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AN INVESTIGATION OF ELECTRONIC GOVERNMENT TRANSITION CASE STUDY IN HEALTH: HOSPITALS IN ERBIL

AHMED ABDULRAHMAN M.JAMEL

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Submitted by: Ahmed Abdulrahman M.JAMEL

Approval of the Graduate School of Natural and Applied Sciences, Cankaya University

Prof. Dr. Taner ALTUNOK
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

Prof. Dr. Billur KAYMAKÇALAN
Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

Assist .Prof. Dr. Ö. Tolga PUSATLI
Supervisor

Examination Date: **24/07/2013**

Examining Committee Members:

Assist .Prof. Dr. Ö. Tolga PUSATLI (Çankaya Univ.) ------------------------------

Assoc. Prof. Dr. Fahd JARAD (Çankaya Univ.) ------------------------------

Ahmet DABANLI (M.S.) (Başarsoft) ------------------------------

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Name, Last Name : Ahmed Abulrahman M.JAMEL

Signature :

Date : 24.07.2013

ABSTRACT

AN INVESTIGATION OF ELECTRONIC GOVERNMENT TRANSITION

CASE STUDY IN HEALTH: HOSPITALS IN ERBIL

M.JAMEL, Ahmed Abdulrahman

M.sc, Department of Mathematics and Computer Science

Supervisor: Assist .Prof. Dr. Ö. Tolga PUSATLI

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Electronic government initiatives and public participation to them are among the indicators of today's development criteria of the countries. After consequent two wars, Iraq's current position in, for example, UN's e-government ranking is quite concerning and did not improve in recent years, either. In the preparation of this work, we are motivated with the fact that handling geographic data of the public facilities and resources are needed in most of the e-government projects; such examples are reported to the literature.

Geographical information systems (GIS) provide most common tools not only to manage spatial data but also to integrate such type of data with nonspatial attributes of the features. With this background, this thesis proposes that establishing a working GIS in the health sector of Iraq would improve e-government applications. As the case study, investigating hospital locations in Erbil is chosen.

The results show that setting up a GIS in Erbil does not require extreme technical knowledge; however, a strong limitation that obtaining clean and up-to-date data is an important concern. Although it is possible to establish a GIS in this sector, the starting point should not be acquiring hardware and software but to collect clean data from the field and to ensure that the data gets updated timely.

Keywords: e-government, Iraq, Erbil, GIS, spatial data, hospital locations

ÖZ

SAĞLIKTA BİR ELEKTRONİK DEVLET DÖNÜŞÜMÜ ARAŞTIRMASI: ERBİL'DEKİ HASTANELER

M.JAMEL, Ahmed Abdulrahman

Matematik-Bilgisayar Bölümü

Yrd. Doç. Dr. Ö. Tolga PUSATLI

TEMMUZ, 2013, 80 Sayfa

Elektronik devlet projeleri ve vatandaş katılımı, günümüzde, ülkelerin gelişmişlik göstergeleri arasında geçmektedir. Peşpeşe iki savaş geçiren Irak'ın, BM'in e-devlet sıralamasındaki yeri endişe vericidir ve son yıllarda da ilerleme göstermemiştir. Bu çalışmanın hazırlanmasında, kamu taşınmazlarının ve kaynaklarının mekansal verilerinin düzenli bir biçimde tutulmasının e-devlet projelerinde önemli olduğundan yola çıkılmıştır; benzer örnekler literatürde gösterilmiştir.

Coğrafi bilgi sistemleri (CBS), sadece mekansal verilerin işletilmesinde değil aynı zamanda bu tür verilerin mekansal olmayan verilerle birleştirilip harmanlanmasında da en sık rastlanan araçları sunar. Uygulama alanı olarak Erbil'deki hastane yerlerinin incelenmesi yapılmıştır. Sonuçların gösterdiğine göre, Erbil'de bir CBS kurabilmek için çok yüksek teknik bilgiye gerek yoktur; bununla beraber, temiz ve güncel veri bulabilmek önemli bir endişeyle, böyle bir çalışmaya sınırlama getirmektedir. Bu alanda CBS kurabilmek olasıdır ancak başlangıç noktası donanım ve yazılım almak yerine sahadan temiz veri toplanması ve bu verilerin zamanında güncellenmesinden emin olmak olmalıdır.

Anahtar sözcükler: e-devlet, Irak, Erbil, CBS, mekansal veri, hastane yerleri.

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CHAPTER I

INTRODUCTION

After surviving two wars in 15 years, Iraq is trying to catch up with the rest of the world in most of the industries in the last 10 years. Within this nationwide development, it is not surprising to see that there will be a controlled passage in managing governmental offices from paper based to electronic media form via electronic government initiatives.

However, such a transition is too big to handle by a single government body even by a ministry; similar attempts are monitored in many countries e.g. Europe (http://ec.europa.eu/dgs/informatics/ecomm), USA (http://www.usa.gov), Turkey (http://www.turkiye.gov.tr) and South Korea (http://korea.go.kr); a common observation shows that those attempts are done through series of actions by multiple parties. These parties include local governments, ministries, central government as well as citizens.

This thesis' base is that such a transition requires participation of both citizen and the government besides acquiring the technology. Hence, technology is one of the essentials in these initiatives but buying hardware and software cannot be expected to establish an electronic enabled governmental work flow. A strong infrastructure including network and more importantly, clean data need to be set up.

The authorities should always remember that the information systems are designed to handle information; hence, the first step should be to collect accurate, timely and clean data. When looked closer, it is seen that in most of the e-government initiatives, spatial data sets are needed to be managed. Once this is discovered in this work, handling geographic information has become a vital part of this thesis.

1.1. Purpose and Scope

This thesis targets potential geographic information systems applications that may be proposed to Iraq's central and local governments. The basic motivation for this research is that electronic government applications are becoming popular in the world especially by the countries which comprehend benefits as first adaptor countries as mentioned shortly before.

For this reason, we will give basic information on e-government (section 2.1) along with the basics of GIS (section 2.2.1) to strengthen background of the thesis. One of the reasons we have selected GIS is that spatial data may be seen in many government services such as education, health, mass transport and environmental issues. In this thesis, we have chosen manipulation of health centers in Erbil on map as a case study; in this way, we shall demonstrate benefits of such an attempt as well as to discover potential and possible obstacles in establishing and using such an information system that can/will be used as a part of infrastructure of e-government. Following gives brief information on Erbil.

The City Erbil (Hawler) is located at north of Iraq in Erbil state. Erbil city center coordinates are 36.18 (36 degree, 11 minutes) North and 44.00 (44 degree, 00 minutes) East. It has a surface area of 13,165 km^2. Apart of the city center, the districts of Dashti Hawler, Makmour, Koya, Shaqlawa, Soran, Rawanduz, Choman and Mergasor are populated centers.

The estimated population of Erbil is 1,612,692 as of 2011 [37].

It is the fourth largest city in Iraq after Baghdad, Basra and Mosul.

Erbil has 18 PHC (Primary Health Centers), 8 governmental hospitals [22], and 11 private hospitals.

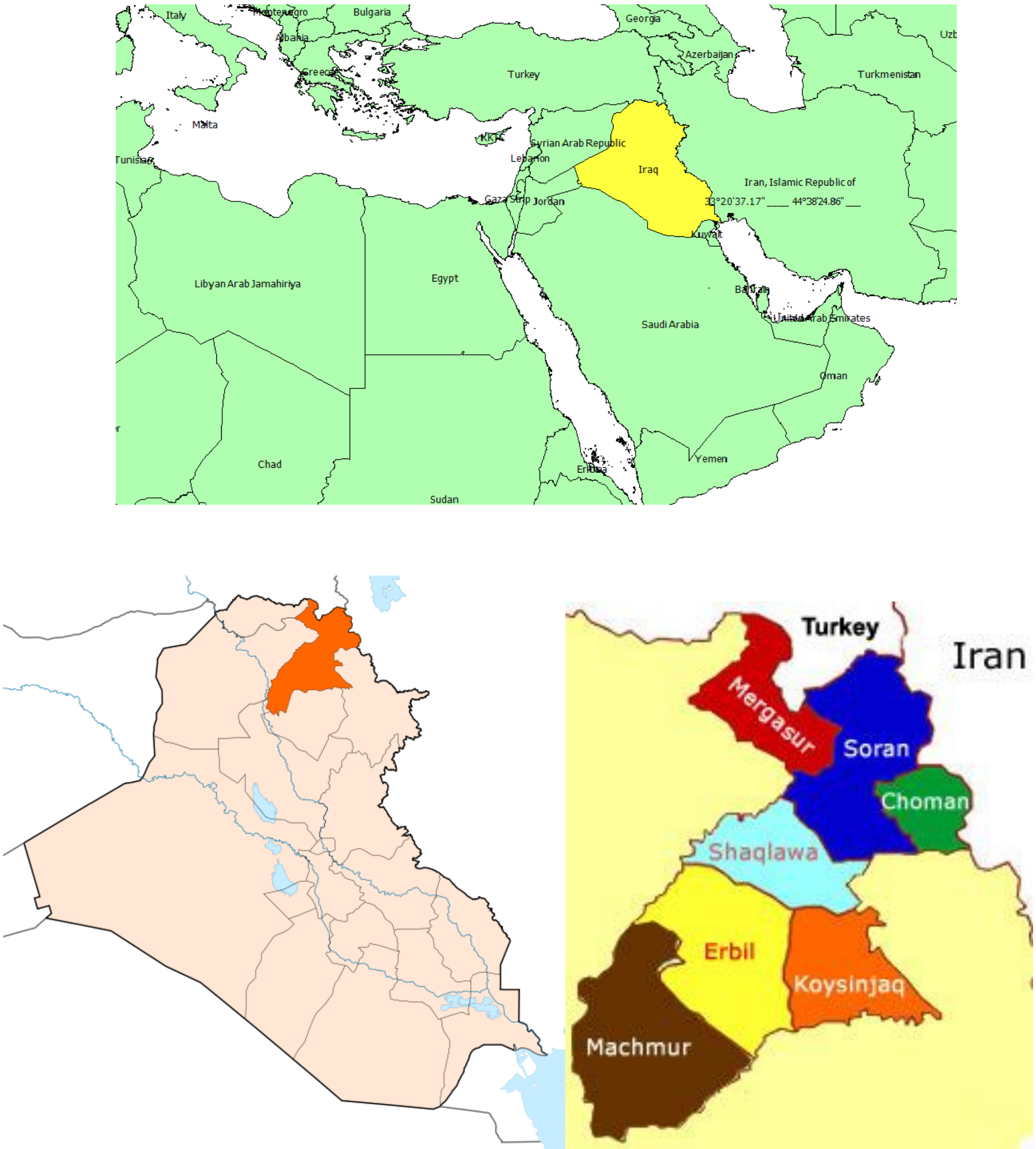

Figure 1 Middle-East Region, Iraq and Erbil

Research question

With the motivation we have explained in this chapter, we aim to seek answer to the following research question of this thesis.

Can Iraq's local governments establish a working GIS to handle hospital distributions and resources to speed up e-government initiatives in its health services?

1.2. Research Method

This study's body of knowledge has a part of literature on electronic government and GIS applications as covered in Chapter 2. The researcher has made a considerable care to avoid any plagiarism due to unintended similarities with the reporting as the researcher has been informed on in academic writing guides such as in [38]. Although the material covered is referenced wherever needed, there are also many parts in which the researcher's own thoughts are expressed, naturally. In such parts, some similarities may be seen but they are not to be evaluated as plagiarism regardless hence it is out of the intension of the researcher. To avoid such an incidence, the whole thesis has been tested in a plagiarism detection software, iThenticate before the final print.

Currently, neither the findings nor the conclusion of this thesis have been presented in a conference proceedings and/or journal; hence, this dissertation is the only report of the whole study so far.

CHAPTER II

LITERATURE SURVEY AND BACKGROUND

As we have explained in Chapter 1, this thesis concerns both e-government and GIS concepts. For this reason, we shall give background on both subjects and visit enough literature to support the research question.

2.1. Electronic Government

Electronic government or e-government in short, is defined in many research articles and reference sources; more-or-less the definition is similar to what is given in [1], where the author defines it as application of ICT (Information and Communication Technology) in the public sector to improve the efficiency, effectiveness, transparency and accountability of government.

Basically, e-government applications target that users can access public information and services 24 hours a day and 7 days in a week through the Internet [4]. One of the aims of e-government initiatives is to provide an easier way to enhance the mechanism of e-government [2]. Such initiatives include centralization and management of only text based as well as spatial data such as health centers as within the scope of this thesis.

E-Government applications provide easy, fast and digitally interaction between government and citizen, business and government departments (figures 3 and 4). E-government represents a "transition" from routine management style to contemporary way. The e-government literature prefers "transition" instead of "change" since they are different in the way they occur. Transition is meant to include improving an old situation, habit to a new one in a controlled manner while, "change" occurs naturally without any control.

For example, usage of mobile phones in the society has spread over as a change and this occasion happens naturally. The technology has been adopted without any enforcement of the authority. However, handling paperwork in the government agencies is shifting to electronic media with the encouragement, guidance and regulation of the government. The latter case is an example of transition in the governmental work.

2.1.1. Benefits

Shifting paper based work into electronic media has several considerable benefits not only for governments but also public and private sector i.e. business.

Firstly, it is fast: instead of going to the government departments, a person can fulfill his work in a faster way electronically. For example: having an appointment from a hospital over the Internet. As seen in the Figure (2), the patient queries hospital from a single port and looks for eligible doctors to get diagnosed.

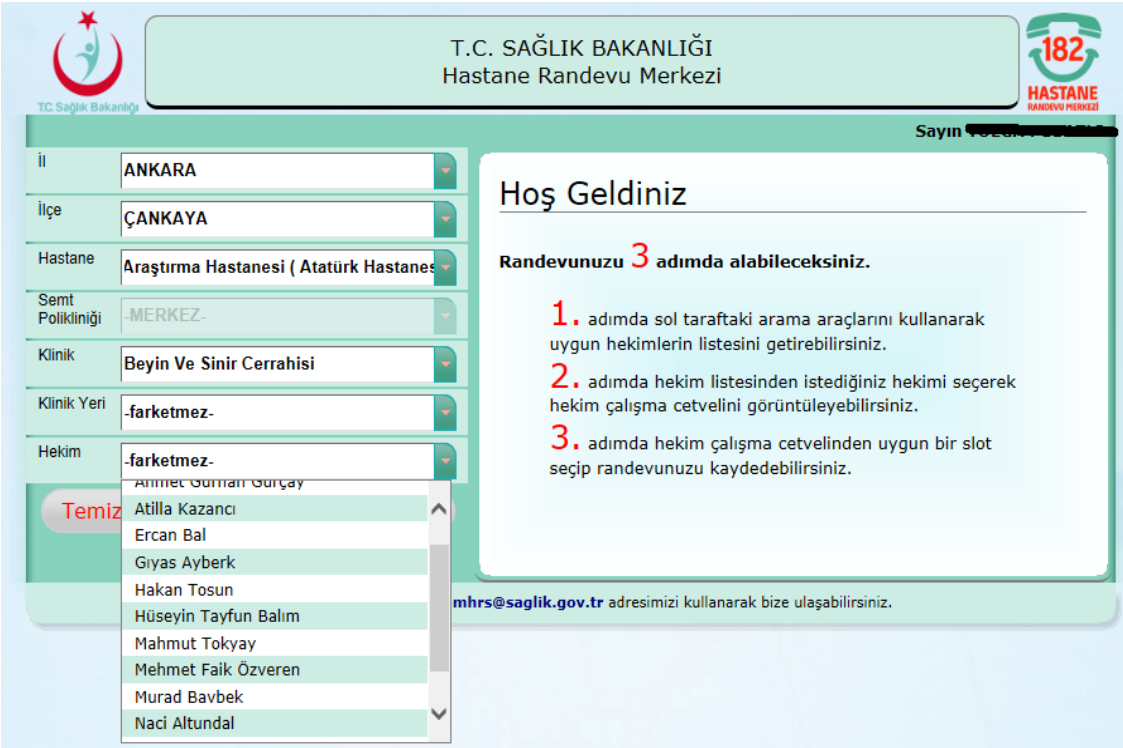

Figure 2 A View From Hospital Appointment Center Web Interface

As the person does not need to be present at the transaction place physically, time required to stand in lines and queues is saved as he can fulfill his work by interaction with government via website. For example: in personal documents service such as passport, a person can submit his personal documents through the Internet, in this case he will save a time to go to passport office.

Doing the paperwork electronically reduces additional costs for the transaction as well. Instead of going to the government department and pay for transport, a person can fulfill his work from while at home. For example: a person can enroll through the Internet to university avoiding transportation cost.

Although minimum requirements are necessary to get involved in the e-government initiatives, the benefits of such initiatives increase computer literacy as well. People understand and learn how to use Internet, websites and learn how to fulfill their work digitally, in this case the efficiency and awareness of people will increase. The technology will force people to learn how to use Internet and adopt modern life.

The e-government process and information will be more accurate than traditional paper base models, because it is easy to control. For example: the electronic fulfilling is more accurate than fulfilling that made manually as discussed in [3].

After giving a brief introduction to the benefits of e-government initiatives, it is useful to discuss related objectives.

2.1.2. E-Government objectives and requirements

There are considerable examples in the practice to justify e-government objectives. Such a list includes but not limited to the following items as discussed in [3] and [5].

- Provide services to local citizens and quick access to the services in less cost, and enable citizens practice democracy, thus save and reduce the time required to complete transactions.
- Achieving effective communication, and reduce the complexity of administration.
- Improve the level of services provided to citizens and institutions to overcome the errors that employees may made in a manual system.
- Create a better working environment using ICT in the institutions and the establishment of an infrastructure for e-government it help to work easily and

conveniently through improving the communication interface between the government and employees.

- Tracking and tracing of service provision electronically, ability to conduct services in steps and indication of time duration for service completion.
- Significantly contributing to high user, accountability transparency, satisfaction and accountability reduced administrative load.

There are many requirements for applying e-government initiatives, including technological, management, legal and human. To build an effective e-government; a state must develop a strategy by qualified teams to ensure technical, organizational and legal infrastructure. For applying e-government we have compiled following fundamentals and requirements from [3] and [39]. This list should be read in conjunction with the list of 20 services given in section 2.1.3.

- Network: For e-government employees to do their duties and interact with each other, their computers have to be connected on a network to share data and information. Additionally they have to learn about using computer, Internet and e-government application. Furthermore they have to have a certificate will provided by government that allow them to work on e-government application.
- Improve government organizations and institutes: For building an effective e-government; must improve government institutes and organizations through changing the regulatory mechanism of government, because the traditional mechanism is not suitable with modern, speed and flexible e-government mechanism.
- Improvement of employee for dealing with e-government: In order to improve government employees for dealing with e-government environment; the government must prepare a training course to improve their experience and choose the more efficient one.
- Awareness of citizens: The citizens have to know of using a computer and Internet and have to be acclimating with the digital environment. The citizens can learn through basic computer courses and also online courses and tutorials on the Internet.

2.1.3 The E-Government delivery models and short history in EU

In order to discuss what is missing to cope with enabling e-government in Iraq we have chosen to visit EU steps starting from late 1990's.

Among the important areas that European Union is trying to promote is to widespread usage of ITC across its nations. With this aim, in December 1999, the European Commission has announced eEurope and shortly after that, this initiative has been accelerated by the acceptance of eEurope Action Plan by the member states in 2000 at Feira, Portugal [11]. Apparently, the eEurope was providing directives just for the members of EU to follow and establish electronic document circulation; in addition to the member countries, there has been a queue that includes Turkey to join the union, and those countries were ready adopt eEurope's guide. Hence, in parallel to eEurope, European Commission has published eEurope+, to cover candidate countries in 2001 [12]. Such an action was not a necessity for Turkey but this guide has been one of the important motivators in Turkey's path to full e-government transition.

In 2005, eEurope initiative phased out but the union had already made i2010 ready as a follower; this was a policy framework that directs the member states to adopt e-government via interoperable electronic identification management for access to electronic document authentication , electronic archiving and public services [13].

In 2010, i2010 has been completed as its action plan progress is evaluated in the final report [14] and its follower, Digital Agenda, came into action [15]. Later in that year, the commission has released a report to inform the member states about the development and influences in the ICT sector including online public services [15]. As the report underlines, the commission encourages and tries to stimulate the member states to transform governmental activities into the digital environment where public and business can benefit with higher access speeds.

Under the guidance of these directives, the EU countries agreed that they are to enable e-government initiatives step-by-step in 20 (12 public + 8 business) services nationwide. We will inform the audience on those services after we visit delivery models.

Basically, there are four types of e-government delivery model classified according to the services that the government prepares and based on the nature of the parties involved: Government to Government (G2G), Government to Business (G2B), Government to Citizens (G2C) and Citizen to Citizen (C2C).

For we have limited the background for the scope of this thesis we will not get into too much detail in G2B and C2C models. Meanwhile, employing GIS in the health sector is directly linked to G2G and G2C models.

Government To Government (G2G):

Principally, G2G is online interaction among government organizations, departments, authorities and other government bodies. Moving a set of information from one government agency to another by ICT enables sharing as well as interoperability among them [1]. The government departments are connected to each other and they share information among them by government servers.

For example: when a person wants to register address change he has to go to civil registration department to change it in Turkey (or he may do this through the e-government portal); so, he does not need to inform all government departments. By this way, his address will appear in all government departments as the information will be shared in the government offices.

Government to Business (G2B):

It is online interaction between government and the commercial business sector. Such services are present to public and private sectors regardless the size. As a European Commission directive, there should be 8 services that the governments are to presents to businesses as seen on Figure 3.

For example: In public procurement service; if one of government department wants to sell or buy something they put an event on the specific website and the business sectors try to bid that procurement from that event.

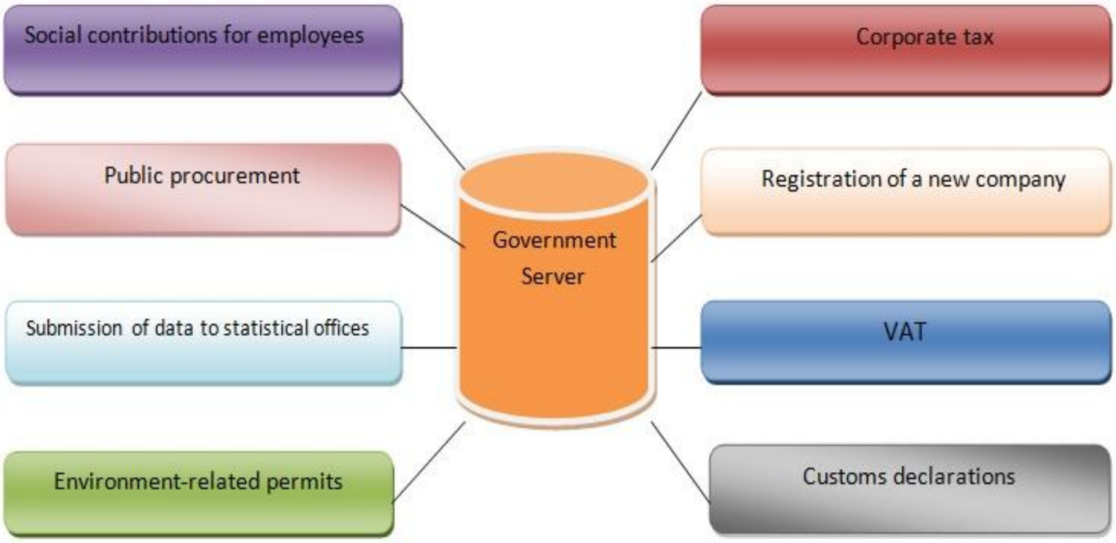

Figure 3 8 G2B Services

Government to Citizen (G2C):

It is an online interaction between government and citizen that the government provides the necessary mechanism to enable citizens to fulfill their administrative works from homes. As a European Commission there are 12 services that government has to provide to citizens.

For Example: Instead of going to the tax office and stand in lines or queues, now the citizen able to pay a tax by government's tax website whenever he want even at night from his home. Another service is health sector, when a patient go to doctor first of all he can register his name through a centralized system (Figure 4), and his doctor want a blood test or MRI or X-Ray; directly his name will appear in the system in that department. Furthermore, he does not need to carry his result with him. The result will appear in his doctor system directly.

Figure 4 12 G2C Services

Citizen to Citizen:. It is online interaction among citizens.

The common example of citizen to citizen is the social network websites such as Facebook and Twitter. Sometimes the government wants to do or to take a decision about issues related to the Interests of the government; in this case the government puts and shares the case on the social network websites so that citizens can vote or comment on.

As we have mentioned previously in this section, we shall inform the audience on the key public services that EU has selected. In brief, there are 12 services that the government should serve the citizens electronically. These are listed below with some examples:

The 12 common public services for citizens

- Income tax: The citizen able to pay tax electronically whenever he wants. A person can pay tax by Internet or ATM machines whenever he wants even at nighttime.
- Job search services: The citizen can search for job online. Through a website an unemployed person can search for a job.
- Social security benefits:
  - Unemployment benefits: this service depending on jurisdiction and it called unemployment insurance or unemployment compensation. It is a payment given by the government to those people cannot find a job.
  - Child allowances: It is one of the social security benefits and it is a payment given by the government to the parent or guardians of children. The rule of payment is different from country to another.
  - Medical costs: In this service the citizens pay to the government every month or every year it depends on the rules of the country, and the citizen get benefit from that payment in hospitals and medical departments, it is called health insurance.
  - Student grants: It is one of the social benefits to the students, in this service the students are getting benefits from government, for example: scholarships for students, providing Internet for dormitories and organize student tournaments.
- Personal documents (passports / driver's license): The citizen should be able to interact with the department that handles documents necessary for such as passport or driver license electronically. For example: a citizen want to get a passport or driver’s license, instead of going to specific department and stand in lines he can submit his documents and required papers via Internet electronically.
- Car registration: This is about registering new car via the Internet. For example: if a citizen bought a new car he does not need to go to car registration office, he submits documents and information about his new car through the Internet.

- Application for building permission: The citizen is able to get permission for building via the Internet.

- Declaration to the police: The citizen can declare the police about illegal issues via the Internet.

    - Online theft declaration.
    - Detection of vehicle theft through the vehicles database.
    - Detecting terrorists

- Public libraries: The citizen should be able to search and access library items such as books, journals via the Internet. For example: developed countries have public websites for their libraries. In this case if a person wants to search about his favorite book he can search in library website easily and also can download an article in pdf extension if it is available or he can put a borrowing order on an item.

- Request and delivery for birth, marriage certificates: With a successful cooperation of central government, general directorate of census and citizenship such certificates can be requested and/or dispensed for the citizens by Internet. For instance, if a citizen gets married he has to get a marriage certificate by submitting the documents by Internet, and also in birth certificates he can submit the birth documents via the Internet.

- Enrolment in higher education/university: Course registration is provided in universities through student information systems.

- Announcement of moving: Informing a change in the address online. For example if a citizen live in address A and want to change or move to address B, instead of going to the related department he inform them electronically via the Internet.

- Health related services: States provide health services to public. This service can be tracked, recorded and managed electronically. For example: there are health systems available in all hospitals that system is connected to social security benefits institute and is connected to pharmacies and all of they are connected and monitored by the Ministry of Health, so they are connected as a network. Another example is that when a patient goes to the doctor, the doctor will enter patient information in the system and when he take an MRI; X-RAY or blood test, the result will appear in the system directly. Additionally the patient can reserve an appointment from the Internet or by call. Furthermore the patient can know which pharmacy is on duty night.

The 8 common public services for business:

- Social contributions for employees: Monitoring of accrual-revenue information and past debts is also available and the system covers both public and private institutions. For example: It is a system of payment for social, medical and pension insurance. This payment will pay to those employees who working in public or private sectors, to getting benefits in social and medical costs and after the employee get retired will pay pension insurance every month.
- Corporate tax: Online submission of tax forms and payment. Functions to monitor the situation in check account balances and tax office to obtain information on regulations and updates via the Internet.
- Registration of a new company: The organization able to register a new company online.
- VAT (value added tax): The organizations or businesses able to submission and payment online.
- Submission of data to statistical offices: Such offices contain information and research about statistics of the government. For example: construction businesses built 100 homes in 2012 and 200 buildings in 2013, if it wants to provide statics for 2012 and 2013 years to the government and how much cost that it spent in the buildings, it can submit all information, statics and researches online via the Internet.

- Customs declarations: Customs declarations can be submitted fully in electronic environment. For example in this job is performed by the owner of the goods or a person acting on his behalf (representative). It can also be performed by a person having control over goods. These people may be individuals or companies, as well as in some cases their own associations. As a general rule these people should be put in the community.

- Environment-related permits: Getting online permission for issues related to environment. For example: If an organization wants to construct a building and before it starts any construction, the organization will need municipal approval, in this case it can get a permission from submitting online via the Internet.

- Public procurement: Related website should contain information about public procurement requirements and forms and public agencies are required to send the forms electronically. For example: If one of the government universities wants to buy 100 computers, it will buy the cheapest cost among the offers. Additionally when that university wants to sell 50 old projectors, it will sell the most expensive cost among the organizations that will pay.

2.1.4. E-government measurements

To monitor its states, EU has a measurement scheme of e-government initiatives. Mainly, the aim of this scheme is to assess the efficiency of these initiatives in the member and candidate countries. EU does this through cooperation with a third party. This organization is one of the world's main providers of consulting, technology and outsourcing services. The Capgemini Present in 44 countries with more than 125,000 employees, the Capgemini Group helps its clients for its reports are on their performance and competitive positioning [6]. In the cooperation, there were International Data Corporation, Rand Europe, Sogeti and Danish Technological Institute as well.

The latest report [6] is from 2010 to our knowledge; the report presents the measurement of the progress of online public service delivery across Europe, measured across 32 countries, the 27 EU member states, plus Croatia, Norway, Iceland, Switzerland, and Turkey (EU27+).

Basically, 20 public services mentioned in section 2.1.3 are measured to monitor e-government transition running in Europe.

The scheme measures the services into four groups:

Online sophistication: The extent to which government services allow for electronic interaction and/or transaction between the administration and citizens or businesses.
Full online availability: The extent to which there is fully automated and proactive delivery of services.
User experience of services: The user-centricity and usability of e-government services.
Portal sophistication: Identifying the most mature, user-centric and personalized portals that provide direct access to a wide range e-government services.

Basically, this is a ranking assessment of service delivery against a 5-stage maturity model: information, one-way interaction, two-way interaction, transaction, and automation. In short, this is a ranking system with lowest sophistication in which the user is limited to acquire information from the service website and with the highest sophistication where the user has a government portal through which he can do all of the governmental enquiries, submissions etc in a user centric interface where 20 basic services are available through a national portal.

The report also covers transparency of service delivery, multichannel service provision, privacy protection, ease of use and user satisfaction monitoring. Basically, the EU aims its members to enable the citizens to track service provision; the service is also available through alternative channels than online (e.g. call centre, e-mail); the privacy regulations are stated clearly concerning personal data usage on the website; the site has support (FAQ, demo, live support); and all those are done through multi-language, user friendly way with user satisfaction monitoring, feedback options and/or complaints management.

Another popular and widely accepted measurement is performed by the United Nations (UN) through interactive e-Government Development Database (UNeGovDD). The database was created by the Division for Public Administration and Development Management (DPADM) of the United Nations Department of Economic and Social Affairs (UNDESA) to provide governments and all members of civil society easy access to this valuable information for research, education and planning purposes [8].

Global Survey of e-government presents an assessment systematic use of the potential of information and communication technology to transform the public sector through enhanced efficiency, effectiveness, transparency, accountability, and access to public services and the participation of citizens in the Member States 193 in the United Nations, and at all levels of development [8]. Basically, the measurement reports member states' status and ranking worldwide. The UN's measurement scheme is more practical and easier to understand than EU's measurement with some similarities. Still, there are four stages:

Stage 1: Emerging information services: citizen can get information from a webpage; it means that there is no interaction between a citizen and the webpage.

Stage 2: Enhanced information services: citizen can download forms from the webpage.

Stage 3: Transactional services: there is interaction between the citizen and the webpage, it means that the citizen can fill the form over the internet and send it at the same time electronically.

Stage 4: Connected services: connecting the government organizations together so that the citizen does not look for the government agency to find the service he is looking for.

When we analyze the 2012 report [8], we see that building upon the transformative nature of ICT and maintaining their focus on e-government development, all of the top 20 countries in 2012 were high income developed economies. While the Republic of Korea (0.9283) maintains its position as achieving the greatest e-government development, in 2012 it is followed by three European countries, with the Netherlands (0.9125) advancing by three and the United Kingdom of Great Britain and Northern Ireland (0.8960) by one to become the 2nd and 3rd leading e-ready governments in the world. Denmark (0.8889), the United States of America (0.8687), France (0.8635) and Sweden (0.8599) follow close behind among the global leaders [7]. With the same measurement scheme, Iraq's position remains at 136th as represented in Figure 5.

Figure 5 Iraq in the UN e-government Ranking

2.2. GIS Applications in the Health Sector

The employing Geographic information systems (GIS) has approved itself in many areas including the health sector with advantages we discuss in this chapter. Before we visit related literature, it is beneficial to give the basics of GIS; this would be useful as the application tool is developed in a GIS environment as explained in Chapter 3.

2.2.1 Fundamental of GIS

In this section, we shall give the principles of GIS, and why CAD programs and non spatial databases are not enough to manage location based objects.

GIS are computer systems that collect, edit, input, retrieve, store, analyze and output geographic data and information for specific purposes [16]. GIS is able to input geographic information (maps, aerial images, etc), data (names and tables), and process (process and review errors), and store, analyze (spatial and statistical) and view on computer; as reports; as maps; or as charts.

Such systems are useful while engineering planning, design, management of distributing hospitals are conducted in municipalities as explained in [23].

The GIS components are set of parts that allow to it to perform its many interrelated tasks. These parts include network, computer hardware, computer software, space and organizations to fulfill GIS processes, data and information upon which the system operates and client who get and use the products [16].

A network is an infrastructure of GIS that connects two or more computers or other devices for sharing data and information. It refers to the terms, (LANs) local area networks, (WANs) wide-area networks and the internet [17]**.** These networks are the fundamental components of GIS; with these terms it will be able to enhance the reusability and accessibility of geo-referenced data and analysis tools [23].

Computer hardware: They are devices that are used by GIS client to perform its tasks. A hardware component is technical equipment needed to run GIS. It is divided into two parts, input devices such as digitizer tablets, large scale scanner and GPS, and output devices such as screen, plotter and printer.

Computer software: It is a computer program that uses in GIS. Hardware devices must have software to run it. The software manipulates and output geographic data. The software can store and show the data. Most common software include ARCGIS of ESRI, MapInfo, Geomedia and IDRISI.

CAD (Computer aided design): it is software for designing and creating virtual models of products [18]. A CAD system can be used to create a graphical representation of such as buildings and machines. CAD systems are usually used by engineers to design their models and samples, such as Auto-CAD software. In the past, such software have been used in design, draft and drawing, but now they are extended to help people to design geographical mapping and associated activities such as rendering 3D topographic views.

Spatial data: it is data that has geographic location, that data that can be displayed as a map and it depends on data on the Earth surface. There are two types of spatial data as vector and raster data.

Raster data: It is asset of cells from intersection of columns and rows. This cells represents storing image unites called pixels. The most common examples are satellite and scanned images [19]. It consists of matrix of pixels organized as rows and columns that represent the structure of image. Each pixel in the raster data is assigned to value it is as integer from 0 to 255. Both computer graphic designers and GIS operators use such data. Satellite images are examples of raster data.

Vector data: It represents geographical feature such as lines, polygons and points. When you see a satellite image (Raster image) of city, we will see trees, houses, roads network, etc. This data is represented as shapes in other layer that represents the roads network, houses and trees this data called vector data [19]**.** For example in section 3.1 we have used road layer and hospital layer of Erbil that represents vector data.

Non-spatial data: Information about spatial feature. It is represented as tabular format; a data can be of text, numeric, data or Boolean format.

Layer: The data with same type are stored separately, these data are stored as a file and this file called layer. For example the roads network data are stored as a layer, buildings data and locations are stored as a layer. These layers are combined and give a better geographical map. Usually maps consist of many layers.

DBMS (Database Management System): It is software that is designed to manipulate with database and interact with the user as an interface [20]. It contains procedures such as query, update, insert, and delete. Examples of DBMS are Oracle, MS Access, SQL Server, etc. GIS can use DBMS to store non-spatial data.

The difference between GIS and CAD and why we use GIS:

In order to the process of geographic data fulfilled, it requires computer aided drawing system, therefore GIS has CAD tools. CAD models features in the real world. By this way, CAD coordinates may be relative to the object being modeled and are not have to be relative to any particular place on earth, whereas GIS use geographic coordinates systems and world map projections.

GIS is able to merge the images that represent the natural of studying earth surface and the data that represents these images that is, GIS combines spatial data with related attributes (non-spatial data) together, but CAD cannot do this merge, therefore GIS is preferred to use than CAD in analyses that require both spatial and non-spatial data.

While some authors such as [21] argue that topology is a difference between GIS and CAD; it is better not to generalize this argument for all CAD programs e.g. AutoCAD.

Shortest Path

The main important things for choosing shortest path are less time and less cost, because for example when you want to go from place to another place by your personal car, you have to choose shortest path to destination with less cost of petrol or auto gas, when you want to go by taxi you have to tell taxi driver to choose shortest path with less kilometers, because each one kilometer has a fixed price.

By using the map software on smart phones to go to specific place, there are two options (Drive to and Walk to) then you can choose one of them. Such programs calculate shortest path by using algorithms.

For example if a person has emergent situation and he has to go to doctor as soon as possible and he lives in Khabat district in Erbil, the ambulance driver should have Erbil map shows the districts, streets and hospitals. The driver has to bring the patient to nearest hospital in Kabat district to one of two hospitals (Rizgary teaching hospital and Eastern hospital), but the first one may be nearest than the other but the way to the first one may have traffic congestion, so he have to bring him to second one. The distance is not the only decider in the shortest path analyses because conditions of the roads and limitations such as traffic jams and/or speed restrictions play important roles.

Buffer analysis

Buffer analysis is a process that we use in GIS to draw polygons around selected features on maps. In buffering usually the operator creates two areas: one of them is area that is within a specified distance to selected real world features and the other area is beyond. The area that is within the specified distance is called the buffer zone.

A buffer zone is any area that serves the purpose of keeping real world features distant from one another. The benefits of buffer zones are useful for example in identifying areas in the environment, residential and commercial zones from industrial accidents or natural disasters [35]. Similarly, buffer zones are useful in identifying service areas around health care centers.

Buffer distance can be specified as a numeric value and unit of distance, for example "100 Meters". The buffer distance must be a numerical value, then as the buffer operation is performed on each input feature, that feature's buffer field value will be used as the buffer distance [36].

An example of buffer and buffer zone is shown on Figure 6.

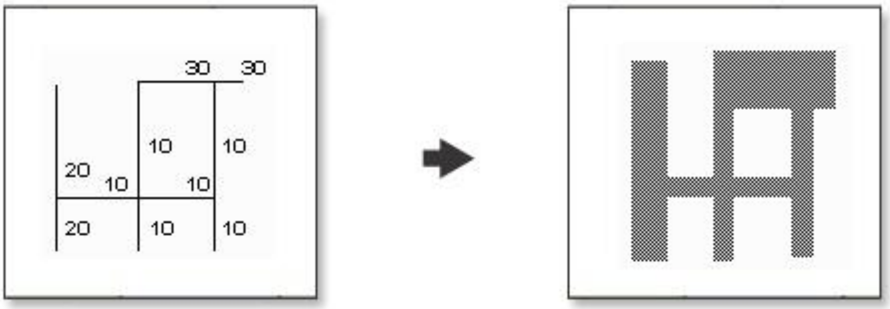

Figure 6 An example of buffer and buffer distance

In a GIS application, buffer zones are represented as vector polygons around various shapes such as line or point features (Figure 7).

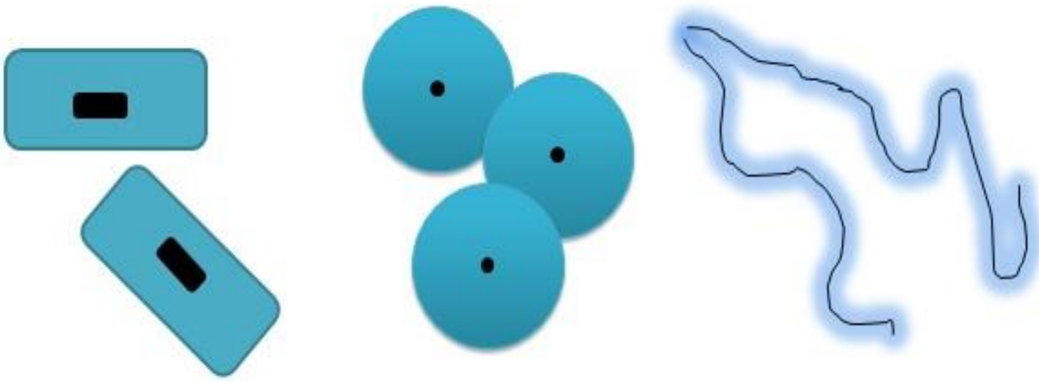

Figure 7 Buffer zones around points, poly-lines and polygons

As seen in the figure the buffer zone depends on the numeric (distance) value, if the distance value is small number the buffer zone will be narrow, and if the distance value is big number the buffer zone will be wide.

GIS software provides a variety analysis tools to create buffer zones. The example shown on Figure 41 is generated in MapInfo.

2.2.2 Literature review

This section is to serve the literature support that there are many successful GIS examples reported on the health services. Following selected literature is on the distribution and finding patterns of diseases, location of health in center city planning and shortest path analyses to investigate accessibilities to the hospitals. As we could collect data only on the hospital locations and roads, we have prepared the application tool to be used in accessibilities and hospital distribution in the city. Hence, the selected literature concentrates on these areas.

In [24], the authors present their work in China where they have used GIS in disease surveillance. The work supports that employing GIS has been successful as they were able to display real time and dynamic change of disease development and able to show space time distribution of malaria, schistosomiasis, Lyme disease and cholera.

As the application instrument, the operators used GIS prediction model and multilayer stack analysis to monitor diseases and they found strong relationship between snail and schistosomiasis and found out that the distribution of schistosomiasis in China is related with the distribution of snails. Same research shows previous works conducted in Jiangsu, Anhui and Jiangxi province in China and a village of south India where break-outs have occurred; researchers used GIS to display and view the distribution of case in a simple map, and compared the differences of cases in spatial distribution, providing clue for the follow-up interventions.

They found that through the unique spatial analysis method of GIS, authorities can find out the distribution law of schistosomiasis and snails, and GIS has a huge advantage in understanding the distribution and trends of such outbreaks.

However, we should not forget the garbage in/garbage out term in the computer literacy because information systems become useless without any valid data. Barriers to better information is discussed in many GIS papers including [40]. Basically, the paper shares experience of UK officers while passing from paper wall maps to digital environment.

A basic finding of this work is that if data stored in national and local databases across the UK are accessed in better way to other local partner agencies, these agencies can discover and add value to the data that was originally collected. The work's main motivation is to monitor crime and to find possible patterns however, their experience in spatial data manipulation shows the following points as barriers to achieve data handling in a digital environment: confusion about the law**,** culture against information sharing, the data can and most of the time will cost, poor meta-data, data inconsistencies and treating the data as not a priority.

"The Social Exclusion Unit report on better information" was presented as the role that geographic referencing can have in better enabling the joining up of information. The data sets that are available in all levels of government can be referenced to a location. For example, a patient being admitted to a hospital can be referenced back to where he lives, because his address is stored in government and shared among the government agencies.

Saudi Arabia is another country where GIS is still too young and needs to be further explored by the health authorities and researchers. An example [26] for explaining how to use GIS by health planners and officers in Saudi Arabia takes Jeddah city as a case study in hospital distribution. The research covers three main health planning issues, distribution of health demand, classification of hospital patients and the definition of hospital service area. In the study, the researchers used ArcGIS, GIS software developed by ESRI, to present hospital demands in the city districts.

The next step in the work includes the patient details, sex, age and hospital utilization type such as emergency clinics patients, specialized and general clinics patients and admitted patients. The third main issue is related to defining hospital service area, by using network analysis and overlay analysis, network analysis is one of the ArcGIS software model that help you to determine the roads, nodes, transportation paths and calculating drive time, overlay analysis is collecting all layers as a single map.

The researchers represent number of patients per districts through thematic maps; by this way, they have emerged hidden information e.g. they found the northern cities of Jeddah have more hospital demand while there is a little hospital demand at the southern city districts. They found, with supplementary information gathered from other sources, that hospital location is among the reasons.

They explored the demand type and they were tried to solve them, for example they divided into two types; health service utilization such as pediatric or diabetic clinics and demand gender as male and female. After putting figures that illustrated the number of male and female in the districts, they found that the female patients are focusing and distributed from the western city districts, and the male patients are distributed at different districts with different amounts. This meant that districts that are located close to the hospitals have female patients more than male patients. This work has helped the authorities as it informs that health services for female patients should be provided in these hospitals with employees, staff and facilitates more than male health services, as desired in Saudi Arabia culture.

Another remarkable work is presented in [26] where the researchers study about ambulance performance and emergency medical services (EMS) and the performance of ambulances to respond within set times to emergency calls from service districts in Ontario, Canada. Basically, the operators use GIS to control the deployment of EMS. GIS technology help planners to arrange and organize and manipulate large volumes of spatially referenced call data and to communicate spatial concepts to decision makers responsible for service deployment planning. In this report, three objectives are presented: admission to provide an analytical model to evaluate and improve the EMS vehicle responses of the spatial reference data call; design and implement GIS-based framework to help planners in mapping and assessing EMS vehicle response; and to explain the benefits of the approach using test data from the Ministry of Health in Ontario, Canada.

They have used an integrated system of Automatic Vehicle Location (AVL), Computer-Aided Dispatch (CAD), Global Positioning Systems (GPS). For example, they use AVL technology to track the real time locations of an ambulance fleet through GPS transponders attached to the vehicles and display their locations on GIS-based computer maps at the dispatch facility. Further, GIS is used in CAD to locate the addresses of calls on a geo-coded street network or property database and as a decision support tool to determine the optimal unit and route that should be taken to respond to each call. The conclusion is they studied EMS and ambulance response by studying the roads, emergency centers and analysis of response time anomalies relative to normal variations in ambulance performance levels by using Graphical User Interface (GUI) the EMS deployment planner can quickly and easily control.

In Johor Bahru city, Malaysia, researchers made a study [27] about health care centers, because of lack of exposure in delivering information to patients who need to get health care center services and the lack of experience in such places; they are motivated to make a study to solve health care center services. In their work, they have approached the problem so that by using GIS they could solve many health care problems such as, finding the shortest path in network analysis for finding the nearest health care facilities to the patient location.

The location of each hospital and health care center are based on addresses; by using GIS they could to find the locations and coordinates of each health care center. The integration of spatial information, the coordinates of healthcare centers and road network will be able to give more information on travel distance and travel time from user's home to the nearest medical center as we have explained in shorthest path in section 2.2.1.

An important consideration for the decision maker is where the people are living, and their travel distance and time to closest hospital or clinic. The implementation of the project is based on four stages, project planning, data collection, data processing, data analysis.

The first one is project planning, in this stage includes the selection of the study areas and the software which is needed to implement this project. The second phase is data collection; this stage includes data collection, attributes and spatial information such as road network (highway, primary road and secondary road). The third one is data processing, in this stage merging spatial information such as roads and hospitals locations. For example, the road's name and its distance information, while hospitals with position information and the name of each hospital, all this information are integrated on the map as attribute data. The final stage is the data analysis by creating geo-database; it is the main stage of the data processing stage. It is a place for storing all the information about the projection of maps, spatial data and attribute data together. Database connection and relationship is done to join external database with an existing geo-database that has been created.

The work represents the benefits of creating map and geo-database of healthcare facilities such as in reporting, doing shortest path analyses and hospital location management. It describes the graphical view of government hospitals geographically. With this information, the viewer can see the locations of the government hospitals. This information gives a better understanding to users that they be able to find the hospitals from their location rather than having only the address of government hospitals as reference. Secondly, the shortest path analysis shows the quickest route from the position of patients to hospital in the shortest distance criteria. The shortest path calculates from the direction starting from patient location. Another product of this work is to find closest facility; the closest facility analysis is performed when there is more than one facility available from the patient's location. For example, patients to find the nearest hospital and the shortest route for emergency cases, the closest facility analysis is necessary to be carried out.

A similar work is reported in [28]; in Fukuoka city, Japan, the researchers used GIS to guide patients to hospitals. Instead of using paper map, they tried to using GIS because it can update daily. Because of high cost of updating geographic information, they constructed an electronic geographical information system using the Google Map API (http://code.google.com/apis/maps/) with open source software to improve their ability to collaborate with other clinics and for referring patients to other clinics.

In Figure 8 explains diagram of the system that was created by OSS system.

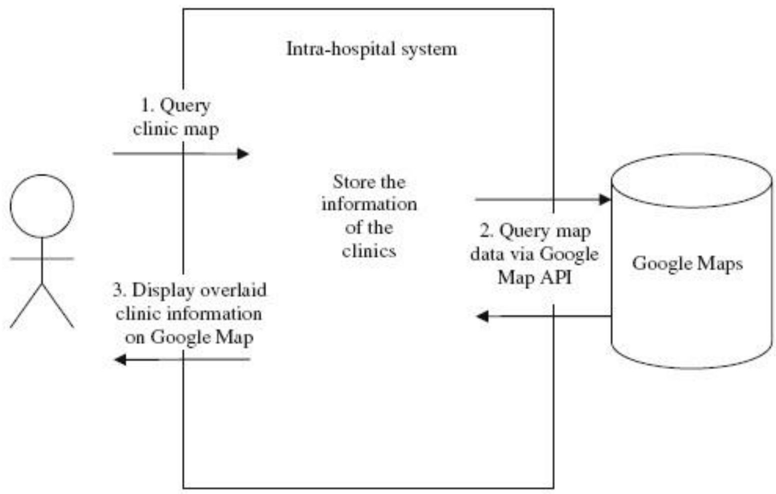

Figure 8 Use Case Diagram Of This System. This System Shows the Registered Clinic Information Overlaid on Google Map

The system provides information on the registered clinics. They registered 155 medical care providers and categorized them based on their specialties. Users of this system can easily switch the area centered by selecting registered points. This system also assists in the creation of guide maps that contain the nearest stations or bus stops. By using Google Map's facilities, the user can change the view point by scaling up and down, and smoothly move the viewable area. However, using third party products have some disadvantages. For example, this system is constructed with open source software (OSS) that is not guaranteed, and Google does not guarantee the geographical information in the Google Map API, either.

The healthcare improvement and accessibility has been a hot topic for a while. For example, it is discussed in an ESRI health GIS conference [29] where the participants shared their experiences in improving accessibility through the case studies.

In that conference, a case study in which the researchers have collected data from the public has guided the researchers on the factors on highest importance for the public when accessing the community hospital sites; they found that quality of care provided is in the highest rank. When integrated this information with the spatial data they have achieved improved reports. In the same conference, another case study is reported where, GIS modeling explains the service area, routes and bus stops and access to bus stop to guide discharged patients.

In [30], it is reported that the impact health reforms had on geographical accessibility to hospital emergency department services from 1991 to 2001 in New Zealand. The travel time was calculated using least-cost path analysis to identifying shortest road network from emergent district to nearest hospital. To analyze the accessibility of healthcare services by using GIS, there are many models to use; this paper informs about a cost path model to analyze travel time by a road network. One of the disadvantages of the method applied is that it has greater complexity than models that use Euclidean distance and Thiessen polygons model. The use of cost path models has been less frequent than Euclidean distance and Thiessen polygons, most probably because of the complex computation involved.

As the starting point, the researchers selected four sources to show the location of emergency departments. These are the New Zealand road network, the New Zealand census mesh blocks as New Zealand's smallest enumeration unit; a demographic table from the 2001 census produced by Statistics New Zealand; and the location of publicly funded EDs as of 2001 and 1991.

As the algorithm and GIS software, the operators used a least cost path analysis algorithm built into the network analyst extension of Arc/Info 9.0 software. By merging the population data and the calculated travel time for each census enumeration district, average travel time can be calculated and summarized by district health boards. As an important finding, they can emerge statistics of the population with more than 60 minutes away from any hospital. In the result of the method they found between 1991 and 2001 the total number of people living further than 60 minutes from an emergency department increased by 63,834. The authorities are provided such information so they can use in decision making in emergency department locations while the population increases.

Two years later, Hiscock and colleagues have published their work [31] on travel time to the nearest surgery doctor and pharmacy in the same country, New Zealand. They made this study to explore not only the travel time to access such facilities but also to explore satisfaction of the patients with the access time.

The data such as surgery doctors' addresses and pharmacist addresses are collected from Ministry Of Health of New Zealand, these information are merged with geographic boundaries and travel times are derived from New Zealand health survey.

In the study design part, they put relationship between travel time access and five health service results, surgery doctor's consultation, blood pressure test, cholesterol test, visiting to pharmacy and satisfaction with latest surgery doctor consultation. In data analysis, the travel time between points and surgery doctors and pharmacist were calculated in a GIS environment.

The work shows findings as blood pressure test are less in urban areas and the surgery doctor's consultation and pharmacist visits are less in highly in rural areas. They also found that the access to doctors in urban areas is better than in rural areas.

Additionally, people who live in rural areas are far from doctors. The women who are living in rural area are less visiting to doctors and pharmacist than those women who are living in urban areas. By studying urban and rural areas in New Zealand, they found there are specific problems such as poor communication between urban specialist care and rural primary care, there are few opportunities for training courses for medical employees and staff, less testing of patients, less existing of medical equipments for testing patients and high cost of petrol in order to visit doctor.

Finally, they concluded that in New Zealand the access to doctors and pharmacist is not satisfied and access to primary health care services is a concern in rural areas. All these knowledge emerged from spatial data analyses with a successful integration of non-spatial data sets.

An interesting work [32] from North of England reports a comparison between GIS estimated of car travel times to health services and actual times reported by a sample of 475 cancer patients who have travel by car to go to clinics at 8 hospitals. Basically, the researchers made GIS estimation of car travel times using the shortest road route between home address and hospital address and average speed assumptions. The estimated time moved to be longer than reported time with increasing the distance from the hospital. The found the reported times exceeding the GIS estimated time, because the reported time will face traffic congestions. It is concluded that the GIS estimated times of car were close approximations to reported times by patients. GIS travel time estimates are better to be reported travel times for modeling purposes because reported times contain errors and can reflect unusual situations. For this reason, more data from different sources should be added to the models to obtain more realistic results on the field i.e. the roads are not sufficient alone, real-time traffic reports and maintenance schedules need to be added to the models.

Estimating access time and path to the health care centers are vital. Another example is reported in [33]. The researchers are motivated with the fact that cardiovascular diseases (CVDs) are among the leading causes of mortality in the USA, especially in the Kentucky State, which has been ranked third in the nation for heart-related deaths in 2000.

They made this study to assess geographical accessibility and access service utilization related to ambulatory care sensitive CVDs in Kentucky. This study used the Kentucky Hospital Discharge Database to evaluate the uses of services and the Compressed Mortality File to study mortality related to CVDs. They found that people who are living in rural areas and far from the medical services, and those who are residing more than 45 minutes from any health facility are more likely to be socially and economically marginalized.

As the fundamentals of the analyses of location data, they used ZIP code zone, hospital service locations, and transportation network features connecting all origin and destination points. As health and socioeconomic data, they collected information about heart-related ACS conditions from Kentucky Department of Public Health hospital discharge records. Finally, in the analytical technique part, they used several GIS and spatial data analysis methodologies in the calculation of travel time between the point of patient residential ZIP Code zones and hospital service facility locations.

Coming back to the disease pattern detection, same diseases remain Australia's biggest killer and has been a motivation for in Australia [34] in which the researchers study the Cardiac Access-Remoteness Index of Australia (Cardiac ARIA) by using GIS to model population level, road network accessibility to cardiac services before and after a cardiac disease events in Australia.

Basically, the purpose of work is to provide a methodology of GIS and accessibility to health care and solving cardiac ARIA problem by using GIS**.** The methodology and study design is similar to what we have visited so far in this chapter: three phases, the first one is collecting the experts to discuss and define the scope of cardiac services, the second one is getting data and information and GIS modeling and the third one is comparison between Cardiac ARIA and census-derived local population characteristics. They put location layer, hospitals and clinics layer, ambulance layer, streets layer and acute cardiac ARIA layer on a single merged map for analyses and reporting in their project. In the GIS modeling, they used in their project Environmental Systems Research Institute (ESRI) Arc Map, version 9.3.1 as software.

2.3. Synthesis of The Literature Surveyed

What we have covered in this chapter includes electronic government initiatives, GIS and related literature with examples. While Iraq's place of e-government development in the world ranking (Figure 5) remains as a concerning issue and has to be addressed without any doubt, we have seen that in many successful e-government initiatives, managing spatial and non-spatial data together plays important role. Basically, handling statistical data, public procurement, registration a new companies, environment-related and building permits, job search, social security and health related services (section 2.1.3) are some of the examples that need spatial data for the operators can have thematic reports and map based statistical analyses. The covered literature on the e-government shows that employing GIS is almost a “must” in governments.

Among the services mentioned in sections 2.1.2 and 2.1.3, we have chosen the health sector that utilizes GIS to enhance data management and provide proactive solutions. Examples include short path analysis for ambulances, investigations on hospital distributions for heath care accessibilities [25], [26], [27], [30], [32], [33] and [34] and further guide to discharged patients [28], [31]. However, surveying the literature is one a part of the equation; we have to actually use GIS software and make basic spatial and/or non-spatial analyses of real data sets. This is to be certain that these are feasible applications, technically.

In order to make the thesis robust, the following chapter is vital for it will fill the gap of GIS application tools can be setup in Erbil, as an example.

CHAPTER III

A SAMPLE APPLICATION IN HEALTHCARE LOCATION MANAGEMENT

This chapter's aim is to show that enabling a working GIS in Erbil is possible, technically. As explained in Chapter 1, the researcher has established enough technical capabilities and knowledge in a considerable short time. This effort has enabled him to prepare the demonstration presented in this chapter.

Since the objectives and requirements of e-government underline stronger infrastructure for faster and more accurate services with the transparency (section 2.1), employing GIS in the governmental health sector proves itself as a strong candidate to enable such initiatives (section 2.3) within the primary aims of this thesis hence this core chapter.

3.1. Data Registration and First Analyses

In this thesis we have used MS Access Database, MapInfo professional software and Google Earth Program to create a hospital data in GIS. The MapInfo professional software is used to represent the location of hospitals in Erbil city.

The information about hospitals in Erbil was collected from the website of the Ministry of Health, www.mohkrg.org, and the locations of them were found from Google Earth from where the coordinates are gathered. Another essential information layer was the roads layer. Erbil Roads taken from Basarsoft Company (Figure 14). The information about hospitals was saved as a table named "HOSPITAL" in Microsoft access software which includes hospital name, location, hospital type, coordinates, etc.

Next step is importing the "HOSPITAL" table from DB database in MapInfo software, Opening from File>open (Figure 9).

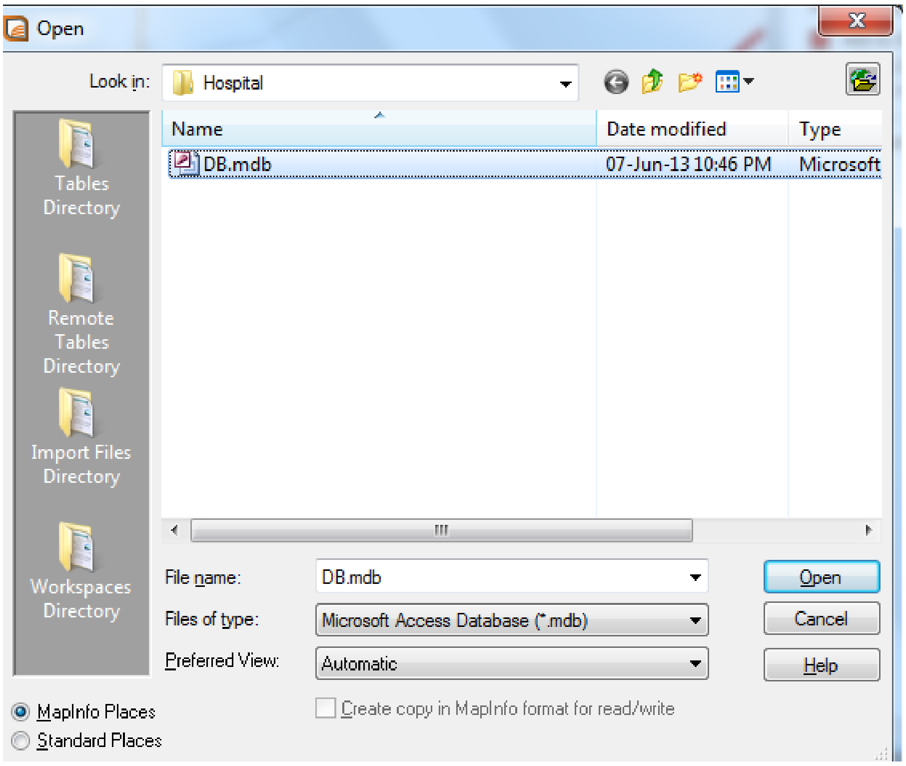

Figure 9 Importing DB database which includes HOSPITAL table

The hospitals coordinates were inserted as Degree Minutes Seconds (DMS) format such as (39 34 45.56), as the MapInfo software does not recognize this type of coordinates, 39 34 45.56 this is converted to Degree 39.553432 the formula is

1 degree = 60 minutes

1 minute = 60 seconds

From DMS to DD

36 degree 30 minutes

= 36 + 30/60

= 36.5 degree

In order to convert them to decimal; we have to follow these steps:

First step, we have to create two new columns that represent the new decimal coordinates.

Table > Maintenance > Table Structure.

Pressing Add Field button, in the name field we write the column name, in the type field we choose Float type, and pressing OK.

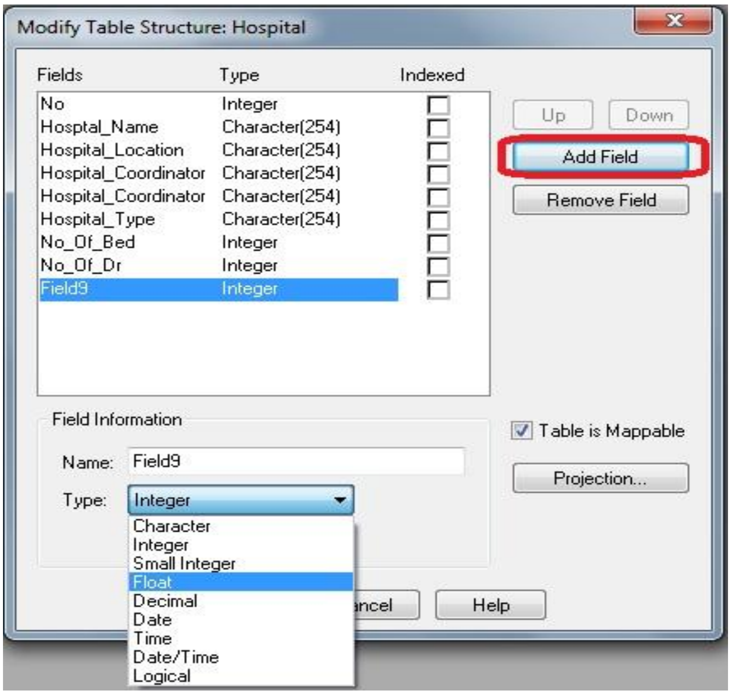

Figure 10 Adding new field to HOSPITAL table

Now the two columns are ready for converting the coordinates and putting them in these new columns as decimal and creating points from these columns.

Second step is creating points: To create points we choose Table > Create Points.

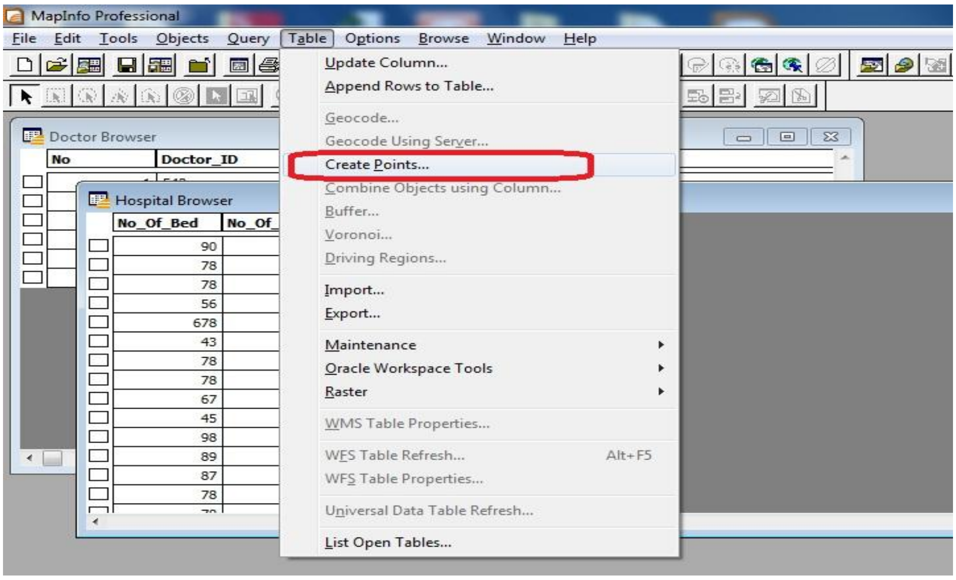

Figure 11 Create Point

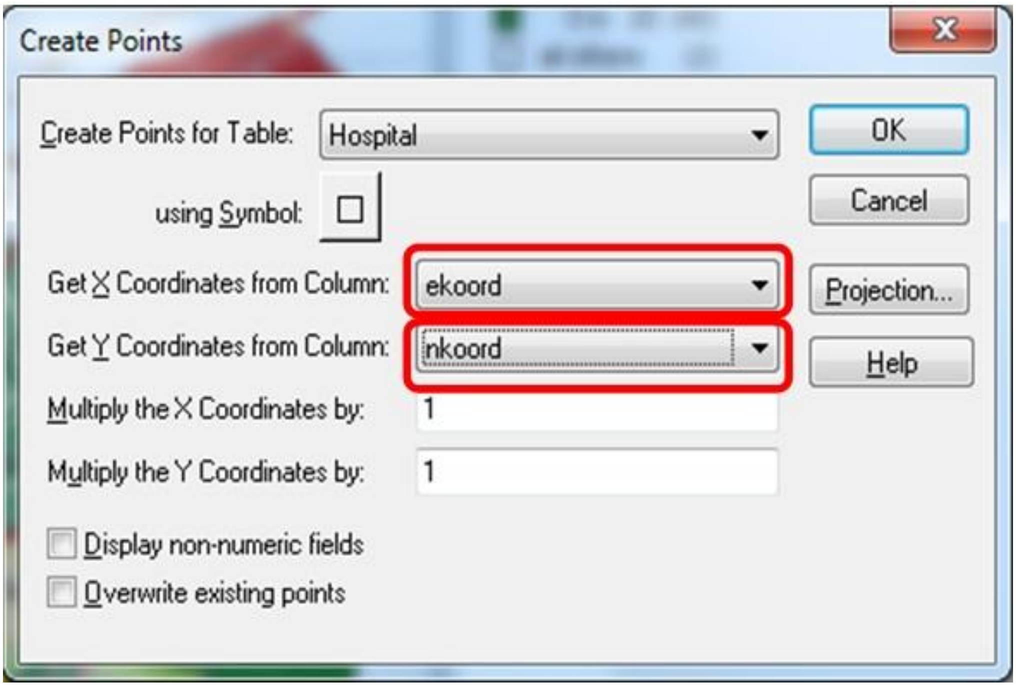

Figure 12 Getting the X and Y Coordinates from Selected Columns

ekoord and nkoord are the new columns that contain decimal coordinates.

The locations of hospitals showed as a map, the hospitals locations arranged according to the coordinators. Figure (13)

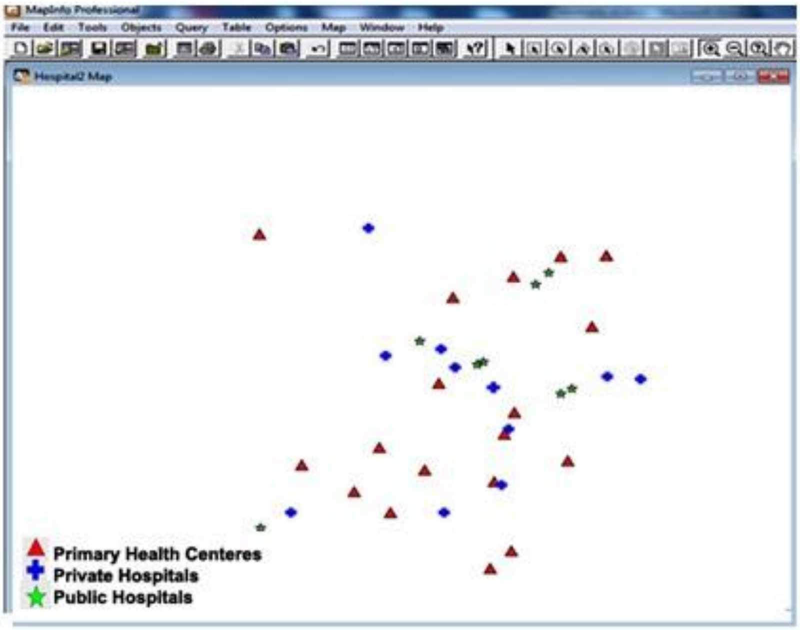

Figure 13 Hospitals locations arranged according to the coordinators (Hospital layer)

Another essential information layer was the roads of Erbil (Figure 14).

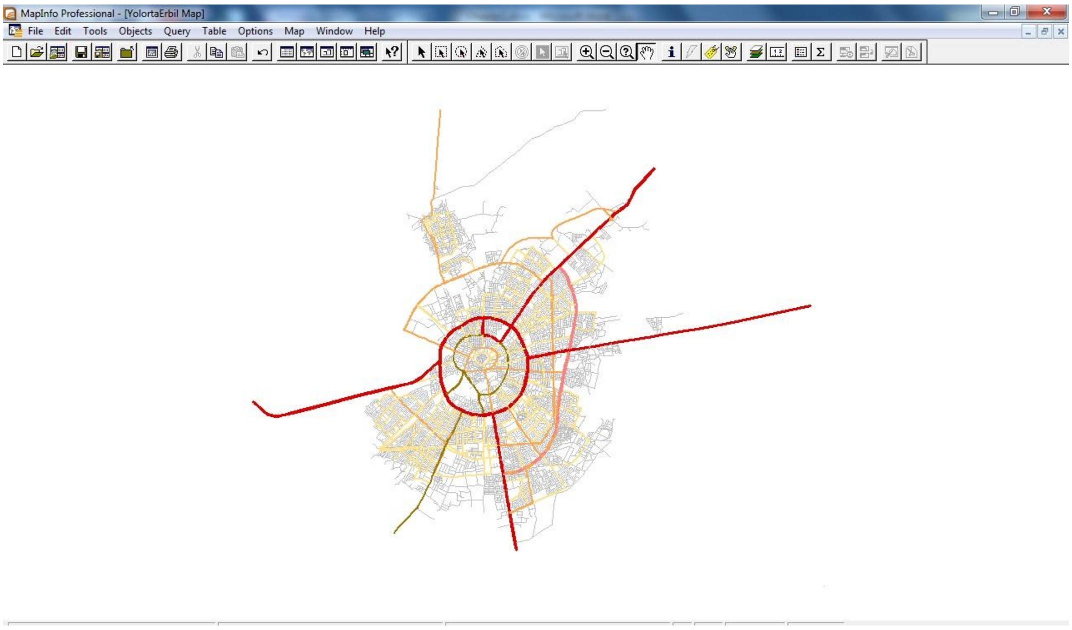

Figure 14 Roads of Erbil (Road network layer)

Next step is importing the satellite map of Erbil which it was captured from Google Earth software.

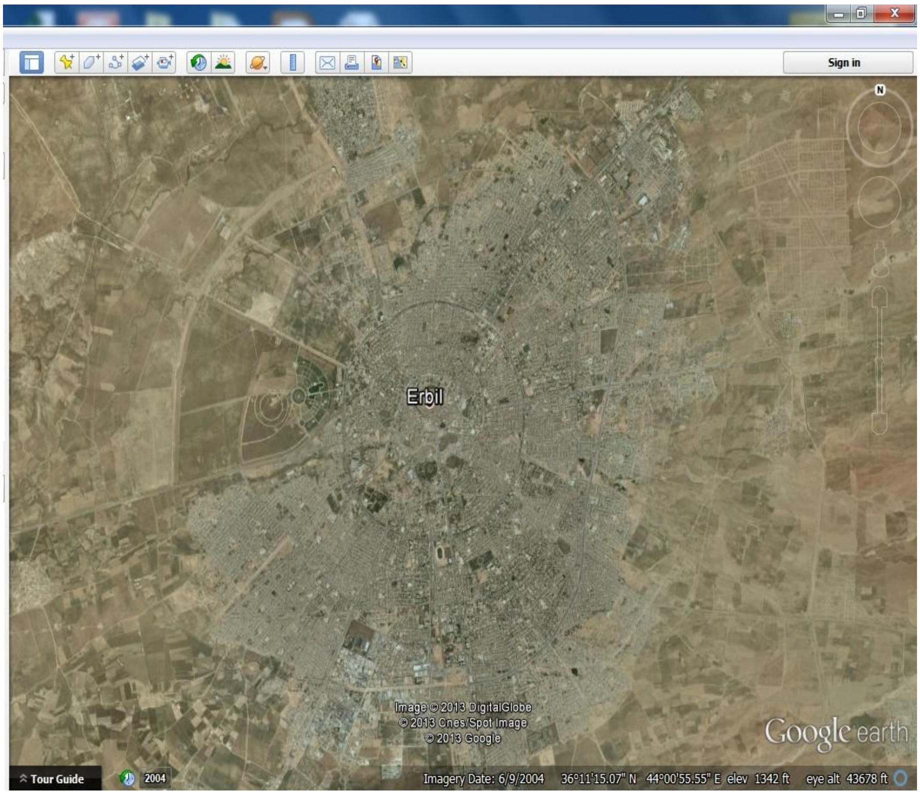

Figure 15 Satellite map of Erbil

We have Erbil satellite map as JPEG format and roads map layers, now we put Erbil road layer over Erbil map layer.

Opening Erbil map layer by File > Open and choose Raster Image from files of type.

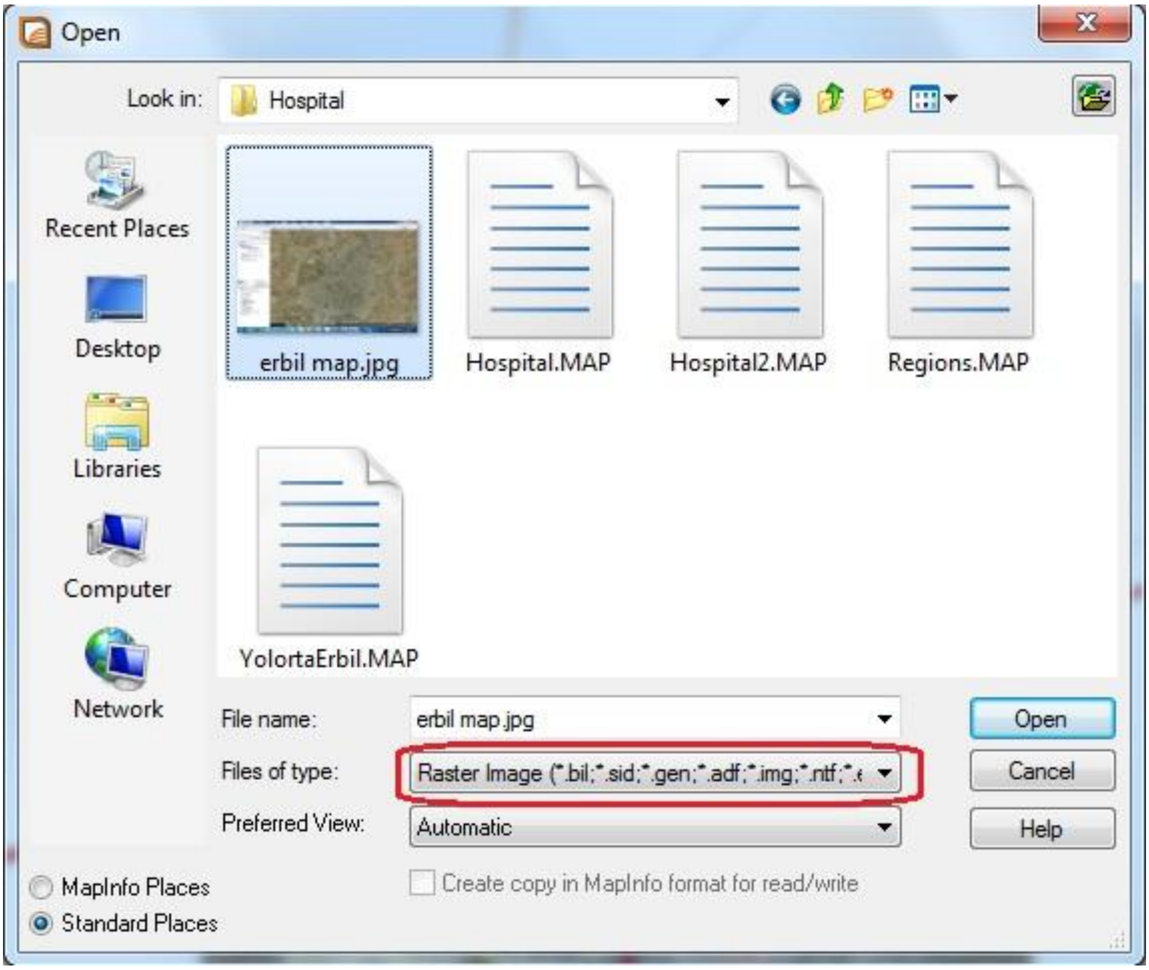

Figure 16 Importing Satellite image of Erbil

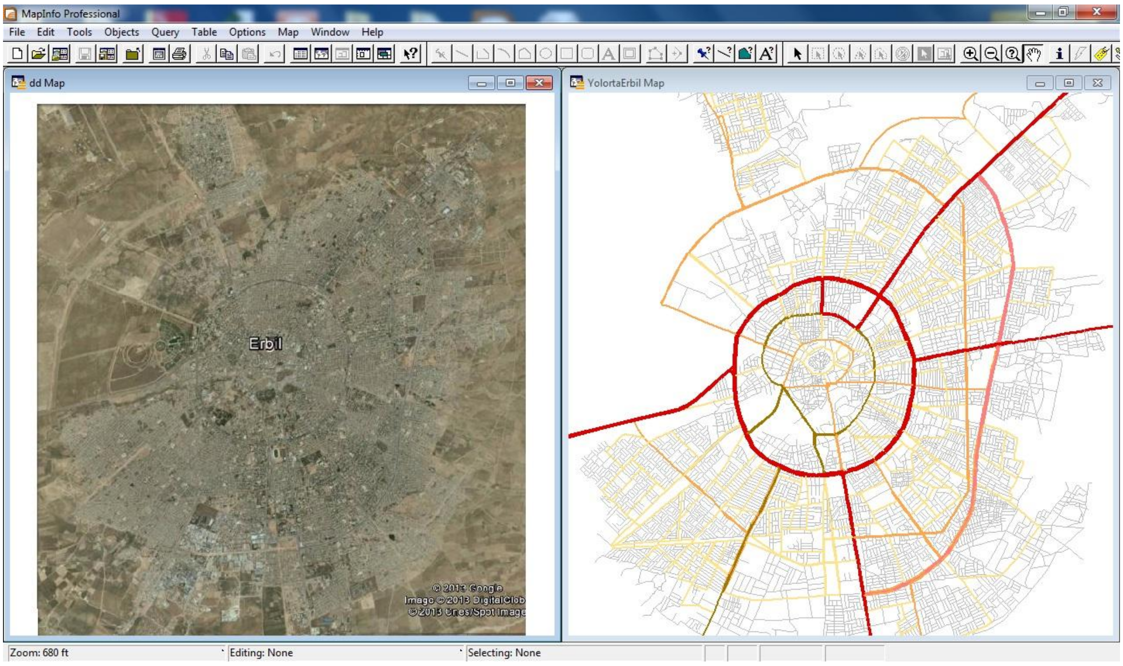

Figure 17 Erbil Map And Roads Network Layers

In order to put Erbil map layer over Erbil road layer, we choose Table > Raster > Modify Image Registration; and we choose at least three points to put the Erbil map layer over Erbil road layer.

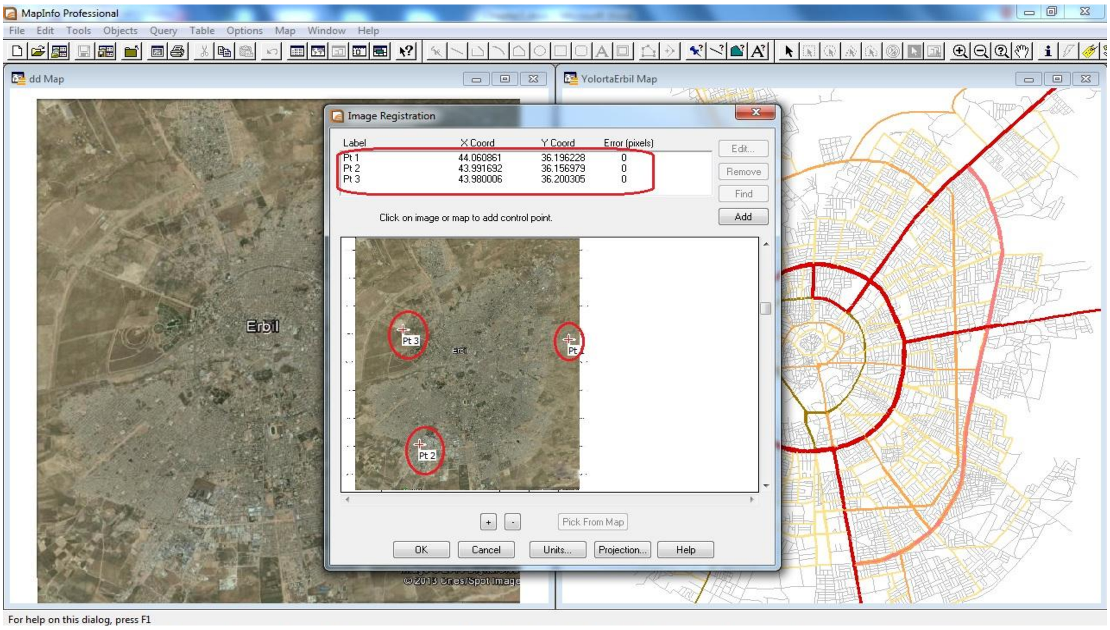

Figure 18 Image Registration

We can also put hospital location layer over the combined layers.

Map > Layer Control by ticking on check box.

We can also control by this window on the appearance of the layers by ticking on check boxes.

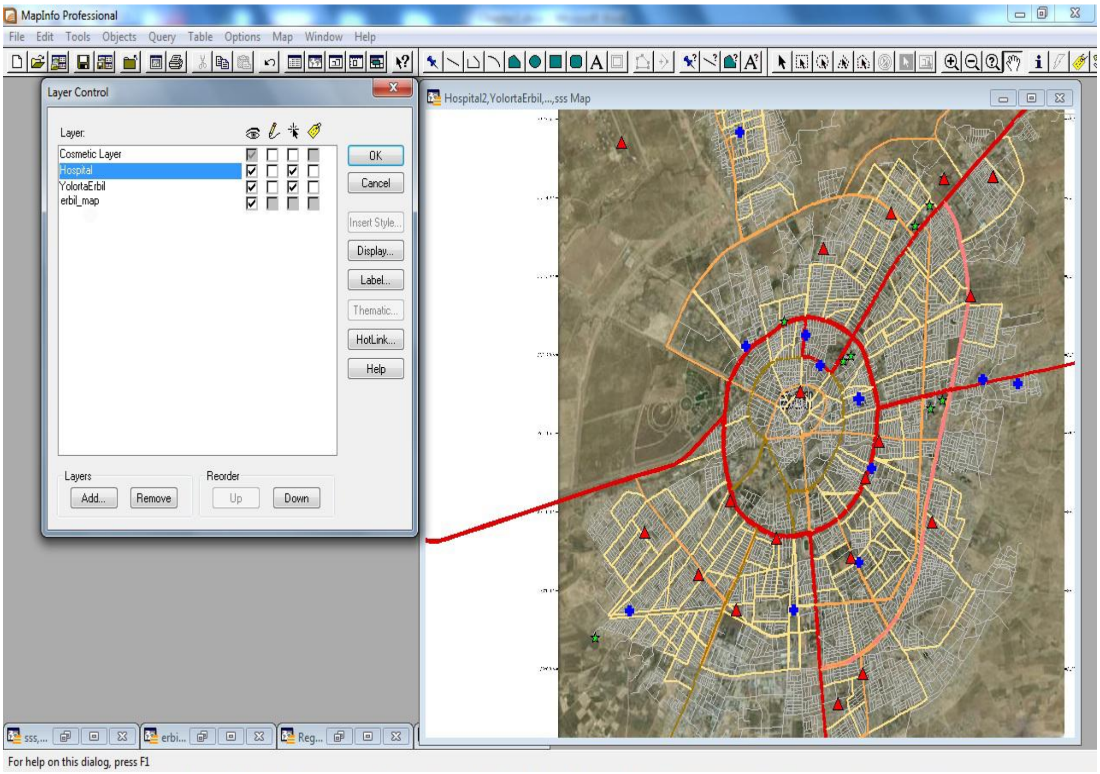

Figure 19 Layer Control

The next step is drawing the regions, from the Options menu we choose Toolbars and we tick on Drawing tool.

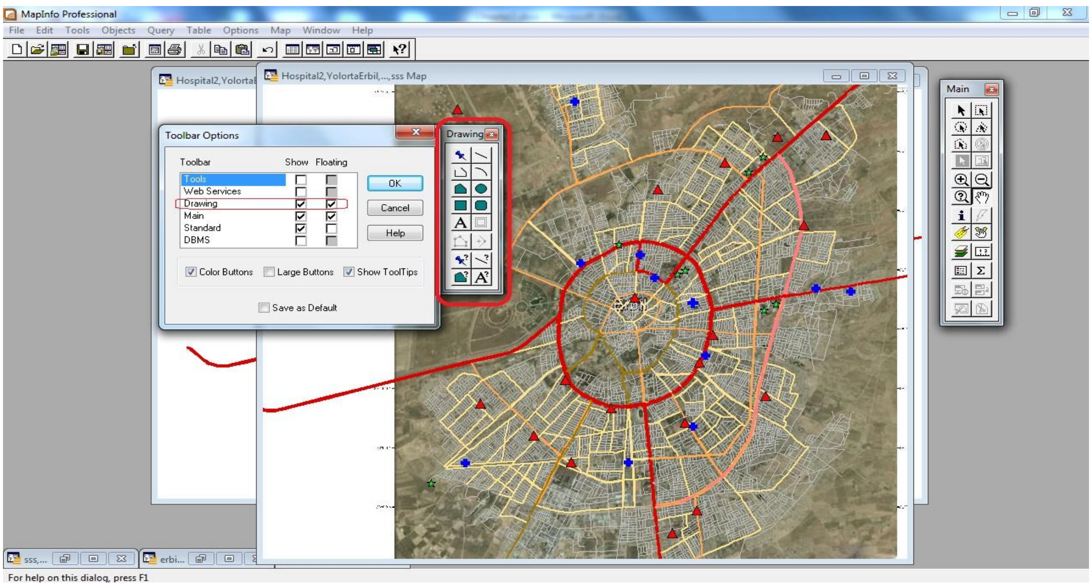

Figure 20 Inserting Drawing Tool

We click on the small green button named Polygon, when we click on that button we will see plus symbol and we start to drawing as we want to represent the region. Figure (21).

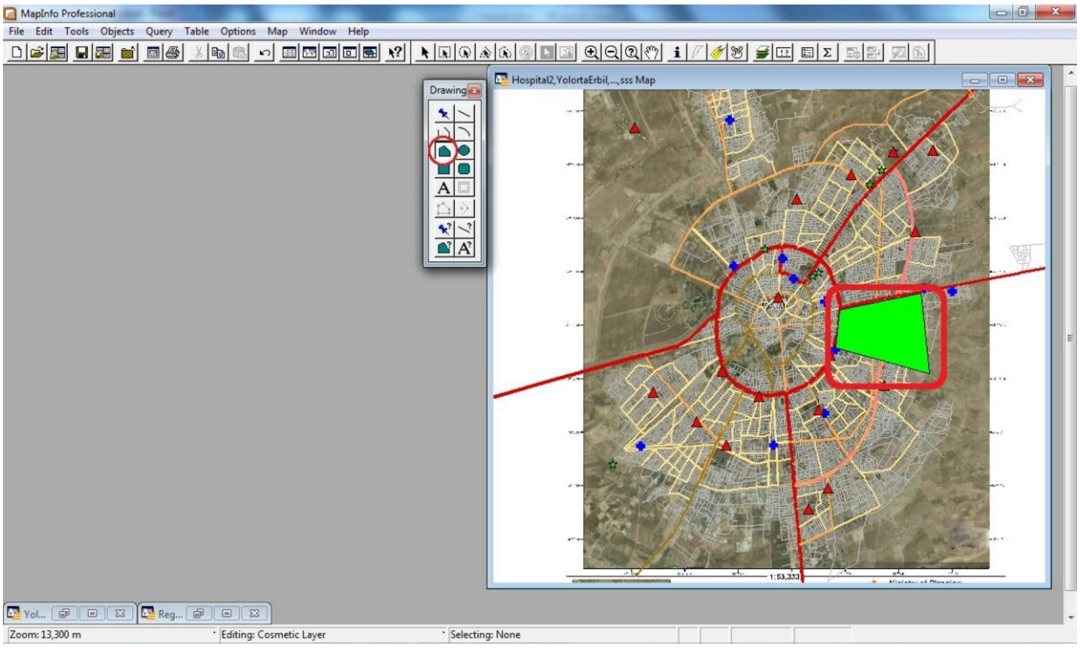

Figure 21 Drawing Regions

By clicking on Info button from the Main tool we can name the region that we have drawn Figure (22).

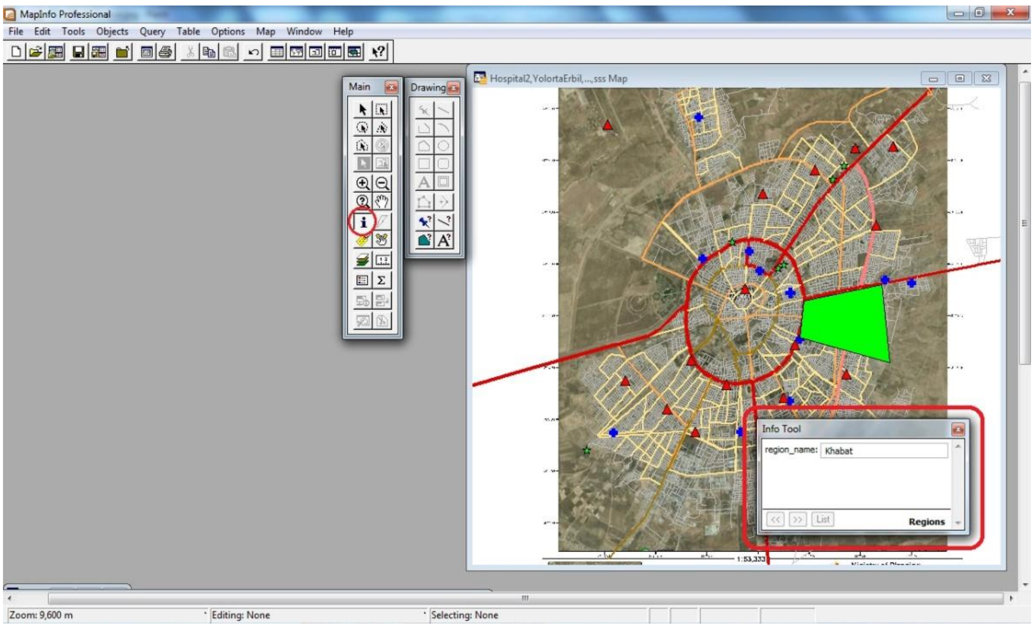

Figure 22 Info Button

As we seen in previous figure, we continue to drawing the regions until we finish getting new layer named Region layer. Now we have put all layers in one map. Figure (23).

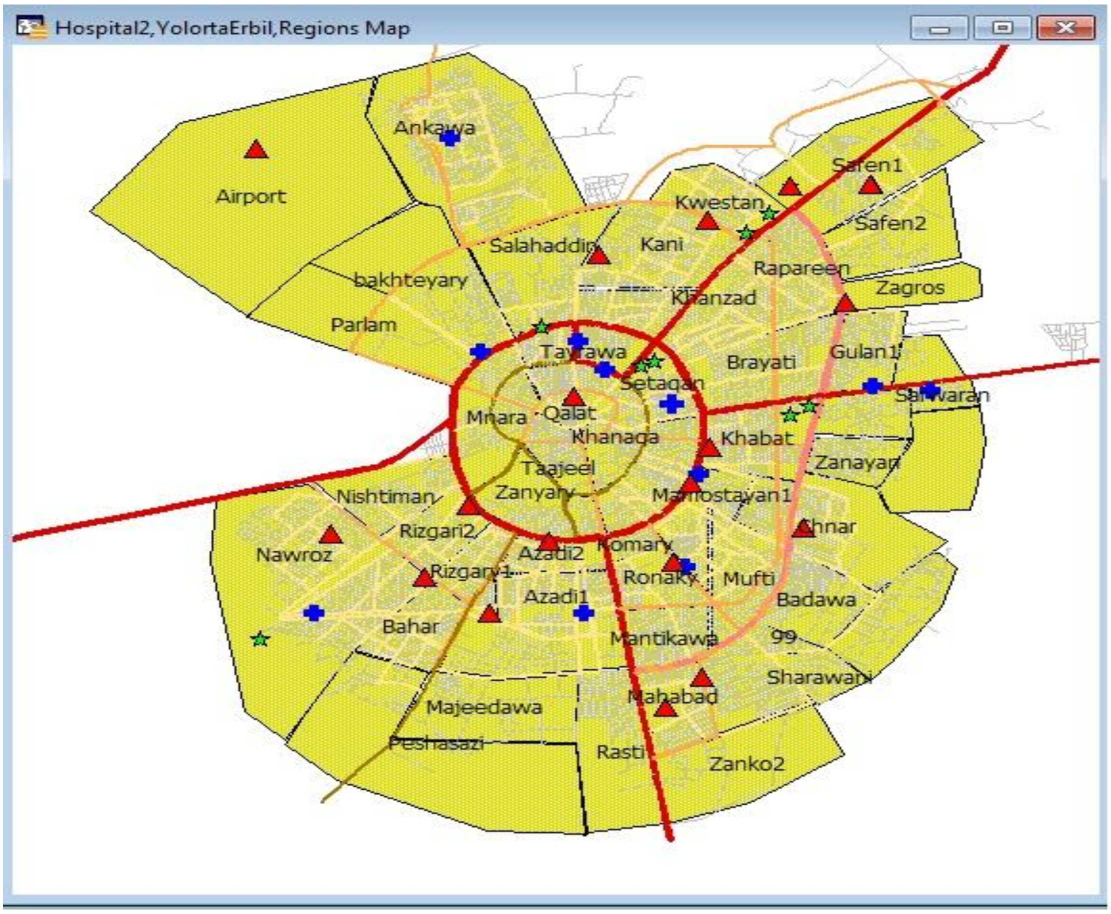

Figure 23 All Layers (Roads, Regions, Hospitals)

The final step is showing and coloring the regions according to number of beds in each hospital through thematic maps.

Map > Create Thematic Map, choosing one of types and press next. Figure (24 .a).

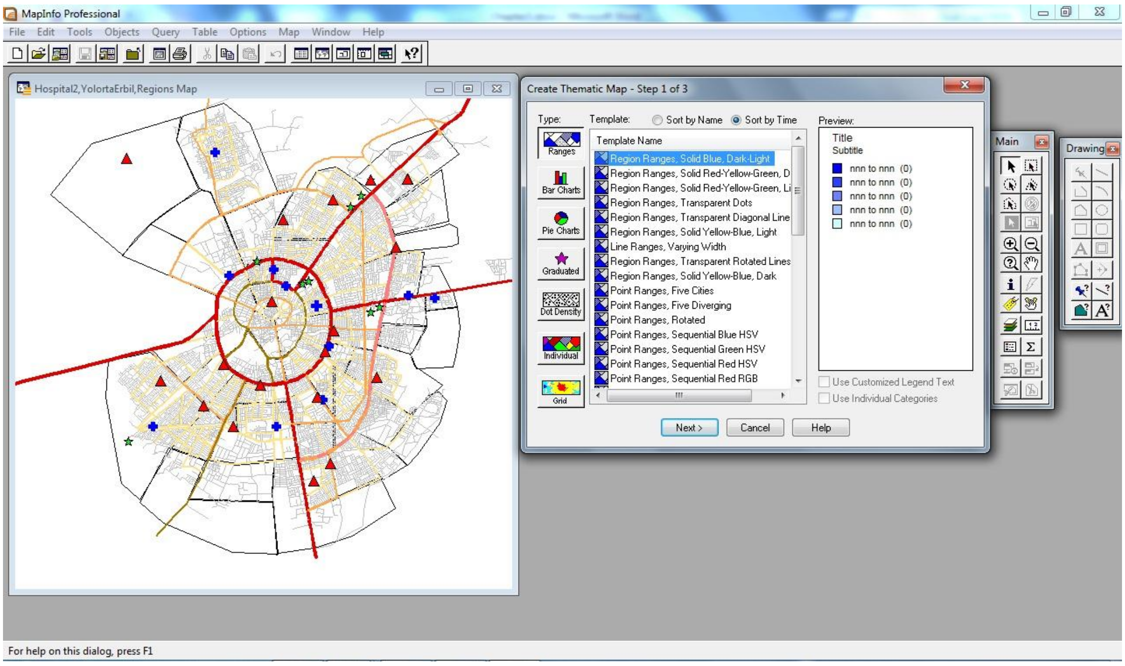

Figure 24 .a Create Thematic Map Step 1

We choose hospital table No_Of_Beds field and press next and press OK. Figures (24 .b).

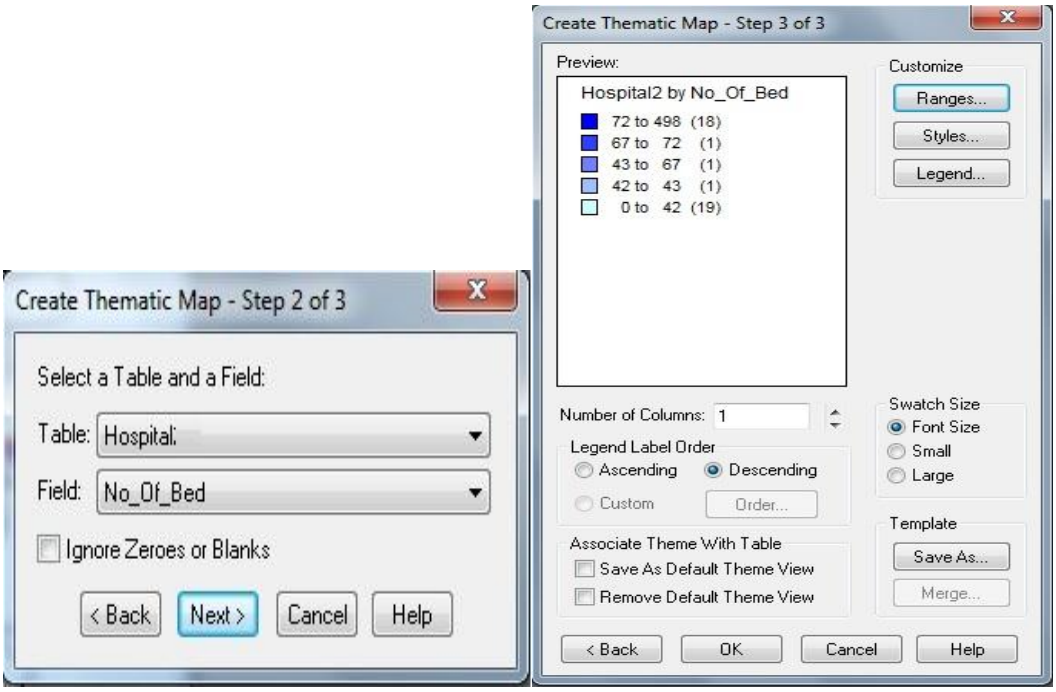

Figure 24 .b Create Thematic Map Step 2 and 3

Previous step was for creating thematic map for hospital layer according to No_Of_Bed field, in the next step we make join between hospital layer and region layer by No_OF_Beds field to take the sum of number of beds in each hospital and put it in region table to show the sum of number of beds according to colors.

Map > Create Thematic Map, we will got the window as Figure (25 .a) and press Next.

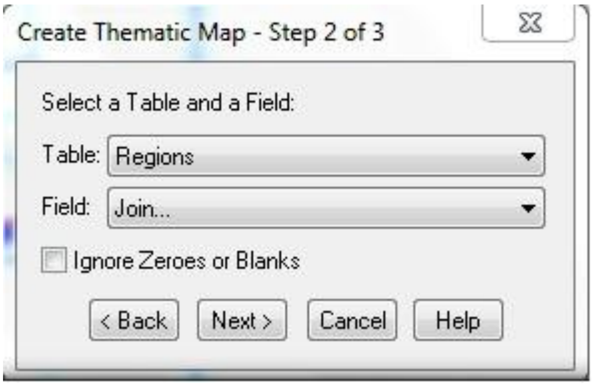

Figure 25 .a Joining between Hospital Layer and Region Layer By No_OF_Beds Field

We choose Region table and Join, we will see another window and we choose as Figure (25 .b), and press OK.

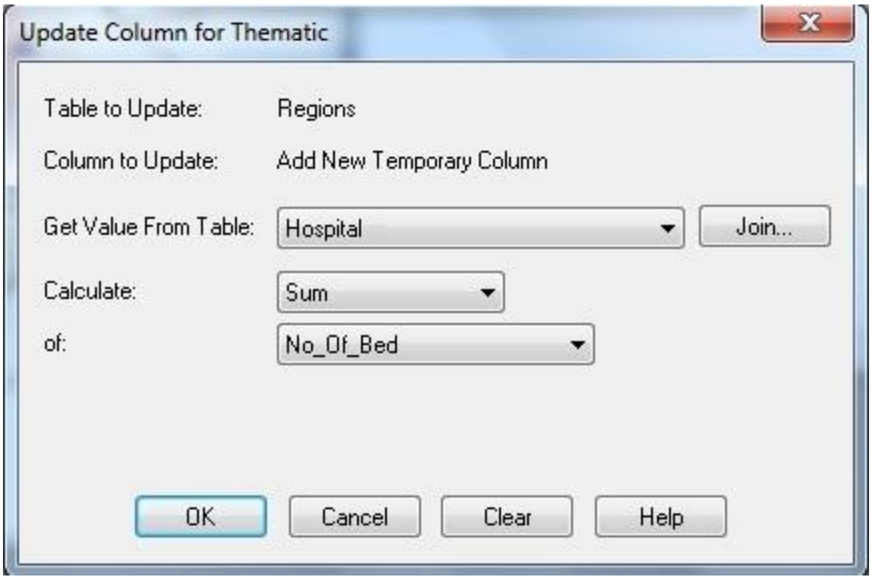

Figure 25.b Joining Between Hospital Layer And Region Layer By No_OF_Beds Field

We will see another window as shown on Figure 25 .c.

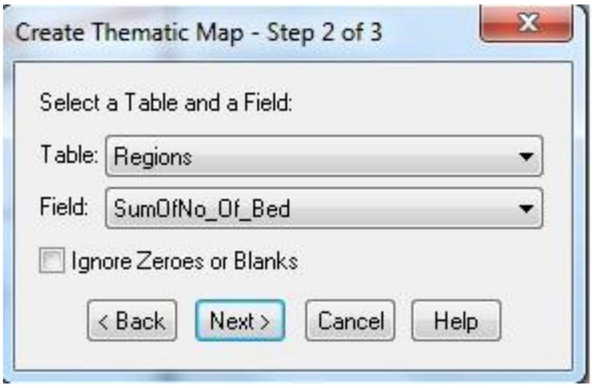

Figure 25 .c Joining between Hospital Layer and Region Layer By No_OF_Beds Field

As we see the field SumOfNo_Of_Bed was added in Region table, and press Next.

We can control the range by clicking on Ranges and we can put the range as we want.

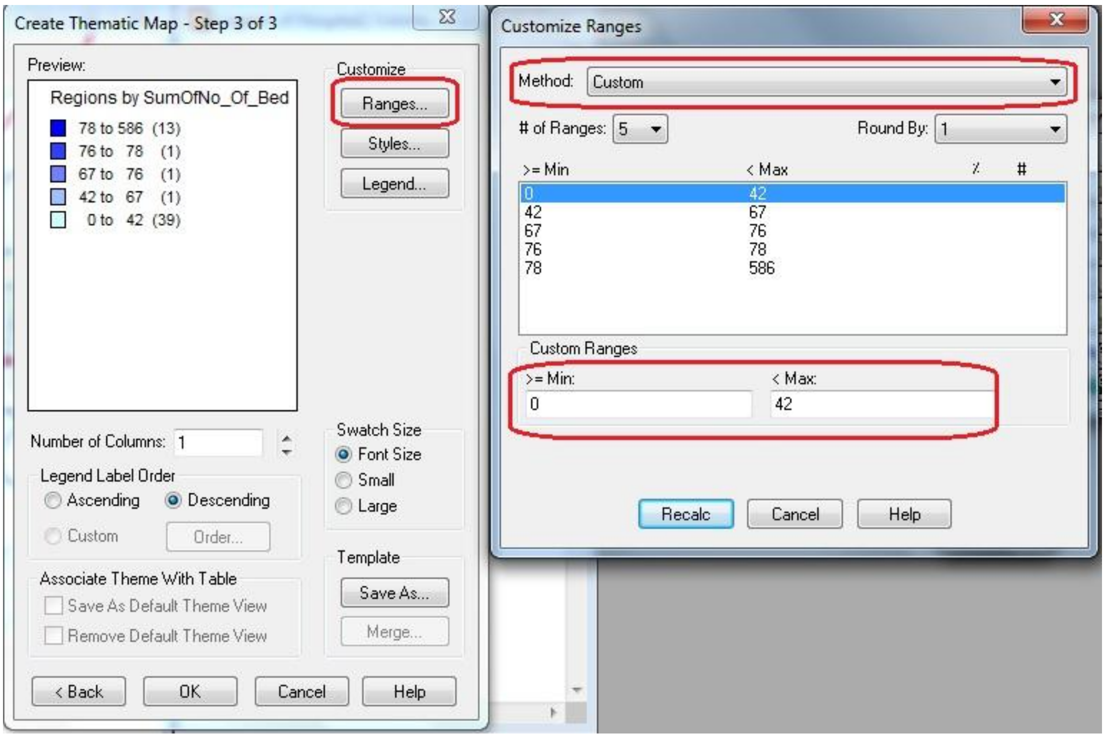

Figure 26 Customizing Ranges

The final result for creating thematic map by coloring the regions according to number of beds.

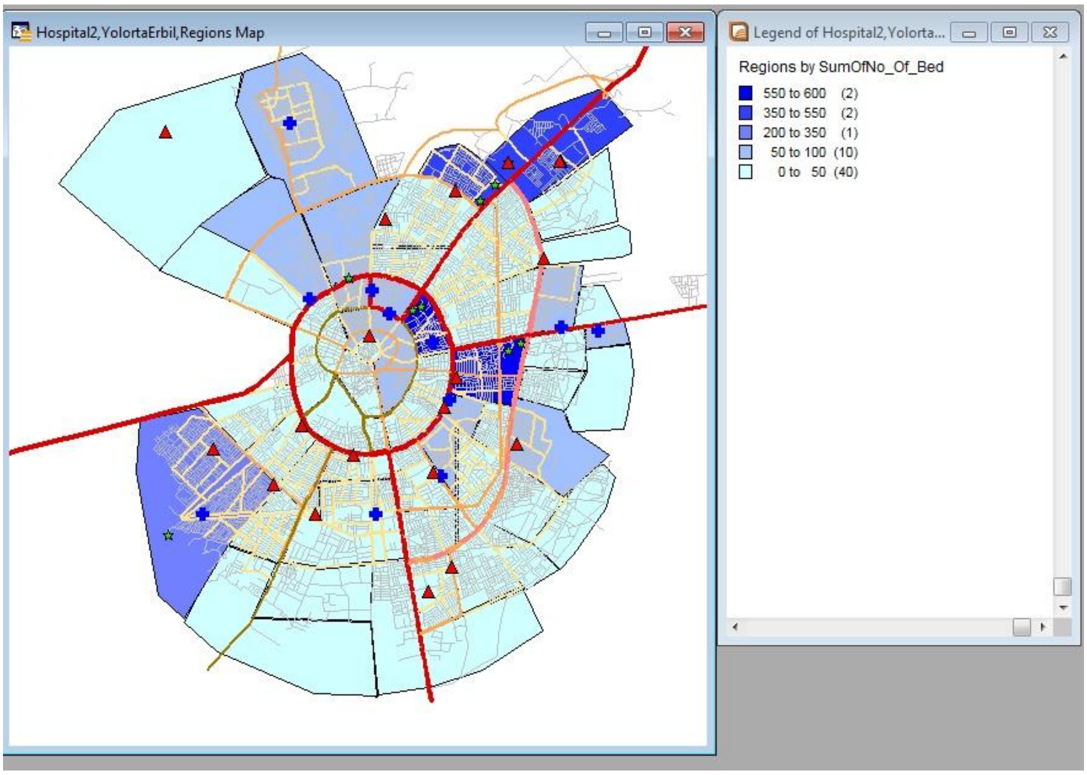

Figure 27 Erbil Regions Colored According To Number Of Beds

The figure below shows another themetic map called Inverse Distance Weighted (IDW) that depicts number of beds in the city.

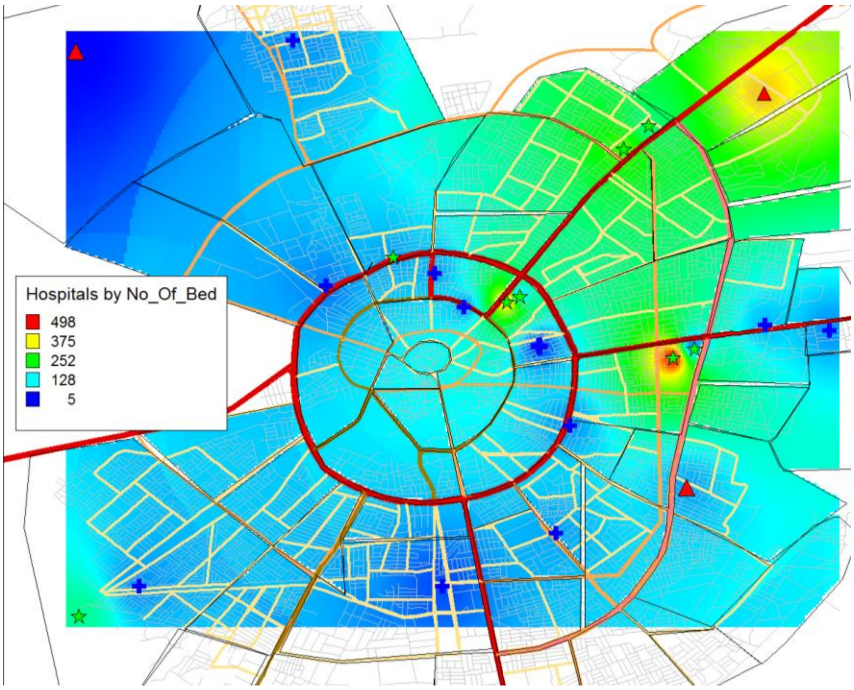

Figure 28 Inverse Distance Weighted (IDW) Thematic Map

3.2. Buffer and Closest Facility Analyses

To find the shortest path to reach a hospital, we can start by searching hospitals within a specified distance around the selected point i.e. by creating a buffer zone and selecting hospitals within; below, we show the steps of an example, if a person lives in an address and have emergent situation, the ambulance driver or in the hospital use the GIS to determine the hospitals that are near from his home.

This process can be done through some complicated steps; however, we can write a script to ease the tasks. Such a program can be written in application development language of MapInfo, MapBasic.

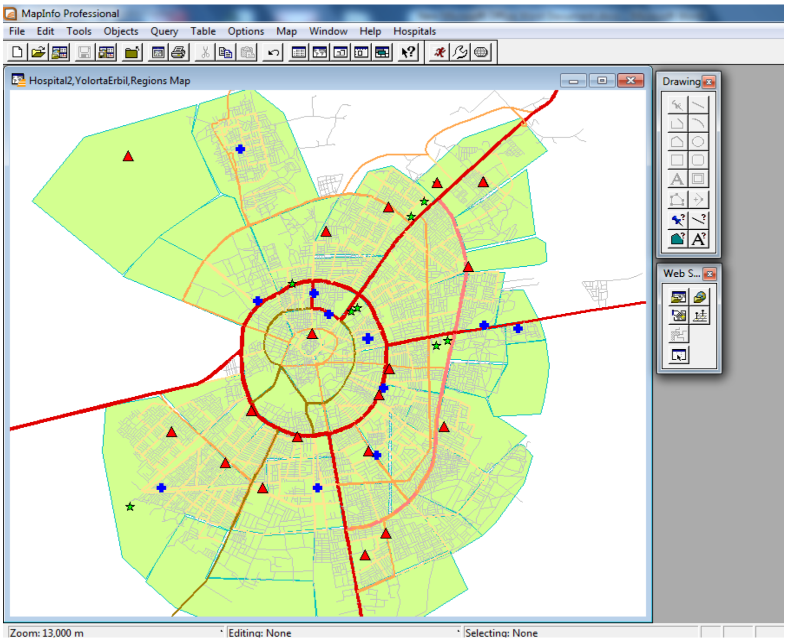

Figure 29 Erbil Regions, Roads Network And Hospitals Layers

The next step is installing software called MapBasic which is related to MapInfo software in order to write the code in this software.

From File menu we choose new and the new untitled file will be open as a figure below.

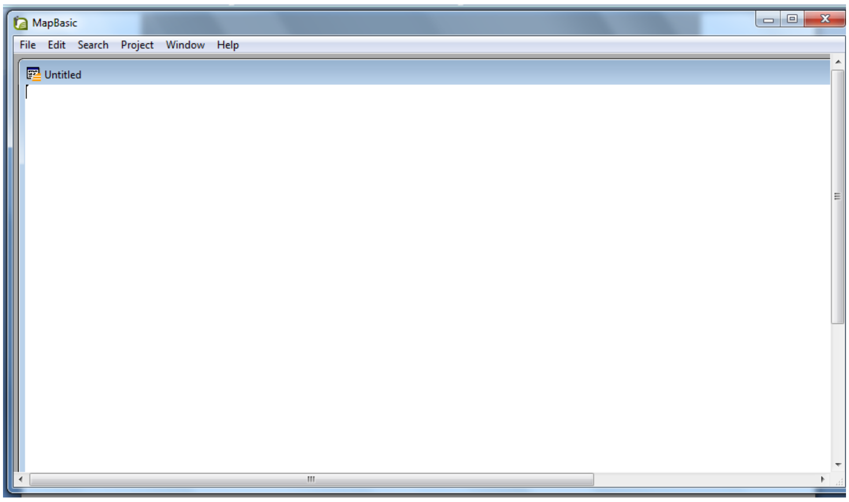

Figure 30 Mapbasic Software

Following steps show code in MapBasic to create the program.

```
include "mapbasic.def"

declare sub FindNearestHospitalToClickedLocation
global hostdist as integer

Create Buttonpad "FH"  as
  ToolButton icon 2 calling FindNearestHospitalToClickedLocation

hostdist =500

sub FindNearestHospitalToClickedLocation

dim x,y as  float
x=commandinfo(cmd_info_x)
y=commandinfo(cmd_info_y)
```

```
Dialog Title "Nearest"
  control edittext value hostDist into hostdist
  control statictext title "meter"
 control okbutton  TITLE "OK"
 control cancelbutton title "Cancel "

if not commandinfo(cmd_info_dlg_ok) then exit sub end if
dim o as object
set distance units "m"
o = CreateCircle(x,y,hostdist)

alter object o info 2, makepen(2,26,14680288)

select * from  hospital2 where obj intersects o into sel_Hosp
Print "Report:"
Print "  There are " + selectioninfo(sel_info_nrows) + " Hospitals in the " + hostdist
+ "m. distance to Coord: " + x + " , " + y

dim tcosmetic as string
tcosmetic = layerinfo(frontwindow(),0,1)
delete from tcosmetic

insert into tcosmetic(obj) values(o)

end sub
```

From Project menu in MapBasic software we will choose compile and run in order to run this code as a figure below. The main important thing is when we run the code in MapBasic software we should open MapInfo as well.

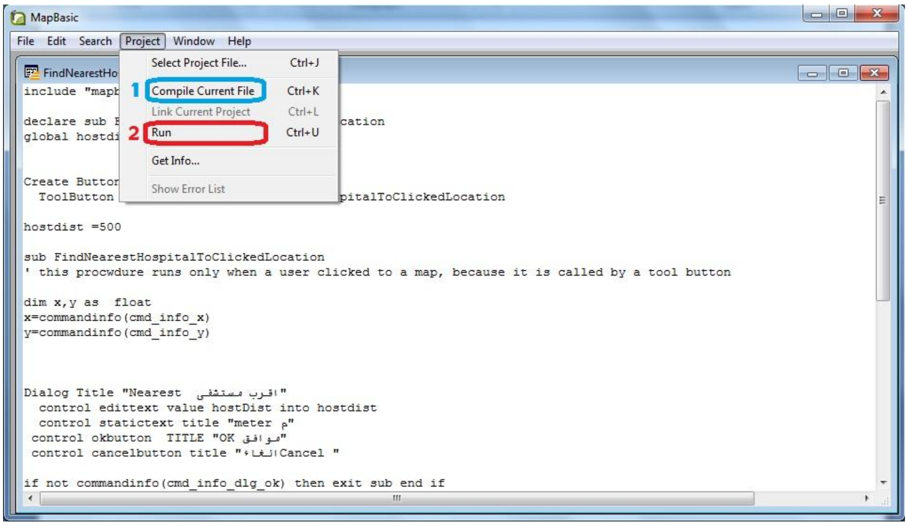

Figure 31 Compile and Run the Code

After running the code we open MapInfo software and we will see **tool button** that we have created by code as a figure below.

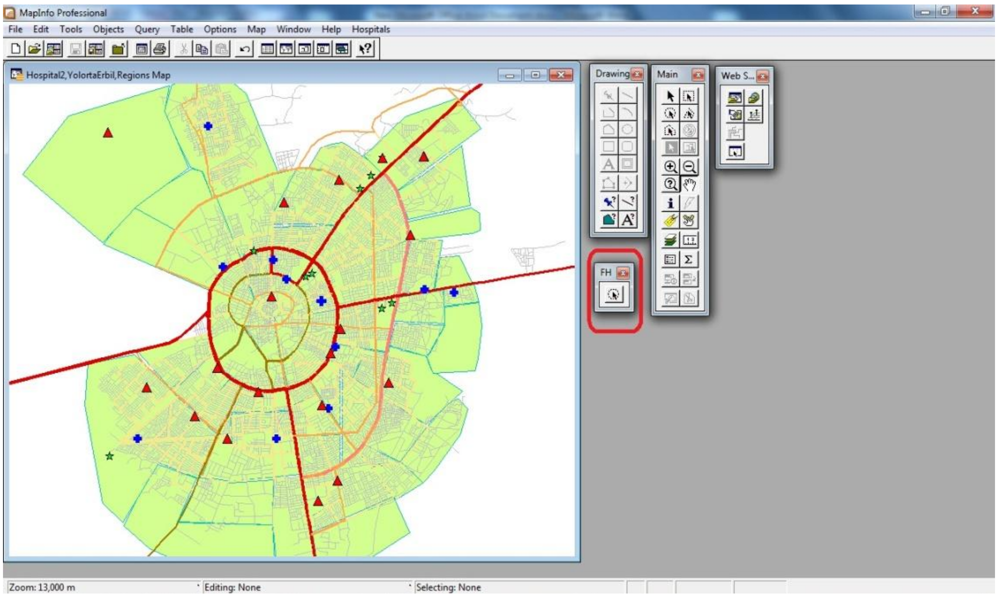

Figure 32 Appearing Tool Button

Now, the user want to press on any point in the map and he want to see how many hospitals that exist around the selected point according the distance that the user enter.

The first step is pressing on that button that we created it. Then pressing on the point as the user wants, after that the user will get the small window to enter a distance by meter, the default distance is 500 meter, and press OK. Figure (33).

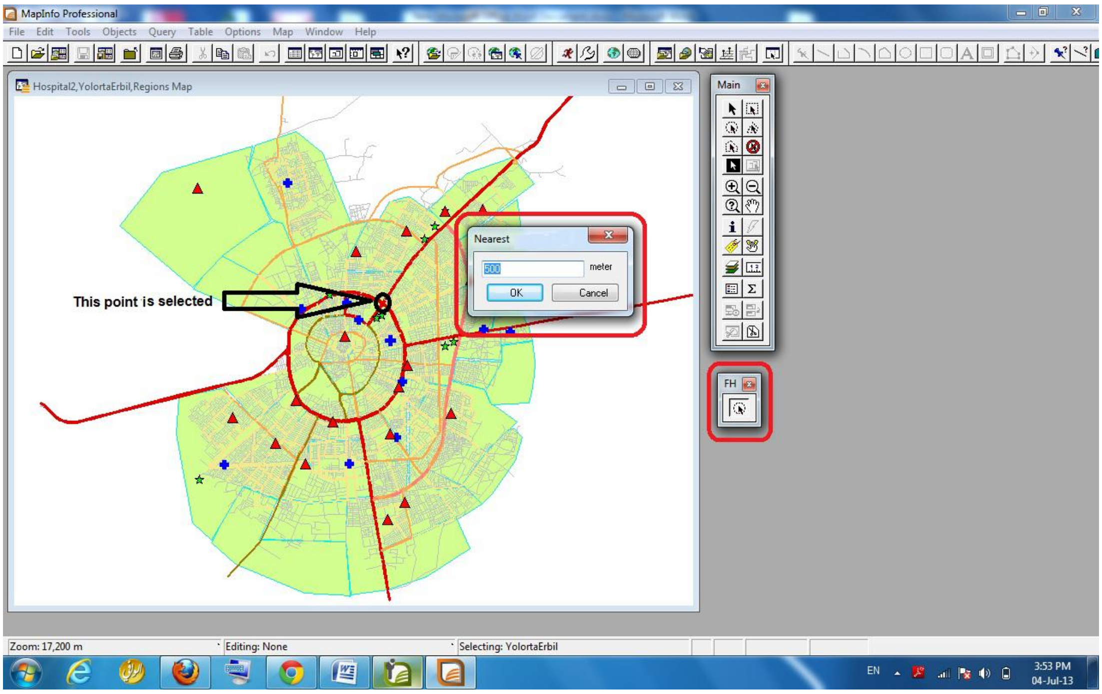

Figure 33 Entering Distance Window

After pressing OK button, the user will see a purple circle around the selected point and a report message that shows the number of hospitals that exist around the selected point and it shows he coordinated of the point. In the figure below shows the circle in 1000 meter distance Figure (34).

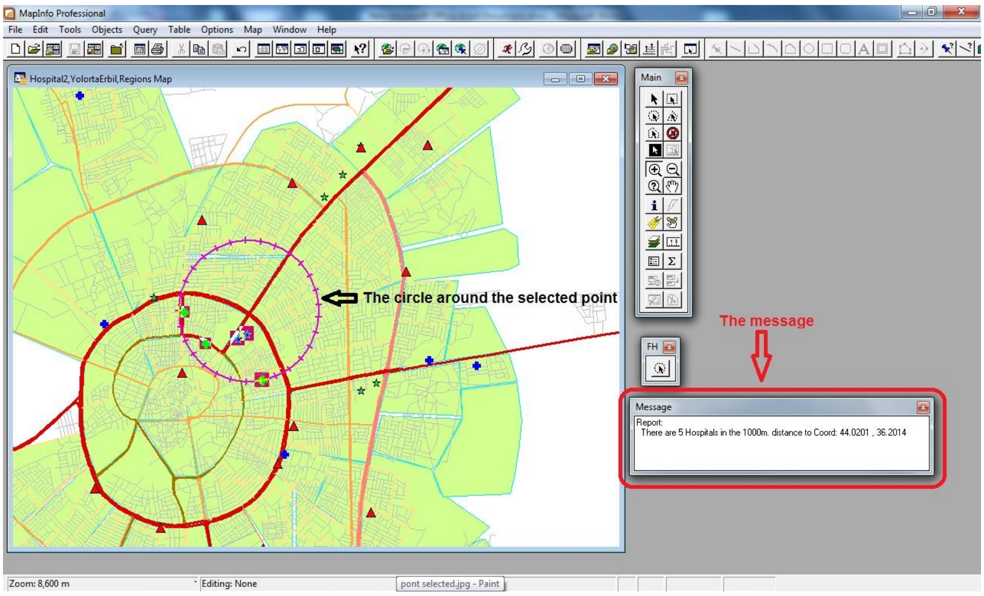

Figure 34 Purple Circle and The Message Dialog

We can show the summation of the information of selected hospitals by clicking on statistics button in the main tool and we get statistics table that shows for example the summation of number of beds, doctors, etc. Figure (35).

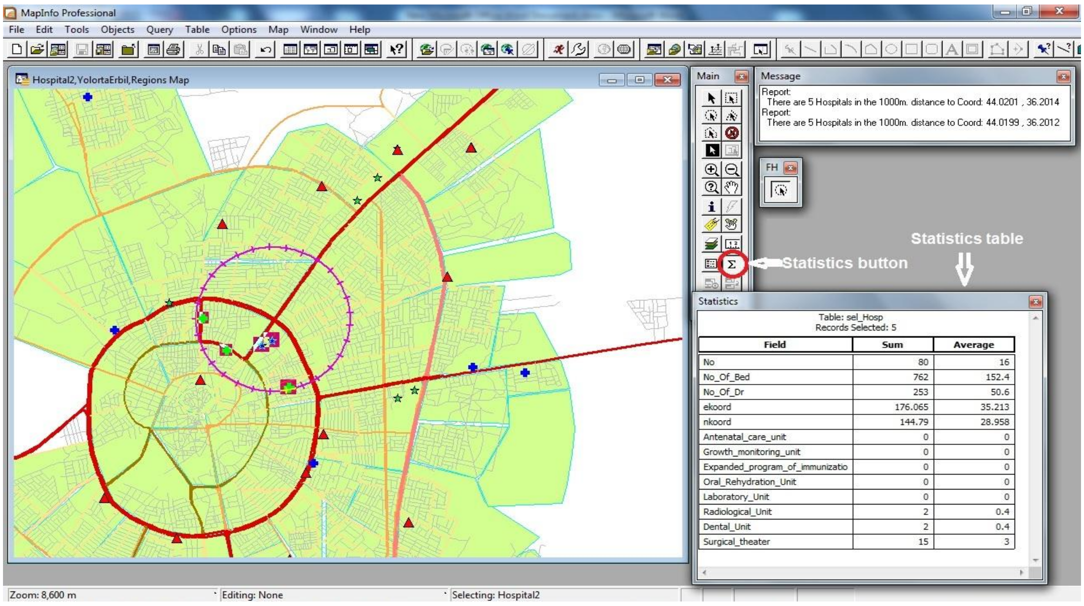

Figure 35 Using Static Button

The explanations of the codes

```
include "mapbasic.def"

declare sub FindNearestHospitalToClickedLocation
global hostdist as integer
```

First line is including *mapbasic* library. The second one is declaring *FindNearestHospitalToClickedLocation* function that. Third one is declaring *hostdist* as a variable.

```
Create Buttonpad "FH" as ToolButton icon 2 calling
FindNearestHospitalToClickedLocation
hostdist =500
```

This code for creating a button pad titled FH (Finding Hospitals) and button, with default value 500 meters (Figure 36).

Figure 36 Finding Hospital Button

```
sub FindNearestHospitalToClickedLocation


dim x,y as  float
x=commandinfo(cmd_info_x)
y=commandinfo(cmd_info_y
```

This procedure runs only when a user clicked to a map, because it is called by a tool button, by clicking on a map it takes X and Y coordinates.

```
Dialog Title "Nearest"
  control edittext value hostDist into hostdist
  control statictext title "meter"
  control okbutton  TITLE "OK"
  control cancelbutton title "Cancel "
```

This code creates the window to enter the distance and the OK and Cancel buttons, as a figure below.

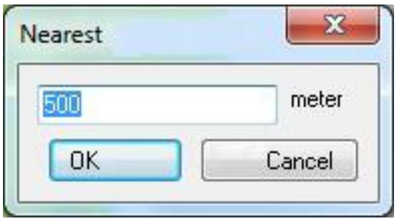

Figure 37 Entering Distance Window

```
if not commandinfo(cmd_info_dlg_ok) then exit sub end if
dim o as object
set distance units "m"
o = CreateCircle(x,y,hostdist)
```

This code is for creating a circle around the selected point.

```
alter object o info 2, makepen(2,26,14680288)
```

This code is for coloring and set the shape of the circle to purple color.

```
select * from  hospital2 where obj intersects o into sel_Hosp
Print "Report:"
Print "  There are " + selectioninfo(sel_info_nrows) + " Hospitals in the " + hostdist
+ "m. distance to Coord: " + x + " , " + y
```

The first line of this code is for selecting the hospitals in the circle area, and the second line for creating the report message, as a figure below.

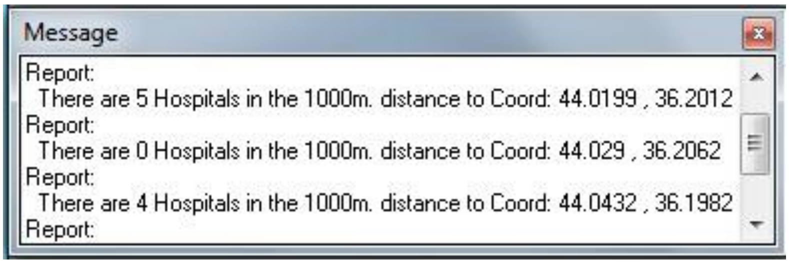

Figure 38 Message Dialog

```
dim tcosmetic as string
tcosmetic = layerinfo(frontwindow(),0,1)
delete from tcosmetic
```

This code is to delete previous Circles in Cosmetic layer in the map.

```
insert into tcosmetic(obj) values(o)
```

This code is to see the Circle in HostDist radius in the map.

Buffer of a polygon

When we want to use buffer analysis to reach nearest hospitals around a specific district, we will select the specific distance around the selected district, in the below shows the code that have done to show this buffer query.

The all steps for creating buffer analysis are same steps in creating a buffer circle around a point except the code is a bit different.

```
include "mapbasic.def"
declare sub FindNearestHospitalToSelectedREgion
declare sub FindNearHospitalToSelectedREgionTool
dim hostdist as integer
```

```
Create Buttonpad "HR"  as
  PushButton icon 3 calling FindNearestHospitalToSelectedREgion
  ToolButton icon 3 calling FindNearHospitalToSelectedREgionTool
hostdist = 500

sub FindNearestHospitalToSelectedREgion
dim obj_reg as object
dim o as object

if selectioninfo(sel_info_nrows) = 0 then note "Please select a region from Regions
Layer" exit sub end if
if selectioninfo(sel_info_tablename) <> "Regions" then note "Please select a region
from Regions Layer" exit sub  end if
obj_reg = selection.obj

Dialog Title "Nearest"
  control edittext value hostDist into hostdist
  control statictext title "meter"
 control okbutton
 control cancelbutton
```

```
if not commandinfo(1) then exit sub end if
o = buffer(obj_reg,3,hostdist,"m")
alter object o info 2, makepen(2,26,14680288)

select * from  hospital2 where obj intersects o into sel_Hosp
Print "Report:"
Print "  There are " + selectioninfo(3) + " Hospitals in the " + hostdist + "m.
distance"
dim tcosmetic as string
tcosmetic = layerinfo(frontwindow(),0,1)
delete from tcosmetic

insert into tcosmetic(obj) values(o)
end sub

sub FindNearHospitalToSelectedREgionTool
dim x,y as float
x=commandinfo(cmd_info_x)
y=commandinfo(cmd_info_y)
select * from Regions where obj intersects Createpoint(x,y)  into selxx

if selectioninfo(3) then

 call FindNearestHospitalToSelectedREgion
end if
end sub
```

After running the code we open MapInfo software and we will see **tool button** that we have created by code as on Figure 39.

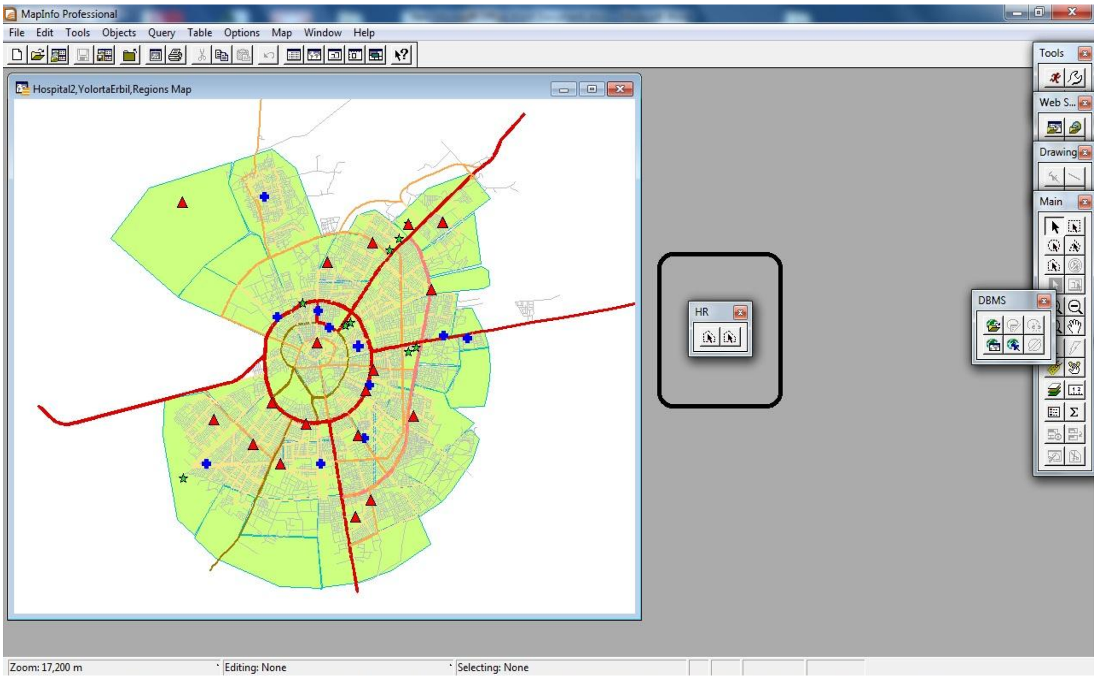

Figure 39 The Two Tool Button

As we have seen in the previous figure there is two buttons, they give as the same result, but their mechanism of work is different.

When the user press on the first button he will get a message says “please select region from Regions layer”.

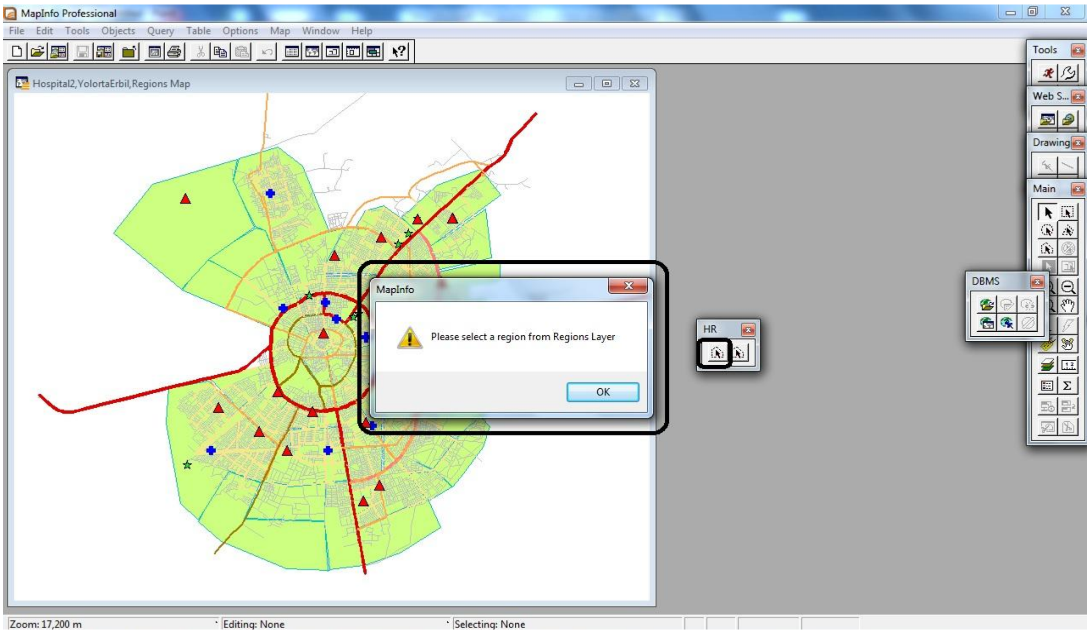

Figure 40 Message Box After Pressing The First Tool Button

After pressing OK button the region have to be selected as a figure below.

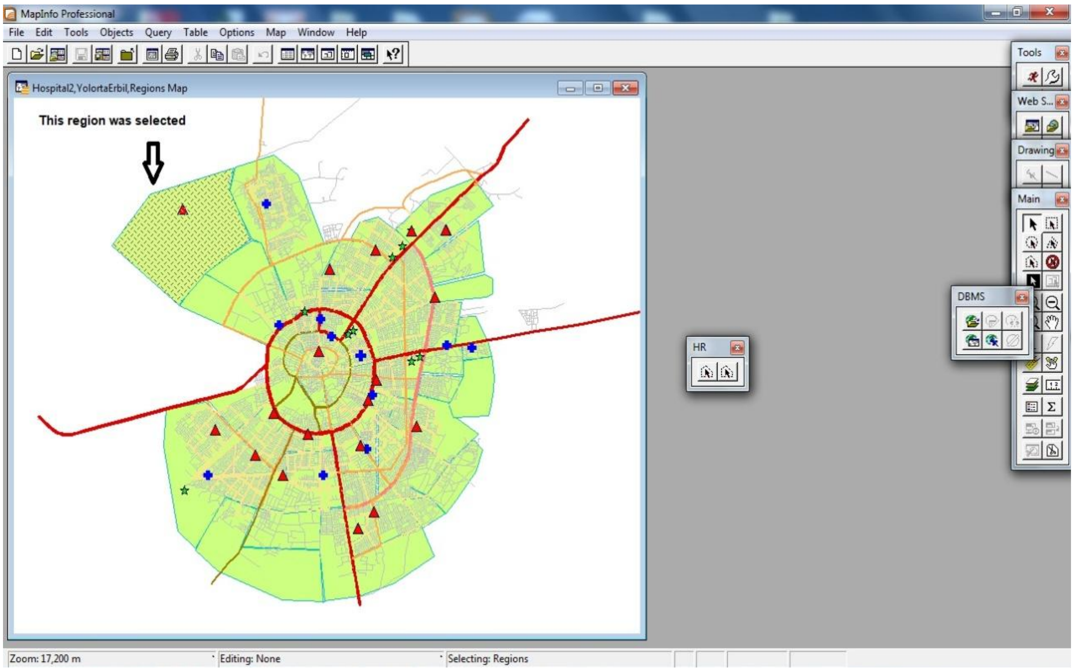

Figure 41 Selecting Region

Then, the first button has to be selected again in order to write the distance after that the purple curve will appear around the selected district.

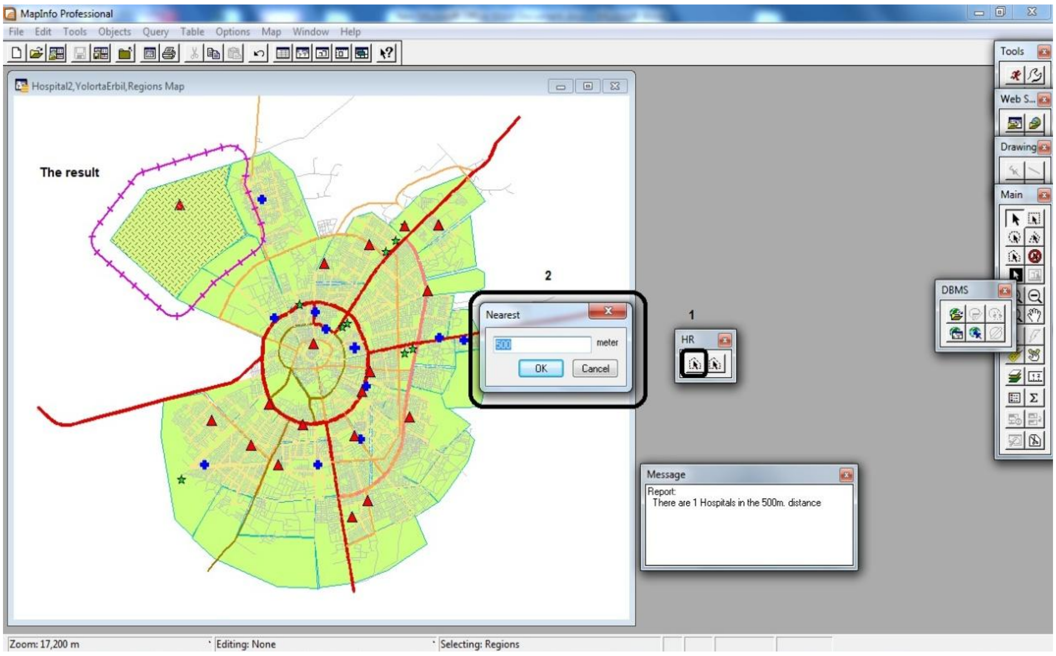

Figure 42 Entering Distance Window after Pressing First Tool Button And Showing Buffer Zone

The other button is a little bit different; this one is when the button is pressed the user will choose the district without appearing a message that it wants to select region, so when the user clicks the button, when the region is selected the window will appear in order to enter the distance.

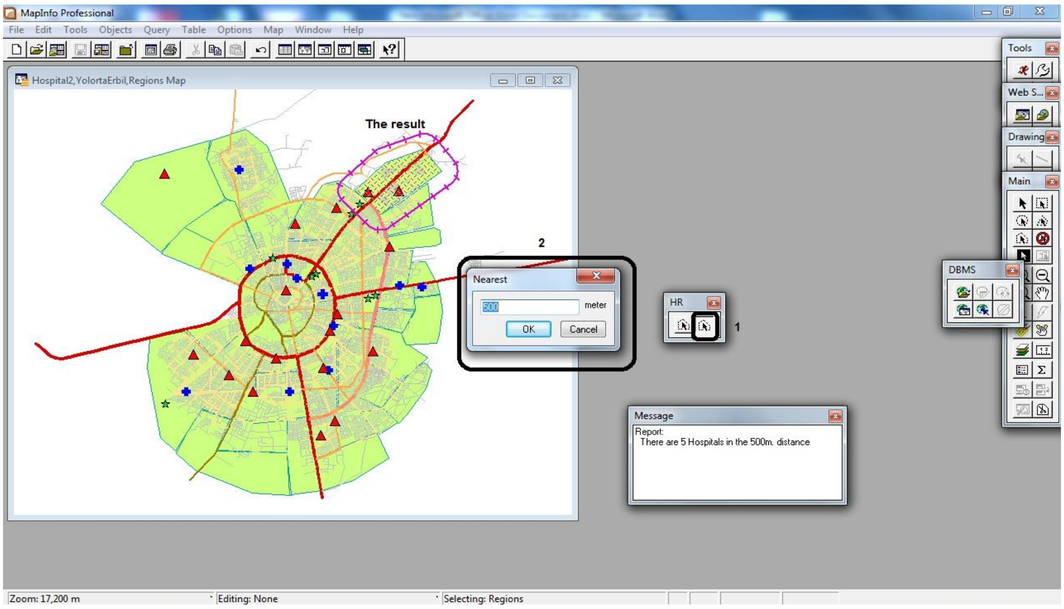

Figure 43 Using Second Tool Button

The explanation of important part of the code

```
Create Buttonpad "HR"  as
  PushButton icon 3 calling FindNearestHospitalToSelectedREgion
  ToolButton icon 3 calling FindNearHospitalToSelectedREgionTool
```

Creating a button pad and create two buttons.

```
if selectioninfo(sel_info_nrows) = 0 then note "Please select a region from Regions Layer" exit sub end if
if selectioninfo(sel_info_tablename) <> "Regions" then note "Please select a region from Regions Layer" exit sub  end if
obj_reg = selection.obj
```

Create a message box says” Please select a region from Regions Layer”

```
o = buffer(obj_reg,3,hostdist,"m")
```

Create a buffer area around the selected area.

3.3. Results

As we have shown our practice on technical application, performing spatial data analyses does not require extensive work. This chapter achieved its purpose i.e. it supports the thesis that setting up a running GIS in Erbil is possible, technically; however, gaps is data are remarkable. We put some of this data and information as estimate just to make the application tool to run.

The following summary list includes what we can do with a more complete data sets:

1. Spatial analyses on hospitals such as number of bed capacity
2. Spatial analyses on hospitals and regions layer by joining other information from other sources such as surgical theater exist in hospital or not, sections of hospital, number of patients, number of emergency cases, number of doctor per 1000 people, number of bed per 1000 people and many more.
3. When we see the difference in color in the regions we understand the number of beds in each hospital, so that time we can decide which region need more beds and which region need to open a new hospital.
4. Thematic maps for enhanced reporting

CHAPTER IV

CONCLUSION

4.1. Conclusion

E-government initiatives require relatively new technology-and-management supported transformation strategies that governments use to connect their organizations each other and provide services to citizens and businesses. During the preparation of this thesis, we have learnt that managing spatial and nonspatial data is required in most of such services. As underlined in the literature, common criteria and basics to assess performance of e-government programs and the services are data integrity and purity are vital, mainly.

Coming back to the research question:

Can Iraq's local governments establish a working GIS to handle hospital distributions and resources to speed up e-government initiatives in its health services?

Our findings in the third chapter (section 3.3) support a positive answer with some limitations.

4.1. Limitations

Major limitation of this study is closely associated with its findings, difficulties in obtaining clean and up-to-date data. The information and data about hospitals of Erbil that are used in this thesis some of them are correct and others are estimated. For example, the reseracher put the number of beds of hospitals as they are mentioned in [22]**;** we faced difficulties for getting information in details; therefore we put some of this data and information as estimate just to make the application tool to run. Additionally we drew the regions as they are shown in Google Earth, the regions name and boundaries may be not exactly in fact, they may be changed as well. For example, in the map we did not draw Sami Abdulrahman park as a district that is placed in the west of Erbil, for this reason the park area is empty on the map.

The goal in this thesis is to show the ability of using this kind of technology in Erbil and in other Iraqi cities as well.
However, a big concern still remains there; if there is no law or regulation enforced than the updates will not happen hence up-to-date and clean data may not be maintained with only encouragements.

4.3. Main Benefits of this Study

Iraq's position in the development ranking can be promoted by leaps in the e-government rankings of UN. This be can supported by managing spatial data of the public facilities and resources. Strong discussions should be started and/or accelerated on this subject in local and central governements in Iraq.

Budgets should be prepared so that buying hardware and software are not the primary activities. The data collection should be started and cetral databases should avoid data varieties.

Future works can and should be established to keep the topic hot and on the table. Promoting e-government initiatives will enhance public services in Iraq. This enhancement will be good in saving valuable time that is wasted in data dublication in the government side and will avoid unnecessary waiting time in the service points.

Strong project managements should be carried out to collect and maintain spatial and nonspatial data of the public facilities as well as human resources.

As a complementary study, the digital gap should be studied so that authorities can focus specific geographic areas and people and in Iraq; by this way, the usage of the e-government application by the public, hence participation can be ensured.

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APPENDIX A

CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: M.JAMEL Abdulrahman, Ahmed

Nationality: Iraqi (IQ)

Date and Place of Birth: 15 August 1988, Iraq

Phone: +90 5532893744

email: ahmed882014@yahoo.com

EDUCATION

Degree	Institution	Year of Graduation
BS	Sulaimani Univ. Computer Science	2010
High School	Dogan High School	2006

WORK EXPERIENCE

Year	Place	Enrollment
2010-2011	The International School of Choueifat- Erbil	IT

FOREIGN LANGUAGES

English, Arabic , Turkish

Hobbies

Movies, Computer, Sport