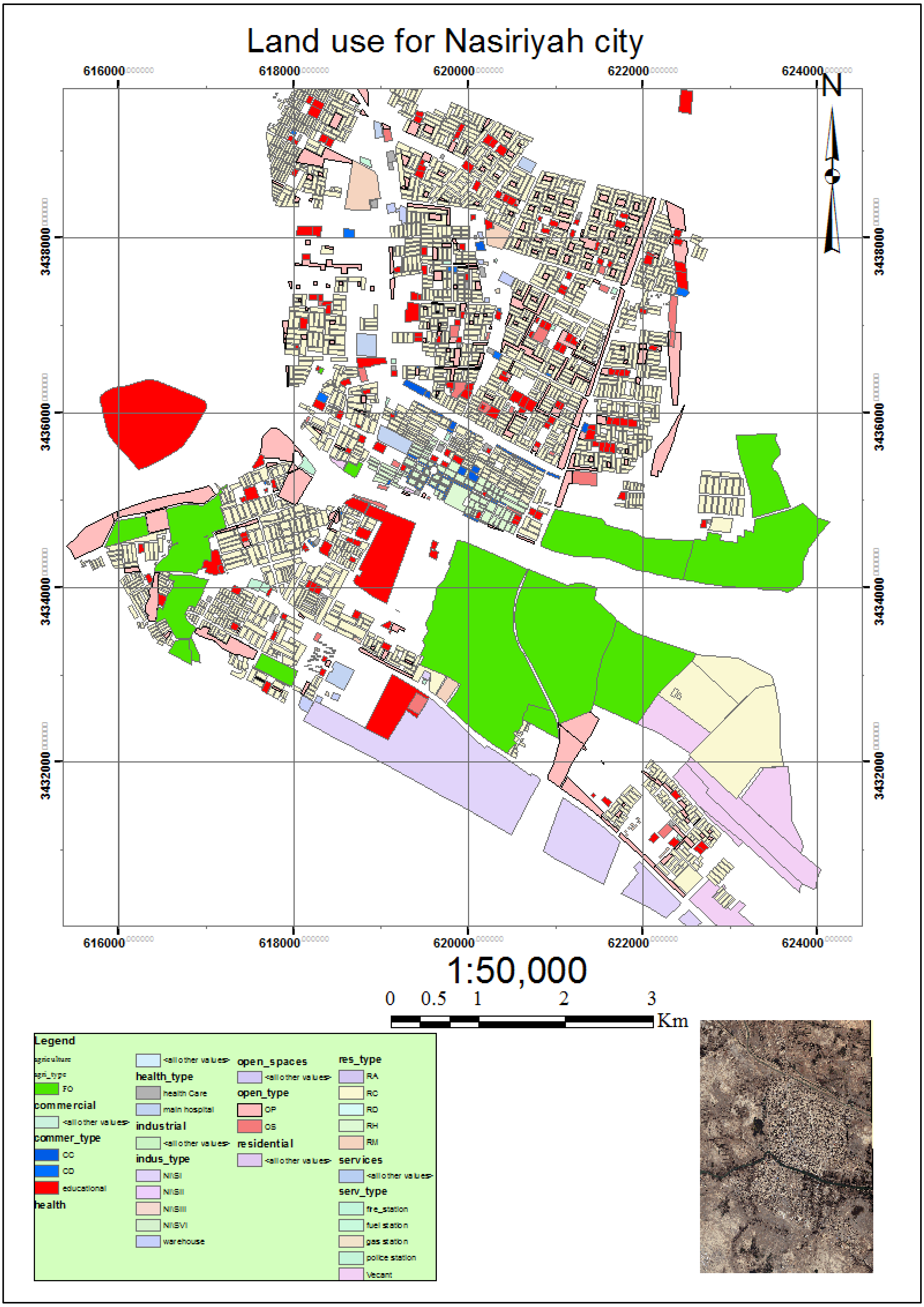


Fig.(4-11): Land use for Al-Nasiriyah city.

4.8 Network density

Network density is one of the important criteria that reflect the economic development of the city and shows how network efficiency within the province. Whenever the network density is high, the city has a good network. If it is low that means this network is weak. That means there are parts of the city suffering from a lack of roads.

The Network Density is one of the simplest and easiest criteria to determine the efficiency of roads network. Its calculation is based on the ratio of total length to the unit area or per unit of numerical population according to the following indicators,(Nimer et. al. 2011).

1-The road network density ratio of the area of the city:

The road network density is calculating as follows:

$$\text{Road density} = \frac{L}{A}*1000 \quad \text{.....(4.1)} \quad \text{(Bradford,2002)}$$

where:-

L= Length of roads in (Km)

A= Area of city in (Km^2)

In Nasiriyah city

L= 407.517 Km

A= 4494 Km^2 *from table (3-3)

$$\text{Road density} = \frac{407.517}{4494}*1000$$

$$= 90.68 \text{ Km}$$

Through the index it is clear that the density of roads in the city for the area reached (90.68 Km) longitudinal per 1000 sq. km, which reduced because of what has been compared with the global average density in excess of the (105 Km) longitudinal per 1,000 sq. km ,(Anbuge et al. ,2009).

2-The road network density ratio for the population of the city:

$$\text{Road density} = \frac{L}{Po} * 100000$$ ……..(4.2) (Bradford,2002)

where:-

Po= Population

In Nasiriyah city

L= 407.517 km

Po= 576116 *From Table (3-3)

$$\text{Road density} = \frac{407.517}{576116} * 100000$$

$$= 70.73 \text{ km}$$

Measuring the density level of the population gives a more accurate indication of the importance of the previous indicator, because the population is users of the road, and who through them gives a pointer to the extent of the road network efficiency. Through the index it is evident that the road density in the city of Nasiriyah reached (70.73 km) per 100,000 inhabitants, where is very low density when compared to the global level, which is up to (496 km) per 100,000,(Ibid, 2009) inhabitants meaning it does not exceed 11% the world average density, which is due to goes many reasons, including the increasing population growth of the population of the province as well as maintaining the capacity of an area and not adding new routes to the transport network. These two indicators

show that the low density of the road network is little and this is reflected negatively on per capita in the city of ways because of the rising population and the lack of construction of new roads in the city.

4.9 Measured Performance of Road Network

Understanding the specification of any road network, it must be that road network to numbers of straight line (links) and nodes, was known (Topological Diagram).The Topological is one of the quantity geometry being positions and relations between points, lines and areas without interested with distance between points or direction of lines or area of zones,(Abood ,2013).

By reducing circuit networks to graphs, it becomes able to use measures that are developed in graph theories to compare sets of networks. In any graph, four basic quantities (using the graph theory terminology) can be defined as following ,(Buyong ,2007).

e: The number of edges (links),

v: The number of vertices (nodes),

m: The total network length.

The measured developed in graph theory are:

• (Beta) Index

• (Alpha) Index

• (Gamma) Index

• ε(Eta) Index

where:

1-(Beta) index

The $\boldsymbol{\beta}$index is calculating as follows:

$$\beta = \frac{e}{v} \ldots\ldots (4-3)$$

Through this indicator the extent of or an extension of the road network is reached in the city and thus judging the network is complete (Ibid ,2011),

The $\boldsymbol{\beta}$index is in fact ½ of the average number of links servicing each node and it represents the circulation of road network. It ranges between zero and three for most route networks; a value of $\boldsymbol{\beta}$below one indicates not – fully connect network, while a value of more than one indicates an increasing complexity (very well connected network). Thus; $\boldsymbol{\beta}$index differentiates simple topological structures from complicated topological structures.

2-(Alpha) index (0-1)

The $\boldsymbol{\alpha}$index is calculated as follows:

$$\alpha = \frac{\mathrm{e} - (\mathrm{v} - 1)}{2(\mathrm{v} - 5)} \dots \dots (4 - 4)$$

The $\boldsymbol{\alpha}$ Index represents another pattern of patterns, methods of analysis of the degree of coherence in the transport network, this guide measures the rate of circulatory in the network any maximum possible number can stay on the road network in the city, ranging from the value of this indicator between (0-1), where zero means no a correlation to the network while (1) means having a maximum correlation to the network (Ibid ,2011).

3- (Gamma) index (0-1)

The $\boldsymbol{\gamma}$ index is calculated as follows:

$$\gamma = \frac{\mathrm{e}}{3(\mathrm{v} - 2)} \dots \dots (4 - 5)$$

It is one of the best quantitative measures used to measure the degree of interdependence, and differs from the beta that takes into account the number of links that can be found within the network, This indicator is

based on the maximum number of connections that can form the road network, starting with the value of this indicator between index (0-1), where zero means there is no link to the network while (1) means that there is a maximum link to the network (Ibid ,2011).

4- ε (Eta) index

The **ε** index is calculated as follows:

$$\varepsilon = \frac{m}{e} \ldots\ldots (4-6)$$

The **ε** index, which calculates the total length, introduces some notices of geographic scale; the more densely a network is packed into a region , the greater the number of junctions the shorter will edge length become. Therefore, **(ε)** is expected to be high in ill-developed networks and low in well-developed networks.

In this study, the first part of network analysis of road network is measuring the performance of Al-Nasiriyah city road network by using the measures developed in graph theory. The degree of complexity of road network, the links shape file is reduced from 1523 links to 946 links by removing all local roads and consequently the node shape file is also reduced from 1232 nodes to 662 nodes as shown in the Figure (4-9).

After studying the theoretical side of the indicators above and finding out the extent of their impact on the road network in the city these indicators are part of the network analysis and determine the level of performance of this network.

Referring to (4.7)

- Number of edges (e) = 946
- Number of vertices (v) = 662
- The total length of network (km) = 407.517 km

1- From Eq. No.(4-3);

$$\beta = \frac{946}{662}$$

$$= 1.429 > 1.0$$

The β is a slightly complex road network as a result of the few increases for the one who is considered the optimal network situation, and this situation is due to the presence of a number of links, which far exceeds the number of nodes.

2- From Eq. No. (4-4);

$$\alpha = \frac{946 - (662 - 1)}{2(662 - 5)}$$

$$= 0.217 > 0.0$$

According to this index, the degree of coherence within the network is considered slight for its proximity to zero

3- From Eq. No. (4-5);

$$\gamma = \frac{946}{3(662 - 2)}$$

$$= 0.478 < 1.0$$

According to the γ index, the network correlation is considered low because it is less than one, meaning that a number of a few links are correlated with each other, and this is the most accurate among the indicators index

4- From Eq. No. (4-6);

$$\varepsilon = \frac{407.517}{946} = 0.430$$

Because of the low value of this indicator, which amounted to 0.430, the network is considered relatively developed.

4.10 ArcGIS Network Analysis

The network analysis process is the most important functions that GIS can be carried out in efficiently. Because the movement of people, and their activities and the distribution of merchandise, services and energy is through road networks and infrastructure, the shape and the efficiency of these networks determines significantly the level of people's lives and significantly affect the distribution of services and efficient networks. And provide practical networking different media analysis for the study of any network and determine the extent of the Impedance of every part of the process to walk and to express it in digital form, and then begin the process of dealing with that network through a series of commands defined spatial orders that calculates the desired tracks and displays them to the user in the form of the concept.

The ArcGIS Network Analyst extension allows you to build a network dataset and perform analyses on a network dataset. The best way to learn Network Analysis is to use it. In the exercises in this tutorial, you will do the following:

- Use Arc Catalog to create and build a network dataset from feature classes stored within a geodatabase
- Define connectivity rules and network attributes for the network dataset
- Perform various network analyses in Arc Map using the Network Analyst toolbar
- Learn how to use the Network Analyst geoprocessing tools to create models that automate analyses.

4.10.1 Impedance of Network

When dealing with any network, if the roads for any area network is noticed that all the way through its impedance to the conduct of its own, which is known as impedance that is the outcome of a variety of properties distinguish it.

When the analysis uses the network tool based analysis gives a weight of each of the factors (speed, length of the roads, capacity, travel time, etc.) Depending on the data and statistics collected for roads, then collects these weights to calculate the final impedance of the road which is used by geographic information system GIS in the different calculations for the analysis of the network. It uses geographic information database of the network system for analysis on this basis.

4.10.2 Create a Network Dataset

Create a network dataset using a geographic database The road network features Nasiriyah, this is illustrated in Figure (4-12), It will also include historical movement data so that you can resolve the methods of time-dependent factors that previously mentioned.

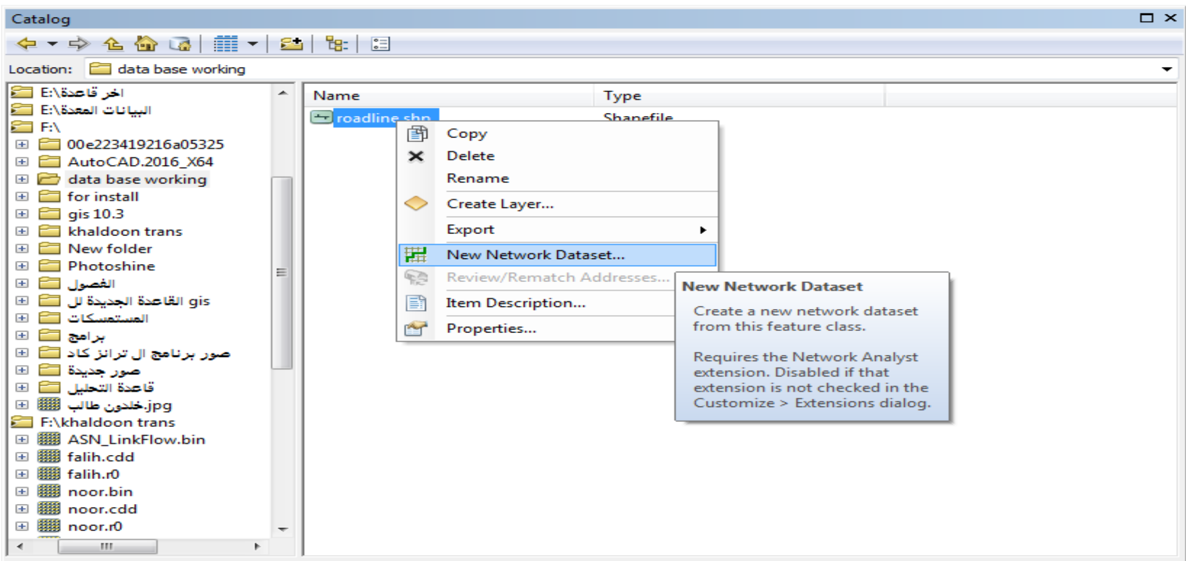


Fig.(4-12): Creating new network dataset

4.10.2.1 Steps are Network Based on the Arc Catalog of The Following:

1- Enter a name of your network dataset

2- Select the feature class

3- Connectivity of network

4- Model turns for network

5- Select the network attributes that are displayed.

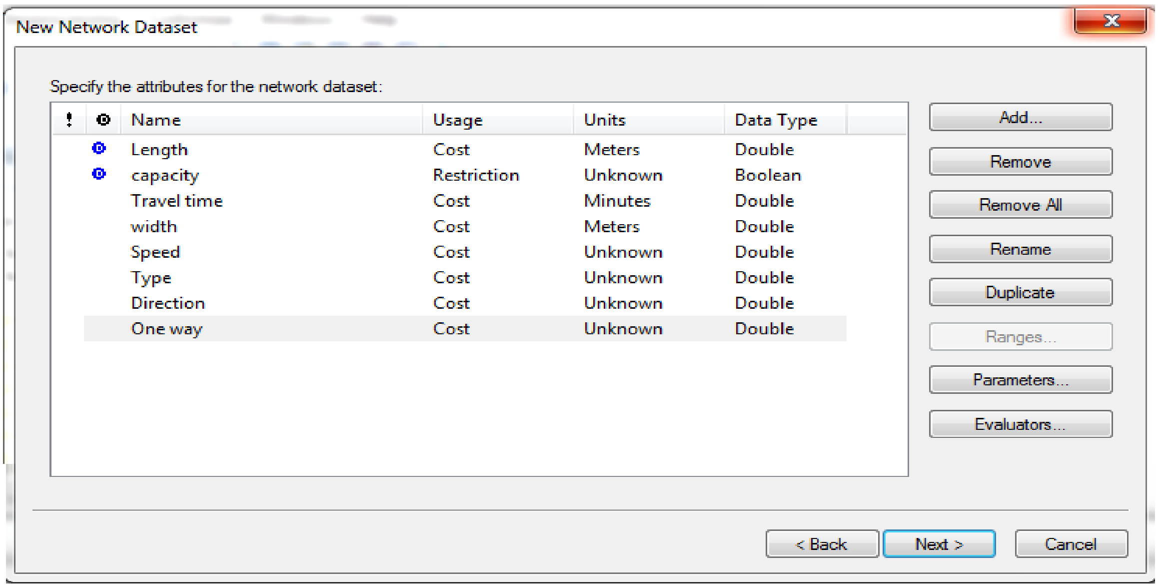


Fig.(4-13): Selecting the attributes for analysis dialog box

6- Network Directions Properties

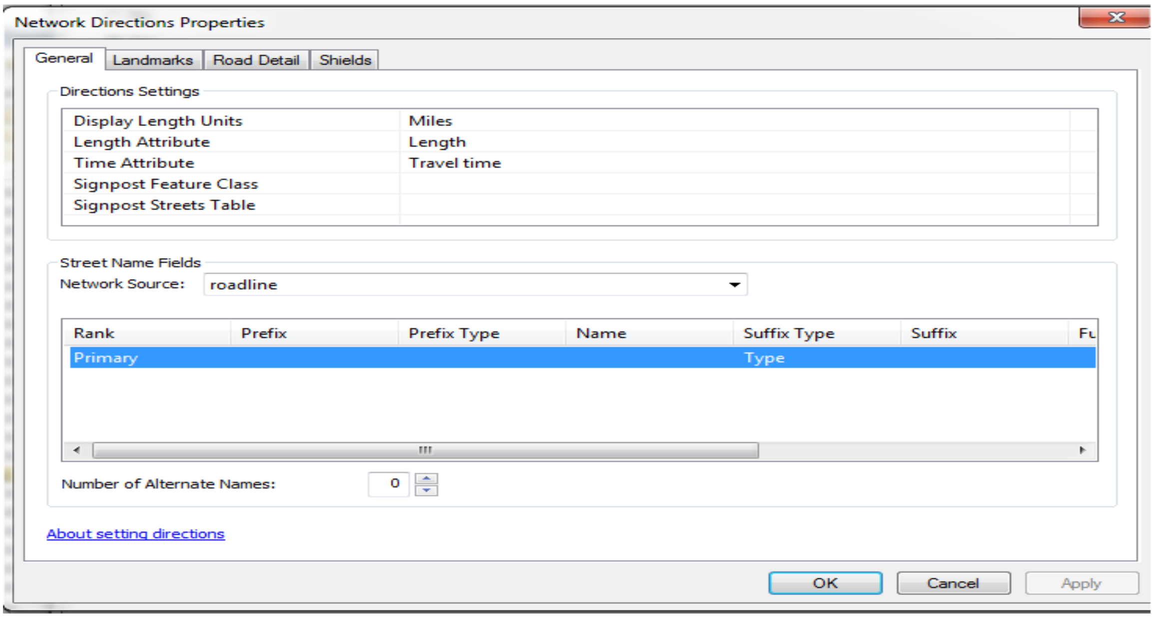


Fig.(4-14): Setting the direction of the network dialog box

7- Summary for network dataset

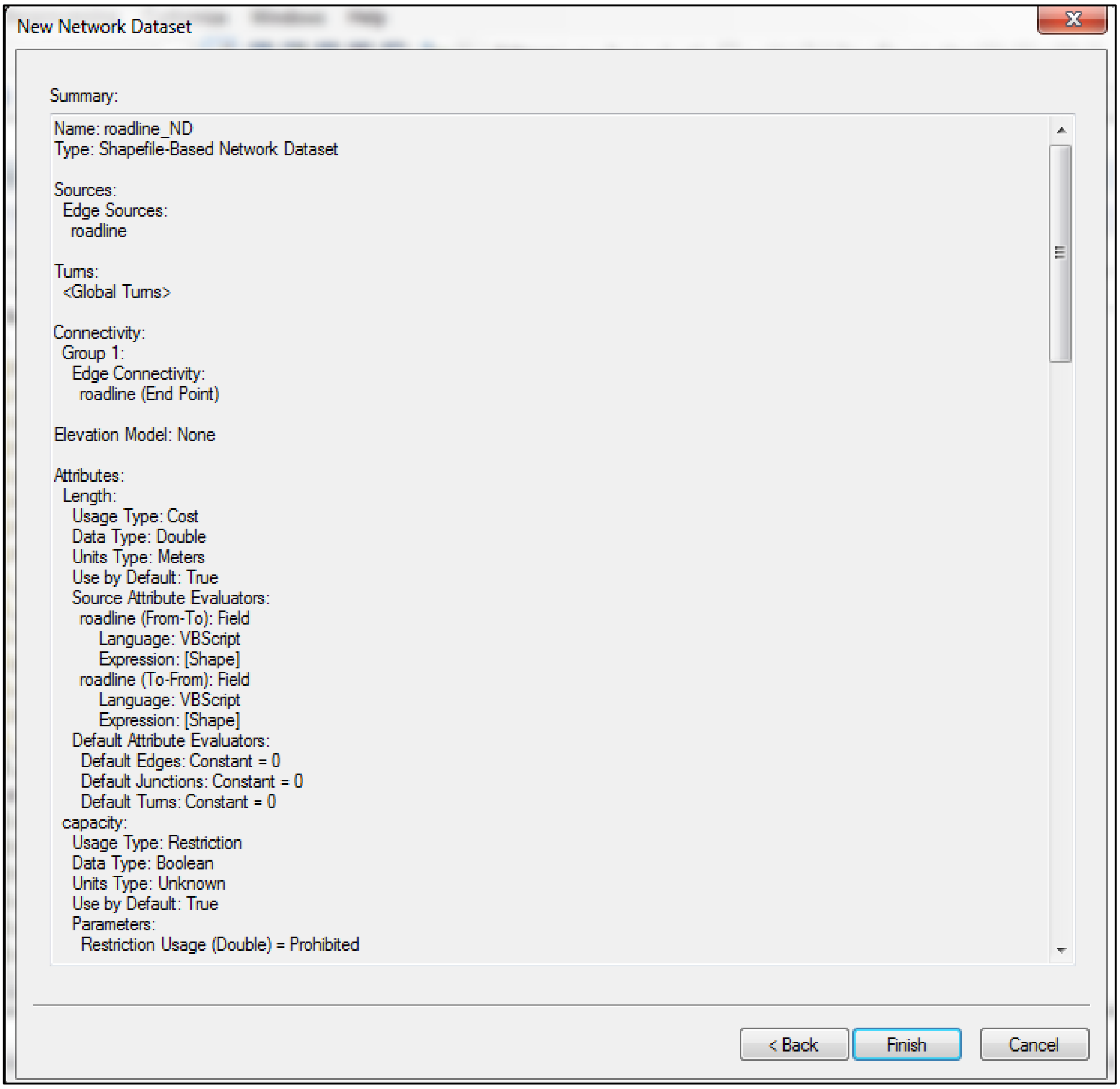


Fig.(4-15): Summary of network dataset dialog box

4.10.3 Network Analysis

4.10.3.1 Finding the Best Route Using a Network Dataset

It is useful to find the best route for each main entrance which number six to the center which as Bahoo intersection

1- North entrance (EX1) to Bahoo intersection

When choosing a point identifier (465) at the beginning of the northern entrance of the city, its symbol is (EX1), then it is chosen another point in the intersection and its identifier (555), the best Route is chosen by the geographic information system shown in Figure (4-16).

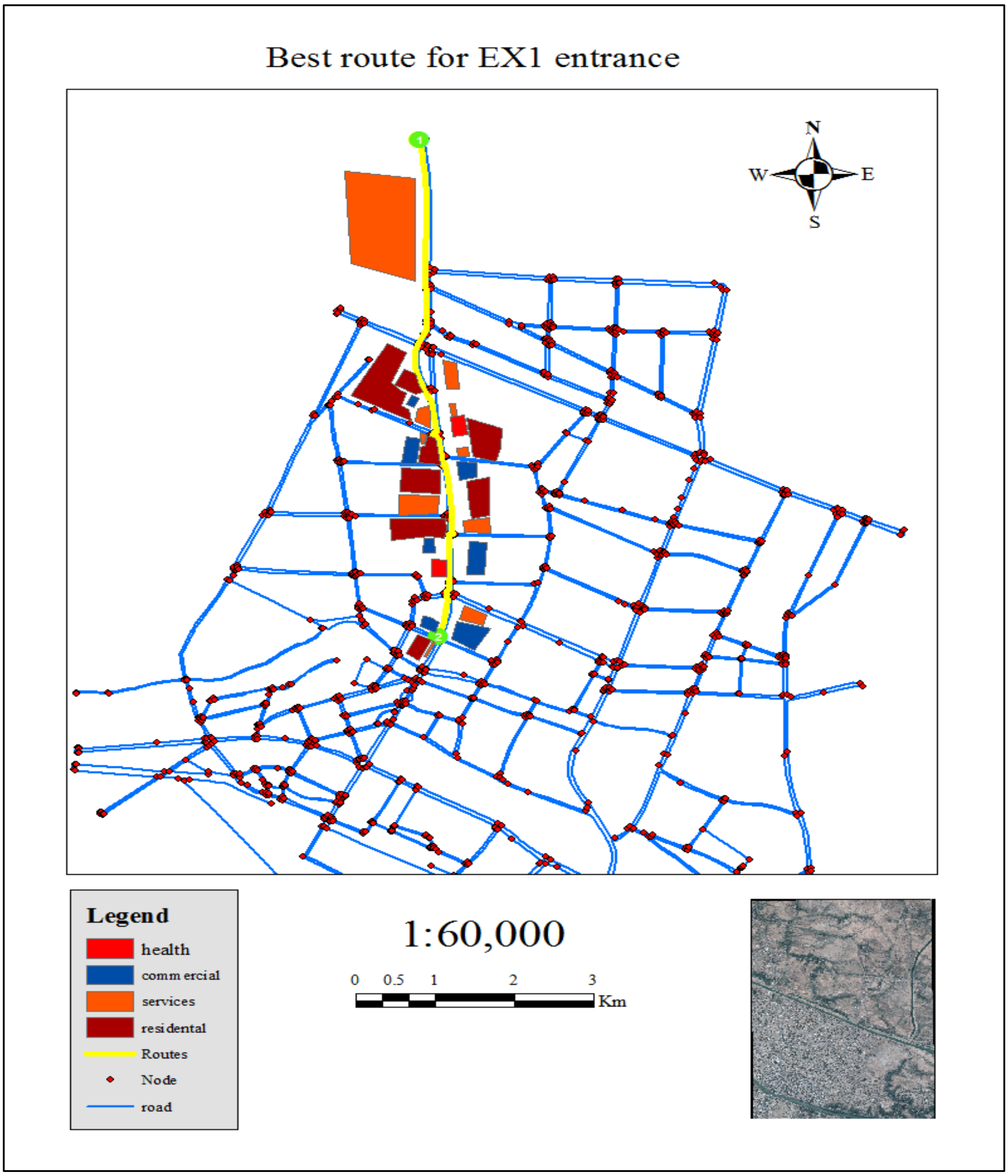


Fig.(4-16): Best route from EX1 to Bahoo intersection

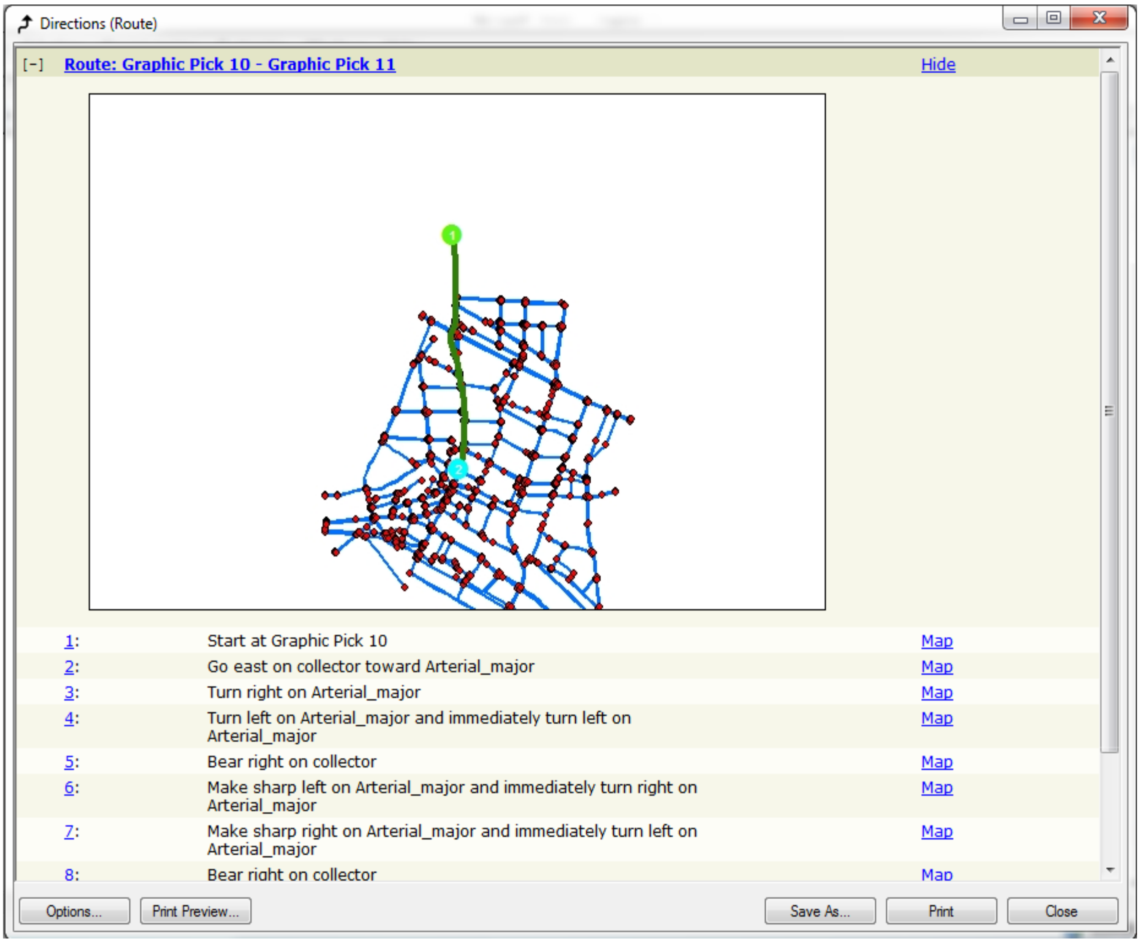


Fig.(4-17): Information about the best route (EX1to Bahoo intersection)

Table (4-8): Properties of best route from EX1 to Bahoo intersection

Attribute	Value
First stop ID	EX1
Last stop ID	Bahoo intersection
First stop No.	465
Last stop No	555
Total distance	10.43 Km
Speed	60 Km/h
Travel time	11.31 minutes
Capacity	1242.82 (pcph)

This is the best route between other routes and has been chosen on the basis of Global Standards has to distinguish between the characteristics of other routes as illustrated in the Table (4-8) and Figure (4-17) and also taking into consideration the shortest length and shortest time to get to the city center.

2-East entrance (EX2) to Bahoo intersection

North eastern entrance (EX2) for Saieed-Dakheel region was selected at the beginning of the entrance node number (1081) and also was selected as a center of the intersection of the Bahoo of the city it was the result of the analysis to choose the best route as illustrated in Figure (4-18).

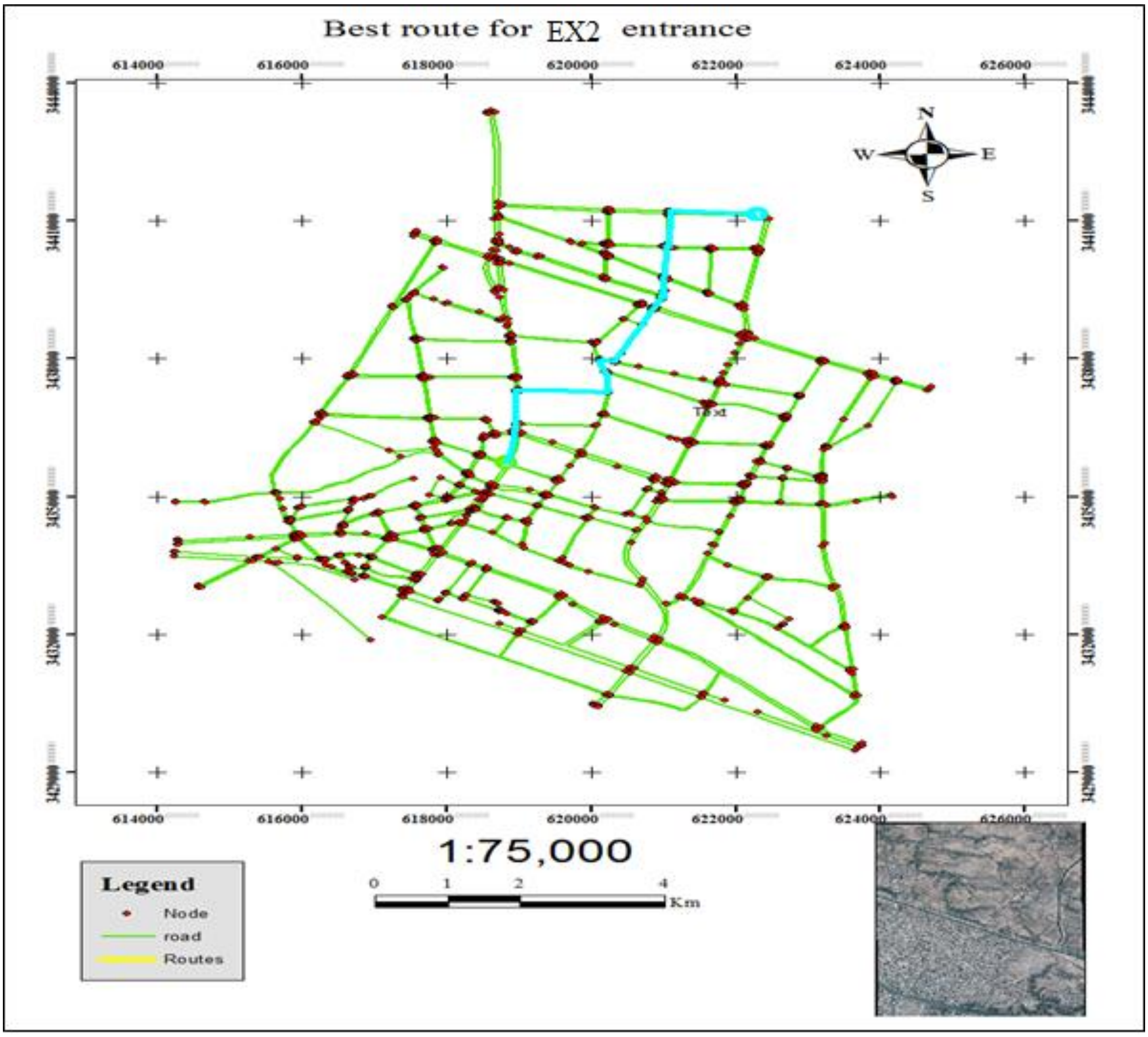


Fig.(4-18): Best route from EX2 to Bahoo intersection

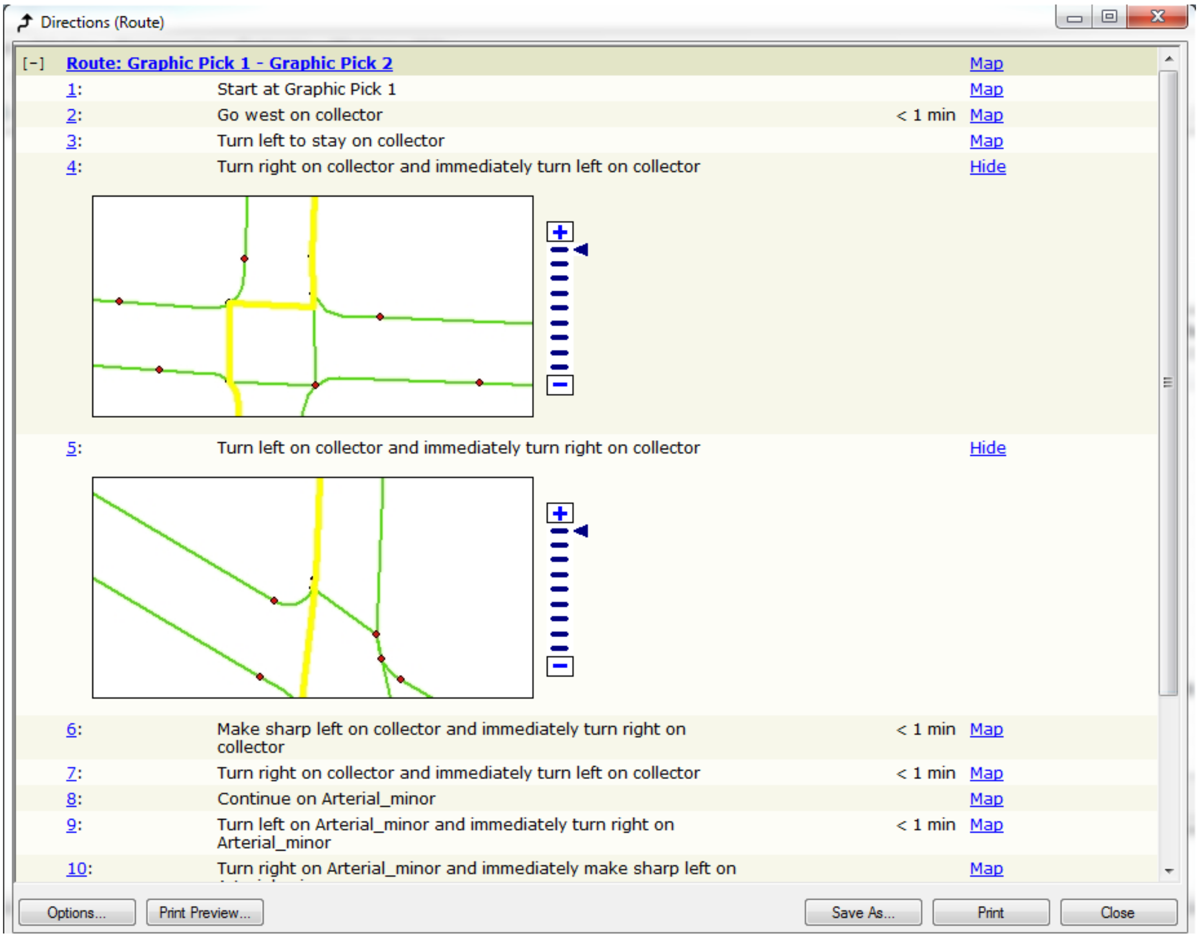


Fig.(4-19): Information about the best route (EX2 to Bahoo intersection)

Table (4-9): Properties of best route from EX2 to Bahoo intersection

Attribute	Value
First stop ID	EX2
Last stop ID	Bahoo intersection
First stop No.	1081
Last stop No	555
Total distance	9.263 Km
Speed	70 Km/h
Travel time	12.86 minute
Capacity	2310.681 (pcph)

This is the best Route that should be used in spite of the use of another road now, which passes the northern entrance (EX1) so it is important to provide services to the Route that has resulted from the analysis in (EX1) because it saves time and is shortest length as shown in Figure (4-19) and Table (4-9) in addition to reducing traffic congestion at the northern entrance, which is one of most important entrances to the city.

3- South entrance (EX5) to Bahoo intersection

Fifth entrance is a private entrance to the coming vehicles from Basrah, it is one of the main entrances where the identified node is in the beginning of the entrance ID (715) and also identified the end of the trip in the city center is identified which is the Bahoo intersection and also identified the node ID (570) in the city center is identified where the best path chosen through analysis is shown in Figure (4-20)**.**

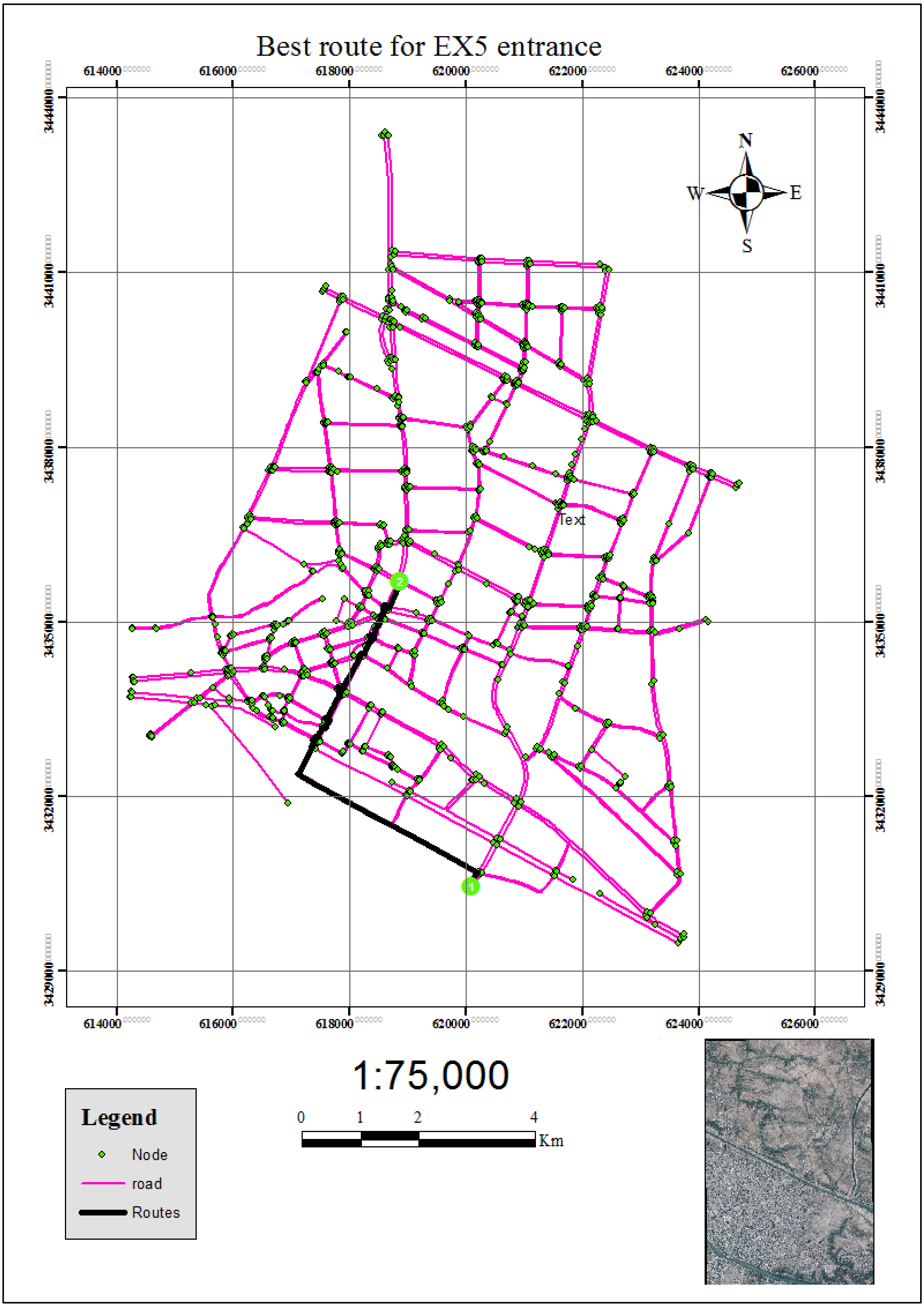


Fig.(4-20): Best route from EX5 to Bahoo intersection

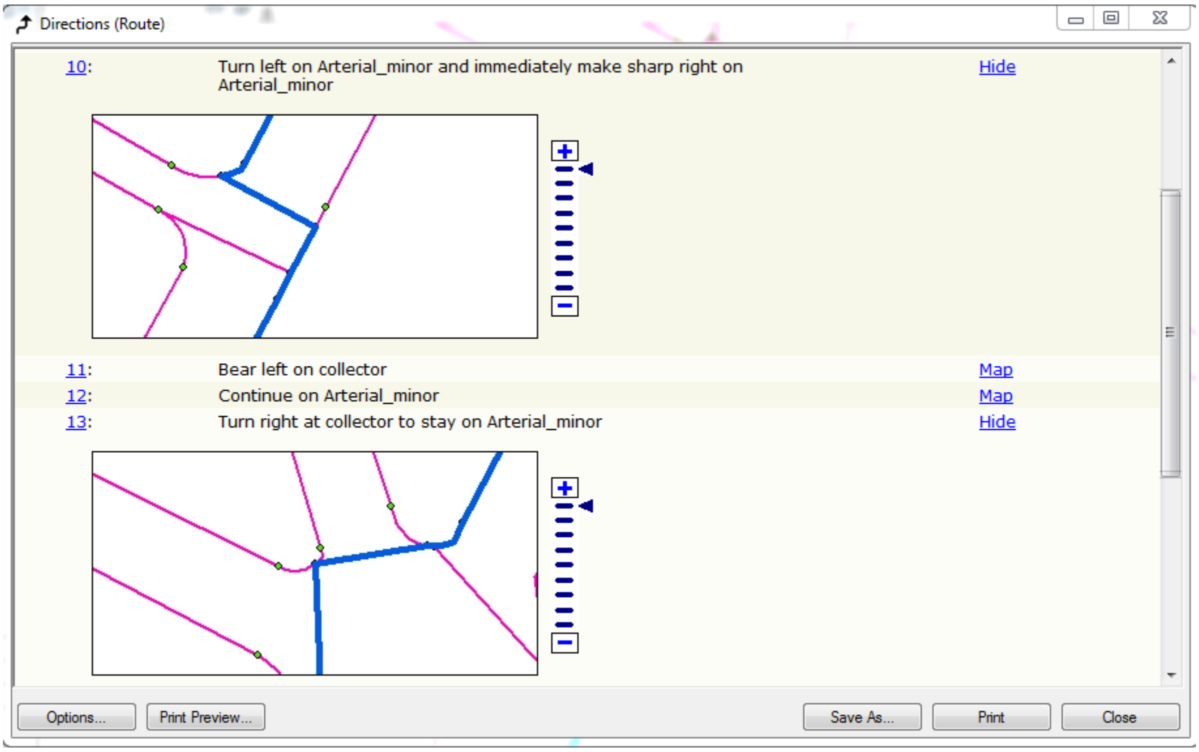


Fig.(4-21): Information about the best route (EX5 to Bahoo intersection)

Table (4-10): Properties of best route from EX5 to Bahoo intersection

Attribute	Value
First stop ID	EX5
Last stop ID	Bahoo intersection
First stop No.	715
Last stop No	570
Total distance	6.345 Km
Speed	80 Km/h
Travel time	8.72 minute
Capacity	2097.540 (pcph)

The proposed road, which represents the best path between the ways is through a new unused lot and not many intersections pass which reduces the time it takes for the trip and is at the lowest length and advantages of this road are that it passes by the train station in the city and all the information on this road is shown in Figure (4-21) and Table (4-10).

4- Southwestern entrance (EX6) to Bahoo intersection

It is the second most important entrance after entrance (EX1) in terms of the number of vehicles entering and leaving because it is associated with the national highway, where it was selected point number (12) which is located at the start of the entrance also into the city center at the point No. (570) at the intersection of the Bahoo and when analysis path appears as indicated in Figure (4-22).

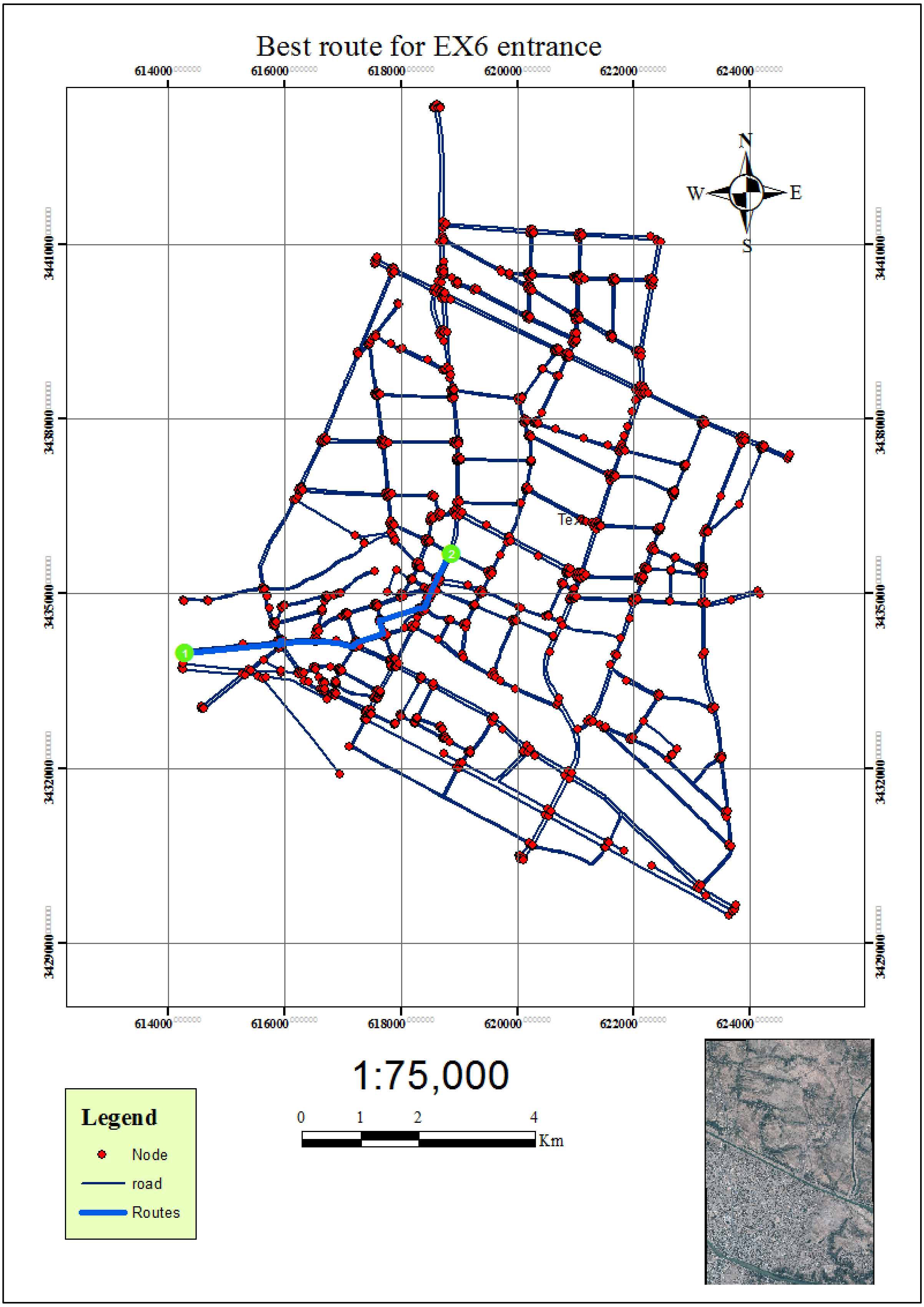


Fig.(4-22): Best route from EX6 to Bahoo intersection

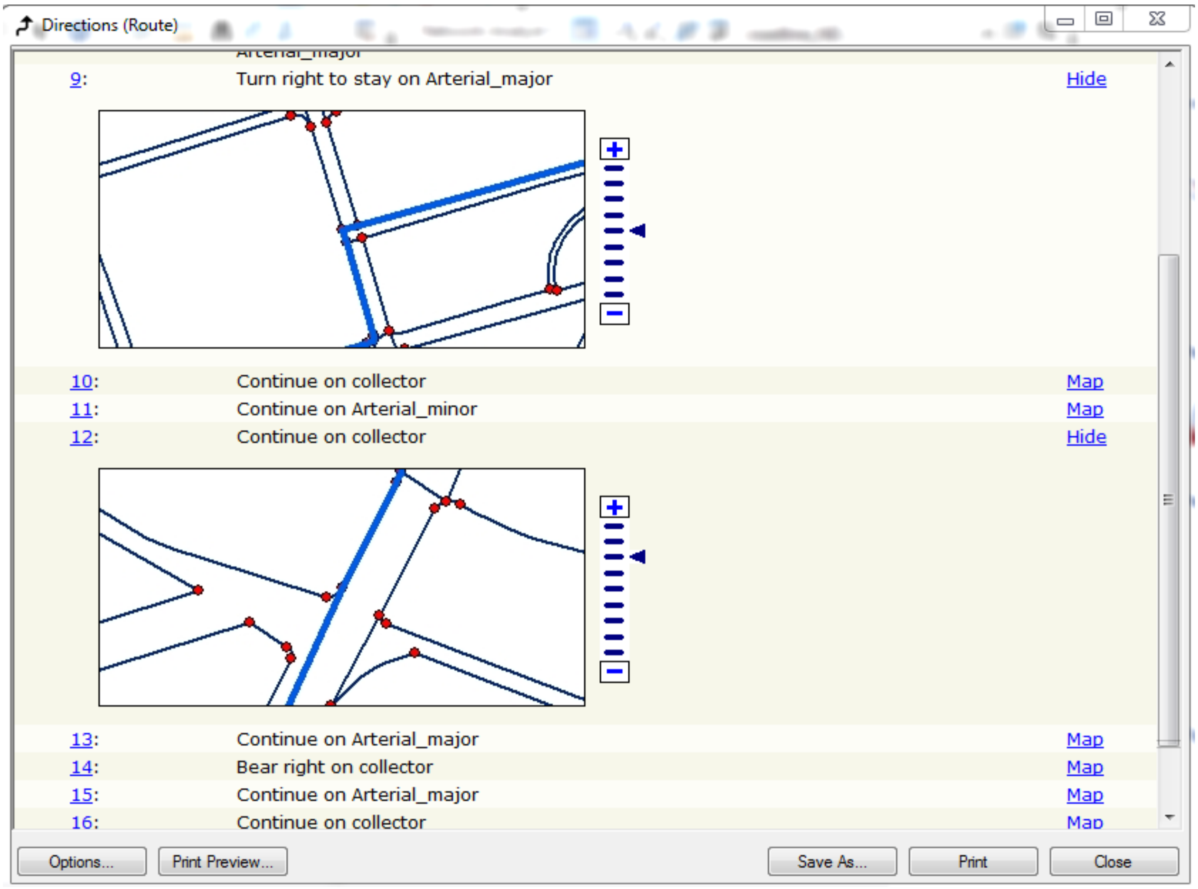


Fig.(4-23): Information about the best route (EX6 to Bahoo intersection)

Table (4-11): Properties of best route from EX6 to Bahoo intersection

Attribute	Value
First stop ID	EX6
Last stop ID	Bahoo intersection
First stop No.	12
Last stop No	570
Total distance	9.696 Km
Speed	70 Km/h
Travel time	12.22 minute
Capacity	2418.510 (pcph)

Suggested route shown in Figure (4-21) represents the best path into the city it is noticeable it is passing through the lowest number intersections

and along the less possible and information shown in Figure (4-23) and Table (4-11).

4.10.3.2 Adding a Barrier on The Route

In this section a barrier will be added to represent a road block ,and will be to find alternative route destination**.** This tool is used when it is in a street in the proposed path (maintenance work for one of the services, checkpoints, or there is a particular traffic problem, etc.) that it will be necessary to convert the path of the road for the second best route after the first route, which occurred by a certain malfunction. It was applied on the best path that was chosen for the entrance (EX5) therefore barrier points are placed to represent of a lot of checkpoints and also when road repairs are going on the roads this is shown in Figure (4-24).

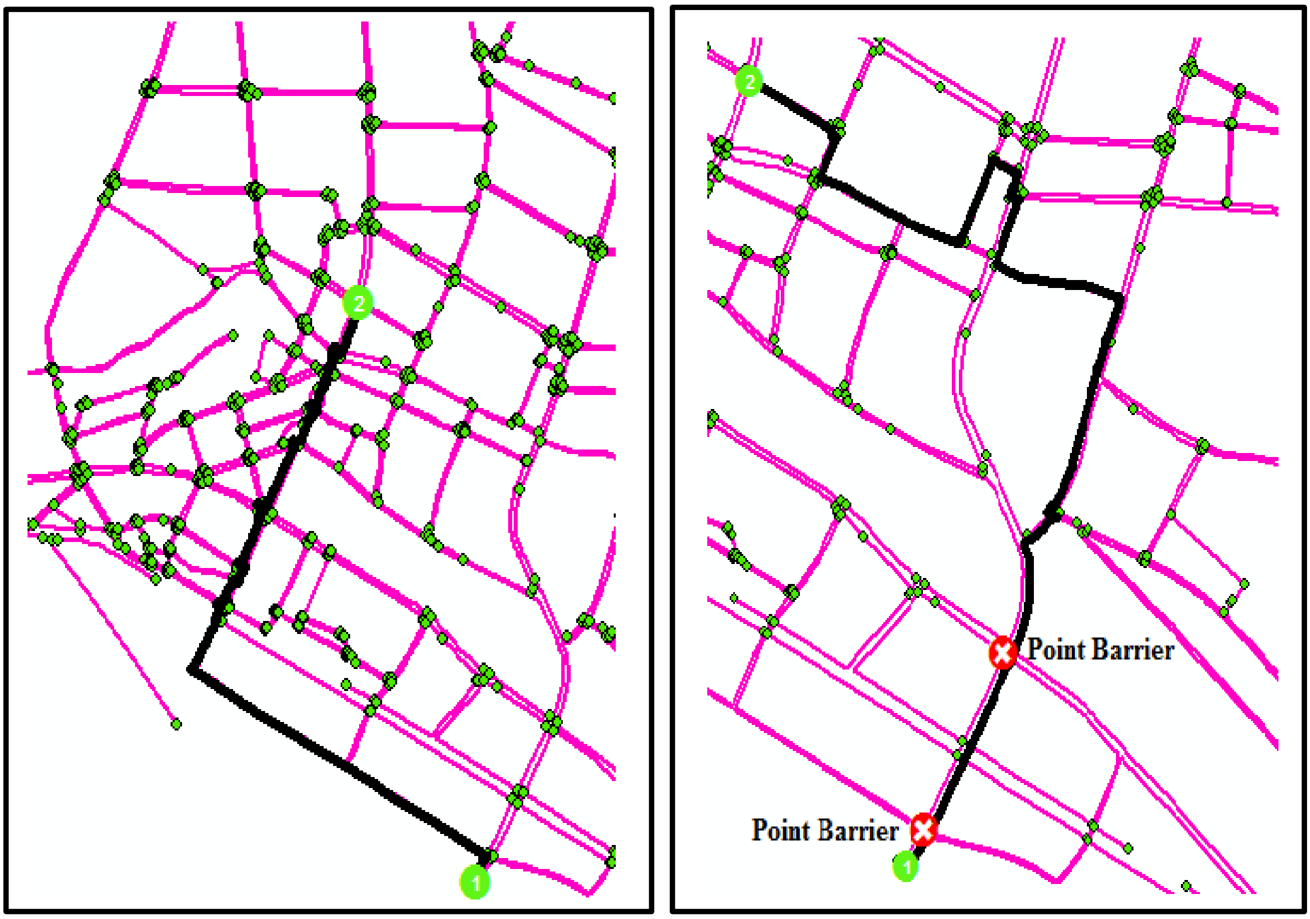


Fig.(4-24): Best route

a- Before adding the barrier b- After adding the barrier

There are some attributes that are different from those of the previous route which has already added the barriers of which the length of the new route is close to the original route shorter, but the speed is lower at 60 km / h as well as the capacity of the new route was lower approximately, at 1944, and the time the trip takes for amounted to approximately 17 minutes, This is illustrated in Table (4-12).

Table (4-12): A comparison between attributes of the best route that was chosen and the path that is extracted after adding barrier

Attribute	Value before adding the barrier	Value after adding the barrier
First stop ID	EX6	EX6
Last stop ID	Bahoo intersection	Bahoo intersection
First stop No.	12	12
Last stop No	570	570
Total distance	9.696 Km	9.159
Speed	70 Km/h	60 Km/h
Travel time	12.22 minute	17.42 minute
Capacity	2418.510 (pcph)	1944.761(pcph)

4.10.3.3 Calculating Service Areas

It is one kind of network analysis, which aims to find out range of various services and shows the effect of the distribution of these services on the network and how to access these services in the best routes application to the distribution of health care services the results are described as Figure (4-25).

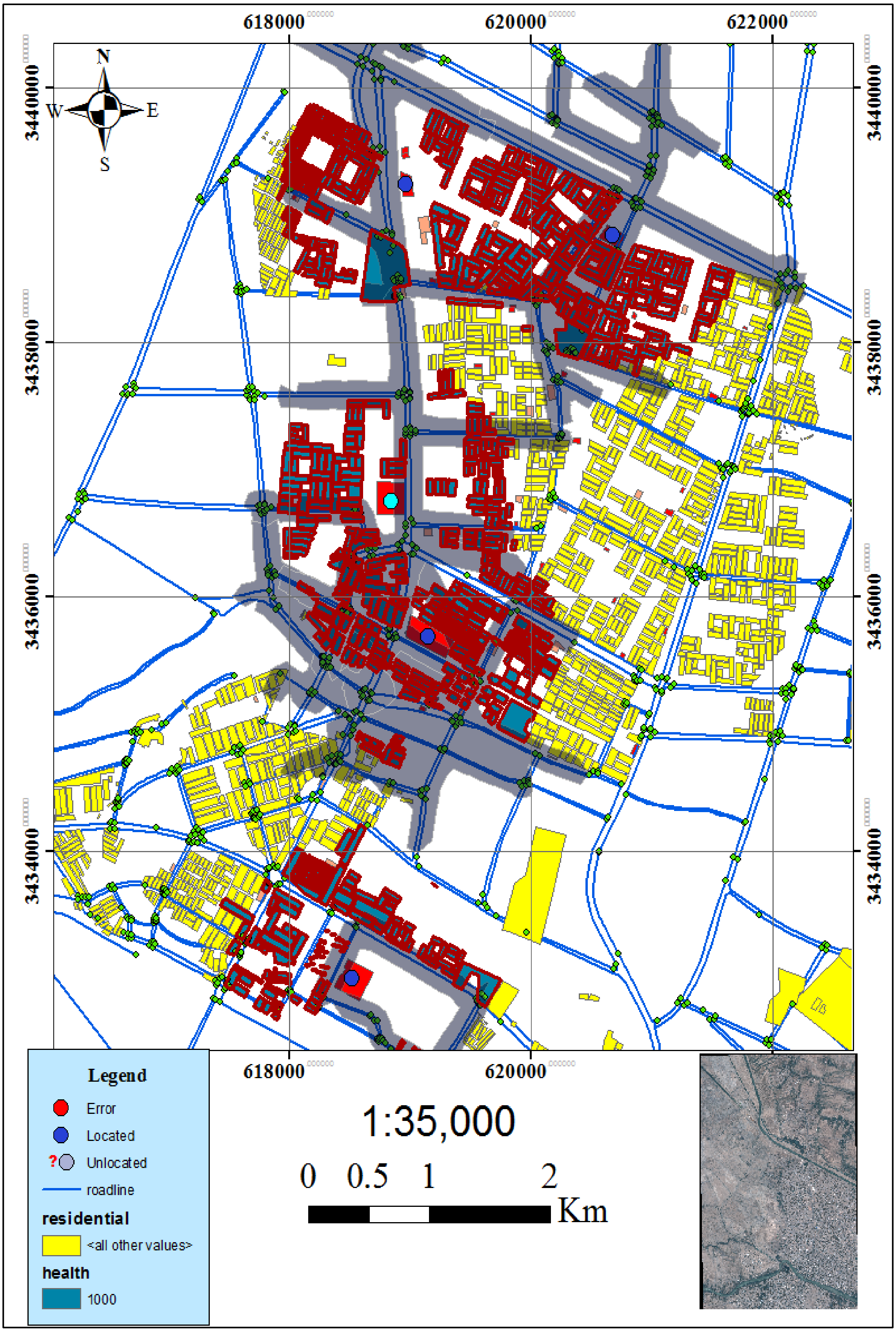


Fig.(4-25): The influence of the health service areas in the province and how to access them through the transport network

From the figure above it is noted services are centered in the middle of the network and the non-coverage for each residential areas. Health services cover only residential areas that are painted red and form a gray illustrates the roads in which the network services that reach areas.

4.10.3.4 Creating an OD Cost Matrix

Optionally it is possible to create a matrix of the original cost of the destination to move from a certain point called origin to other points called destination . Three points were chosen at the entrances to the city, a point of origin has been selected three a dynamic points in the city center a destination point. The results of this matrix can be used to identify the routs that will be launched from every point.

After a process of analysis using the (network analysis) the result was shown in Table (4-13) .The specifications of each path resulted after the analysis in terms of (path length, speed, and capacity of the road, and the time it each trip takes to the road) and Figure (4-26) shows the forms of these routes.

Table (4-13): The resulting routes specifications after the analysis which can be configured O-D matrix

ID	Name	Length (Km.)	Time (min.)	Capacity (pcph)	Speed (Km/h)
10	Graphic Pick (1 – 7)	10.4376	14.02	3296.734	70
11	Graphic Pick (1 – 6)	11.1171	14.62	3222.595	60
12	Graphic Pick (1 – 8)	12.6117	17.48	4151.554	50
13	Graphic Pick (3 – 8)	5.2036	6.91	1576.316	80
14	Graphic Pick (3 – 7)	6.3380	8.74	2120.645	70
15	Graphic Pick (3 – 6)	7.0104	9.78	2305.284	50
16	Graphic Pick (4 – 8)	7.4062	8.47	1325.191	80
17	Graphic Pick (4 – 7)	9.5761	11.92	2179.519	70
18	Graphic Pick (4 – 6)	10.1720	12.96	2333.158	40

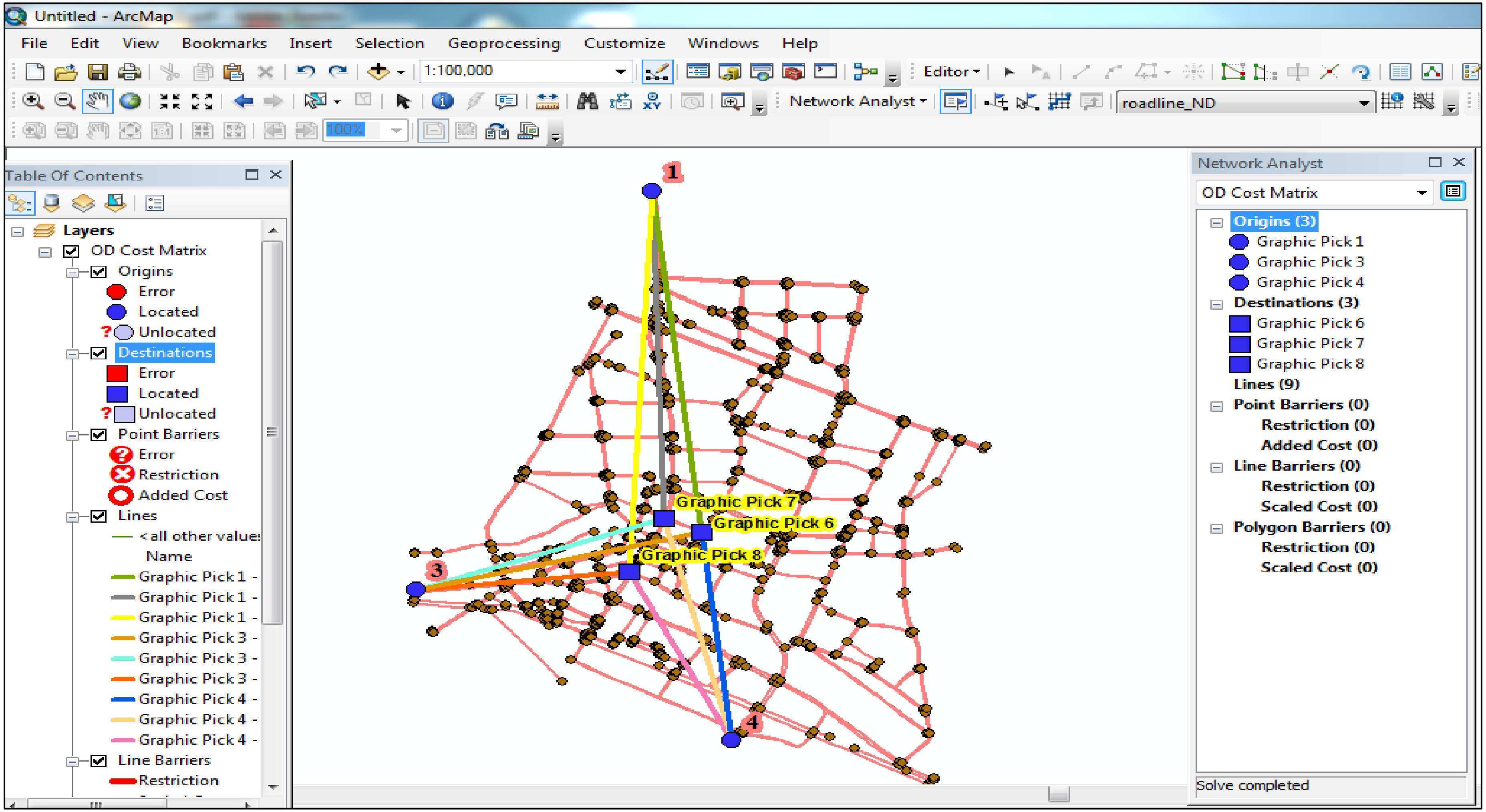


Fig.(4-26): Form illustrates points of origin and destination, their routes after making the analysis process

Chapter Five

Traffic Assignment Model

5.1 General

This chapter includes the detailed analysis of the final stages of the methodology of this study. It deals with the major step in the travel demand modeling process (Traffic Assignment). Traffic assignment models are used to load or assign the flow of traffic on a network (usually expressed as a matrix identifying the number of trips) . The purpose of trips distribution is to estimate number of trips generated ,that is explained in (ch.3) from TAZ to every others within the study area. Generally, traffic is assigned to the fastest route from the origin to destination. The analysis is done using TransCAD software . Finally, the proposals improved transportation network for Al-Nasiriyah city.

5.2 Traffic Assignment Model in TransCAD

Traffic assignment models are used to estimate the flow of traffic on a network. These models take a certain demand for travel usually expressed as a matrix identifying the number of trips between all possible origins and destinations (O-D pairs) and then loads or 'assigns' these trips to the network itself. Generally, trips are assigned to the fastest possible route from the origin to destination. The end result is a table containing the number and characteristics of flows observed on each link in the network. These results are a key element in the urban travel demand forecasting process and are used in a variety of applications including benefits estimation, air quality impact analysis, modal choice analysis and traffic safety models.. Figure (5-1) shows the process used for Al- Nasiriyah traffic assignment model.

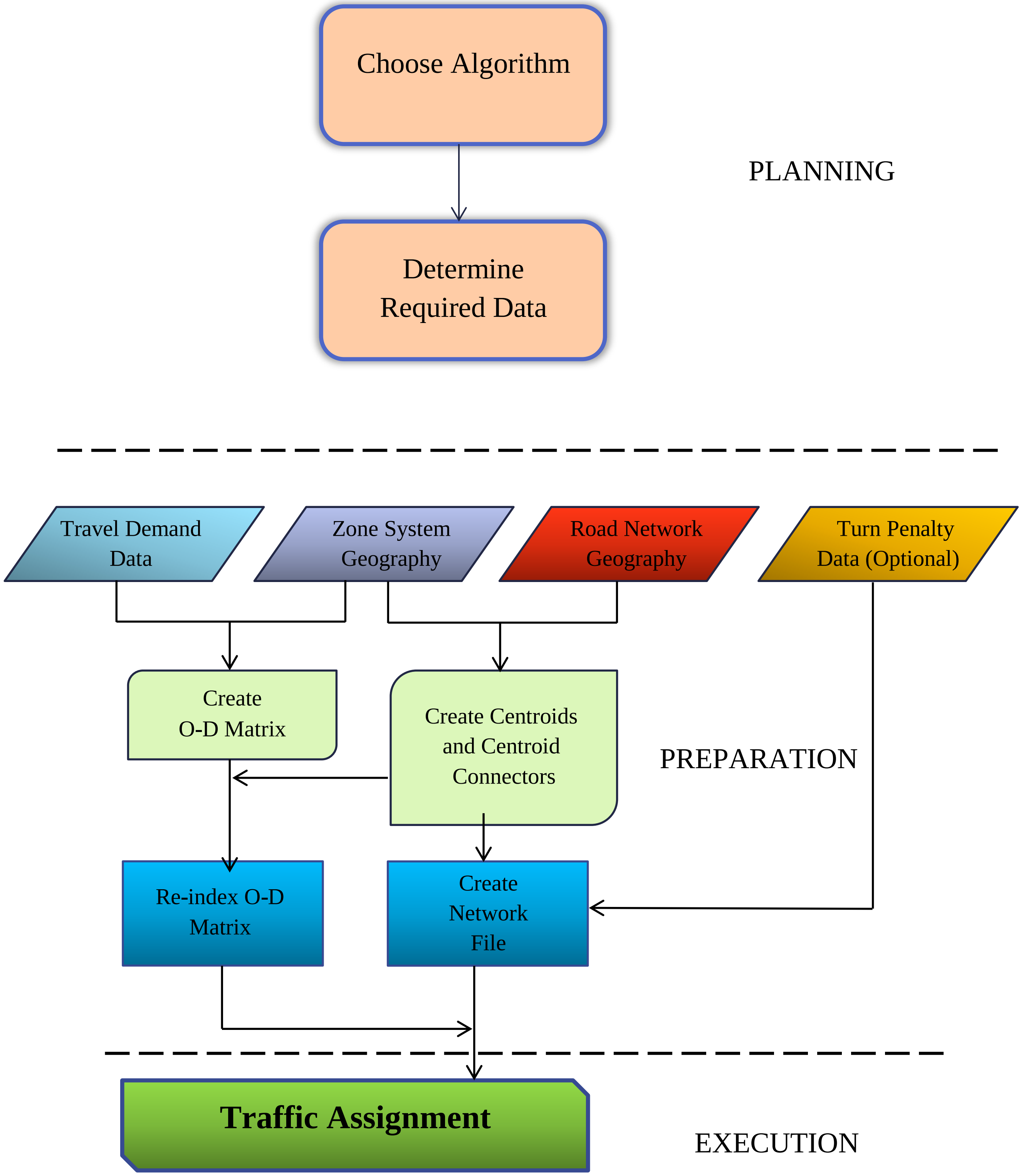


Fig.(5-1): Traffic Assignment Process

5.3 The Assignment Models

There are seven traffic assignment models available in the TransCAD software ver. 4.5, each of them is encountered in transportation planning practices . These models are:

1- All-or-Nothing Model.

2- STOCH Model.

3- Capacity Restraint Model.

4- Incremental Model.

5- User Equilibrium Model.

6- Stochastic User Equilibrium Model.

7- System Optimum Model.

Table (5-1) presents a brief description of these different models to understand the conceptual differences between algorithms and what applications they might be useful in this study. The regular models utilized are: All-or-nothing, User-equilibrium, and System-optimum assignment models. Stochastic User-equilibrium Model is used for traffic assignment in this study.

Table (5-1): Traffic Assignment Models Algorithm Summary

Assignment Method	Assignment Methodology	Iterative	Conver =gent	Required Network Attributes	Required Algorithm Settings
All-or-Nothing	All flows assigned to least costly route	No	No	Time	None
STOCH	All flows assigned to least costly route (systematic error introduced)	No	No	Time	Theta
Capacity Restraint	Repeated All-or-Nothing assignments. Link speeds updated each iteration.	Yes	No	Time Capacity	Iterations Convergence Alpha Beta
Incremental	Small fraction of total flow assigned per iteration. Link speeds updated each iteration	Yes	No	Time Capacity	Iterations Convergence Alpha Beta
User Equilibrium	Mathematical minimization of Individual user's travel time.	Yes	Yes	Time Capacity	Iterations Convergence Alpha Beta
Stochastic User Equilibrium	Mathematical minimization of Individual user's travel time (systematic error introduced).	Yes	Yes	Time Capacity	Iterations Convergence Alpha, Beta Function Error
System Optimum	Mathematical minimization of total system travel time.	Yes	Yes	Time Capacity	Iterations Convergence Alpha Beta

5.4 Inputs Required in Traffic Assignments

Traffic assignments in TransCAD ver. 4.5 require two main inputs:

1- Road network file.

2- Origin-destination, or ‘demand’, O-D matrix.

The following sections will more details about the road network and O-D matrix files used in these methods.

5.4.1 Road Network File

A network file is a special data structure used by TransCAD software ver.4.5 to store the characteristics, attributes and spatial layout of a transportation system. This file is used in an array of transportation planning applications including traffic assignment but isn’t like the standard shape files and geographic files employed in most GIS based analysis.

Network file is created from the line and node layers that are prepared using Arc GIS 10.3 program discussed previously. Figure (5-2) presents the Arc GIS line and node layers and their attribute tables used in the TransCad software ver. 4.5 to construct the network file.

At the time of creation the network file, you must select which attribute fields of the line and node layers will be stored in the network file. Every network file requires that its length be specified, but there is additional information required to be included in the network depending on the traffic assignment model is performed.

The Stochastic User Equilibrium (SUE) and System Optimum Assignment (SOA) methods require data on both travel time and capacity of each link (street) must be included when creating the network File.

1- Link Id: presents the identified number (Id) of the link (street) in the network.

2-Length: represents the length of each link (street length) in the network measured in [km].

3- Width: presents the width of each link (street width based on the number of lane) in [m].

4-Direction: presentst the direction of flow on the link [1] for link flow in two directions, [0] for link flow in one direction.

5- Speed: presents the operating speed of vehicles on each link measured in [Km/h].

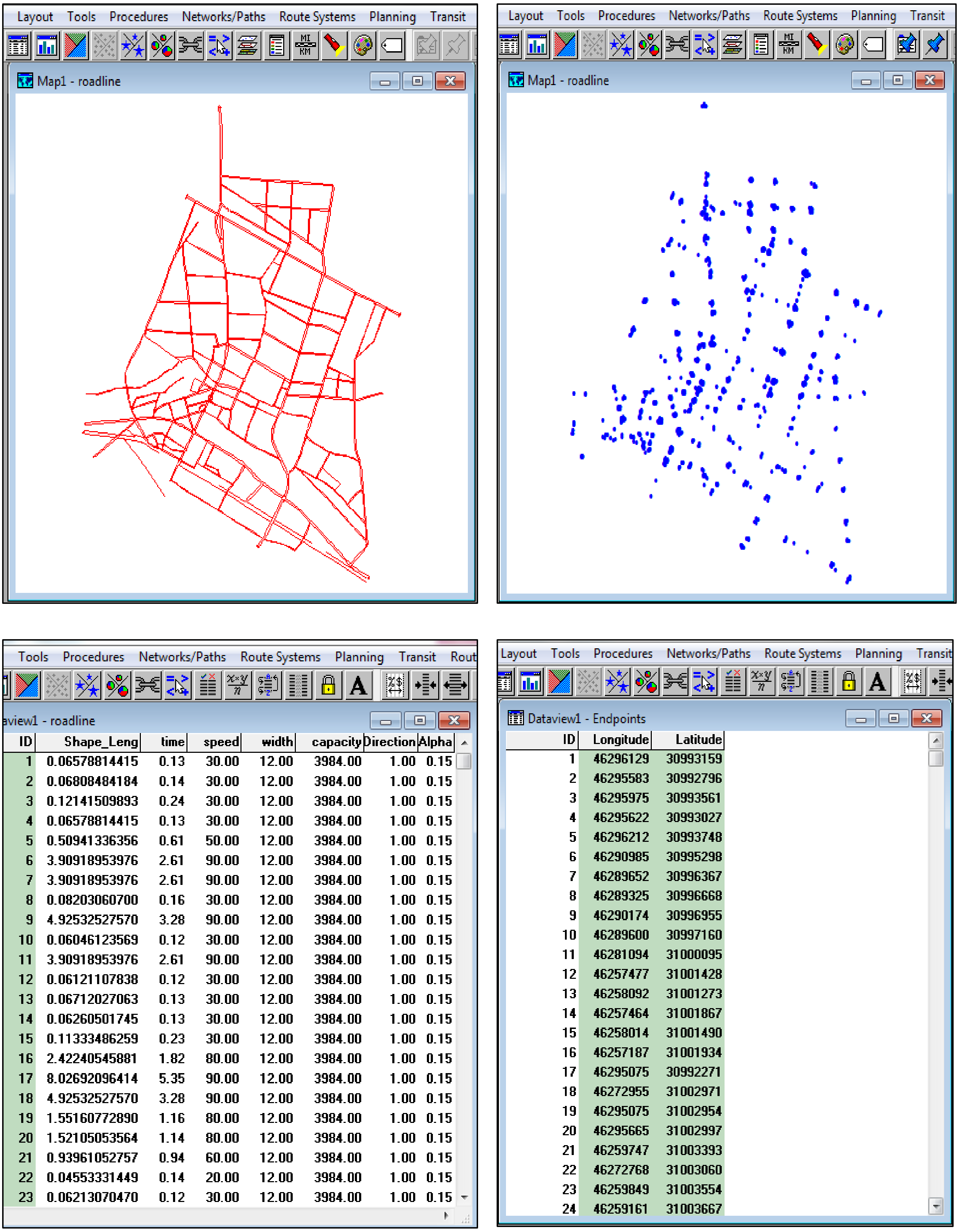
6- Travel Time: presents the time required for vehicle to traverse the link measured in [min].

7- No. of Lane: presents the number of lanes for each link in the network.

8- Capacity: represents the capacity of each link is calculated using the Highway Capacity Manual 2000, HCM (Chapter 20, 21) procedures.

9- Volume: represents the external- external traffic volume in the network links.

10-α, β: presents volume /delay coefficients. Explain how severely increasing link flows affects link travel time. The program default values used are (0.15, 4.0).



ID	Shape_Leng	time	speed	width	capacity	Direction	Alpha
1	0.06578814415	0.13	30.00	12.00	3984.00	1.00	0.15
2	0.06808484184	0.14	30.00	12.00	3984.00	1.00	0.15
3	0.12141509893	0.24	30.00	12.00	3984.00	1.00	0.15
4	0.06578814415	0.13	30.00	12.00	3984.00	1.00	0.15
5	0.50941336356	0.61	50.00	12.00	3984.00	1.00	0.15
6	3.90918953976	2.61	90.00	12.00	3984.00	1.00	0.15
7	3.90918953976	2.61	90.00	12.00	3984.00	1.00	0.15
8	0.08203060700	0.16	30.00	12.00	3984.00	1.00	0.15
9	4.92532527570	3.28	90.00	12.00	3984.00	1.00	0.15
10	0.06046123569	0.12	30.00	12.00	3984.00	1.00	0.15
11	3.90918953976	2.61	90.00	12.00	3984.00	1.00	0.15
12	0.06121107838	0.12	30.00	12.00	3984.00	1.00	0.15
13	0.06712027063	0.13	30.00	12.00	3984.00	1.00	0.15
14	0.06260501745	0.13	30.00	12.00	3984.00	1.00	0.15
15	0.11333486259	0.23	30.00	12.00	3984.00	1.00	0.15
16	2.42240545881	1.82	80.00	12.00	3984.00	1.00	0.15
17	8.02692096414	5.35	90.00	12.00	3984.00	1.00	0.15
18	4.92532527570	3.28	90.00	12.00	3984.00	1.00	0.15
19	1.55160772890	1.16	80.00	12.00	3984.00	1.00	0.15
20	1.52105053564	1.14	80.00	12.00	3984.00	1.00	0.15
21	0.93961052757	0.94	60.00	12.00	3984.00	1.00	0.15
22	0.04553331449	0.14	20.00	12.00	3984.00	1.00	0.15
23	0.06213070470	0.12	30.00	12.00	3984.00	1.00	0.15

ID	Longitude	Latitude
1	46296129	30993159
2	46295583	30992796
3	46295975	30993561
4	46295622	30993027
5	46296212	30993748
6	46290985	30995298
7	46289652	30996367
8	46289325	30996668
9	46290174	30996955
10	46289600	30997160
11	46281094	31000095
12	46257477	31001428
13	46258092	31001273
14	46257464	31001867
15	46258014	31001490
16	46257187	31001934
17	46295075	30992271
18	46272955	31002971
19	46295075	31002954
20	46295665	31002997
21	46259747	31003393
22	46272768	31003060
23	46259849	31003554
24	46259161	31003667

Fig.(5-2): Import from GIS Line and Node Layers and The Attribute Tables Used to Prepare a Network File in TransCAD.

5.4.2 Network Creation

To create network, you must select which attribute fields of the line and node layers will be stored in the network. Every network requires that its length be specified, but you will usually want or require additional information included in the network depending on the traffic assignment you are performing. For example, the User Equilibrium Assignment requires data on both travel time and capacity of each link which must be included when creating the network. Figure (5-3) shows the network dialog box creation. The data that is included in the network of Al-Nasiriyah city.

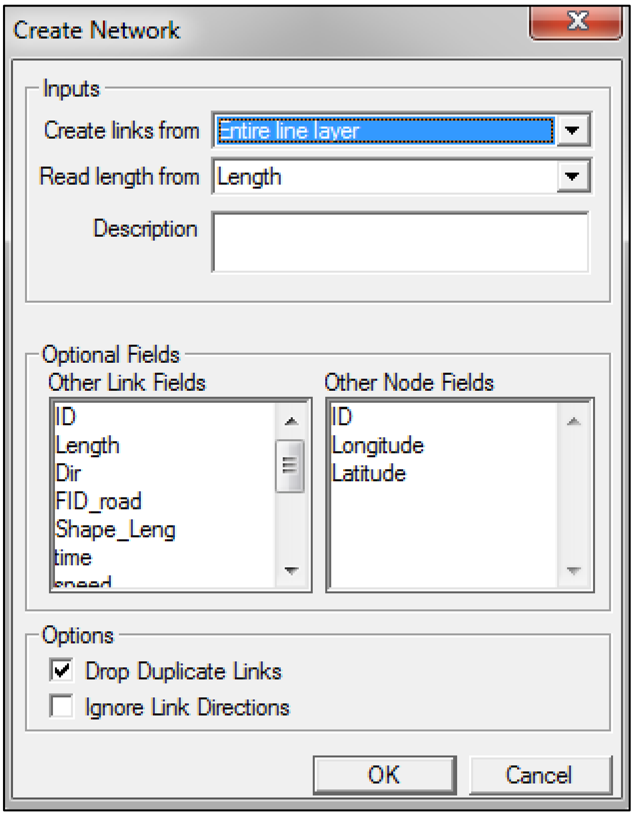


Fig.(5-3): Network Dialog Box Creation

5.4.3 Origin-Destination Matrix

The O-D matrix is a convenient way of representing travel demand in a city or region. The matrix's rows and columns represent origin and destination locations respectively.

All traffic assignment models included in TransCAD software ver.4.5 require that travel demand be represented as an O-D matrix. Most O-D matrices are based on a system of zones with each zone being considered a single possible origin and destination. TransCAD software ver4.5 can't able to modeling the traffic flows unless all trips begin and end their journey at some discrete point in the city network. To overcome this problem, centroids and centroid connectors are often employed.

A centroid is the geographic center of a zone. Since centroids will not be connected to the road network, a new set of links, called centroid connectors, are created to form the connection. TransCAD software ver. 4.5 can automatically connect any number of centroids to a network. Table (5-2) represents Al-Nasiriyah peak hour O-D matrix (vph) by zone Id.

Table (5-2): Al- Nasiriyah City volume during Peak Hour O-D matrix (vph).

Zone ID	1	2	3	4
1	1	8149	7629	2137
2	10190	1	2925	3481
3	2784	2860	1	2387
4	3470	2553	4675	1

The type of matrix for (O - D) is (4*4) depending on the number of zones which divided al-Nasiriyah city to 4 zone , the zone shown in Figure (5-4).

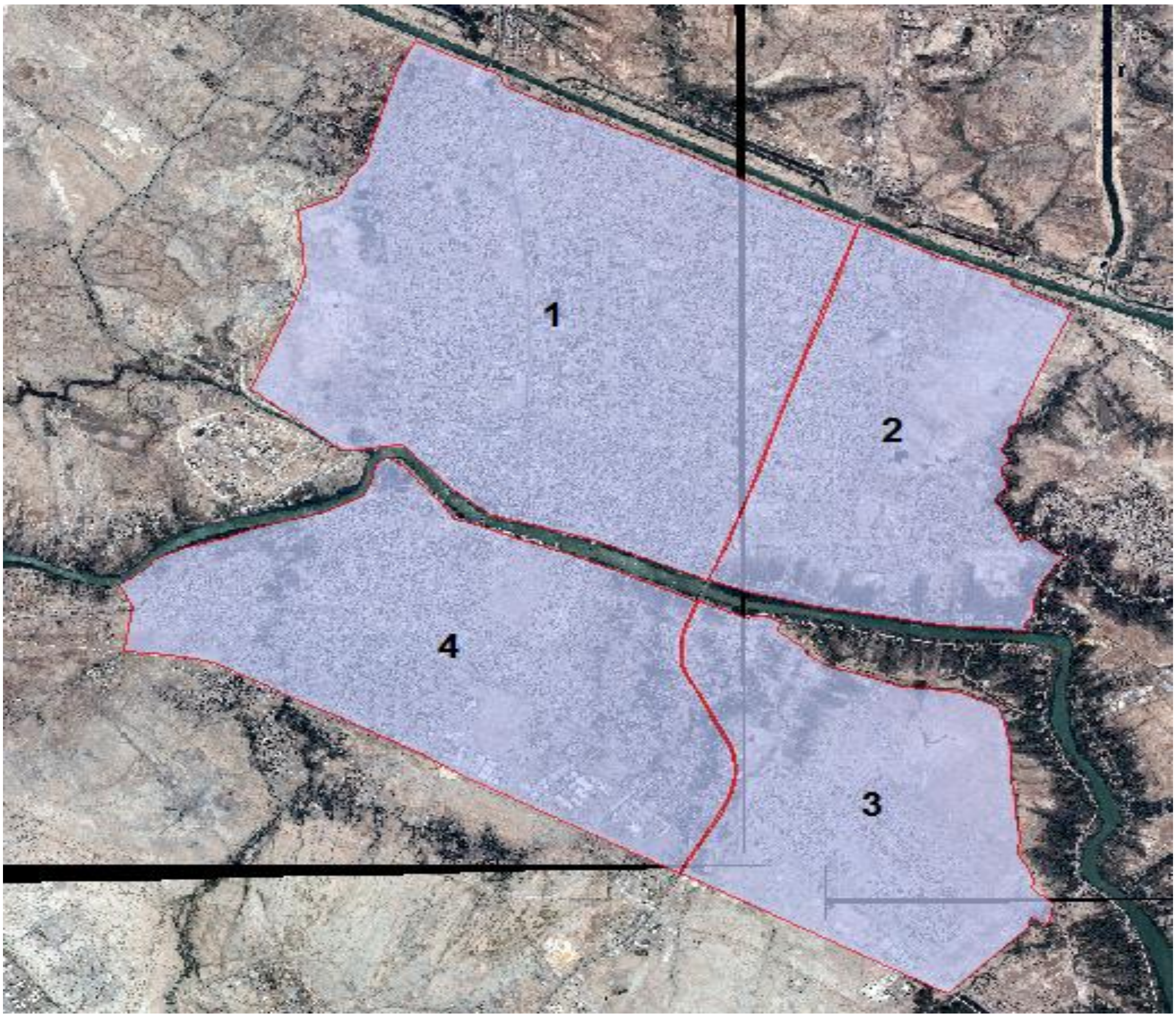


Fig.(5-4): Zones of Nasiriyah city

5.4.4 Centroid Connectors

As with the matrix above , most O-D matrices are based on a system of zones with each zone being considered a single possible origin and destination However, TransCAD (and almost all transportation planning software) cannot model traffic flows unless all trips begin and end their journey at some discrete point in the network. To overcome this problem, centroids and centroid connectors are often employed It were four focal points chosen for each zone shown in the Table (5-3) and Figure (5-5).

Table (5-3): Numbers zones and Numbers locations geographic center points

Zone No.	ID of Centroid Point
1	815
2	633
3	50
4	258

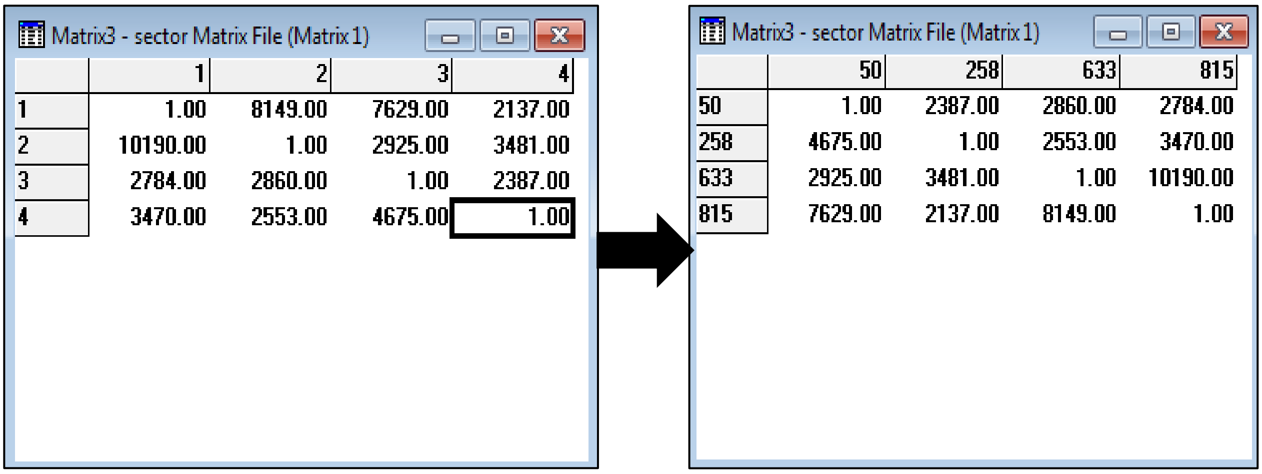
Dataview1 - Endpoints

ID	Longitude	Latitude	[Center]
258	46235975	31031813	4
50	46284300	31016492	3
633	46281940	31048900	2
815	46247709	31063334	1
835	46301835	31064505	--
849	46302071	31065085	--
846	46302307	31064996	--
836	46302079	31064519	--
1206	46269366	31097869	--
1205	46269744	31098425	--
1197	46269908	31097959	--
885	46297839	31066236	--
886	46297837	31066237	--
893	46298443	31066462	--
875	46298596	31065794	--

Fig.(5-5): Node layer attribute table identifying the connection between Zone ID’s and centroid ID’s

5.4.5 Re-Indexing the O-D Matrix

For any traffic assignment to work correctly, TransCAD must be able to link the row and column ID's of the O-D matrix to the centroid points in the road network where the trips will be loaded and terminated. However, the row/column headings of most O-D matrices correspond to the ID values of zones and not the ID of the points in the network where the trips are actually loaded. The O-D matrix's row and column headings must be relabeled, or 're-indexed', to show the centroid ID's instead of the zone ID's this process illustrated in Figure (5-6) shows you how to work Indices depending on the centroid points that have been selected for each zone



	1	2	3	4
1	1.00	8149.00	7629.00	2137.00
2	10190.00	1.00	2925.00	3481.00
3	2784.00	2860.00	1.00	2387.00
4	3470.00	2553.00	4675.00	1.00

	50	258	633	815
50	1.00	2387.00	2860.00	2784.00
258	4675.00	1.00	2553.00	3470.00
633	2925.00	3481.00	1.00	10190.00
815	7629.00	2137.00	8149.00	1.00

Fig.(5-6): Two possible indices for the O-D Matrix

5.5 Performing Traffic Assignment

Executing traffic assignments is simple in TransCAD software ver. 4.5. It is preparing the O-D matrix and network files with all the right data included as discussed in previous sections. TransCAD Stochastic User Equilibrium and System Optimum models are utilized for each assignment with a default number of iterations equal to 20 per assignment. After each assignment, the output volumes for each link are exported to a new geographic file. Table (5-4) presents Stochastic User Equilibrium and System Optimum methods settings are set at the time the assignment process is performed,**[Haider M. and Gregoul B. 2009]**.

Table (5-4): Stochastic User Equilibrium (SUE) and System Optimum Models Settings.

Algorithm Settings	Description	Assignment Method Default Value	
		SUE	System Optimum
Iterations	The maximum number of iterations to be performed	20	20
Convergence	The convergence threshold: If the maximum change in all the link flows is less than this value, the traffic assignment procedure will end even if the maximum number of iterations has not been performed.	0.0100	0.0100
Alpha and Beta	Calibration parameters of the volume-delay function.	$\alpha = 0.15$ $\beta = 4.0$	$\alpha = 0.15$ $\beta = 4.0$
Function	The type of error function used in the Stochastic User Equilibrium assignment	Normal	–
Error	Describes the extent to which the error function employed in the Stochastic User Equilibrium assignment	5.000	–

Trips for each O-D pair are then assigned to the links in the minimum path and the trips are added up for each link. The assigned trip volume is then compared to the capacity of the link to see if it is congested. If a link is congested the travel time is adjusted to result in a longer travel time on that link. Changes in travel time means that the shortest path may change. The whole process is repeated several times (iterated) until there is an equilibrium between travel demand and travel supply. Trips on congested links will be shifted to uncongested links until this equilibrium, condition occurs. TransCAD automatically joins the results table to the attribute table of the street network file and shows this as a new data view on screen. Table (5-5) represents the level of service (v/c) ratio used in Al-Nasiriyah city model, The distribution of the level of service is based on the speed and density of traffic so the municipality department used to verify the suitability of this table to the city's roads.

Table (5-5): Level of Service LOS (v/c) Ratio used in Al-Nasiriyah City Models.

Level of Service	(V/C) Ratio
A	0.00-0.50
B	0.51-0.70
C	0.71-0.80
D	0.81-0.90
E	0.91-0.99
F	≥ 1

5.5.1 Performing Stochastic User Equilibrium Method

The first of the three convergent algorithms, the SUE assignment assigns trips to a network so that no individual user can reduce their travel times by choosing an alternate route as shown in Figure (5-7). It continues to be one of the most commonly used algorithms in the transportation planning industry and transportation research. Its underlying assumption is that travelers choose the route that minimizes their individual travel times and that if they discover a faster route, they will take it – a relatively realistic assumption.

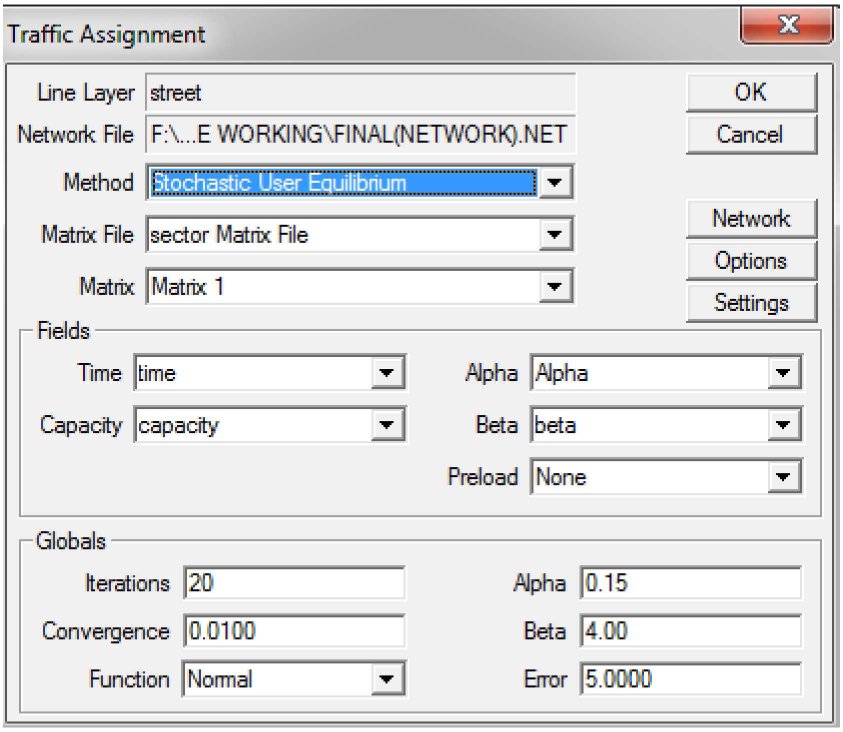


Fig.(5-7): Selecting the Stochastic User Equilibrium method

The results of the stochastic user equilibrium assignment model are presented in Figure (5-8) and Table (5-6) which present part of the of result table that joins to the attribute table of the road network.

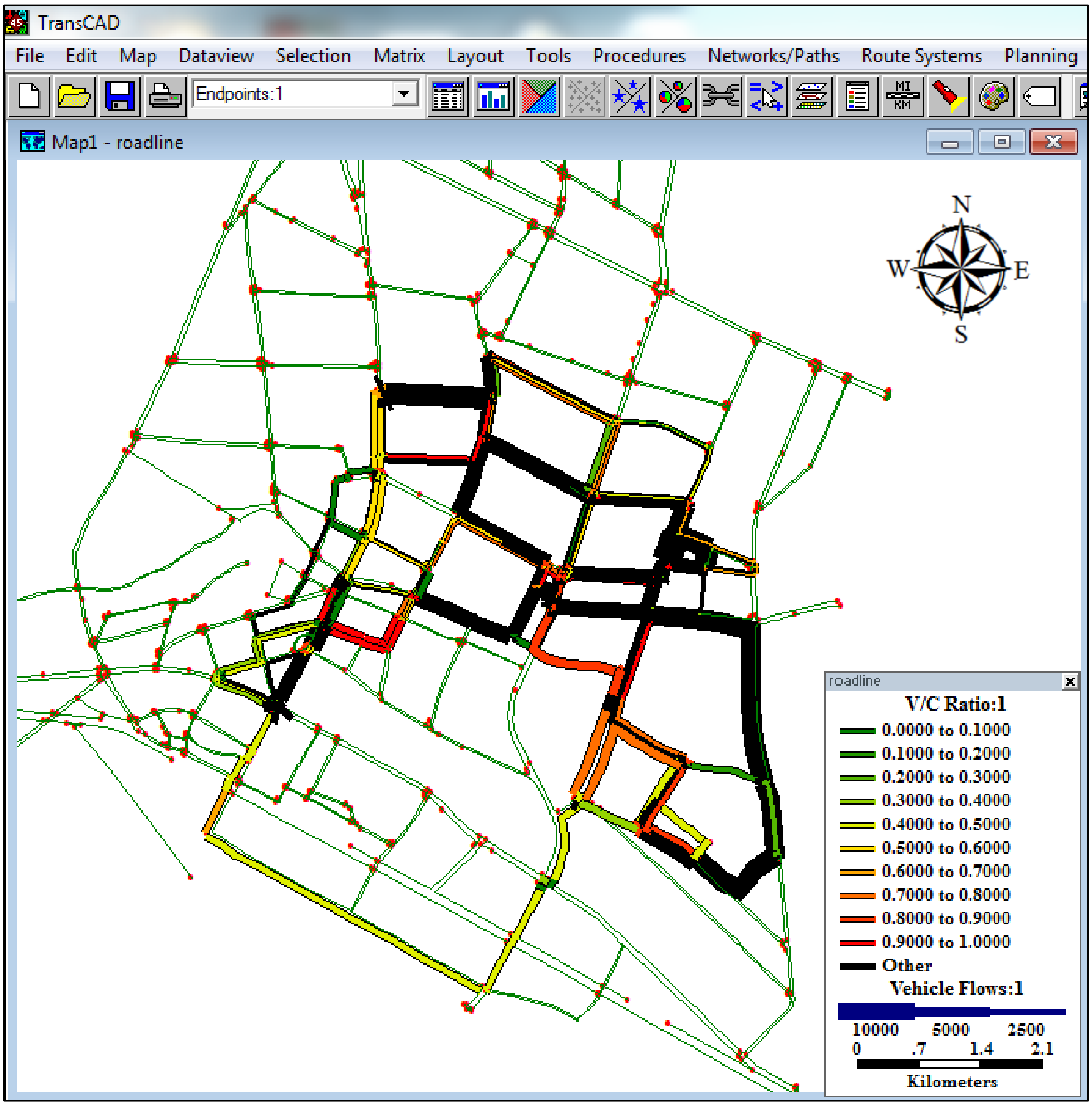


Fig.(5-8): Stochastic User Equilibrium Assignment Model Result

From Figure (5-8) it can be noticed that: the v/c ratio is divided into ten classes. The links with green color present most of Al-Nasiriyah road network have (v/c) ratio range between (0.00-0.50), level of service A. The yellow and orange colors represent the v/c range between (0.50-0.70) LOS B that includes links approximately 2% from all links , such as (188-521-616-617-628-655-660-724-730-789-791-812-815. etc.). The links with orange color represent the range between (0.70-0.80) LOS C are (341-651-544-251-285-321-204-709-714-749-693-868-847-849-841). Then there are 1.5% links in Al-Nasiriyah network which has v/c ratio between the range (0.80-0.90) which represent level of service D and the ID for some links (88-91-93-867-980-982-1114-1123) and there are 14 links which have v/c ratio between the range (0.90-0.1) which represent LOS E. The Black color represent the range (v/c > 1) which is shown clearly in the city, especially in the center where it appeared in 93 link such as (57-171-179-488-508-575-853-966-1001-1121) This indicates a weakness in these regions. The overall evaluation of Al-Nasiriyah road network is LOS equal to A.

Table (5-6): Part of Stochastic User Equilibrium Assignment Model Result Table.

ID	DIR	ONE WAY	LENGTH m	TIME min	SPEED Km/h	LINK WIDTH	CAPACITY	ALPHA	BETA	TYPE
33	1	--	939.61	0.96	60	12.00	3984.000	0.15	4	Arterial minor
43	1	--	93.54	0.18	30	12.00	3984.000	0.15	4	Arterial minor
66	1	--	321.03	0.38	50	12.00	3984.000	0.15	4	Arterial minor
135	0	FT	70.46	0.14	30	9.00	2813.000	0.15	4	Collector
156	0	FT	69.57	0.07	20	9.00	2813.000	0.15	4	Collector
262	1	--	2209.19	1.65	80	15.00	6855.000	0.15	4	Arterial major
309	1	--	471.99	0.56	50	13.00	4241.000	0.15	4	Arterial minor
432	0	FT	281.84	0.33	50	9.00	2813.000	0.15	4	Collector
441	1	--	727.69	0.87	50	13.00	4241.000	0.15	4	Arterial minor
537	1	--	55.23	0.16	20	15.00	6855.000	0.15	4	Arterial major
542	1	--	89.82	0.09	20	9.00	2813.000	0.15	4	Collector
698	1	--	898.01	0.89	60	11.50	3255.500	0.15	4	Arterial minor
770	0	FT	77.53	0.19	20	9.50	3341.500	0.15	4	Collector
793	1	--	87.95	0.08	20	19.00	6683.000	0.15	4	Arterial major
808	0	FT	2969.69	2.22	80	9.5	3341.500	0.15	4	Collector
814	1	--	564.22	0.67	50	11.5	3341.500	0.15	4	Arterial minor
1120	1	--	58.23	0.17	20	11.50	3255.500	0.15	4	Arterial minor

Table (5-6): Part of Stochastic User Equilibrium Assignment Model Result Table(Continued).

ID	AB_ FLOW	BA_ FLOW	TOT_ FLOW	AB_ TIME	BA_ TIME	MAX_TIME	AB_ VOC	BA_ VOC	MAX_VOC	AB_ SPEED	BA_ SPEED
33	1722.36	0	1722.36	0.944	0.939	0.944	0.432	0	0.432	35.402	35.588
43	246.05	0	246.05	0.187	0.187	0.187	0.061	0	0.061	30.002	30.002
66	0	0	0	0.385	0.385	0.385	0.000	0	0.000	50.018	50.018
135	0		0	0.140		0.140	0.000			29.996	
156	0		0	0.079		0.079	0.000			20.007	
262	0	0	0	1.656	1.656	1.656	0.000	0	0.000	80.022	80.022
309	1722.36	0	1722.36	0.568	0.566	0.568	0.406	0	0.406	49.813	50.016
432	0		0	0.338		0.338	0.000		0.000	21.038	
441	1881.63	1957.89	3839.52	0.142	0.142	0.142	0.443	0.461	0.461	29.851	29.821
537	0	0	0	0.165	0.165	0.165	0.000		0.000	20.042	
542	926.526	1790.42	2716.94	0.059	0.060	0.060	0.329	0.636	0.636	20.028	19.582
698	3756.89	3945.47	7702.36	1.136	1.188	1.188	1.154	1.211	1.211	47.400	45.339
770	0		0	0.142		0.142	0.000		0.000	20.035	
793	3421.73	1912.05	5333.78	0.087	0.087	0.087	0.512	0.286	0.512	19.825	20.010
808	0		0	2.227		2.227	0.000		0.000	52.485	
814	182.63	112.473	295.105	0.128	0.128	0.128	0.054	0.033	0.054	20.000	20.000
1120	3349.05	3900.73	7249.78	0.606	0.679	0.679	1.028	1.198	1.198	42.819	38.201

5.6 Transportation Proposals

Development of the Nasiriyah transportation system was woefully neglected over the last two decades. As a result it is only recently that a program of road construction has been instigated, starting with the surfacing of key routes and making junction improvements. The installation of surfaced roads in neighborhoods will take some considerable time due to the backlog of work involved. This should be undertaken in a rolling program of annual activities.

5.6.1 Road System

Expansion of the city requires the clear identification of a hierarchy of roads to facilitate traffic movement in support of economic activity. To that end the Master Plan proposes the use of a basic three-fold hierarchy of roads:

- Primary- Major Arterial Roads
- Secondary – Minor Arteria Roads
- Tertiary- Collector Roads

Below this upper hierarchy of roads there will be other types of roads - Collector Roads and Access Streets - within residential and other areas. The Master Plan identifies only the main levels of road – the National Highway. Each of these levels in the hierarchy has specific rights of way widths, geometric standards of alignment and other controls associated with them

5.6.2 Traffic Regulation

As part of the latter measures it is proposed to implement a city Centre-wide ban on certain current practices. These include:

- ❖ Prohibiting entry by heavy goods vehicles and trucks outside specified delivery hours؛
- ❖ Prohibiting passing large trucks at day time؛
- ❖ Prohibiting parking of vehicles except in designated places.
- ❖ Prohibiting the use the kerbs for delivery and display goods by shops

5.6.3 Road Improvements

In the medium term the introduction of Area Traffic Control (ATC) should be studied as a means of controlling traffic entering and circulating around the central business area and city Centre. An ATC system should be studied in the context of enhanced public transport including the proposed tramway system.

Area Traffic Control is a way of monitoring, operating and controlling traffic lights by means of a computer. The computer uses information gathered from sensors in the road to decide whether traffic is getting heavy or congested on a particular stretch. When it does, the computer changes the timing of traffic lights to let the traffic move more freely and thereby reducing congestion.

An ATC system is usually applied to main corridors and in the most dense traffic areas. Carpooling can be part of the ATC system promoted through incentives. For example a 3-in-1 scheme can be operated for main corridors whereby only private cars with three or more passengers can enter during peak hours (for example 6:30-10am / 1-3pm on weekdays).

1-Al-Haboobli and Al Nasir Streets

This intersection can be improved (and an acceptable v/c ratio obtained) by constructing additional lanes for all approaches. In addition our modelling suggests that grade-separation is required for left turns for both north and south approaches. However this intersection lies within the proposed conservation area to protect the historic core of Nasiriyah. Such a large-scale physical intervention would be deeply damaging to the urban fabric. Therefore we strongly recommend the adoption of ATC techniques and one-way traffic management to control traffic flows through the intersection.

2-Al Corniche and Al Nile Streets

This intersection can be improved by signalization and the banning of U-turns and HGVs during day time. However our studies suggest the need for additional lanes for all approaches. This would be deeply damaging for the urban fabric at this visually important junction. Therefore it is strongly recommended to use ATC techniques to control traffic flows through the junction to an acceptable level.

5.6.4 Key Traffic Intersections

Examining five of the most heavily used junctions within the existing urban area where traffic issues are evident. in Figure (5-10) In general consider that the installation of traffic signals will be an effective short term measure. Calculations have been carried out using observed traffic flows and a standard intersection software package (TransCad and GIS). As a result particular improvements have been proposed to ensure the volume to capacity ratio of each intersection falls below 1.00 v/c ratio where the intersection is operating below capacity. The five intersections can be improved by signalization – usually 2-phase signals – and with the prohibition of U-turns and an additional lane in one case. (see Table 5-7)

However two heavily used intersections require more substantial treatment, including the prohibition of heavy goods vehicles (HGVs) during day time and making additional approach lanes.

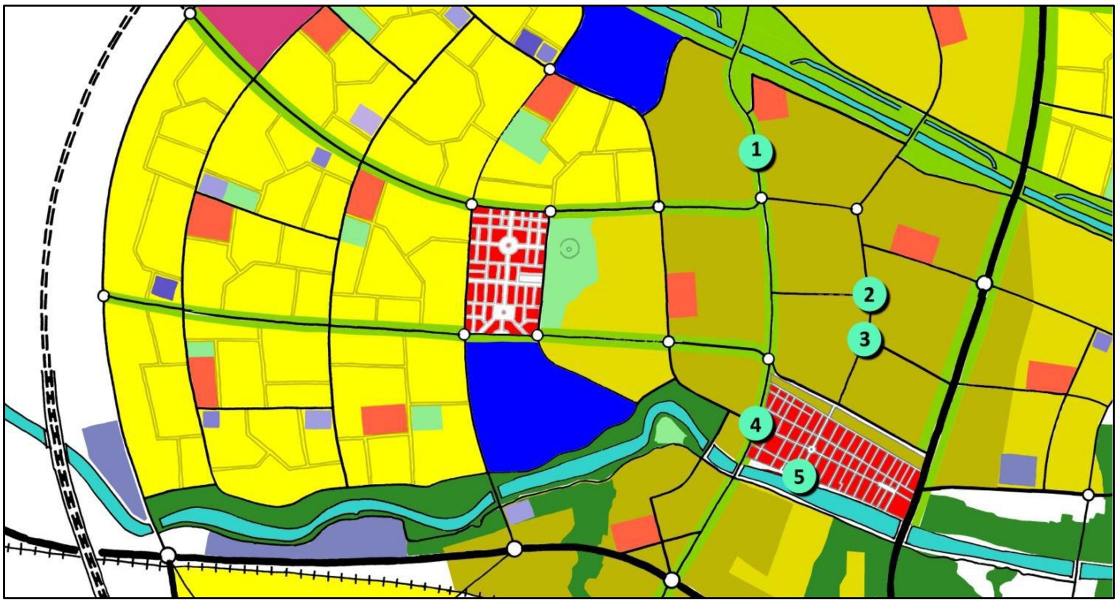


Fig.(5-9): Location of Key Intersections

Table (5-7): Improvements for Key Intersections

Intersection Name	Link ID	Current Situation	Proposal
1- Al-Sadr and Al Nasir Streets	1225-1227-1232-1233	4-lane and 3-lane uncontrolled v/c ratio 0.957	Signalized (2- Phase) prohibition of U-turns Additional northbound lane v/c ratio 0.49
2-Al-Nile and Al Sumer Streets	1003-1004-1007-1008	2-lane and 3-lane uncontrolled v/c ratio 0.922	Signalized (2-phase) v/c ratio 0.54
3-Al-Nile and Al Wgaai Streets	827-859-912-955	4-lane and 3-lane uncontrolled v/c ratio 1.021	U-turns 100m from intersection on dedicated lane Prohibition of HGVs during daytime Additional lanes (all approaches) Overpass for left turns (south and north approaches) v/c ratio 0.54
4-Al-Haboobi and Al Nasir Streets	890-903-907-908	4-lane and 3-lane uncontrolled v/c ratio 1.331	Signalized (2-phase). U-turns 100m from junction on dedicated lane. Prohibition of HGVs during daytime. Additional lanes (all approaches). v/c ratio 0.70.
5-Al-Corniche and Al Nile Streets	616-623-626-627	4-lane and 3-lane uncontrolled v/c ratio 1.215	Signalized (2-phase). U-turns 100m from junction on dedicated lane. Prohibition of HGVs during daytime. Additional lanes (all approaches). v/c ratio 0.82.

Chapter Six

Conclusions and Recommendations

6.1 General

In this chapter, the conclusions that have been obtained from this study are presented within the limits of collected data for AL-Nasiriyah city. Recommendations for future research are also given.

6.2 Conclusions

1- Traffic flow pattern for Al-Nasiriyah network shows that there is only two peak hour in the morning period from 7:00 a.m. to 8:00 a.m., and the general trend of the traffic flow curve is expected to have another peak on the afternoon period from 2:00 p.m. to 3:00 p.m.

2- Al-Bahoo intersection has the highest traffic volume. Its total one day for out of center and vehicle to center traffic volume was 35705.62 pcu/day. The peak hour traffic flow was 8569.35 pcu/hour. The second larger traffic flow was Al-Nile street - Al-Habobi street intersection (Al-Hdarate) which has a traffic volume for out and in center of 12600 pcu / day and a peak hour traffic flow of 2699 pcu/hour.

3- The purpose of the trip for transport network in the city after conducting questionnaires on several city stations which show that the purpose of the trip is mostly for the private job with parentage approximately 49.53% and was followed by other purposes of nearly 27.04%.

4- The trips generated are affected more by the number of males in the household more than by female due to social considerations in the city.

5- Type of traffic composition in external traffic flow as a result of survey the private small cars represents the basic component for the external traffic of the city , after it the small buses , then the small Van, The percentage sequence is (26%, 17%,12%) respectively .

6- The road network density ratio of the area of the Nasiriyah city equals 90.68 Km longitudinal per 1000 sq. km and the road network density ratio for the population of the city reached (70.73 Km) per 100,000 inhabitants

7- Evaluating Measured Performance of Road Network is made Through the following indicators { $\boldsymbol{\beta}$(Beta), $\boldsymbol{\alpha}$(Alpha), $\boldsymbol{\gamma}$(Gamma) and $\boldsymbol{\varepsilon}$(Eta)} index The results were arranged respectively (1.429, 0.217, 0.478 and 0.430) according to the indices of which is considered slightly complex, correlation considered low because it is less than one although the network is considered relatively developed.

8-The traffic direct to the city, represent survey trip generation concentrating basically in the hinterland area of the city approximately 42.3%, followed closely by the other administrative provinces nearly 35.6% from the generation of traffic towards Al Nasiriyah city.

9- The O-D Matrix is determined by continuous monitoring using a device (MSSS) which divided the city into four zones where the highest flow of vehicles is from the zone No. two (north-eastern side of the city) towards the zone No. one of (the northwest of the city) approximately 10190 vph.

10-Analysis of Traffic Assignment using TransCAD is very important because it clarifies the weak points in the network directly with digital data presented in tables and after analysis conformity to reality is shown.

11- It recommended using another method in the process of Traffic Assignment for comparison with the method used in this study, taking into account the use of the largest number of data for high accuracy in the analysis process.

12- The result of some streets show the level of service (F) for the first direction specially in the center of Network because there are many causes The large number of government departments in this part of the network, business centers, and the narrow streets in these areas, causing a lack of capacity in vehicles.

6.3 Recommendations

From the travel demand modeling of Al-Nasiriyah city, the type of improvement required for the Al- Nasiriyah roads network to carry the existing and future traffic flow has been identified.

1- The external-external trips that pass through the network should their path to Al- Hollandi arterial road as planned by the previous design study as first step and a ring road should be constructed to carry the external trips without passing through the center of the city.

2- In order to increase the capacity of congested links, on street parking and encroachment should be removed and the carriageway of these links should be widened in addition to the required traffic management.

3- ATC system should be applied in main corridors and in the most dense traffic areas. Carpooling can be part of the ATC system. For example a 3-in-1 scheme can be operated for main corridors whereby only private cars with three or more passengers can enter during peak hours (for example 6:30-10am/5-7pm on weekdays).

4- The city needs to establish a modern public transport system based on coordination with the General Directorates of Traffic in the city to identify new paths of movement in order to reduce traffic congestion, travel time, costs and improve the sustainable transport in the city and the possibility of applying Tram System should be studied.

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الخلاصة

تعاني مدينة الناصرية من الازدحام المروري في عدد من تقاطعاتها وذلك بسبب ارتفاع الكثافة السكانية فيها وضعف شبكتها المرورية ووجود تركيز عالي من المؤسسات الحكومية وغير الحكومية فيها , ومن المتوقع تفاقم المشكلة المرورية في مدينة الناصرية مع ازدياد عدد السكان فيها وخصوصا مع عدم تطوير وتحسين شبكتها المرورية, لذلك هناك حاجة إلى دراسات مرورية على أسس علمية لتقييم نظام المواصلات في مدينة الناصرية واقتراح خطط تطويرية لنظم المواصلات واستخدام الأراضي فيها.

معظم عمليات التطوير التي يتم تطبيقها على شبكة الطرق في الناصرية، تواجه العديد من التحديات في عملية التنبؤ الطلب على السفر التقليدية مثل: عدم وجود دراسات تخطيط النقل السابقة، وعدم وجود بيانات حركة المرور لذلك كان من الضروري إجراء تعداد لحركة المرور من خلال جهاز (MSSS)، وكذلك استبيانات الحركة المرورية، للحصول على بيانات يمكن اعتمادها كأساس في عملية التنبؤ في الطلب على السفر.. طبقاً لما تم ذكره فان غرض هذه الدراسة هو تقييم نظام المواصلات لمدينة الناصرية بتطبيق منهجية التخطيط المروري المناسبة للأوضاع السائدة في مدينة الناصرية ويمكن تلخيص أهداف الرسالة بما يلي : تحليل الوضع المروري الحالي لمدينة الناصرية استناداً إلى عد مروري موثوق، بناء نموذج محاكاة لشبكة الطرق في مدينة الناصرية باستخدام برنامج التخطيط المروري المناسب، وتبعا لمنطقة الدراسة فقد تم تطوير وبناء المصفوفات الخاصة ب O-D (المنشأ -المقصد) باستخدام العد المروري وتقدير وتقييم التدفق المروري وأداء شبكة المواصلات استناداً إلى منهجية البحث المناسبة.

تم الاعتماد في منهجية البحث في هذه الرسالة على مستويين في تقييم نظام المواصلات لمدينة الناصرية ، المستوى الاول هو نطاق اختيار افضل المسارات بين المحطات المختلفة وقد تم ذلك باستخدام برنامج (GIS 10.3) ، والمستوى الثاني هو نطاق شبكة المواصلات حيث تم استخدام برنامج TransCAD. وقد أوضحت نتائج جمع وتحليل البيانات أن ساعة الذروة المرورية الصباحية كانت من 7:00 إلى 8:30 وكذلك بلغت أكبر قيمة حركة مرورية في ساعة الذروة 4585.7pcu/hr عند المدخل الشمالي لمدينة الناصرية (EX1) اما بالنسبة الى التقاطعات فبلغت القيمة 3874.3 pcu/hr عند تقاطع البهو في مركز المدينة . وباستخدام برنامج ال TransCAD تم تطبيق Traffic Assignment للشبكة حيث تم استخدام

نموذج (Stochastic User Equilibrium) في عملية توزيع المرور على شبكة الطرق لمدينة الناصرية حيث اوضحت النتائج ان هنالك خلل كبير في مركز المدينة في كثرة الازدحامات وقلة الخدمات حيث بلغت نسبة (v/c) اكبر او مساوية الى (1) وهذا ما اثبته العد المروري الذي بين التدفق المروري الكبير في هذه المناطق وتدرجت ال(v/c) لبقية الشبكة . عرضت المقترحات التي تخص تحسين كلا من (نظام الطرق، مواقف السيارات ،التقاطعات الرئيسية للمدينة). وتم اختيار خمسة تقاطعات رئيسية لتحسينها وكان اكثرها ازدحاما هو تقاطع البهو حيث بلغت نسبة (v/c) حوالي 1.331 وهذه نسبة تعتبر كبيرة نسبيا. فكان المقترح (وضع اشارات مرورية تعمل بالسيطرة الالكترونية للمرحلة الثانية ، منع الاستدارة (U) الا على بعد 100 متر ، منع مركبات الحمولة الثقيلة من المرور اثناء وقت الذروة ، توسعة للطريق واضافة ممرات اخرى ، تقليل نسبة (v/c) قدر الامكان حتى تصل الى (0.70)).

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وهي جزء من متطلبات نيل درجة الماجستير في

علوم هندسة البناء والإنشاءات هندسة الجيوماتك

من قبل

خلدون طالب فالح

بأشراف

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