Geographical Information Systems in Analysis and Enhancement for Problems Solving and Decision Making

Master Thesis

By

Zaid Farhood Makki

Supervised by

Prof. Alaa H. Al- Hamami

Submitted in Partial Fulfillment of the Requirements for the Master Degree in Computer Information Systems

Department of Computer Information Systems
Faculty of Information Technology
Middle East University
Amman, Jordan

April, 2012

Middle East University

Authorization Statement

I, Zaid Farhood Makki, authorizes Middle East University to supply copies of my thesis to libraries, establishments or individuals upon request, according to the university regulations.

Signature: 

Date: 15-5-2012

Examination Committee Decision

This is to certify that the thesis entitled "Geographical Information Systems in Analysis and Enhancement for Problems Solving and Decision Making "was successfully defended and approved on 2012.

Examination Committee Members **Signature**

Chairman

Prof. Reyadh S. Naoum

Dean of Faculty of Information Technology

Middle East University

Supervisor

Prof. Alaa H. Al- Hamami

Dean of Faculty of Information Technology

Amman Arab University

External Examiner

Prof. Riyad F. Shalabi

Amman Arab University

Dedication

الإهـــــــداء

إلى التي فاجأت الكل بفراقها الأبدي .. إلى التي من اجل هذه الدراسة لم الحق سكراتها الأخيرة...

إلى التي لم تغمض عينها تحديا لقوانين الموت إلا بعد رؤيتي

إلى التي أذاقتني مرارة اليُتم وأنا كبير

إلى التي أبدلت جرحها ابتسامة لم تفارق محياها

إلى مدرسة الأمومة ..وعنوان التضحية .. أمي الحنونة ..

رحمك الله وأسكنك فسيح جنانه

والدي العزيز ..رحمك الله حبًا وإكرامًا وعرفانًا

Acknowledgments

First and foremost, I thank and pray to God who gave me the health and the strength to do this research.

I would like to express my gratitude to my supervisor Prof. Alaa H. Al- hamami for his advice, guidance, and constant supervision during the work of this thesis.

Also I would like to thank Dr.Zeyad M. Al Fawaer for his support during doing the proposal of this thesis.

I am deeply indebted to thank my wife and children (Rafeef , Ayman and Zahraa) for their support, kindness, patience and continuous support

I have to express my great thankful for my family who played a great role in my success finishing this thesis special grateful to my brothers Hussein, Hassan, Muhammad, Fadhel and Ali, My sisters, Zainab , Aayad, Amal and Intissar .

I wish to thank all my friends specially Omar Abdullatef , Moataz, Audi, Loay, Haider, Amar,Ali, Ahmed, Laith, Zina ,Abeer , Haneen and Dalya for their moral support, encouragement, and technical discussions.

Warm feelings and thanks for my directorate, Baghdad University specially Dr. Mustafa Abdul Jallil , Mr. Ahmed Asaad , Dr. Marwa and Miss fadai , Traffic of Police General Directorate, Central organization for statistical and information technology Ebtisam & Asil, municipality of Baghdad Ms. Hanan, Governorate of Baghdad city Mr. Mustafa, and every department supported me to accomplish this work.

I would further like to acknowledge all of the Middle East University members at the for Graduate Studies for helping and encouraging my efforts especially at the end of the thesis.

Finally, a special thank for CSS "Complete spatial solutions company" for their technical GIS related support by providing software and personals.

Abstract

Geographical Information Systems in Analysis and Enhancement for Problems Solving and Decision Making

By

Zaid Farhood Makki

The rapid development in the various aspects of life has increased the complicities in our lifestyle, and that leads to create continuous problems. Overcoming these problems required efficient, convenient and fixable solutions, to adapt to these quick changes in the world.

The geographic Information system tools are a modern technology, which involved the implementation of complex matters by giving the users a high ability for deep understanding of the problems through analyzing the spatial data, production of digital maps and thus enables the decision maker for saving time, effort and cost by selecting the accurate decisions to reach an optimized solution for the problem.

One of the complex problems in modern times is the traffic jams that have swept most of the world in recent years, especially in the major capitals and cities, where an intensive emigration of people living in villages and small towns, has been taking place, in addition to that a great urban expansion and the increase of the number of using vehicles in transport resulted in exacerbating the problem of traffic congestion significantly.

Al-Karadah City in Baghdad, one of the busiest and most crowded cities in Iraq due to the large population of the large compared to its area, as well as to the presence of a diversity of land uses (commercial, residential, industrial, recreational and educational). These various components provide indications that the region is attractive and lively to the large number of their visitors. In addition to that, there are important religious places and variety of government departments, not to mention its geographical location in the heart of the capital and surrounded by the Tigris River from all directions; all this has caused the researcher to choose it as an area for the study.

This study focues on analyzing proposed factors and measuring how much these factors affect the traffic jams problem and then to propose both short and long term solutions for this problem based on the study results, which are principally not found in the departments concerned and make available satellite imagery of the place of study in order to establish special layer for these elements and establish complete geographical database for each one of them and analyze every layer to find out the extent of its influence on the traffic jam separately and to put these layers together in order to produce a complete map to acknowledge their location and degree of its influence on the study problems in order to find the above solutions.

الملخص

نظم المعلومات الجغرافية في تحليل وتحسين حل المشكلات وصناعة القرارت

زيد فرهود مكي

مع التطور المتسارع الذي يشهده العالم في مختلف جوانب الحياة، يزداد اسلوب الحياة تعقيدا، الأمر الذي خلق ويخلق الكثير من المشكلات و بالتالي تزداد الحاجة الى إيجاد حلول سهلة ومرنة ، للتأقلم مع التغيير الحاصل.

تعتبر نظم المعلومات الجغرافية من الأدوات التكنولوجية الحديثة، التي تساهم في تنفيذ الإعمال المعقدة من خلال منحها مساحة واسعة للمستخدم لتعدد أدواتها ووظائفها لتحليل البيانات المكانية و انتاج الخرائط الرقمية وبالتالي تمكن صانع القرار من اختصار الوقت والجهد والكلفة لاختيار قرارات دقيقة للوصول إلى حل أمثل للمشكلة.

ومن المشاكل المعقدة في عصرنا الحديث هي الاختناقات المرورية التي اجتاحت معظم دول العالم في السنوات الأخيرة، وخاصة في المدن والعواصم الكبرى، التي نزح اليها الكثير ممن يسكنون القرى والمدن الصغيرة، بالإضافة إلى التوسع العمراني الكبير وزيادة عدد وسائط النقل. فتفاقمت مشكلة الزحام المروري بشكل كبير.

تعتبر مدينة الكرادة في بغداد من أكثر المدن العراقية زحاما نظراً لعدد سكانها الكبير نسبة للمساحة، كذلك لوجود تنوع في استعمالات الأرض (تجارية و سكنية و صناعية و ترفيهية وتعليمية). إن هذه المكونات المختلفة تعطي مؤشرات إن المنطقة جذابة و حيوية ، بالإضافة الى احتوائها على أماكن دينية مهمة، ودوائر حكومية متنوعة ، ناهيك عن موقعها الجغرافي المميز في قلب العاصمة والذي يحده نهر دجله من كل الاتجاهات مما دفع الباحث الى اختيارها كمنطقة للدراسة

يهدف البحث بشكل خاص الى دراسة و تحليل عدد من العوامل التي اقترحها الباحث كمسببات ل لزحام المروري و مدى تأثير كل منها على مشكلة الدراسة مع تحليل للنتائج و اقتراح مجموعة من الحلول القصيرة و الطويلة الامد ، من خلال جمع البيانات غير المتوفرة في المؤسسات ذات العلاقة ميدانياً وتوفير صورة فضائية حديثة لمنطقة الدراسة لبناء الطبقات الخاصة بتلك العوامل وعمل قاعدة بيانات جغرافيه متكاملة لكل منها وتحليل كل طبقة ومدى تأثيرها على الزحام المروري بشكل مستقل ثم جمع تلك الطبقات لإنتاج خارطة متكاملة لمعرفة مواقع ودرجات تأثيرها على مشكلة الدراسة لغرض اقتراح الحلول أعلاه.

Contents

List of Figures

List of Tables

List of Abbreviations

AADT	Annual Average Daily Traffic
CLI	Canada Land Inventory
CGIS	Canada Geographic Information System
CARIS	Computer Aided Resource Information System
DSS	Decision Support System
DGPS	Differential Global Positioning System
ESRI	Environmental Systems Research Institute
ERDAS	Earth Resources Data Analysis System
GIS	Geographical Information System
HCA	High Consequence Area
MOSS	Map Overlay and Statistical System
RGB	Red-Green-Bleu "3D color image"
RDBMS	Relational Database Management System
WELUT	Western Energy and Land Use Team

Chapter 1

Introduction

Content of chapter

Chapter 1

Introduction

1.1 Overview

Geographical Information System (GIS) is a system for capturing, storing, analyzing and managing data and associated attributes which are spatially referenced to the Earth (Zhiwei, Wancai , 2010).

As the concept of sustainable development and the need for public involvement in planning by diverse groups become more widely accepted among politicians, policymakers and the general public, it is critical to incorporate impact assessment and analysis into the planning and decision-making process. During such a process, all stakeholders in a region, including public/private organizations and residents, should work together to analyze, compare, contrast and prioritize different development alternatives for a sustainable future (Xinhao Wang, 2005)

Worldwide, the problem of traffic jams is considered major issue that must be faced and solved. Route planning and guidance systems are common decision support systems, especially if applied using GIS technology. **(**Nadi S., M.R. Delavar,2011; Ginty and Smyth, 2000;Park, 2007; Jozefowiez, 2008; Sadeghi Niaraki and Kim, 2009).

One of the most common measurement tasks in road network is vehicular traffic flow, which is defined as the number of vehicles passing a specific location along a road during a unit of time. The Annual Average Daily Traffic (AADT) is usually taken as one of measuring traffic flows. (AADT) is important information for many transportation planning, design, operation, and maintenance activities, as well as for the allocation of highway funds **(**Coifman And Yang, 2004; Hartgen and Lemmerman,1983; Jiang, Mark , McCord and Prem,2006).

Many methods have been developed in the past decades of year in for measuring the AADT, such as ground-based sensors, most common of which are inductive loop detectors and pneumatic tube detectors (Hartgen, D.T., and J.H. Lemmerman, 1983).

But it's better and more effective to prevent the problem of traffic jams rather than resolve it, the thing that will be presented through this thesis.

Baghdad, the capital of Republic of Iraq covers an area of 4,555 km^2 inhabited with about 7 million people, the second largest city in the Arab world. Baghdad consists of 14 municipalities which consist of 97 districts as shown in Figure (1). (Central organization for statistical and information technology, 2010).

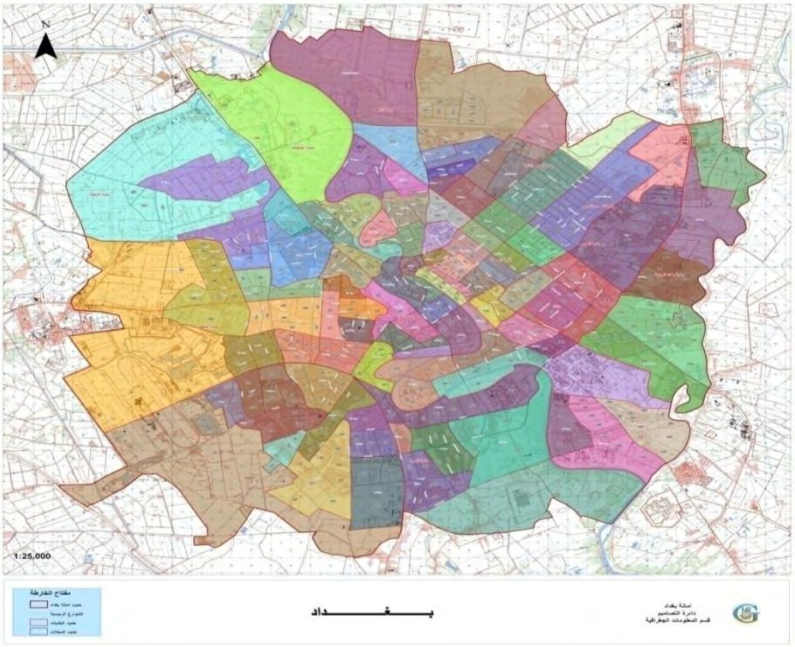

Figure. (1): Baghdad Districts

Al Karadah, which contains many industrial zones, 70 % of governmental agencies, commercial zones, University of Baghdad "the biggest university in Iraq", the green zone and huge residential complexes, indicated as a major city in Baghdad, all this yielded to create a major issue regarding traffic jam in this specific area. Al Karadah consists of 8 districts that cover 49 km2, with 279,311 inhabitants for 2010 census predictions. (Central organization for statistical and information technology, 2010). as shown in Figure (2)

Historically, Al Karadah was an agricultural area specially in the Othman era, but with the Iraqi independence and starting from the middle of the twentieth century this area faced an unexpected urban development compared to other areas in Iraq. (Al-Saffar, 2006) .

Figure.(2): shows satellite imagery for Al Karadah city, Baghdad.

1.2 Problem Identification

By applying GIS technology and previous national studies results have been done for Al Karadah district which is a major, crowded and centralized area that contains many governmental agencies, academics, private sector companies, the green zone, and many other major landmarks; in addition to the lack of roads and infrastructure, Al Karadah forces Iraqi government to face a huge issue to deal with in regarding reducing the traffic on it.

This thesis tries to discuss in detail traffic jam causes and the proposed solution for Al Karadah persistent traffic jam. This problem has many negative effects on different aspects. These effects are:

- Delay in transportation.
- Delay in emergency vehicles to response to incidents.
- The potential of increased cars breakdown in jams that causes extra traffic jams.
- Drivers temper regarding traffic jams in a country known for hot weather with high temperatures.
- It's become difficult to apply any urban development projects especially for the infrastructure due to of the lack of roads and the traffic jams that occurs.

1.3 Thesis Objectives

The aim is to study the traffic jam reasons in Al Karadah and propose both short and long term solution by adopting state of the art technologies represented by GIS and its related sciences.

The main objectives are:

- Gathering and creating Al Karadah geospatial and statistical information in addition to national related studies.
- Analyze Al Karadah geospatial information "GIS Layers, Satellite imagery" and apply every available statistical piece of information which enriches the geospatial information quality the thing that enhances analysis results.
- Define the layers "factors" of the study on the maps.
- Measure each layer "factor" level of effect on the traffic jam.
- An overall analysis for the layers "factors" combined to identify locations of jam.
- Determine areas of expansion and rezoning in order to solve the traffic jam.
- Proposing recommendations based on the results that yield out from the study.

1.4 Thesis Importance

The main beneficiary from the results of this study will be Al Karadah residence and all decision making authorities represented by:

- Baghdad Municipality.
- Ministry of Transport.
- Baghdad City Council.
- Baghdad Police Department.
- Baghdad Command and Control Center.
- Traffic of Police General Directorate
- The local council in Al Karadah .
- Universities in the area.

1.5 Methodology

The proposed methodology to be adopted in the writing of the thesis which is a practical approach consists of the following:

- Testing each factor in each category as a standalone factor, using GIS technology to identify its level of effect.
- Combine the analysis result for each factor in the same category in order to create an overlay analysis for the set of layers "factors" together.
- A final analysis for the all categories to create a final image for the traffic jam causes.
- Based on the results of the analysis of all the proposed layers "factors", a set of proposed solutions will be proposed and divided into two groups, strategic and tactical solutions. strategic solutions propose the solution for the layers "factors" that has the major effect on the traffic jam, while the tactical solutions will solve the layers "factors" that have less impact of the traffic jam for Al Karadah city.

1.6 Thesis Organization.

The thesis contains, in addition to chapter 1, the following chapters:

- Chapter 2: Literature review and previous related work: this chapter covers the previous related work performed represented by papers, thesis and national studies where every reference will be described by presenting the problem, methodology, results and recommendations.
- Chapter 3 :Thesis Methodology: this part contains the actual work represented by, factor by factor analysis, factor related maps, testing results, overall analysis and overall results in addition the comments on each factor and their related results.
- Chapter 4: Results Discussion and Recommendations: this part contains the proposed solutions divided into two types, long and short term solutions.
- Chapter 5: Conclusion and recommendations: this part contains final results and other recommendations to our thesis.
- Appendixes
- References.

Chapter 2

Literature review, previous related work and Geographical Information Systems (GIS)

Chapter contents

2.1 GIS Overview

GIS technology is considered nowadays to be the backbone technology that provides systems that support, aids and helps small up enterprise agencies in their day to day, planning, decision making and analysis activities.

The GIS is a supporting tool which can store the graphical features, attribute data and display the relational patterns over time and space frames (Rao, Sunitha, and .Jayasree, 2005) .

In 1854, John Snow depicted a cholera outbreak in London using points to represent the locations of some individual cases, possibly the earliest use of the geographic method . (John ,2011), His study of the distribution of cholera led to the source of the disease, a contaminated water pump (the Broad Street Pump, whose handle he had disconnected, thus terminating the outbreak) within the heart of the cholera outbreak.as shown in Figure (3)

]

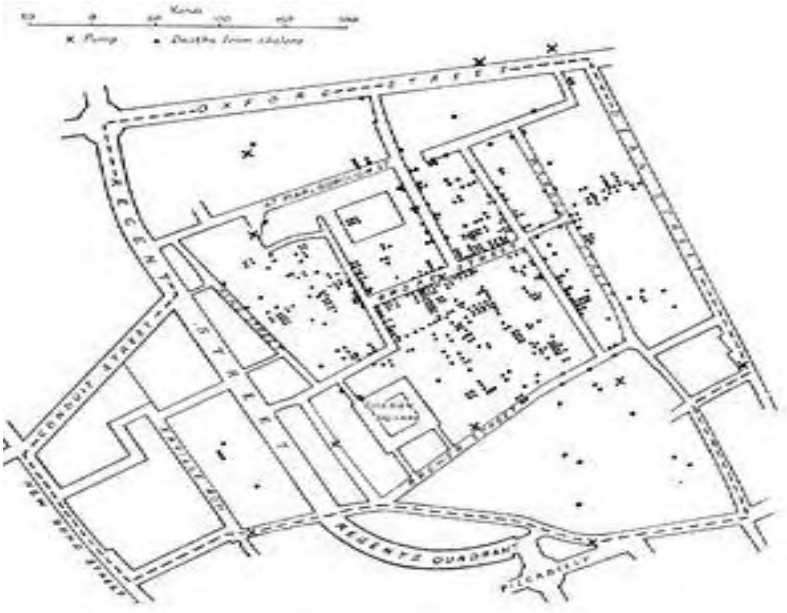

Figure.(3): John Snow's Cholera map.

E. W. Gilbert's version (1958) of John Snow's 1855 map of the Soho cholera outbreak showing the clusters of cholera cases in the London epidemic of 1854.

While the basic elements of topography and theme existed previously in cartography, the John Snow map was unique, using cartographic methods not only to depict but also to analyze clusters of geographically-dependent phenomena for the first time.

The early 20 th century the development of photozincography, which allowed maps to be split into layers, for example one layer for vegetation and another for water. This was particularly used for printing contours - drawing these was a labor intensive task but having them on a separate layer meant they could be worked on without the other layers to confuse the draughtsman. This work was originally drawn on glass plates but later, plastic film was introduced, being lighter, using less storage space and being less brittle were several of its advantages over glass plates. When all the layers were finished, they were combined into one image using a large process camera. Once color printing came in, the layers idea was also used for creating separate printing plates for each color. While the use of layers much later became one of the main typical features of a contemporary GIS, the photographic process just described is not considered to be a GIS in itself - as the maps were just images with no database to link them to.

Computer hardware development spurred by nuclear weapon research led to general-purpose computer 'mapping' applications by the early 1960s. (Fitzgerald, Joseph 2007).

The year 1960 the development of the world's first true operational GIS in Ottawa, Ontario, Canada by the federal Department of Forestry and Rural Development. Developed by Dr. Roger Tomlinson, it was called the Canada Geographic Information System (CGIS) and was used to store, analyze, and manipulate data collected for the Canada Land Inventory (CLI) – an effort to determine the land capability for rural Canada by mapping information about soils, agriculture, recreation, wildlife, waterfowl, forestry and land use at a scale of 1:50,000. A rating classification factor was also added to permit analysis.

CGIS was an improvement over 'computer mapping' applications as it provided capabilities for overlay, measurement and digitizing/scanning. It supported a national coordinate system that spanned the continent, coded lines as arcs having a true

embedded topology and it stored the attribute and location information in separate files. As a result of this, Tomlinson has become known as the 'father of GIS', particularly for his use of overlays in promoting the spatial analysis of convergent geographic data. (Tomlinson 2007).

CGIS lasted into the 1990s and built a large digital land resource database in Canada. It was developed as a mainframe-based system in support of federal and provincial resource planning and management. Its strength was continent-wide analysis of complex datasets. The CGIS was never available in a commercial form.

In 1964, Howard T. Fisher formed the Laboratory for Computer Graphics and Spatial Analysis at the Harvard Graduate School of Design (LCGSA 1965-1991), where a number of important theoretical concepts in spatial data handling were developed, and which by the 1970s had distributed seminal software code and systems, such as 'SYMAP', 'GRID' and 'ODYSSEY' - that served as sources for subsequent commercial development — to universities, research centers and corporations worldwide. (Fisher 1979).

By the early 1980s, M&S Computing (later Intergraph), Environmental Systems Research Institute (ESRI), CARIS (Computer Aided Resource Information System) and ERDAS (Earth Resources Data Analysis System) emerged as commercial vendors of GIS software, successfully incorporating many of the CGIS features, combining the first generation approach to separation of spatial and attribute information with a second generation approach to organizing attribute data into database structures. In parallel, the development of two public domain systems began in the late 1970s and early 1980s. (Evenden and Botbol, 1985)

The Map Overlay and Statistical System (MOSS) project started in 1977 in Fort Collins, Colorado under the auspices of the (Western Energy and Land Use Team (WELUT) and the US Fish and Wildlife Service. GRASS GIS was introduced in 1982 by the US Army Corps of Engineering Research Laboratory (USA-CERL) in Champaign, Illinois, a branch of the US Army Corps of Engineers to meet the need of the US military for software for land management and environmental planning.

In the later 1980s and 1990s, industry growth was spurred on by the growing use of GIS on UNIX workstations and the personal computer. By the end of the 20th century, the rapid growth in various systems had been consolidated and standardized on relatively few platforms and users were beginning to explore the concept of viewing GIS data over the Internet, requiring data format and transfer standards. More recently, a growing number of free, open-source GIS packages run on a range of operating systems and can be customized to perform specific tasks. Increasingly geospatial data and mapping applications are being made available via the World Wide Web (Fu, P., and J. Sun. 2010).

Several authoritative books on the history of GIS have been published. (Coppock, and Rhind, 1991).

GIS technology is considered nowadays to be the backbone technology that provides systems that support, aids and help small up enterprise agencies in their day to day, planning, decision making and analysis activities.

As the concept of sustainable development and the need for public involvement in planning by diverse groups become more widely accepted among politicians, policymakers and the general public, it is critical to incorporate impact assessment and analysis into the planning and decision-making process. During such a process, all stakeholders in a region, including public/private organizations and residents, should work together to analyze, compare, contrast and prioritize different development alternatives for a sustainable future (Xinhao 2005; Smith , Blake and Davies, 2000; Wang, 2001)

Over the last decades, computer technologies became a powerful and unique means for solving different kinds of problems in numerous fields of human labour and knowledge. Computer technologies allow reliable and short time exchange and versatile processing of a huge amount of information. An important achievement of the contemporary management technologies are the Geographic Information Systems (GIS). In fact, GIS is a technology that allows the creation of an abstract model of the real world (or parts of it) via people, hardware, and software Figure. (3). GIS is a dynamic

structure, where people constantly collect, enter, process and update various information. The database contains information about objects from the real world, the description of the relations between objects, as well as between objects and subjects, the description of conditions etc (Diamiter and Andreev 2009)

GIS data represents real objects (such as roads, land use, elevation, trees, waterways, etc.) with digital data determining the mix. Real objects can be divided into two abstractions: discrete objects (e.g., a house) and continuous fields (such as rainfall amount, or elevations). Traditionally, there are two broad methods used to store data in a GIS for both kinds of abstractions mapping references: raster images and vector. Points, lines, and polygons are the stuff of mapped location attribute references. A new hybrid method of storing data is that of identifying point clouds, which combine three-dimensional points with RGB (Red-Green-Bleu) information at each point, returning a "3D color image". GIS Thematic maps then are becoming more and more realistically visually descriptive of what they set out to show or determine.

A raster data type is, in essence, any type of digital image represented by reducible and enlargeable grids. Anyone who is familiar with digital photography will recognize the Raster graphics pixel as the smallest individual grid unit building block of an image, usually not readily identified as an artifact shape until an image is produced on a very large scale. A combination of the pixels making up an image color formation scheme will compose details of an image, as is distinct from the commonly used points, lines, and polygon area location symbols of scalable vector graphics as the basis of the vector model of area attribute rendering. While a digital image is concerned with its output blending together its grid based details as an identifiable representation of reality, in a photograph or art image transferred into a computer, the raster data type will reflect a digitized abstraction of reality dealt with by grid populating tones or objects, quantities, conjoined or open boundaries, and map relief schemas. Aerial photos are one commonly used form of raster data, with one primary purpose in mind: to display a detailed image on a map area, or for the purposes of rendering its identifiable objects by digitization. Additional raster data sets used by a GIS will contain information regarding

elevation, a digital elevation model, or reflectance of a particular wavelength of light, Landsat, or other electromagnetic spectrum indicators.

Raster data type consists of rows and columns of cells, with each cell storing a single value. Raster data can be images (raster images) with each pixel (or cell) containing a color value. Additional values recorded for each cell may be a discrete value, such as land use, a continuous value, such as temperature, or a null value if no data is available. While a raster cell stores a single value, it can be extended by using raster bands to represent RGB (red, green, blue) colors, color maps (a mapping between a thematic code and RGB value), or an extended attribute table with one row for each unique cell value. The resolution of the raster data set is its cell width in ground units.

Raster data is stored in various formats; from a standard file-based structure of TIF, JPEG, etc. to Binary Large Object (BLOB) data stored directly in a Relational Database Management System (RDBMS) similar to other vector-based feature classes. Database storage, when properly indexed, typically allows for quicker retrieval of the raster data but can require storage of millions of significantly sized records.

In a GIS, geographical features are often expressed as vectors, by considering those features as geometrical shapes. Different geographical features are expressed by different types of geometry:

Points: A simple vector map, using each of the vector elements: points for wells, lines for rivers, and a polygon for the lake. Zero-dimensional points are used for geographical features that can best be expressed by a single point reference—in other words, by simple location. Examples include wells, peaks, features of interest, and trailheads. Points convey the least amount of information of these file types. Points can also be used to represent areas when displayed at a small scale. For example, cities on a map of the world might be represented by points rather than polygons. No measurements are possible with point features.

Lines or polylines: One-dimensional lines or polylines are used for linear features such as rivers, roads, railroads, trails, and topographic lines. Again, as with

point features, linear features displayed at a small scale will be represented as linear features rather than as a polygon. Line features can measure distance.

Polygons: Two-dimensional polygons are used for geographical features that cover a particular area of the earth's surface. Such features may include lakes, park boundaries, buildings, city boundaries, or land uses. Polygons convey the most amount of information of the file types. Polygon features can measure perimeter and area.

Each of these geometries is linked to a row in a database that describes their attributes. For example, a database that describes lakes may contain a lake's depth, water quality, pollution level. This information can be used to make a map to describe a particular attribute of the dataset. For example, lakes could be colored depending on level of pollution. Different geometries can also be compared. For example, the GIS could be used to identify all wells (point geometry) that are within one kilometer of a lake (polygon geometry) that has a high level of pollution.

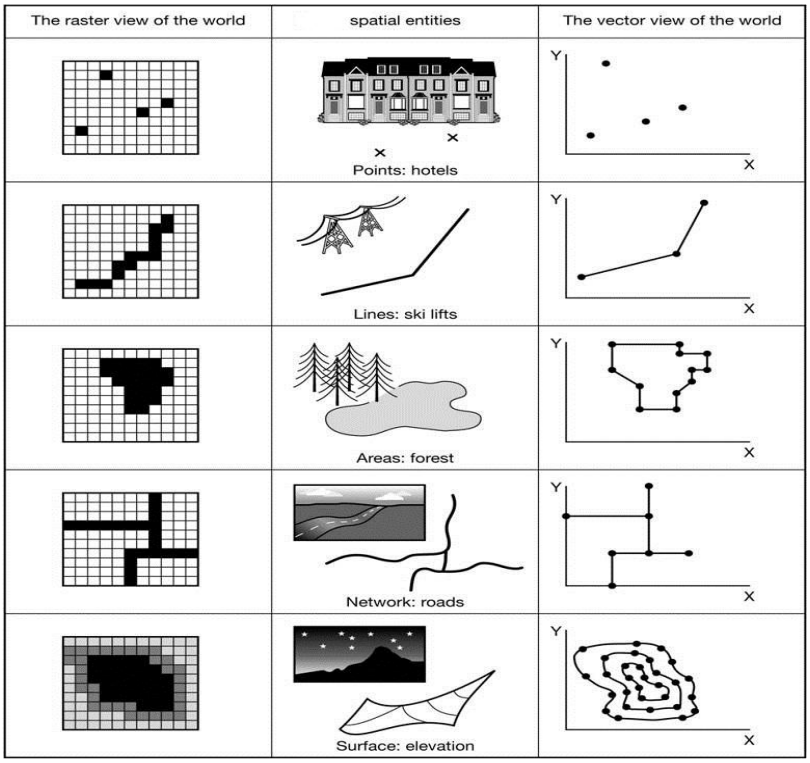

Figure. (4): raster to vector representation

GIS is an integration of five main elements users, data, hardware, software and analysis or procedures. (Padma Kumara 2003) as shown in Figure (5)

Figure. (5): Integration of the main components of GIS

2.2 Advantage of GIS

GIS now days is considered to be the backbone for any business looking for rapid development, since GIS improves business outcomes, reduces time and effort, supports decision making activities if and only if implemented in a professional manner.

All sciences or businesses can include GIS as a powerful tool and these sciences and business cover a wide spectrum including:(Esri, 2011)

- Earth surface-based scientific investigations.
- Resource management.
- Reference and projections of a geospatial nature, both artificial and natural.
- Asset management and location planning.
- Archaeology.
- Environmental impact-assessment.

- Infrastructure assessment and development;
- Urban planning and regional planning;
- Cartography, for a thematic and/or time-based purpose;
- Criminology;
- Geospatial intelligence;
- GIS data development;
- Geographic History;
- Marketing (Geomarketing);
- Logistics;
- Population and demographic studies;
- Public health planning.
- Prospectively Mapping;
- Statistical Analysis;
- GIS in environmental contamination;
- Disease surveillance;
- Military planning.
- Utility and analysis applications;
- High consequence area (HCA) analysis;
- Outage and trouble call management;
- Damage Prevention;
- Engineering Analysis.

GIS advantages are be listed as follows: (Esri, 2011)

- Collaboration: GIS working environment offers an intensive environment of cooperation and collaboration and supports team work where every user can be an effective role in the business life cycle.
- Improved planning and decision qualities: GIS can be considered a DSS (decision support system), thus GIS improves planning and decision making since its analysis is based not only on tabular and raw data, but in addition to geospatial data, data related to location the thing that makes a bigger and clearer picture for decision makers.
- Automated business cycle: instead of adopting the demised paper work environment, GIS improves work cycle by converting every piece of day to day activities, planning and decision making fully automated the thing that results in reducing costs, time and effort with better results.
- State of the art analysis capabilities and simulation: with a wide range of available options to be applied in real life from a business point of view, GIS can

simulate and offer pre scenario analysis models to imitate these proposed options regardless how simple or complex options.

- Scalability and flexibility systems: GIS supports they may be a wide range of technologies regarding operating systems, database engines and data formats in addition to the ability to work with huge amounts of data and large areas.

2. 3 GIS layers

There are many layers of geospatial information that will be used and analyzed using GIS software while all of these layers "each layer will represent a factor for causing traffic jam" categorized into related classes which include:

- **Streets Network Structure:**
  - Bridges and tunnels
  - Street network
  - Intersections and circles
  - Road Blocks and security check points
- **Landmarks Distribution:**
  - Governmental agencies
  - Universities and Schools
  - Commercial areas
  - Entertainment sites
  - Religious sites
  - Health care sites
- **Extra Layers :**
  - Statistical data for cars count and cars specs.

GIS role in the proposed solution will be implemented to study each factor from the previously mentioned as a single or set of Geospatial Data Layers supported with the powerful analysis and patterns detection capabilities in order to evaluate, weighing and calculate each factor effect in addition to represent the proposed solutions also as geospatial layers that will be treated in similar manner to the layers "factors". Urban planning and transportation management are important fields where GIS can take place.

These layers “factors” will be studied, tested , and analyzed using GIS to find the effect of each and every factor of concern ,in this study ,in order to produce the solutions also supported with GIS and statistical analysis results as final recommendations that vary between short term and long term solutions.

With available data layers collected using field survey, raster digitization and data conversion from multiple sources for Al Karadah, the implementation of GIS as a backbone tool for testing and evaluating becomes crucial.

All these layers “factors” will be tested spatially using GIS technology, GIS data processing should not be considered only a method used in urban planning, as it is not sufficient to build wider roads or to decongest the crossroads etc., but it has to be taken into account as an instrument able to modify the administrative politics regarding land-use for the relocation of the urban poles (shops, industrial platforms, administrative centers) in the areas with low road traffic values on the base of cost/benefit analysis.

2.4 proposed data analysis workflow

Figure (6) represents the proposed data analysis workflow.

The tools intended to be used in the thesis are:

- ArcGIS Desktop: an ESRI software which is known as number one GIS application providers worldwide.
- 50 cm GeoEye Satellite imagery.
- Statistical data from previous Iraqi national projects related to the scope of work.

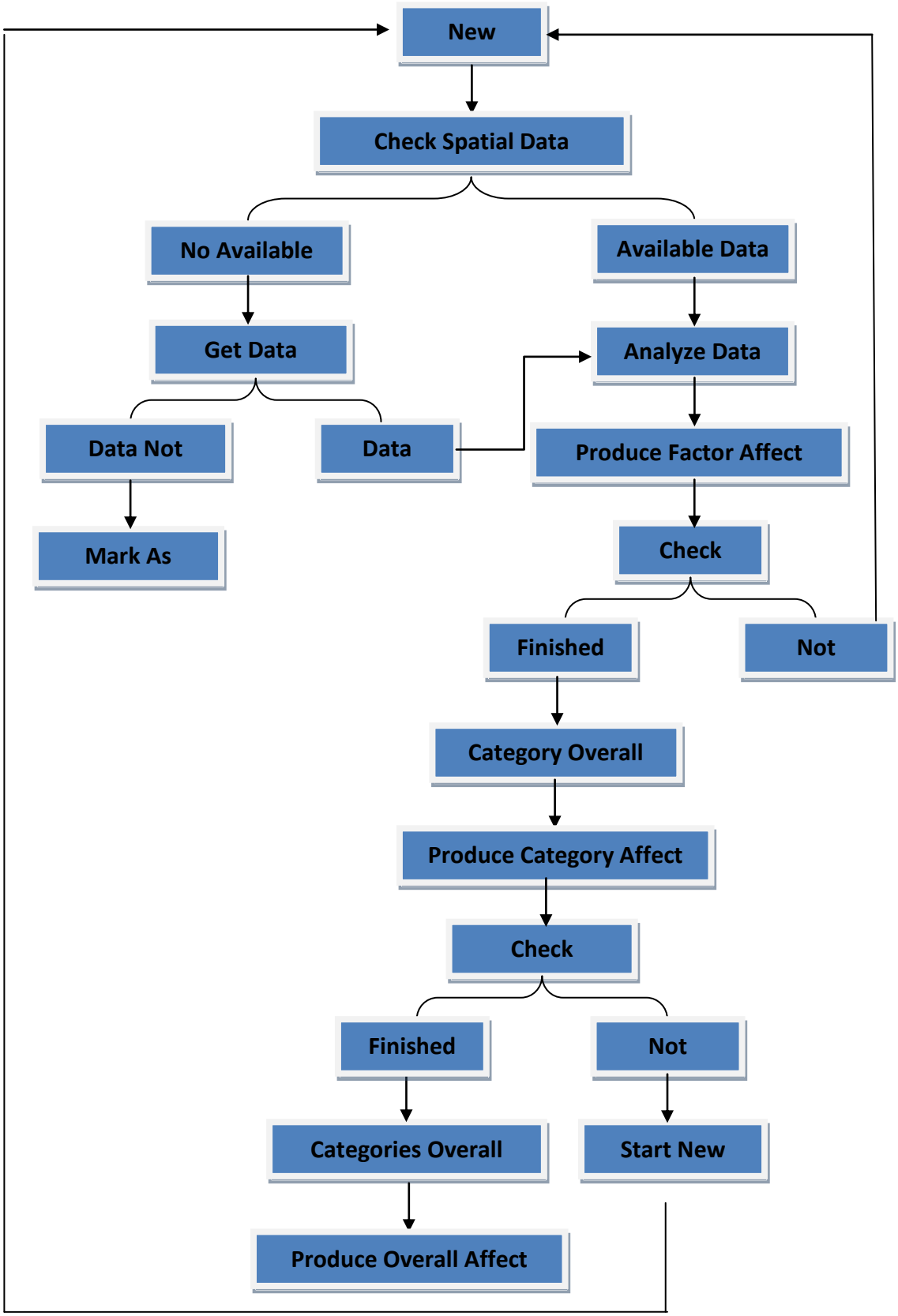

Figure. (6): Proposed Data Analysis Workflow Diagram

Table (1): contains detailed specs of Al Karadh based on 2010 census predictions (Central organization for statistical and information technology, 2010).

Seq.	Entry	Value
1	Area	49 km2
2	Inhabitants	279,311
3	Males	140,520
4	Females	138,791
5	Districts	8

The graph below represents the main framework for the analysis process starting from layer by layer analysis, followed by set analysis and finally overall analysis.

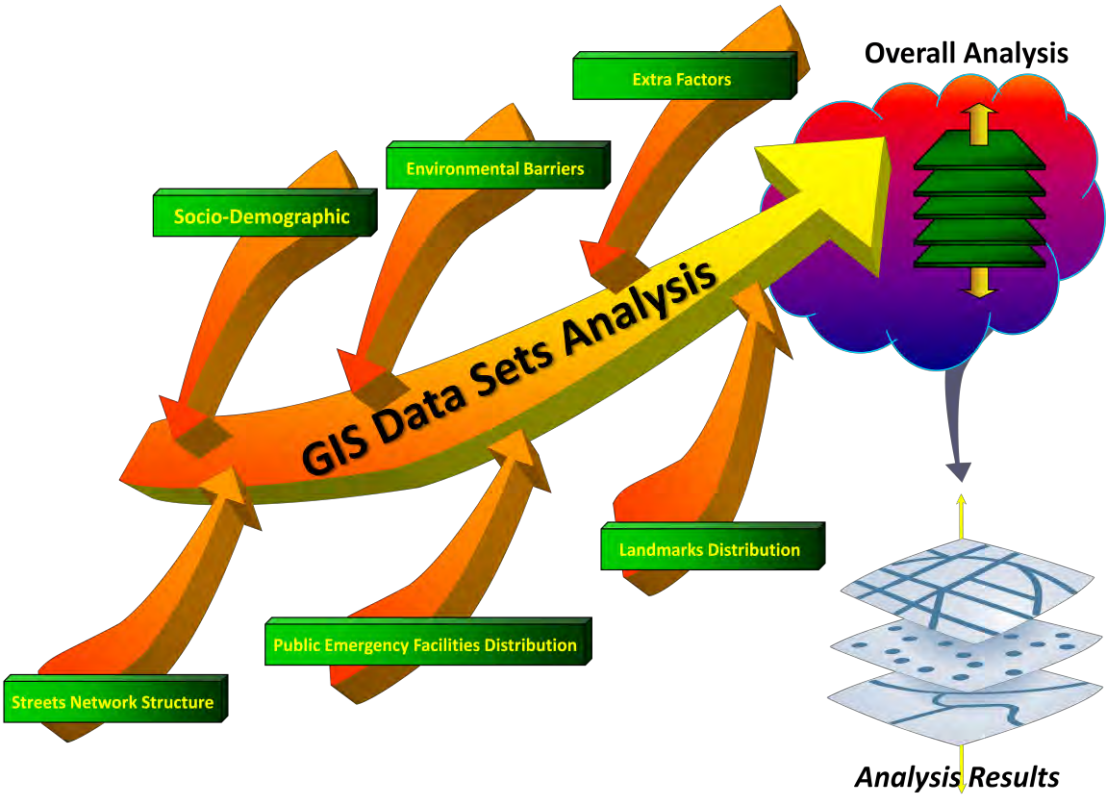

Figure. (7): Proposed GIS Data Sets Analysis Model

The model presents the intended workflow to be adopted by studying each factor as a standalone jam reason, and to evaluate its weight.

After the analysis of each factor "layer", there will be an overall analysis for the whole set of layers "factors". In addition an overall analysis for the result of sets analyses will be performed to create a final map that measures the traffic jam as described in figure(7).

2.5 Literature review

In recent years, traffic problems have been widely investigated. As traffic jams started to be an international problem, methodologies and solutions based on set of different GIS based technologies, used in order to produce dynamic traffic management systems started to emerge

Many newly developed methodologies and solutions showing how much it is helpful to utilize advanced GIS technologies including "Differential Global Positioning System" DGPS, remote sensing, monitoring spots and more hardware and software based technologies in order to measure traffic flow and jam (Rao, Sunitha, and Jayasree, 2005).

In this thesis the researcher will introduce same concept by utilizing latest state of the art GIS technologies in order to study, analyze and solve traffic jams and to produce a model to be applied further more in different cities in order to avoid this type of traffic jams.

In addition to propose technologies and studies to reduce traffic jams and with the highly increased number of vehicles, providing modern, more complex and more accurate way to measure traffic flow on a given street based on applying intensive analysis results "which is the model resulted on the paper" to identify the flow status during a given period of time, is a must and has advantages (Daiyong and Zhou, 2008).

This done by introducing some new hybrid models for traffic flow analysis based on aerial remote sensed imagery to analyze cars speed, distances covered by time and

then to judge on traffic status based on weighing criteria (Daiyong and Zhou, 2008).

In this thesis the researcher will use the same concept of adopting aerial photogrametry but not to be remotely sensed, rather to be used in actual and real analysis procedures when merged with geospatial layers.

In addition to provide single system or new models the need for systems integration and more generic and powerful systems emerge by providing a general system structure frame work that combines many and different technologies into one standalone system. The goal now is how to integrate different systems that adopts different technologies such as GP, GIS, GPRS, OBDII "on board diagnostics" into one system (Zhiwei, Wancai , 2010). In this thesis the researcher will introduce the same concept by utilizing latest stat of the art GIS technologies in order to study, analyze and solve traffic jams and to produce a model to be applied further more in different cities in order to avoid this type of traffic jams.

Utilized GIS technology in order to study, analyze, understand and provide proposed solutions for the traffic jam based on studying the industrial zones, governmental agencies, parks distribution, residential areas, and commercial areas all in regarding to streets that passes by these zones as layers "factors" that affect and causes this traffic jam (Avram Sorin, Curcan Gheorghe, Vladut Alina, Marinescu Ioan, 2010).

The difference which is an addition in this thesis is that the authors analyzed limited number of standalone layers without an overlay analysis, instead the researcher will use in this thesis more layers deeply analyzed supported by the functionality of complex analysis processes that studies all layers in all categories as one to identify weighing and required spatial information. The increased number of factors compared to the previously mentioned reference is that the political and social uniqueness for Iraq compared to most of countries around the world all represented by the Extra Factors set that contains terrorist incidents, religious activities, law enforcement and control processes and more.

Chapter 3

Work Methodology

Chapter Contents

3.3 Data analysis

3.3.1 Streets Network Data

3.3.1.1 Street network

3.3.1.2 Bridges and tunnels

3.3.1.3 Intersections and circles

3.3.1.4 Road blocks and security check points

3.3.2 Landmarks

3.3.2.1 Governmental agencies

3.3.2.2 Universities and Schools

3.3.2.3 Commercial areas

3.3.2.4 Entertainment Sites

3.3.2.5 Health care facilities

3.3.2.6 Religious sites

3.1 Introduction

This chapter covers in detail the work done step by step starting from:

1. data gathering and collection.
2. layers conversion and creation.
3. geodatabase creation.
4. basic layers analysis.
5. overall analysis.

ArcGIS 9.3.1 was the application used to design all layers, build the geodatabase model and perform all analysis and map production activities.

ArcGIS is an (Environmental Sciences Research Institute) ESRI which is an American company with an international reputation in the field of GIS systems, studies and applications. ArcGIS is software that is mainly used to create and maintain geospatial data in addition to the wide range of analysis functions and data editing tools. The software mainly consists of several applications that include:

1. ArcCatalog: it's the application that is used to prepare data layers structure, creation, management in addition to geodatabase. On the other hand geodatabase is an ESRI format used to store the geospatial data in a centralized location in a professional manner.
2. ArcMap: this application used to edit, present, analyze, query data and map production.
3. ArcScene: this application is mainly used to create 3D models like terrain models based on predesigned layers and satellite imagery supported with elevation and topography data.
4. ArcGlobe: is a Google Earth similar client side application which is used mainly to represent layers and data on a surface similar to earth surface.

First of all, a work plan was proposed with a corresponding time plan started by data gathering followed by data management, data analysis and over all analysis. The next chapters will represent in details and covers how every task took place.

3.2 Data gathering and collecting

Data collection is a term used to describe a process of preparing and collecting data, for example, as part of a process improvement or similar project. The purpose of data collection is to obtain information to keep on record, to make decisions about important issues, to pass information on to others. Primarily, data are collected to provide information regarding a specific topic. (Australian Bureau of Statistics, 2011) .

Data collection usually takes place early on in an improvement project, and is often formalized through a data collection plan which often contains the following activity: (Coxon, 1999)

- Pre collection activity — agree on goals, target data, definitions, methods
- Collection — data collection
- Present Findings — usually involves some form of sorting analysis and/or presentation.

Prior to any data collection, pre-collection activity is one of the most crucial steps in the process. It is often discovered too late that the value of their interview information is discounted as a consequence of poor sampling of both questions and informants and poor elicitation techniques. (Weller, 1988).

After pre-collection activity is fully completed, data collection in the field, whether by interviewing or other methods, can be carried out in a structured, systematic and scientific way.

A formal data collection process is necessary as it ensures that data gathered are both defined and accurate and that subsequent decisions based on arguments embodied in the findings are valid. (Roger and Victor 1996)

The process provides both a baseline from which to measure from and in certain cases a target on what to improve.

Other main types of collection include census, sample survey, and administrative by-product and each with their respective advantages and disadvantages. A census refers

to data collection about everyone or everything in a group or population and has advantages, such as accuracy and detail and disadvantages, such as cost and time. A sample survey is a data collection method that includes only part of the total population and has advantages, such as cost and time and disadvantages, such as accuracy and detail. Administrative by-product data are collected as a byproduct of an organization's day-to-day operations and has advantages, such as accuracy, time simplicity and disadvantages, such as no flexibility and lack of control. (Weimer, 1995).

As any regular GIS data gathering and collecting, the data source was the corresponding governmental agencies, In addition to gathered geospatial data there was a lot of missed data which forced us to create it from scratch based on a new acquired satellite image in addition to field survey.

3.2.1 Streets Network Data

The streets network data was mainly collected from Baghdad municipality but the problem was that lot of features and lot of attribute data were missing. The researcher collected several layers listed as shown in Figure (8).

3.2.1.1 Streets Network

The layer in Figure (8) contains the street network of area of interest.

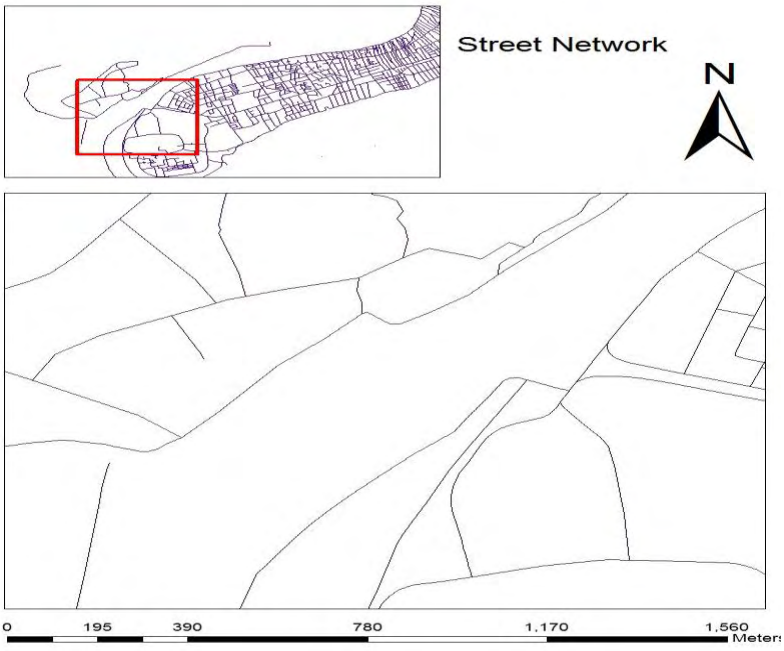

Figure. (8): street network of al karadah.

As presented in Figure (8) the layer contains all the streets of Al Karadah as a center line with some spatial errors like misplaced features at some points. Some of these streets were missing where the researcher had to digitize it from a new satellite image for the city. And most of them were without any attribute data like name or type and the attribute data was collected and entered manually.

Figure (9) shows Al- Karadah Dakhel Street map and Figure (10) represents a photos from the same street that illustrates the traffic jam:

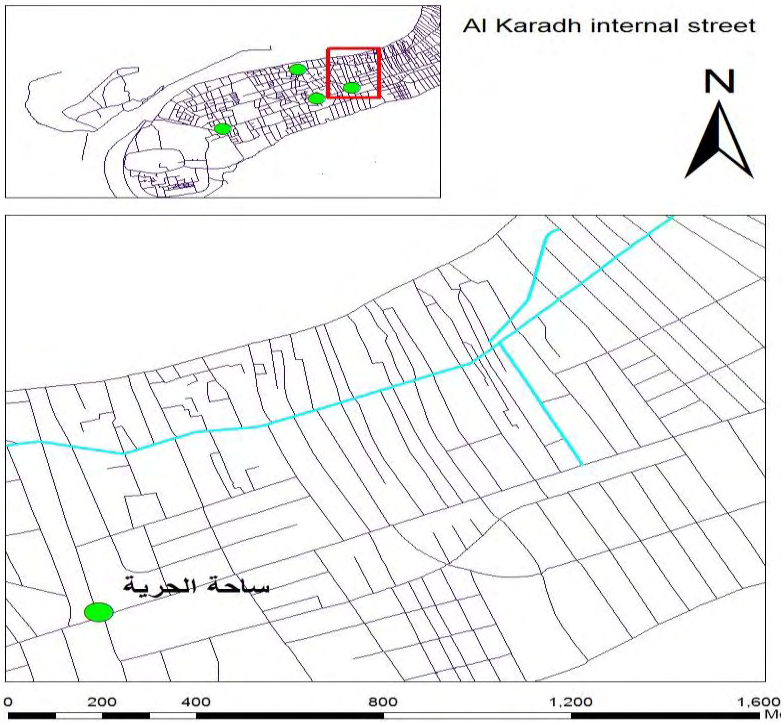

Figure. (9): Al- Karadah Dakhel Street

Figure. (10): Traffic Jam at Karadah Dakhel Str.

Figure (11 a) the photo illustrates the traffic jam in Al- Karadah kharej Street Figure (11 b) showing the traffic jam even for a late hours of the night.

Figure. (11): a and b Traffic Jam at Al- Karadah kharej Str.

3.2.1.2 Bridges and tunnels

This layer contains the bridges at area of interest. No tunnels in Al Karadah. This layer created from satellite imagery and field survey and no data were available in any department for this purpose. and the photos shows the traffic jam in these streets because it connects the two sides of Baghdad and it leads to the main universities.

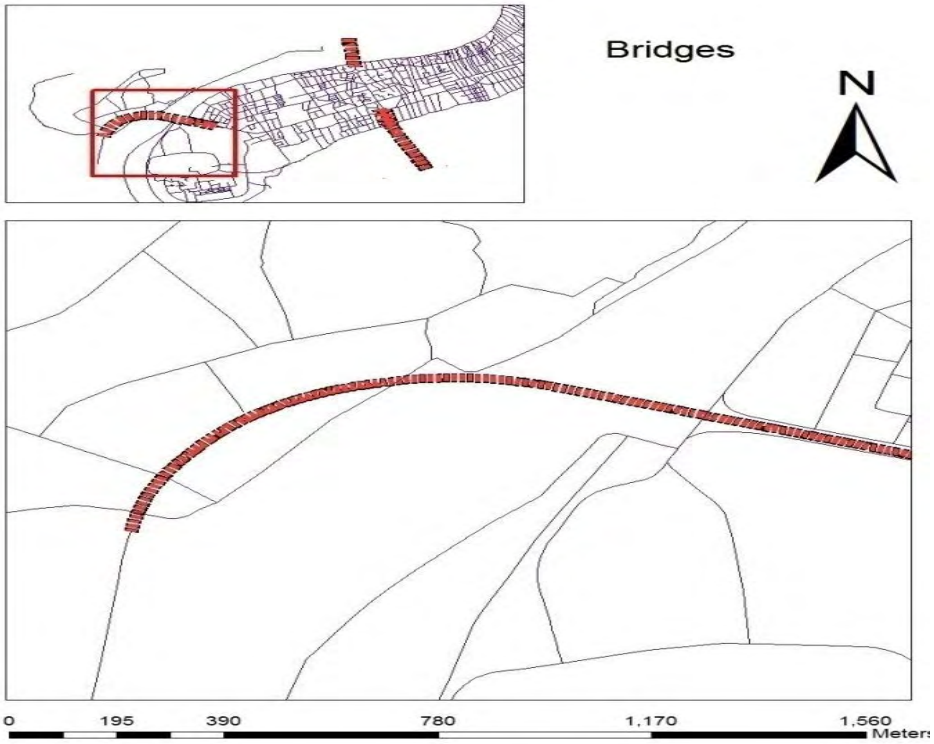

Figure. (12): Map for AL- Jadriah Bridge

Figure (12) shows the AL- Jadriah Bridge map which is a main bridge in Baghdad and it's important to refer that this bridge has two main check points (at the same bridge) belongs to a different army division and that would add large impact of traffic jam to the bridge .

a

Figure. (13):a and b AL- Jadriah Bridge

3.2.1.3 Intersections and circles

This layer contains the circles and road intersections at area of interest.

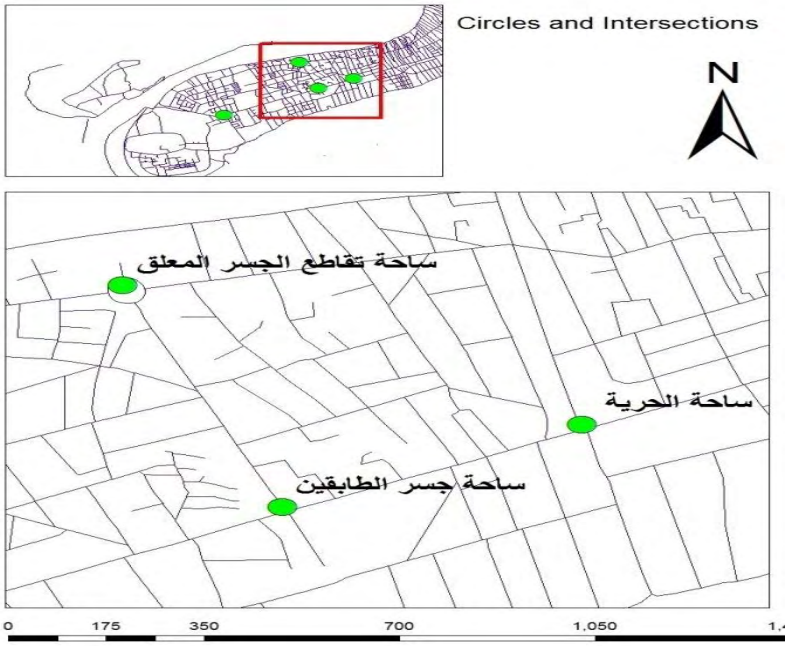

Figure. (14): intersections map

Figure. (15) shows the intersection in the study area which is always has a traffic jam because it connects the main streets together and it has no (u-turn) .

ure. (15): a, b, and c intersections

3.2.1.4 Road blocks and security check points

This layer represents the road blocks at Al Karadah. The road blocks and security check points is a serious problem in all Iraq streets because of the terrorist attacks and conflicts which led to close many of the main roads of Baghdad and placing check points at main and secondary roads , as shown in Figure. (16):

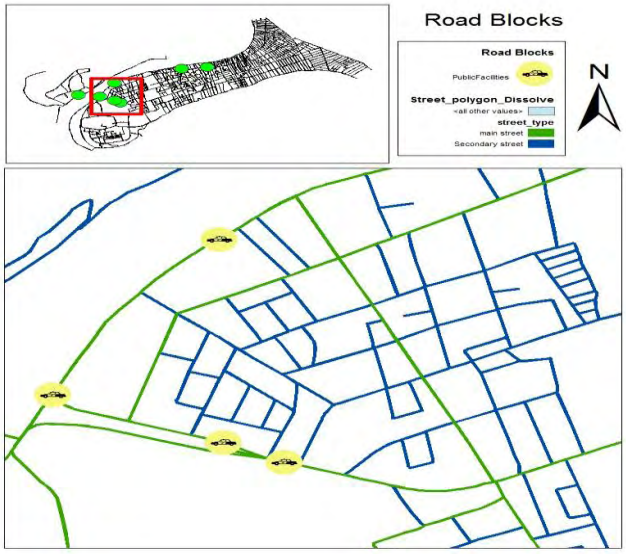

Figure. (16): Road blocks and security check points map

3.2.2 Landmarks

The landmarks data was mainly collected from Baghdad municipality but the problem was that lot of features and lot of attribute data was missing. The researcher created and prepared several layers

3.2.2.1 Governmental agencies

This layer contains all governmental agencies and department at area of interest .It is useful to notice that 70 % of Iraq ministries located in al – Karadah area and most of its related department.

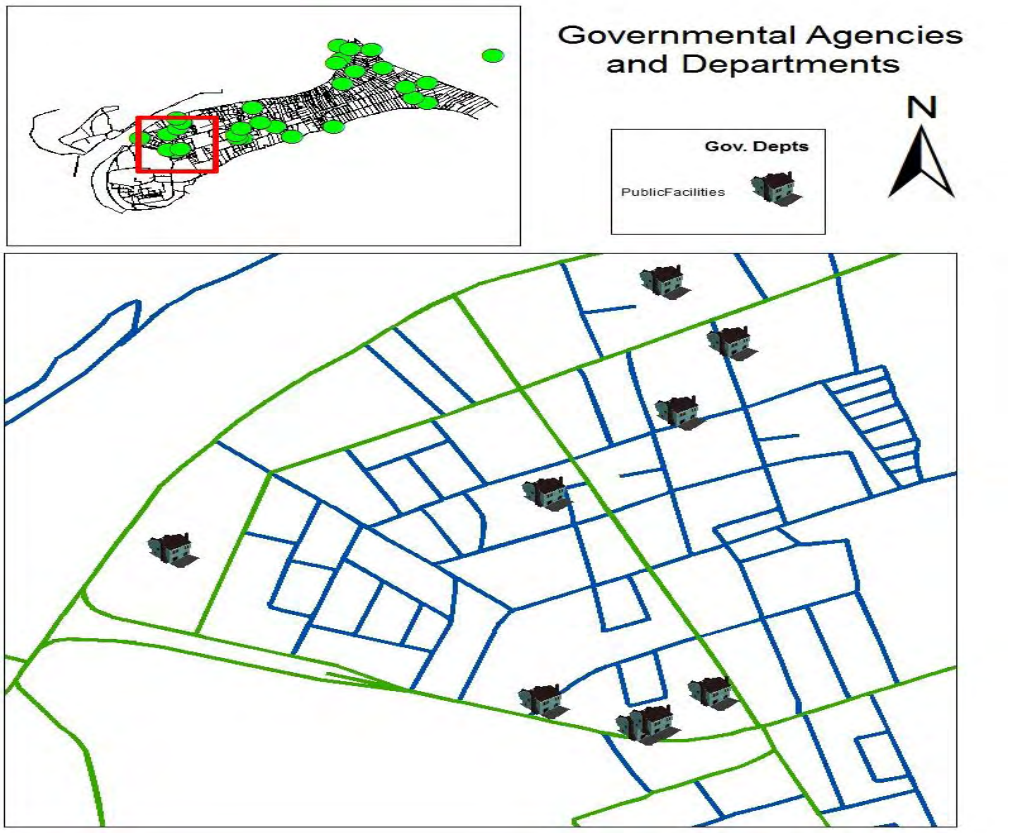

Figure. (17): governmental agencies and Department map

3.2.2.2 Universities and Schools

This layer represents the schools, universities and other educational facilities at area of interest. such as the two main universities (Baghdad ,Al-Nahraen) and many governmental and nongovernmental primary and high schools .

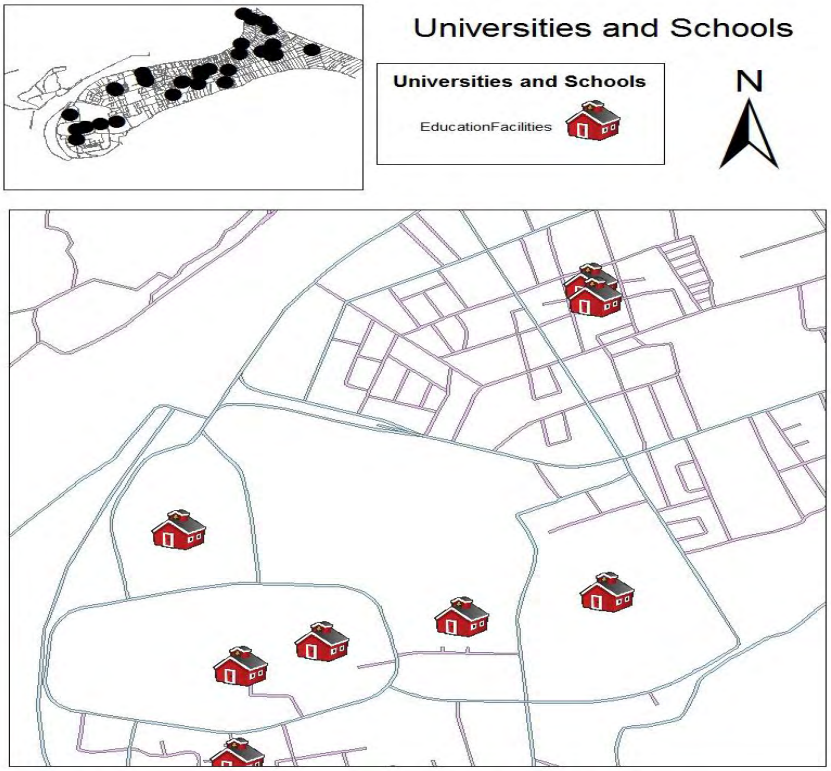

Figure. (18): Universities and schools map

Figure. (19): Traffic Jam at Baghdad University intersection.

3.2.2.3 Commercial areas

This layer represents the commercial landmarks at area of interest. And this is a serious problem because it's the central market for electronics and electricity devices all over Iraq and provides most of Baghdad citizens with their requirements.

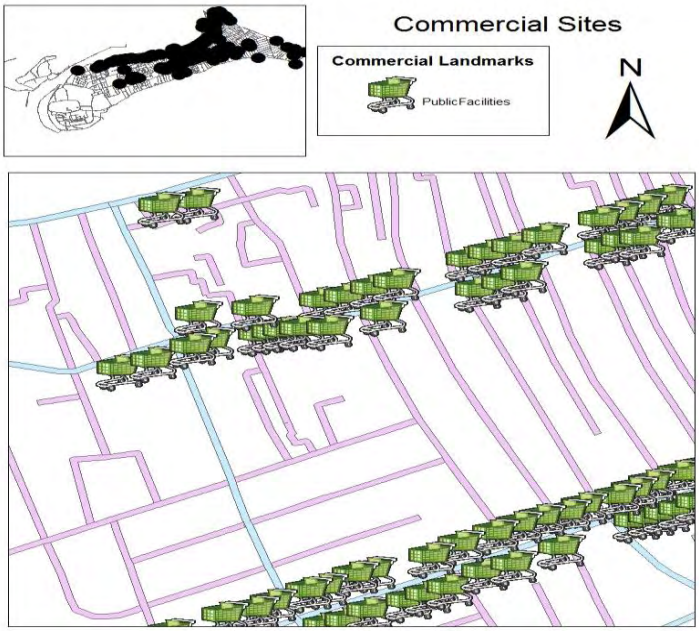

Figure. (20): Commercial landmarks map

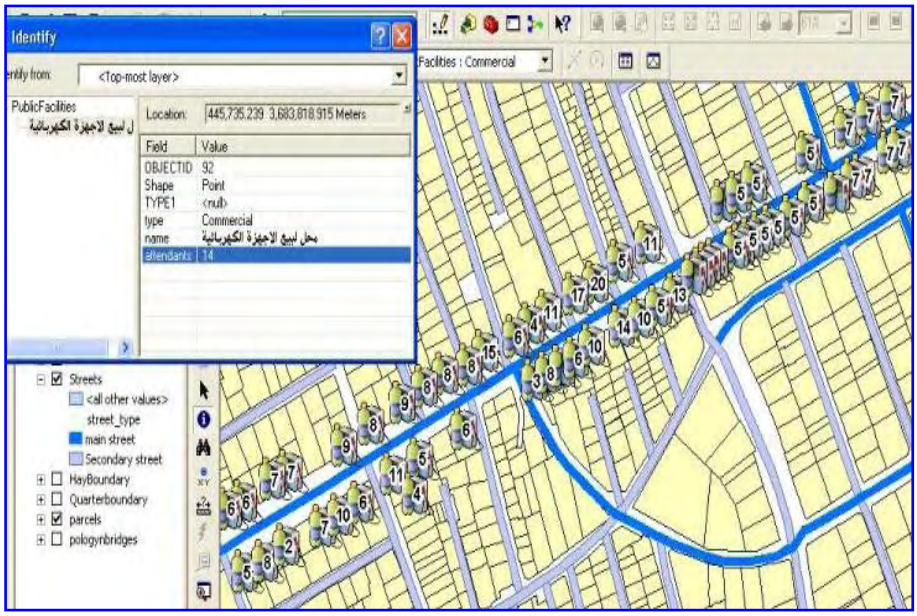

Figure. (21): the impact of shops in the traffic jam at Al-Karadah Kharig Street.

Figure (21and 22) show the traffic jam comes from the customers whom attend those stores and supermarkets.

Figure. (22): Traffic Jam at Al- Karadah Kharig Str.

3.2.2.4 Entertainment Sites

This layer represents the entertainment landmarks at area of interest as shown in Figure (23).

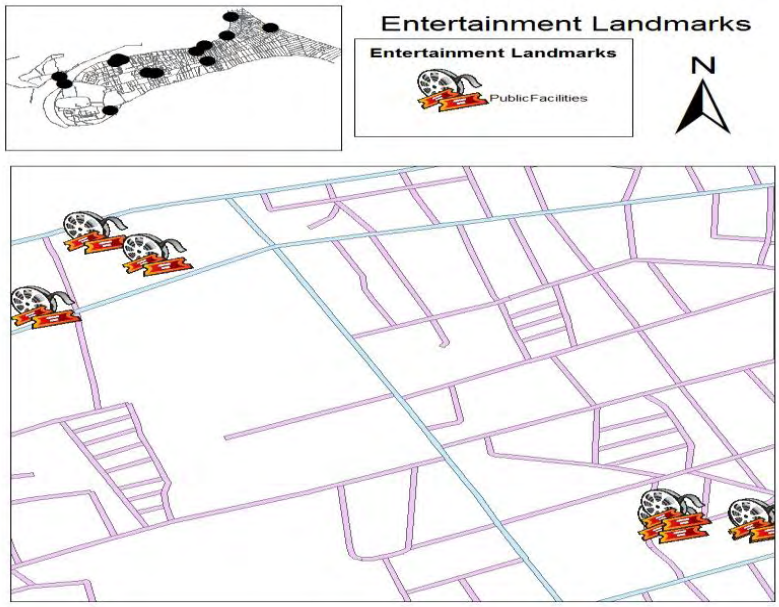

Figure. (23): Entertainment Landmarks map

3.2.2.5 Health care facilities

This layer represents the health care landmarks at area of interest.

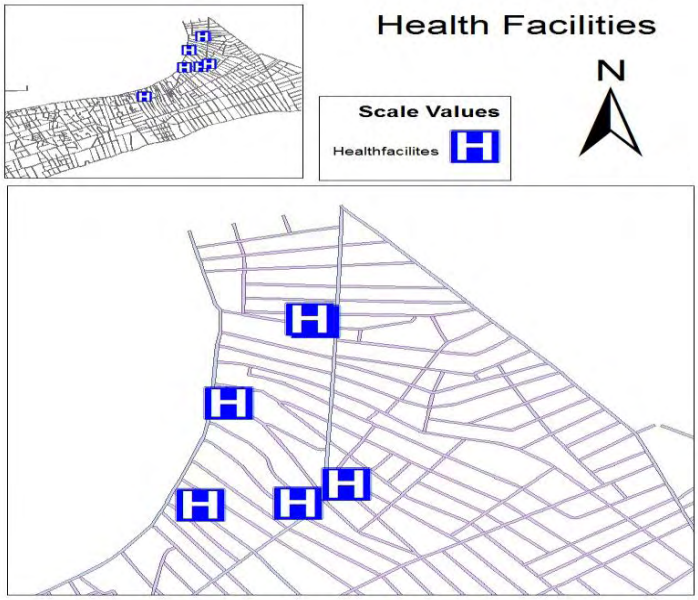

Figure. (24): health facilities map

3.2.2.6 Religious sites

This layer represents the religious landmarks at area of interest.

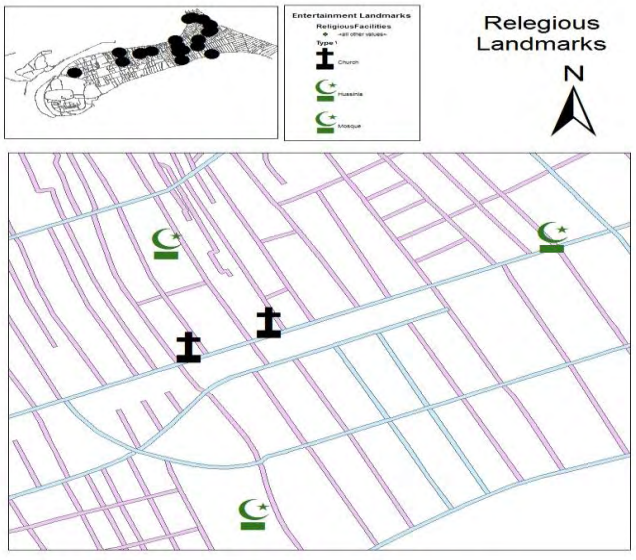

Figure. (25): Religious landmarks map

3.2.3 Extra Layers:

The extra layers data mainly collected from Iraqi census and department of statistics in addition to some extra layers that were very important for the work. The researcher collected and prepared several data pieces as listed in the following:

3.2.3.1 Statistical data for cars count and cars specs

This was an important piece of information gathered from both the Iraqi General Directorate of Traffic and Central organization for statistical and information technology of transportation for census information and car counts.

It is important to mention here that the laws after 2003 have significantly contributed to the increased numbers of cars without a solution to the problem of the infrastructure to prepare for this massive increase. In Baghdad governorate Where the number of cars in all their types 543,075 in 2003 and the latest statistics on 12/9/2011 and reached 1,578,179 (Traffic of Police General Directorate 2011).

3.2.3.2 Satellite Imagery

The satellite imagery used to collect data by creating it from scratch. The researcher bought this satellite imagery from Geoeye with 0.5 m resolution.

3.3 Data Analysis

Analysis of data is a process of inspecting, cleaning, transforming, and modeling data with the goal of highlighting useful information, suggesting conclusions, and supporting decision making. Data analysis has multiple facts and approaches, encompassing diverse techniques under a variety of names, in different business, science, and social science domains.

There are several types of data:

Quantitative data: is a number Often this is a continuous decimal number to a specified number of significant digits, Sometimes it is a whole counting number.

Categorical data: one of several categories.

Qualitative data: is a pass/fail or the presence or lack of a characteristic.

Data analysis is a process, within which several phases can be distinguished (John Dewey 2008)

Data cleaning is an important procedure during which the data are inspected, and erroneous data are—if necessary, preferable, and possible—corrected. Data cleaning can be done during the stage of data entry. If this is done, it is important that no subjective decisions are made (John Dewey 2008).

Initial data analysis is the most important distinction between the initial data analysis phase and the main analysis phase, is that during initial data analysis one refrains from any analysis that are aimed at answering the original research question. The initial data analysis phase is guided by the following points: (John Dewey 2008).

1- Quality of data: The quality of the data should be checked as early as possible. Data quality can be assessed in several ways, using different types of analyses: frequency counts, descriptive statistics (mean, standard deviation, median), normality (skewness, kurtosis, frequency histograms, normal probability plots), associations (correlations, scatter plots).

Other initial data quality checks are:

The choice of analyses to assess the data quality during the initial data analysis phase depends on the analyses that will be conducted in the main analysis phase (John Dewey 2008).

2- Quality of measurements: The quality of the measurement instruments should only be checked during the initial data analysis phase when this is not the focus or research question of the study. One should check whether structure of measurement instruments corresponds to structure reported in the literature. There are two ways to assess measurement quality:

- Confirmatory factor analysis
- Analysis of homogeneity (John Dewey 2008).

3- Initial transformations: After assessing the quality of the data and of the measurements, one might decide to impute missing data, or to perform initial transformations of one or more variables, although this can also be done during the main analysis phase (John Dewey 2008)..

4- Did the implementation of the study fulfill the intentions of the research design?: One should check the success of the randomization procedure, for instance by checking whether background and substantive variables are equally distributed within and across groups, If the study did not need and/or use a randomization procedure, one should check the success of the non-random sampling, for instance by checking whether all subgroups of the population of interest are represented in sample. (John Dewey 2008).

Characteristics of data sample: In any report or article, the structure of the sample must be accurately described. It is especially important to exactly determine the structure of the sample (and specifically the size of the subgroups) when subgroup analyses will be performed during the main analysis phase (John Dewey 2008).

5- Final stage of the initial data analysis: During the final stage, the findings of the initial data analysis are documented, and necessary, preferable, and possible corrective actions are taken. Also, the original plan for the main data analyses can and should be specified in more detail and/or rewritten (John Dewey 2008).

6- Analyses: Several analyses can be used during the initial data analysis phase: (John Dewey 2008).

- Univariate statistics
- Bivariate associations (correlations)
- Graphical techniques (scatter plots)

It is important to take the measurement levels of the variables into account for the analyses, as special statistical techniques are available for each level: (John Dewey 2008).

- Nominal and ordinal variables
  - Frequency counts (numbers and percentages)
  - Associations

- circumambulations (cross tabulations)
- hierarchical log linear analysis (restricted to a maximum of 8 variables)
- log linear analysis (to identify relevant/important variables and possible confounders)
  - Exact tests or bootstrapping (in case subgroups are small)
  - Computation of new variables
- Continuous variables
  - Distribution
- Statistics (M, SD, variance, skewness, kurtosis)
- Stem-and-leaf displays
- Box plots

Main data analysis phase analyses aimed at answering the research question are performed as well as any other relevant analysis needed to write the first draft of the research report (John Dewey 2008).

7- Exploratory and confirmatory approaches: In the main analysis phase either an exploratory or confirmatory approach can be adopted. Usually the approach is decided before data is collected. In an exploratory analysis no clear hypothesis is stated before analyzing the data, and the data is searched for models that describe the data well. In a confirmatory analysis clear hypotheses about the data are tested. Exploratory data analysis should be interpreted carefully. When testing multiple models at once there is a high chance of finding at least one of them to be significant, but this can be due to a type 1 error. It is important to always adjust the significance level when testing multiple models with, for example, a bonferroni correction. Also, one should not follow up an exploratory analysis with a confirmatory analysis in the same dataset. An exploratory analysis is used to find ideas for a theory, but not to test that theory as well. When a model is found exploratory in a dataset, then following up that analysis with a confirmatory analysis in the same dataset could simply mean that the results of the confirmatory analysis are due to the same type 1 error that resulted in the exploratory model in the first place. The confirmatory analysis therefore will not be more informative than the original exploratory analysis. (John Dewey 2008).

8- Stability of results: It is important to obtain some indication about how generalizable the results are (John Dewey 2008). While this is hard to check, one can look at the stability of the results. Are the results reliable and reproducible? There are two main ways of doing this:

- Cross-validation: By splitting the data in multiple parts the researcher can check if analyzes (like a fitted model) based on one part of the data generalize to another part of the data as well.
- Sensitivity analysis: A procedure to study the behavior of a system or model when global parameters are (systematically) varied. One way to do this is with bootstrapping.

9- Statistical methods: A lot of statistical methods have been used for statistical analyses. A very brief list of four of the more popular methods is:

- General linear model: A widely used model on which various statistical methods are based (e.g. t test, ANOVA, ANCOVA, MANOVA). Usable for assessing the effect of several predictors on one or more continuous dependent variables.
- Generalized linear model: An extension of the general linear model for discrete dependent variables.
- Structural equation modelling: Usable for assessing latent structures from measured manifest variables.
- Item response theory: Models for (mostly) assessing one latent variable from several binary measured variables (e.g. an exam).

In this step and after the researcher created all the layers which represent the factors that will be studied and how they affect traffic and stored in a geodatabase the researcher started with factor by factor analysis.

3.3.1 Streets Network Data

3.3.1.1 Street network:

For the street network analysis all the researcher had from data collection phase was a streets center line layer, the thing that doesn't meet the technical needs for the thesis since analysis will cover real streets "as polygons / closed areas" thus the researcher had to create this layer from scratch. The next Figure illustrates the created streets polygon layer which was created by digitizing from a new acquired Geoeye satellite imagery with 50cm resolution:

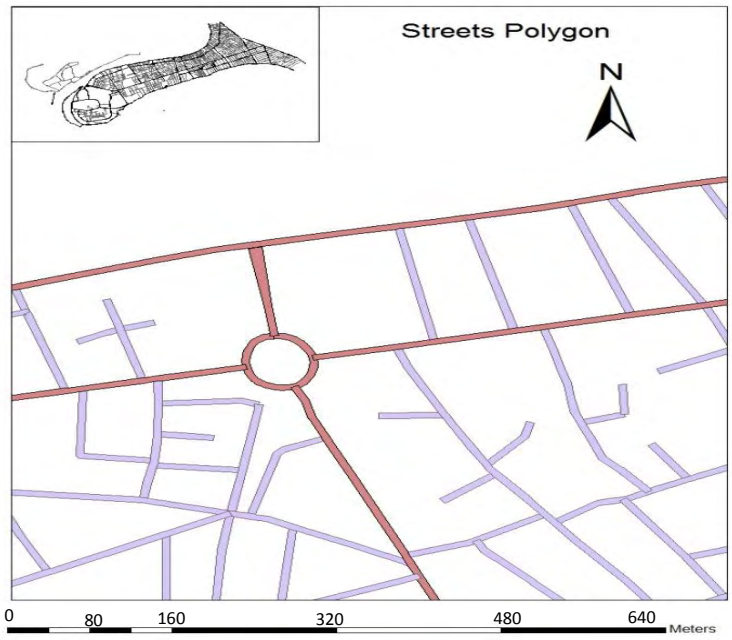

Figure. (26): Streets Polygon map

The proposed analysis procedure which is explained in previous chapter in detail aims in first place to measure the affect for every proposed factor. The main factor for sure is the streets network, for this purpose the researcher had to create a weight table for each element in the streets network and these elements are described by the street types, main streets and secondary streets. Thus the created analysis layer represents the scale value for each type as represented below where low values represent high effect. This criterion will be adopted throughout the implementation of this study.

Table (2): Layer: streets network

Layer: Streets Network		
Street Code	**Street Type**	**Scale Value***
1	**Main Street**	**1**
2	**Secondary Road**	**5**

* Lower values means high impact or effect on traffic jams. As mentioned before this is the scale value criterion to be adopted among this thesis

Figure (27) illustrates the analysis result map.

Figure. (27): Street Type Factor Analysis Map

3.3.1.2 Bridges and tunnels

The effect of bridges and tunnels on the traffic jam will be measured by the daily average of car count per hour that crosses that bridge.

Table (3) illustrates a daily average car count for cars cross bridges per hour, provided by transportation department as follows:

Table (3): daily average car counts

Daily average car counts	
Bridge Name	**Car Count**
Al Jadereyeh Bridge	**5000**
Al Tabeqeen Bridge	**1500**
AlMo'alaq Bridge	**750**

Based on the previous mentioned car counts the researcher proposed that bridges that have high car count average will cause more traffic jams on the roads that are directly connected to these bridges.

Table (4) illustrates the scale values for the streets that are directly connected to the bridges:

Table (4): the scale values for the streets that are directly connected to the bridges:

Layer: Bridges		
Street Code	**Street Type**	**Scale Value***
1	**Ultra**	**1**
2	**High car counts**	**3**
3	**Medium car count**	**5**
4	**Low car counts**	**9**

Table (5): The values that differ bridges based on car counts levels

Car Count Interval	Level Type
– 1000	Low
1001 – 2500	Medium
2501 – 5000	High
More than or equal 5001	Ultra

The Figure (28) illustrates the scale values map:

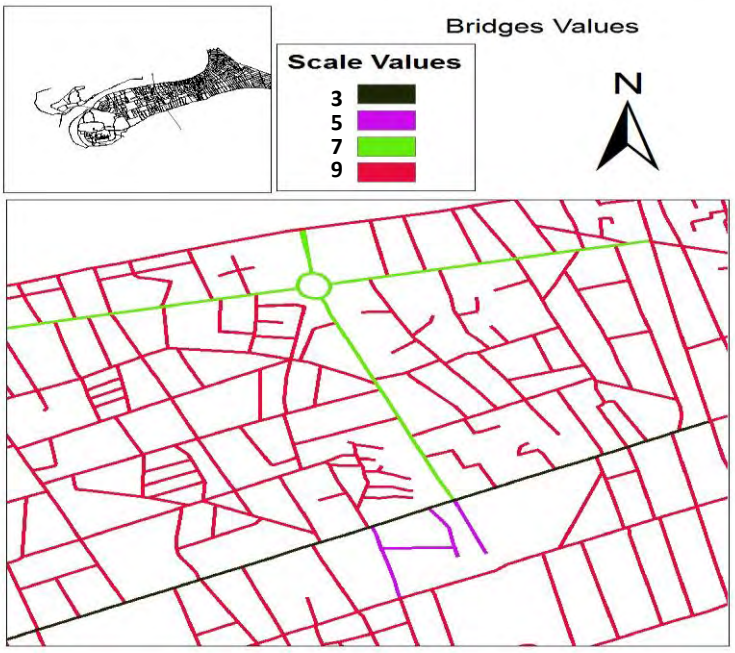

Figure. (28): Bridge values map

3.3.1.3 Intersections and circles

The effect of intersections and circles on the traffic jam will be measured by the daily average of car count per hour that crosses those intersections.

The next table illustrates a daily average car count for cars crosses intersections per hour, provided by transportation department as follows:

Table (6): Daily average car counts

Intersection Name	Car Count
Baghdad Uni. Circle	**7000**
Al Tabeqain Circle	**3000**
Al Moa'alaq Circle	**2000**
Al Hurreyah Circle	**4000**
Al Masbah Circle	**2000**
Al Fath Circle	**2000**

Based on the previous mentioned car counts the researcher proposed that the bridges that have high car count average will cause more traffic jams on the roads that are directly connected to these circles.

Table (7): the scale values for the streets that are directly connected to the circles:

Layer: Circles		
Street Code	**Street Type**	**Scale Value***
1	**Ultra**	**1**
2	**High car counts**	**3**
3	**Medium car count**	**5**
4	**Low car counts**	**9**

Table (8): The values that differ circles based on car counts levels

Car Count Levels	
Car Count Interval	**Level Type**
0 – 1000	**Low**
1001 – 2500	**Medium**
2501 – 5000	**High**
More than or equal 5001	**Ultra**

The Figure (29) illustrates the scale values map:

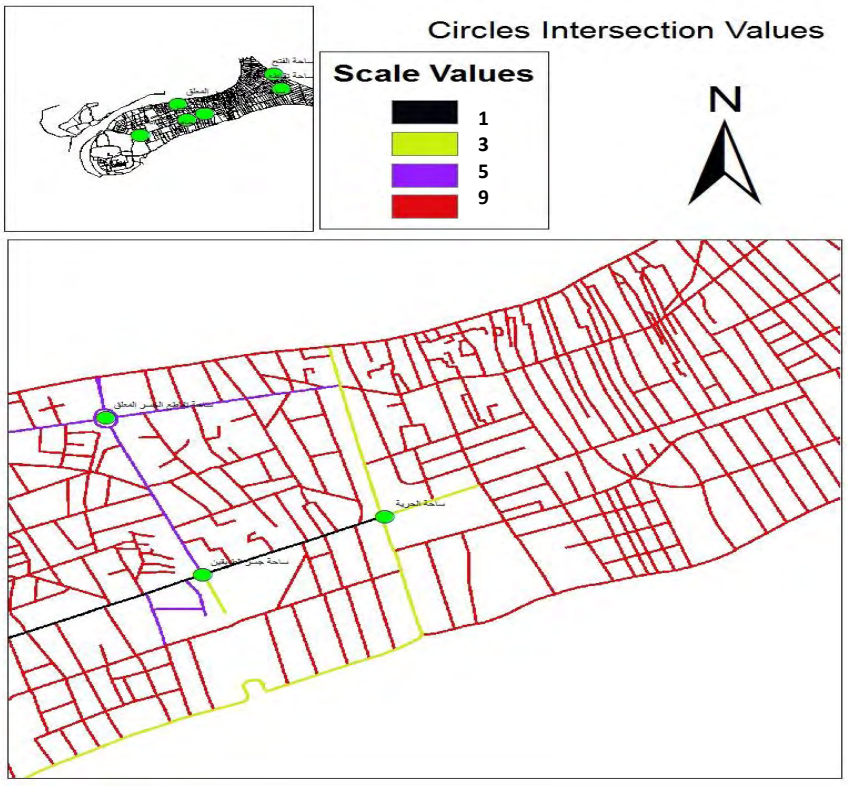

Figure. (29): Circle Intersection Values Map

3.3.1.4 Road blocks and security check points

The effect of road blocks in Al Karadah on traffic jams is measurable, since these road blocks are always active to avoid terrorist activities especially the blocked roads leads directly to the green zone. This factor effect is measured by negating any traffic on the blocked roads and causing minimal traffic jams compared to unblocked roads that have traffic jams. The next scale values Table (9) describes the values:

Table (9): scaled values

Layer: Road Blocks		
Street Code	**Street Type**	**Scale Value***
0	**Unblocked Roads**	**5**
1	**Blocked Roads**	**1**

the Figure (30) shows the layer created After applying the weight analysis:

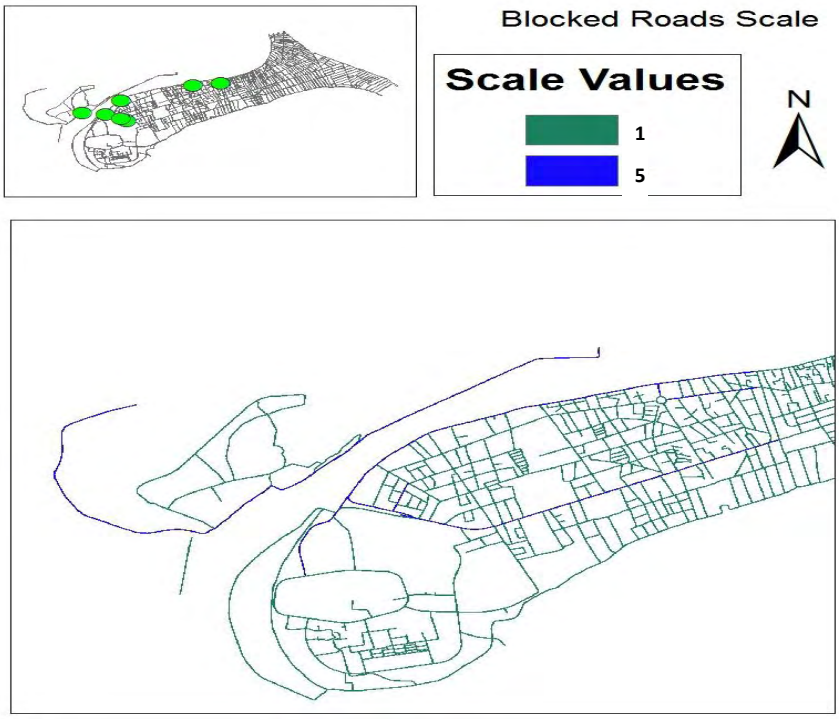

Figure. (30): Block Roads Scale Map

3.3.2 Landmarks

3.3.2.1 Governmental agencies

Governmental agencies and departments considered among the busiest sites in this city, since most of these departments located exactly on this small crowded area. The affect of the governmental agencies and departments will be measure through applying a multiple ring service area buffer analysis as described in Table (10):

Table (10): The affect of the governmental agencies and departments will be measure through applying a multiple ring service area buffer analysis.

Layer: Governmental Departments		
Buffer Radius Level	**Buffer Distance**	**Scale Value**
1	**Less than 1 km**	**1**
2	**1-3 km**	**3**
3	**3-5 km**	**5**
4	**5-7 km**	**7**
5	**More than 7 km**	**9**

The proposed distances above selected based on the area since it is not too big such as a country or a city like Baghdad and these values are reasonable regarding the area of Al- Karadah.

Figure. (31) illustrates the multiple ring buffer result layer:

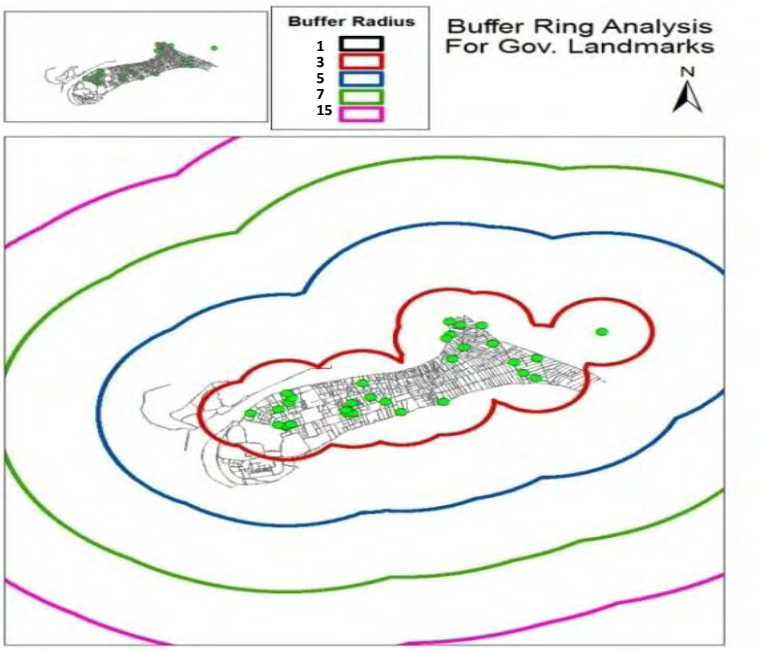

Figure. (31): Butter Ring Analysis for Governmental Landmarks

The Figure (32) illustrates the factor analysis result based on the scale values table (10):

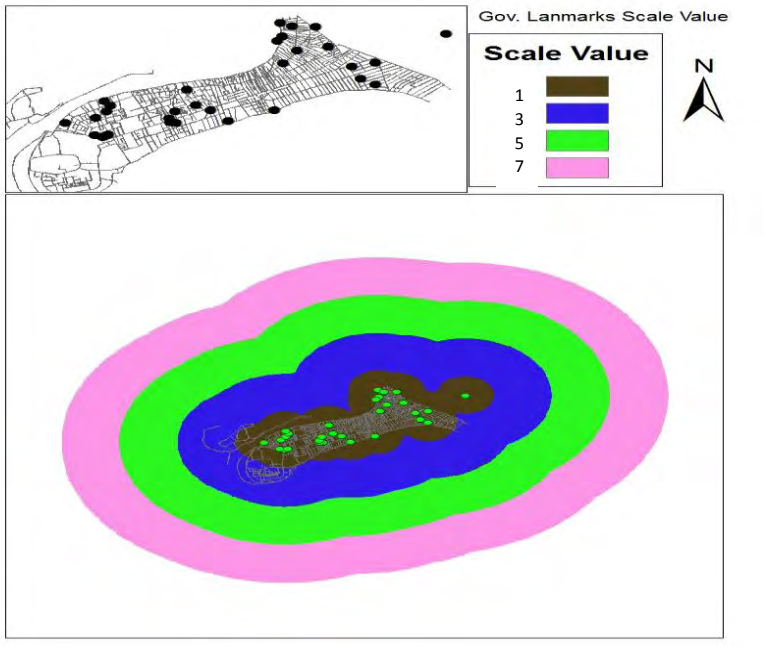

Figure. (32): Governmental Landmarks Scale Value

As described in Figure (32) the areas with the lowest values represent areas where traffic jams will occur because of the distribution of the governmental departments on the area, the closest the department from residential areas the more traffic would happen because of people who visits these sites.

3.3.2.2 Universities and Schools

Al Karadah contains many universities, colleges and school; thus this area faces lots of traffic jam`s and this part will cover the affect of universities and colleges on this traffic jam. This affect will be measured by assigning high values for roads connected directly to the educational land marks and lower as the distance becomes further from it.

Table (11): The scale values for this layer analysis

Layer: Universities and Schools		
Buffer Radius Level	**Buffer Distance**	**Scale Value**
1	**Less than 0.5 km**	**1**
2	**0.5 - 1 km**	**3**
3	**1.1 – 1.5 km**	**5**
4	**1.6 - 2 km**	**7**
5	**More than 2 km**	**9**

This created a new buffer layer that analyzed and processed using a weighing to determine the scale values as represented in Figure. (33):

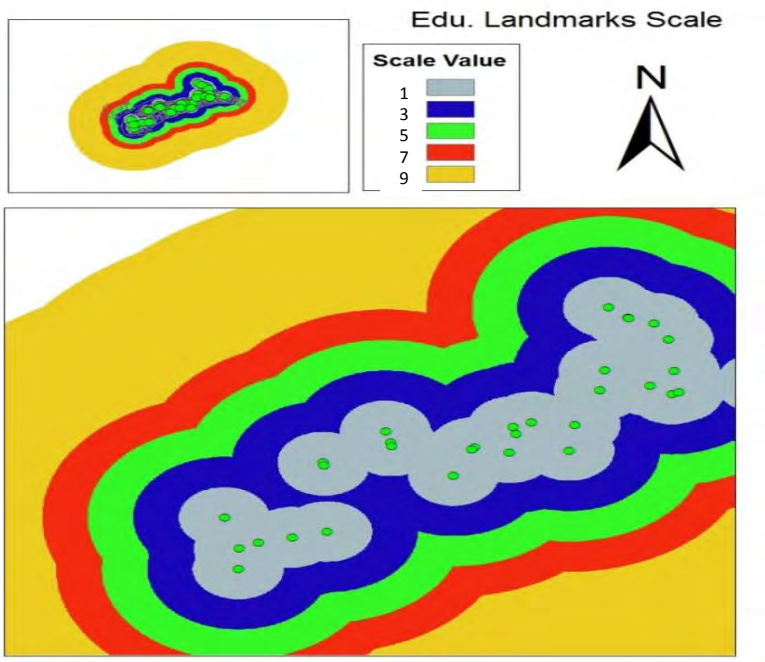

Figure.(33): Education landmarks scale map

3.3.2.3 Commercial areas

Al Karadah contains as any other major city all around the world some intensive commercial areas. This creates an addition to traffic jams. This affect will be measured by assigning high values for roads connected directly to the commercial land marks and lower as the distance becomes further from it. In addition to that, some statistical information about average daily car counts per hour that stops by these shops.

Table (12): the scale values for this layer analysis

Layer: Commercial Landmarks		
Buffer Radius Level	**Buffer Distance**	**Scale Value**
1	**Less than 0.25 km**	**1**
2	**0.25 - 0.5 km**	**3**
3	**- 0.75 km**	**5**
4	**- 1 km**	**7**
5	**More than 1 km**	**9**

This created a new buffer layer that analyzed and processed using a weighing to determine the scale values as represented in Figure (34).

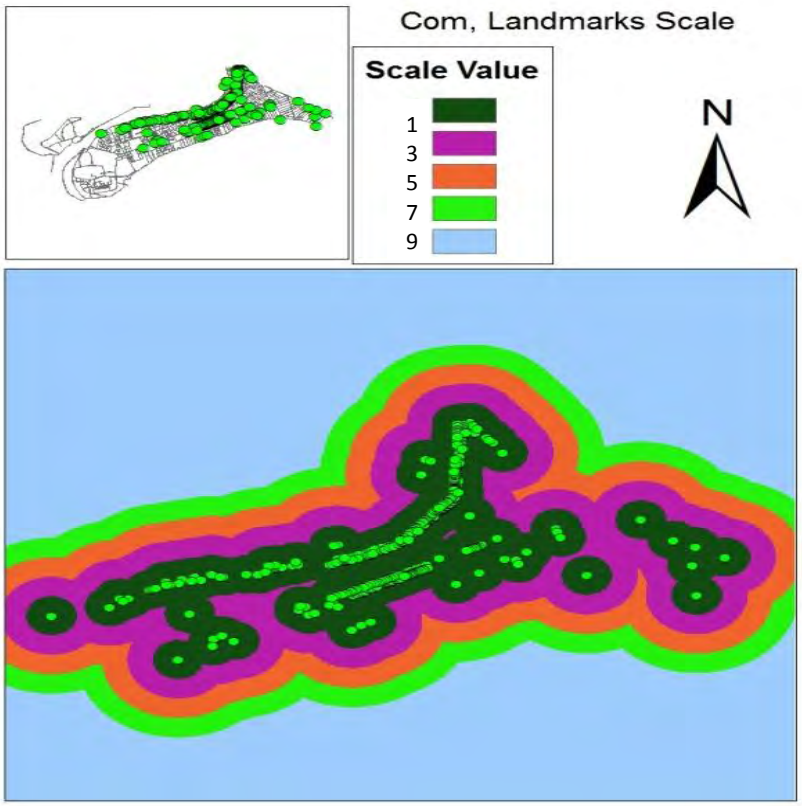

Figure. (34): Commercial Landmarks Scale

3.3.2.4 Entertainment sites

Al Karadah contains various entertainment sites that includes parks, green areas, theaters and more. This affect will be measured by assigning high values for roads connected directly to the entertainment land marks and lower as the distance becomes further from it.

Table(13): shows the scale values for this layer analysis

Layer: Entertainment Landmarks		
Buffer Radius Level	**Buffer Distance**	**Scale Value**
1	**Less than 0.5 km**	**1**
2	**– 1 km**	**3**
3	**– 1.5 km**	**5**
4	**– 2 km**	**7**
5	**More than 2 km**	**9**

This created a new buffer layer that analyzed and processed using a weighing to determine the scale values as represented in Figure (35).

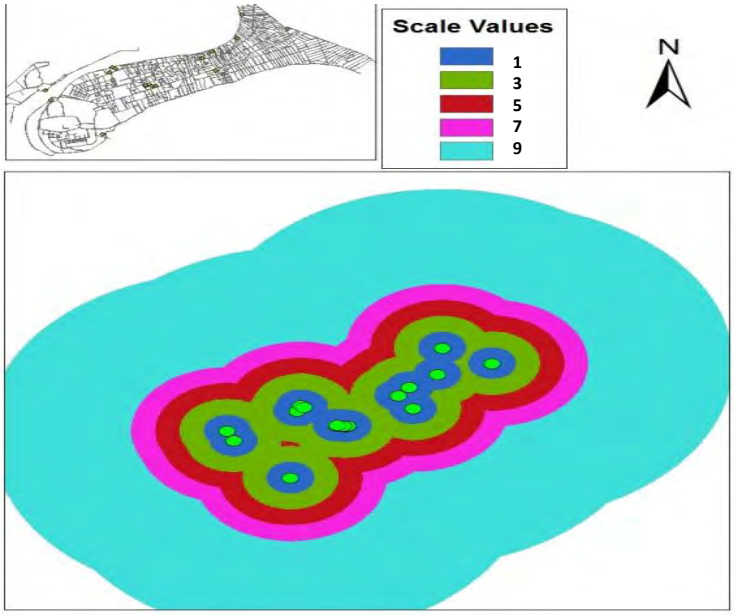

Figure. (35): Entertainment Landmarks Scale

3.3.2.5 Health care facilities

Hospitals and other health care facilities in Al Karadah affect the traffic jam issues. This effect will be measured by assigning high values for roads connected directly to the health care land marks and lower as the distance becomes further from it.

Table (14): The scale values for this layer analysis

Layer: Health Care Landmarks		
Buffer Radius Level	**Buffer Distance**	**Scale Value**
1	**Less than 0.5 km**	**1**
2	**– 1 km**	**3**
3	**– 1.5 km**	**5**
4	**– 2 km**	**7**
5	**More than 2 km**	**9**

This created a new buffer layer that analyzed and processed using a weighing to determine the scale values as represented in Figure (36).

Figure. (36): Health Facilities Scale

3.3.2.6 Religious sites

Al Karadah contains has various religious sites including different Muslim's worship places in addition to Christian's. This affect will be measured by assigning high values for roads connected directly to the religious land marks and lower as the distance becomes further from it.

Table (15): The scale values for this layer analysis

Layer: Universities and Schools		
Buffer Radius Level	**Buffer Distance**	**Scale Value**
1	**Less than 0.25 km**	**1**
2	**– 0.5 km**	**3**
3	**– 0.75 km**	**5**
4	**– 1 km**	**7**
5	**More than 1 km**	**9**

This created a new buffer layer that analyzed and processed using a weighing to determine the scale values as represented in Figure (37).

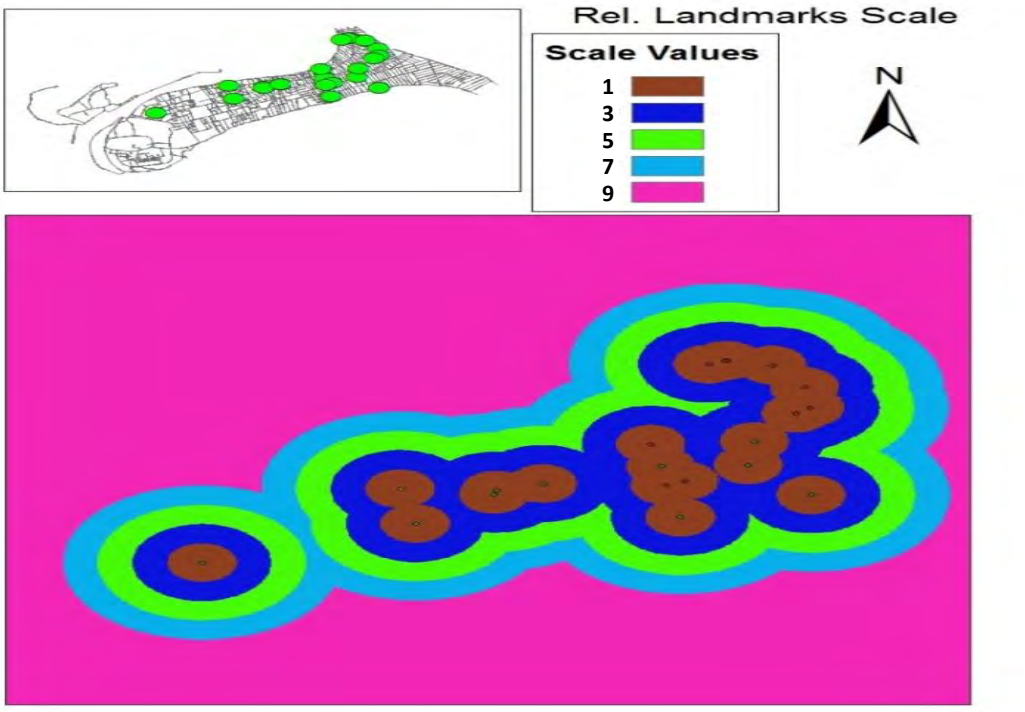

Figure. (37): Religious Landmarks Scale

Chapter 4

Final results and discussion

Chapter Contents

4.1 Final over all analysis

All the analysis procedures provided in the previous chapter aimed to measure each factor effect on traffic jams as an independent facto, this part will introduce an overall analysis that aims to weight the effect of the factors combined and produce a map that illustrates the best the traffic jam situation based on the analysis, the thing that will be compared to the real life situation.

This analysis will describe the traffic jam problem for decision makers in a logical, scientifically and technical way for better understanding and better planning takes in the future.

The layers to be analyzed are:

1- Street network
2- Bridges
3- Intersections and circles
4- Road blocks
5- Governmental landmarks
6- Commercial landmarks
7- Health care landmarks
8- Entertainment landmarks
9- Educational landmarks
10- Religious landmarks

This overall analysis will be done by applying an overlay analysis that targets multiple layers, and uses the stored scale values that resulted in the single factor analysis part.

For this overall analysis, all factors had 10% influence “equal influence values for all factors” which created a map that can differ than other maps once influence levels are changed.

Figure. (41) shows layer created for the overall analysis:

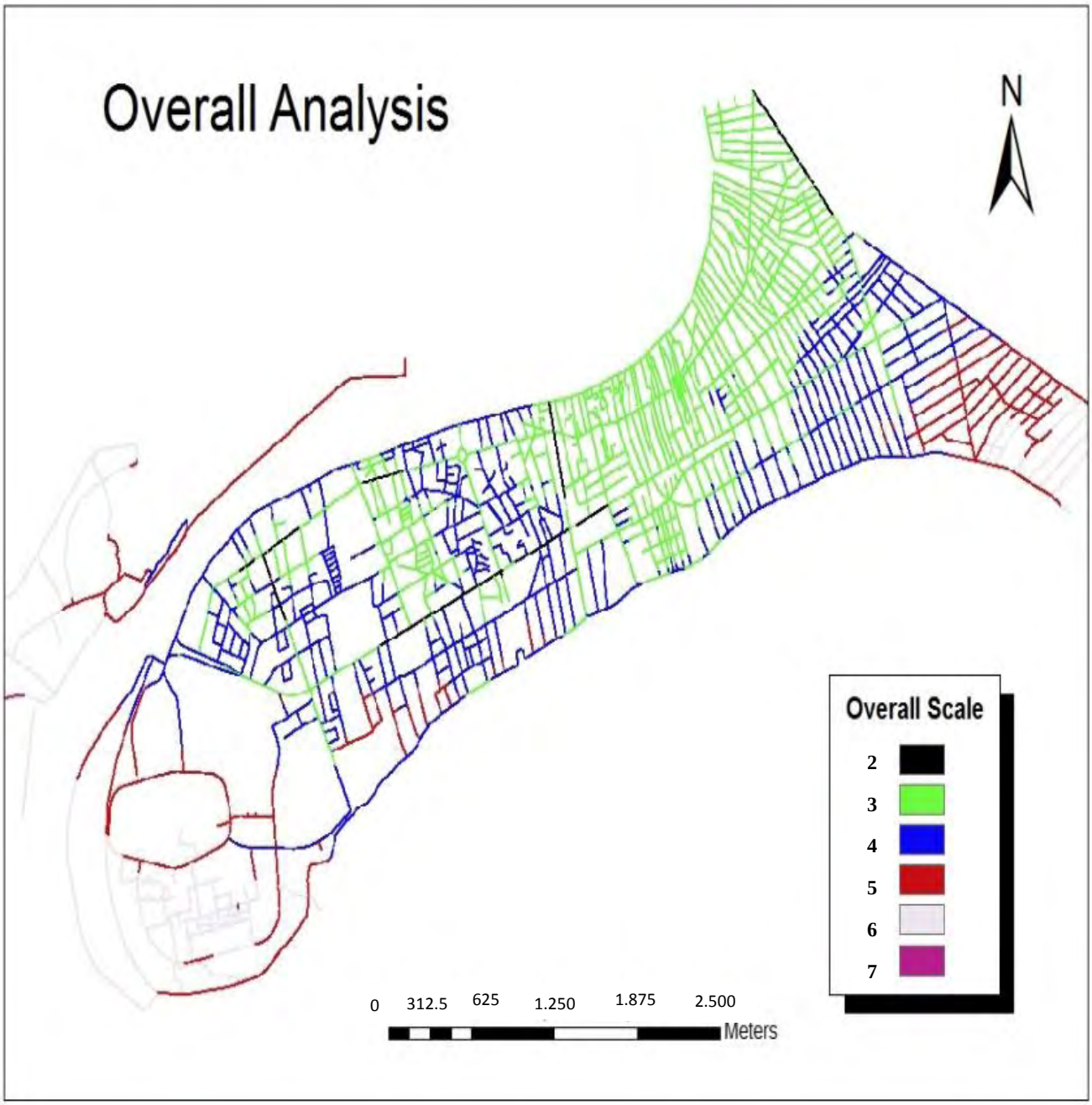

Figure. (38): Overall Analysis Map

The overall analysis resulted in a complex map with a medium to high level of traffic jams in general and this happens because of the influence values. So this can be a tool to measure every factor as a factor with highest level of influence.

The overall analysis indicates that there is actually a major problem regarding traffic jams. Some of the notes about the data, analysis and results are:

1- Street network has few main roads, the thing that creates more and more traffic jams since these roads will be considered as the backbone of the area so all traffic flow will concentrate on these roads.
2- Road blocks will create more and more jams since this area has a critical location especially near to the Green Zone, has many governmental departments center of Baghdad, high level of population and more reasons causing this city to be a terrorists goal for their actions.
3- The distribution of commercial sites is very poor since most of these sites are located and concentrated around 2 streets only, the thing that causes extra traffic flow on these roads where these roads are already main streets and on the city center.
4- Distribution of religious, governmental, health care and entertainment sites is un planned and arbitrary so service area is not evenly distributed.
5- The university area creates a complex traffic jam since most of the traffic will go through it, in addition the road that connects the 2 banks of Tigris is the same road that takes to the university.
6- The bus terminal near the university creates lot of traffic jams since most of street lanes are covered by the buses and transportation carriers.

4.2 Proposed solutions

From the previous analysis ,the researcher concludes, in addition to the knowledge related to this particular area and propose solutions for this traffic problem as a major issue facing people in charge of Al Karadah.

The solutions to be proposed are divided into two categories long and short term solutions.

4.2.1 Short term solution

There are many applicable solutions that can be implemented as soon as possible by decision makers that result in reducing traffic jams to a measurable value. These short term solutions can be listed as the following:

4.2.1.1 Tigris river taxi

This solution will reduce the traffic on the street by removing many road takers into river transportation taxi. This solution requires some passengers, goods and cars transporting ships and boats. The researcher proposed this path with different terminals that covers the area along its diameter from north down to western south area. The layer in Figure. (42) represents the river taxi path and terminals. There will be terminals all around the bank area especially intensive terminals around the university area around bridges and major areas and streets.

Figure. (39): River taxi

4.2.1.2 Site suitability selection system for urban planners

This is a proposed GIS based system that allows planners to distribute landmarks in an efficient way to ensure organized services distributions, best location selection based on laws and procedures applied in the municipality and GIS enabled workflow.

A very good sample for site selection suitability is to choose how to implement a new health care facility in addition to what currently available. Figure. (43) illustrates the current available health care facilities:

Figure. (40): Health Facilities Scale

As seen above, there is a marked area which doesn't contain any health care facility, this site suitability selection system is an expert system that provides users with the results they are looking for and must create a new layer that points to the proposed locations as suitable locations for this new facility.

4.2.1.3 Bus and car terminal at the university compound

One of the most effective reasons for this traffic jam at Al Karadah is the university. The university covers a huge area where much of this area is an unused space. The transportation for the university creates major jams as in Figure (44) showing how the parked cars took three sides of the main street in front of Baghdad university .

Figure. (41) three sides of the main street in front of Baghdad university.

Thus, through program the researcher was able to present a suitable place the Park, that a new bus terminal to be created within the university compounds, the thing that will sure reduce the traffic jams.

4.2.1.4 Pre-intersections and circles U turns

An applicable solution that provides drivers with more options to change roads is the U turn before the intersections and circles that reduces the traffic within these circles and intersections and creates what is known by smart transportation solutions. As shown in Figure (15), a massive traffic jams is on one of the major circles in the city caused by the lack of these turns.

4.2.2 Long term solution

There are many applicable solutions that can be implemented in the future by decision makers that result in reducing traffic jams to a measurable value. These long term solutions can be listed as the following:

4.2.2.1 Bridges and tunnels

By creating multi levels bridges and tunnels, the traffic will be reduced since these multi level structures allows drivers to change direction in an easy and efficient matter. And the researcher suggests a walk way bridge on the river to allow the students and employees of the two main universities to enter the university in order to reduce the traffic on Aljadreyah bridge.

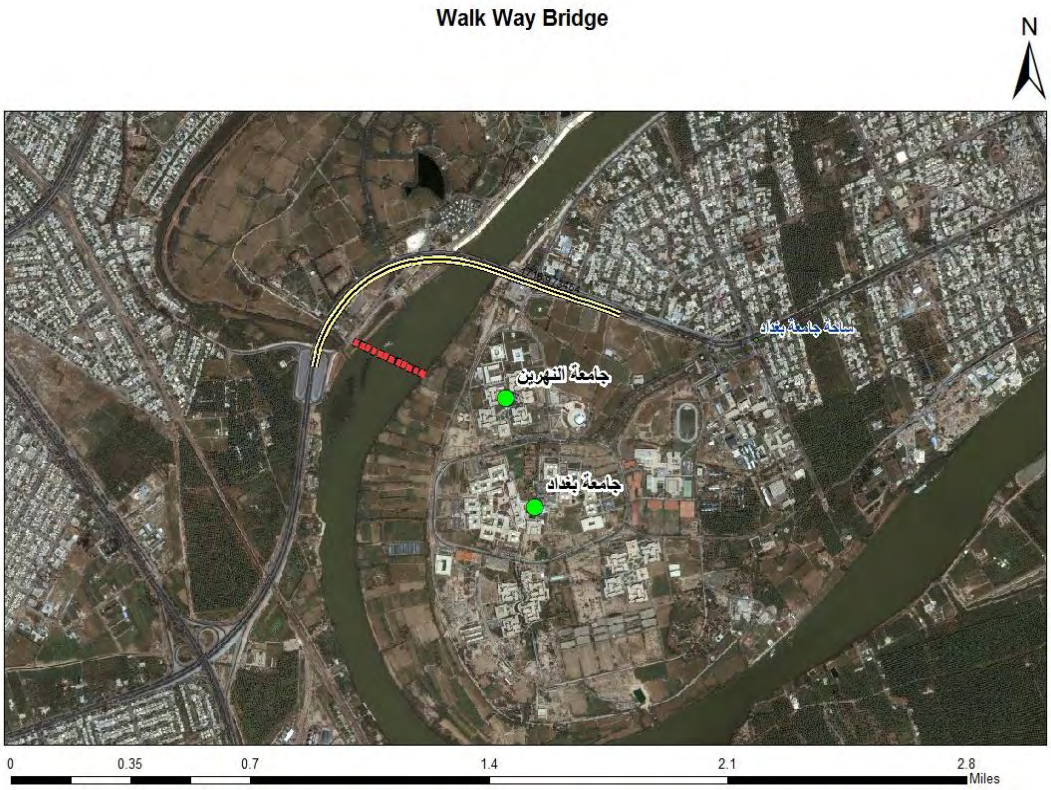

Figure (42) the walk way bridge.

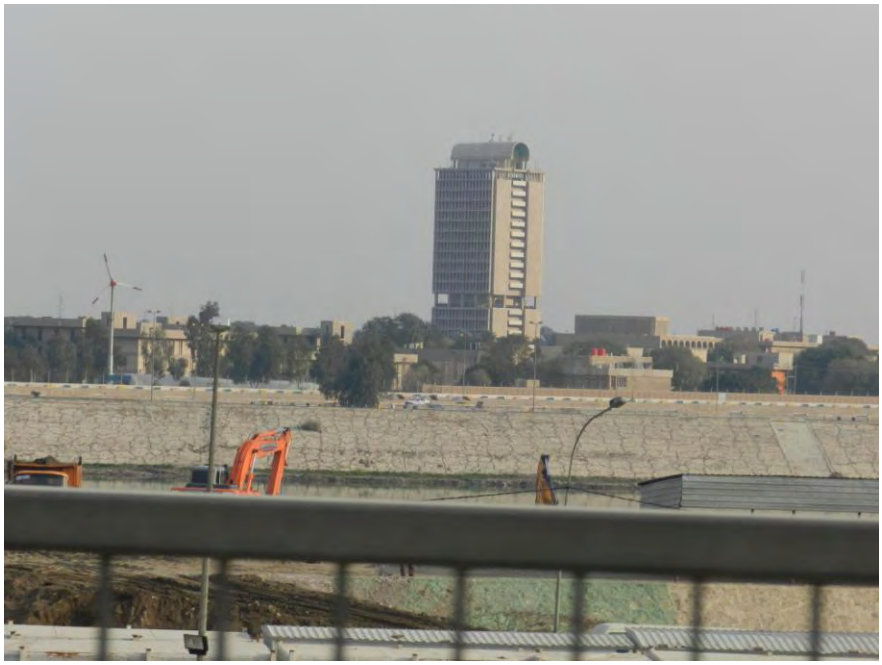

Figure (43) the Place for the proposed walk bridge.

4.2.2.2 Facilities rezoning and redistribution

This solution aims in the first place to redistribute all of the facilities which include health care, governmental, commercial, religious, educational and entertainment facilities so these facilities service area will cover as much as possible of the city.

4.2.2.3 Multi level parking lots

Al Karadah contains few parking lots available for public especially around public services facilities, the thing that causes double parking on the streets and other problems which cause by itself traffic jams. With a professional distributed multi level parking's this issue as a reason for traffic jams will be reduced. And the researcher did a series of analyses to select a new location for the new multi floor parking lots as we will see now.

To determine the best place to build a new multi- floor parks we have to use GIS analysis tools by applying the following conditions:

1. The parcel owned by the government.
2. The parcel is with enough area to build a multi- floor park on it.
3. The parcel is within a close distance from the main streets.

For these analyses we need a layer that represents all the parcel in Alkarradah area which is called the parcel layer which presents every parcel in Alkarradah and its area and if it was owned by the government or by a citizen.

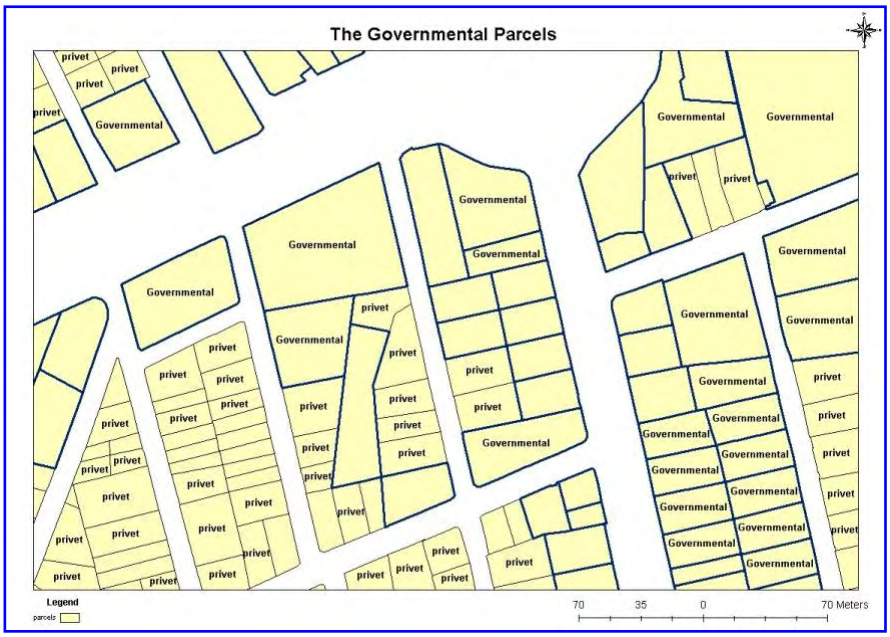

Figure (44) the Governmental Parcels in the study Area

After that we need to select out of these governmental parcels the parcels that are with an area between 2000 to 3000 m2 which is enough to build a Multi-floor Park

.

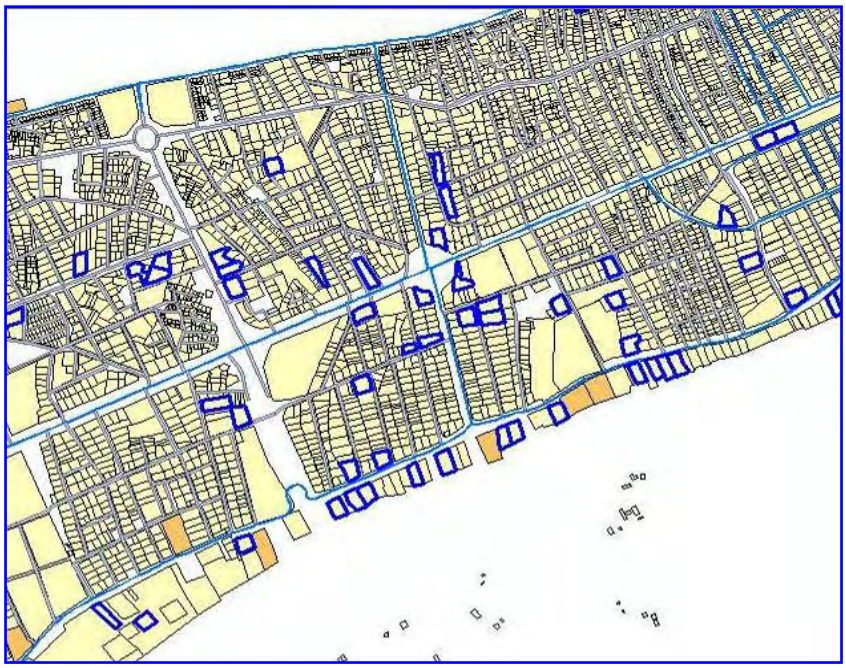

Figure (45) Governmental Parcels with area between 2000 m and 3000 m.

Finally the parcels that are owned by the government and with enough area and now we need to select from this group the parcels that are with distance of 100 m from the main street so it won't be far away from the street and the customers will not walk for a long distance.

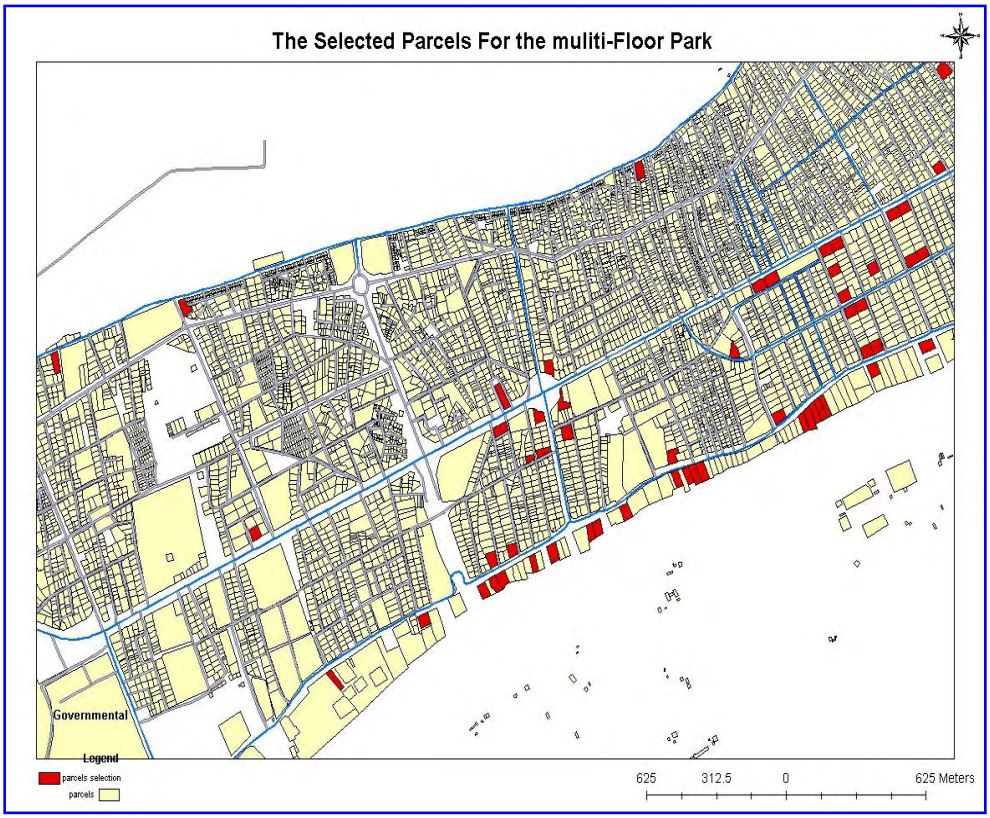

Figure (46) the selected Parcels for the multi-floor Park

4.2.2.4 Streets expansion

Al Karadah contains few primary roads because it's a crowded area with no much area for expansion and creating new routes and roads, the best solution becomes to perform streets expansions.

4.2.2.5 Developing an Image classification measures:

This proposed solution can be used to measure traffic jams by satellite imagery analysis. In this type of analysis using some special tools like ERDAS, analysts will be able to classify the content of an image by applying a spectral classification. Every image contains unseen spectral by human eye reflected by objects in the image.

This solution allows analysts to measure traffic jams by measuring the weight of cars which reflects spectrum totally different from other objects like buildings, green areas, water, land or any other objects. (Every object has its own spectrum level).

The ERDAS Image software performs the classification of an image for identification of terrestrial features based on the spectral analysis. Classification is the task of assigning a set of given data elements to a given set of labels or classes such that the cost of assigning the data element to a class is minimum. Classification involves labeling the pixels as belonging to a particular spectral and thus information classes using the spectral data available. The image classification procedure is to automatically categorize all pixels in an image into land cover or land use classes or themes. Image classifiers are used in hybrid mode and the approach depends upon the nature of the data being analyzed, the computational resources available, and the intended application of the classified data.

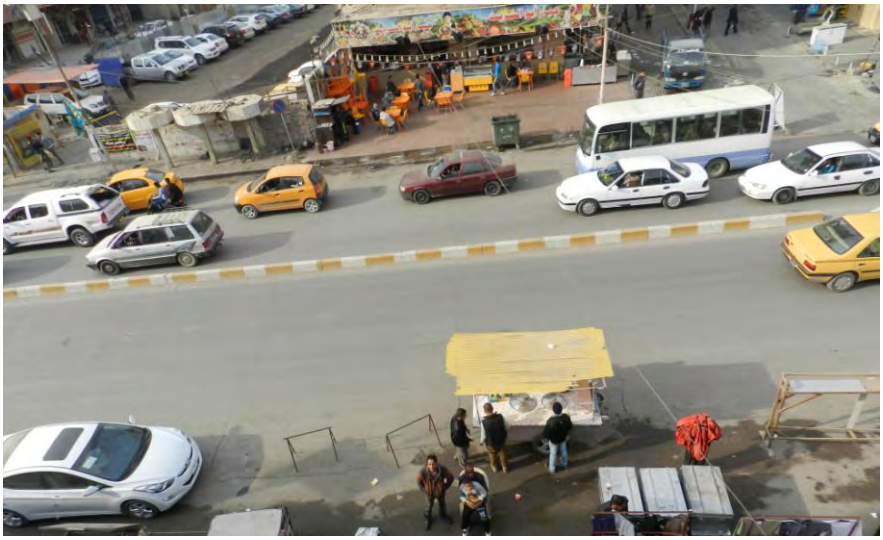

Figure. (47): Original Image

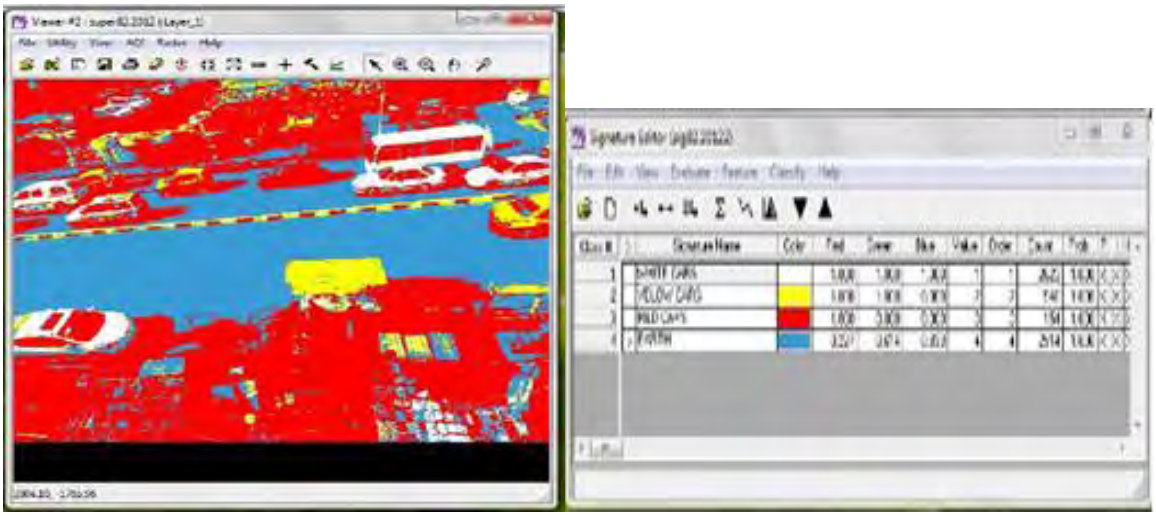

Figure. (48): Supervised Classification

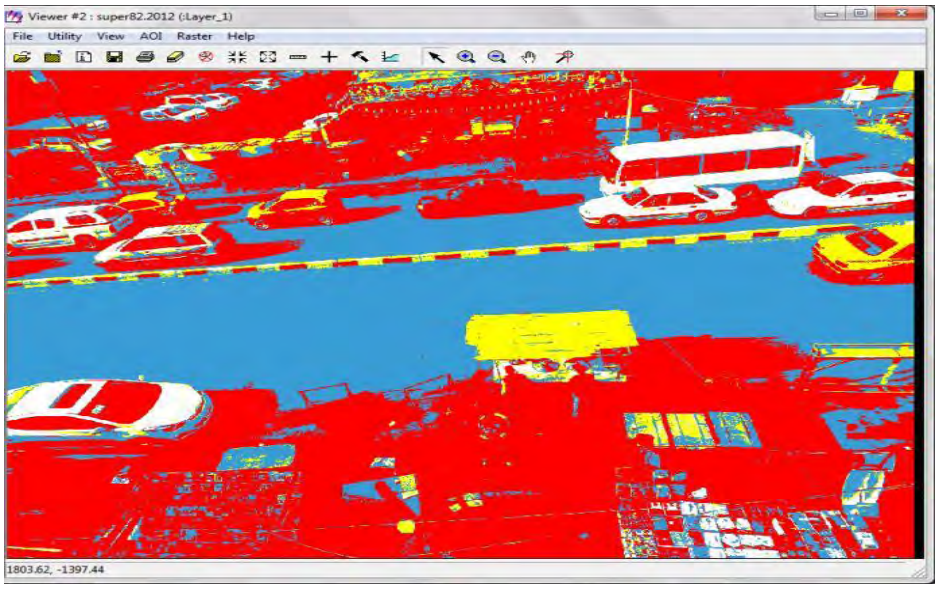

Figure. (49): Zooming for Supervised Classification

Chapter 5

Conclusion and Recommendations

Chapter Contents

5.1 Conclusions

This study aimed in the first place to study the traffic jams problems from a new point of view by using GIS as the main tool for data gathering, analysis and presentation. From the beginning to the end every piece of work done has a geospatial notation.

What this study resulted was not imaginary; it is the true situation in matter of fact which gives a feeling of relief and what makes these feelings grow larger is that the researcher used an important accurate, robust, trusted and state of the art tool known as GIS.

All of the proposed factors as reasons for traffic jams proven as a real cause for traffic jams. In addition, the researcher had the chance to see further that there were solutions to eliminate or decrease these factors affect on the traffic jam.

Finally, traffic jam problem has a solution once the researcher remove the global constrains, then by solving each part the problem will come into end. This is left to the decision makers who have the power to do so.

In this study, the researcher created an analysis criterion that would take a piece of geospatial information and measures how this piece of information affects the traffic jams, then the researcher produced maps that illustrates the results followed by an overall analysis to present the big picture for all factors accumulated.

Since this thesis was done, that doesn’t mean that the researcher has actually Figured out what really causes traffic jams, instead the researcher has proven that the proposed factors have a hand in causing these traffic jams.

5.2 Recommendations and future work

The researcher encourages people to adopt this study since there are many added values that can be achieved since this one has achieved its goals, and created a door for other researchers to enter. Thus the researcher has to propose the following ideas to improve this study results as the following:

1- Perform new studies that take into consideration some extra factors that haven't been analyzed yet.
2- Make this study more generic by applying it not to a limited area but further more to cover the city of Baghdad or even Iraq.
3- Perform studies that can actually analyze and discuss the proposed short and long term solutions and to measure how these solutions will reduce traffic jams.
4- Improve the analysis model used in this thesis further more and produce a new and improved results the thing that can improve some new solutions.

Without motivation, organization, persistence and hard work this thesis or any other futuristic work will not come to life. This thesis is an entrance to a world of more complex and more varied studies if implemented in a professional manner.

References

Al-Saffar M., (2006). *futuristic vision for the effect of technology and information on al-Karradah district in BAGHDAD city* ,PHD thesis High Institute For Urban & Regional Planning University Of Baghdad.

Avram S., Curcan G., Vladut A. and Marinescu I, (2010). **Improvement Of Urban Road Traffic In Craiova City By Using GIS Data Processing***"*. ***Proceedings of 3rd International Conference on Cartography and GIS*.** 15-20 June, Nessebar, Bulgaria**.**

Australian Bureau of Statistics, (2011). (on line), Available at:

http://en.wikipedia.org/wiki/Data_collection Accessed in 10/8/2011

Central organization for statistical and information technology. (2010) *"The group's annual statistical*", Ministry of Planning in Iraq**.**

Coifman B. and Yang, Y.,(2004). *"Estimating Spatial Measures of Roadway Network Usage from Remotely Sensed Data*". **Journal of the Transportation Research Board**, Transportation Research Record, No. 1870, National Research Council, Washington, DC. PP:133-138.

Coppock, and. Rhind , (1991). *"The history of GIS. Geographical Information Systems: principles and applications"*. Longman Scientific & Technical.

Coxon, A., (1999) . *"Sorting Data collection and analysis*" . London SAGE publisher.

Daiyong W. and Zhou G.,(2008). *"Traffic Spatial Measures and Interpretation of Road Network Using Aerial Remotely Sensed Data*", ***IEEE International Geosciences and Remote Sensing Symposium*** — IGARSS 2008 in Boston.

Diamiter V. and Rei Andreev,(2009). *"The Relife of The Shuman's Plateau in GIS Environment",* PP:50- 57.

Evenden and Botbol, (1985),(on line),Available at :

http://wiki.osgeo.org/wiki/Open_Source_GIS_History, Accessed in 9/10/2011

Esri. Company (2011) ,(on line),Available at :

http://www.esri.com/. Accessed in 9/10/2011

Fisher H. (1979). Harvard University. (on line),Available at :

http://www.gis.dce.harvard.edu/fisher/HTFisher.htm. Accessed in 9/10/2011.

Fitzgerald,J.,(2007). (on line), Available at :
http://www.broward.org/library/bienes/lii14009.htm, Accessed in 10/8/2011.

Fu P. and Sun J. (2010) Web GIS: Principles and Applications. ESRI Press

Available at:

http://esripress.esri.com/display/index.cfm?fuseaction=display&websiteID=188&moduleID=0. Access in 20/5/2011

Ginty L. and Smyth, B.(2000). *"Personalized Route Planning: a Case-Based Approach. In: Blanzieri, E., Portinale"*, Advances in Case-Based Reasoning: 5th European Workshop, Lecture Notes in Computer Science, vol. 1898. ***Springer-Verlag***, pp. 431–442

Hartgen, D. and Lemmerma H.,(1983). *"Streamlining Collection and Processing of Traffic Count Statistics*". ***Transportation Research Record***, No. 928, National Research Council, Washington, D.C.. PP:11-20.

Jiang Z., Mark R., McCord and Prem K.,(2006*). "Improved AADT Estimation by Combining Information in Image - and- Ground-Based Traffic Data*", ***Journal of Transportation Engineering,*** July, Vol. 132, PP: 523-530.

John D. (2008). "*Phases and Initial Steps in Data Analysis*", Netherlands: Johannes van Kessel Publishing , Chapter 14, PP: **334-371**

John Snow., (2011) , York University. (on line),Available at:

http://www.york.ac.uk/depts/maths/histstat/snow_map.htm, Accessed in 10/8/2011.

Jozefowiez,(2008). *"Multi-Objective Vehicle Routing Problem*". ***European Journal of Operational Research,*** 189. PP:293–309.

.Nadi S. and Delavar M.,(2011). "*Multi-criteria, Personalized Route Planning Using Quantifier-Guided Ordered Weighted Averaging Operator*s", ***International Journal of Applied Earth Observation and Geoinformation,*** vol. 13, PP: 322-335

Padma K., (2003),"***The history of GIS.***" ,(On line), Available at: , http://arcgisforlandslidenalysis.blogspot.com/, Accessed in 5/8/2011.

Park K.,(2007). *"Learning User Preferences of Route Choice Behavior for Adaptive Route Guidance*". Intell. Transport Syst. 1 (2), PP:159–166.

Rao, Sunitha, and Jayasree, K., (2005). *"Dynamic Geographic Information System for Intelligent Traffic Guidance Systems"*. Geosciences and Remote Sensing Symposium 2005 , ***Proceedings. IEEE International***.

Roger S. and Victor J.,(1996). *"Data Collection and Analysis*". SAGE Publications , London.

Sadeghi N., Kim K.,(2009). "***Ontology Based Personalized Route Planning System Using a Multi-Criteria Decision Making Approach Expert System***". Appl. 36 (2, Part 1), PP:2250–2259.

Smith J., Blake J., and Davies A.,(2000). *"Putting Sustainability in Place: Sustainable Communities Projects in Huntingdonshire*". ***Journal of Environmental Policy and Planning***, 2(3). PP: 211–223.

Tabachnick G. and Fidell L., (2007). ***"Cleaning up your act. Screening data prior to analysis"***. Using Multivariate Statistics, Fifth Edition. PP:60–116. Boston: Pearson Education, Inc. / Allyn and Bacon.

Tomlinson R., (2007) "*GIS Hall of Fame*", (on line),Available at: http://www.urisa.org Accessed in 9/10/2011.

Traffic of Police General Directorate (2011), *the latest statistics in 12/9/2011*, Interview with the Director of Computer Center, BAGHDAD

Wang X.,(2001)." *Integrating Water Quality Management and Land Use Planning in a Watershed Context*". ***Journal of Environmental Management***, 61(1), PP:25–36.

Weller S., (1988). *"Systematic Data Collection",* (Qualitative Research Methods Series 10). Thousand Oaks, California: SAGE Publications , London.

Weimer J. (1995). " *Research Techniques in Human Engineering*" 1st Edition

Xinhao W.,(2005) ,"*Integrating GIS, Simulation Models, and Visualization in Traffic Impact Analysis*, Computers", Environment and Urban Systems, 29, PP: 471–4961

Zhiwei T. and Wancai L.,(2010)," ***One Vehicular Information Service System***". ***International Conference on Information Engineering and Computer Science*** (ICIECS), PP:1-4.