AMBULANCE MANAGEMENT SYSTEM USING GUI MATLAB

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AMBULANCE MANAGEMENT SYSTEM USING GUI MATLAB

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Submitted by **Taha Darwassh Hanawy HUSSEIN**

Approval of the Graduate School of Natural and Applied Sciences, Çankaya University.

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

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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.

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ABSTRACT

AMBULANCE MANAGEMENT SYSTEM USING A MATLAB GUI

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An efficient emergency ambulance service must be provided in order to reach injured persons and transport them to the nearest hospital as rapidly as possible. To do so, the ambulance driver must select the shortest road network to reach the accident site, followed by the shortest path to the nearest hospital. Over the last few decades, a variety of different GIS-based systems have been developed to aid in the selection of such a path. This thesis aims to introduce an ambulance management system (AMS) to the city of Kirkuk, Iraq. A MATLAB graphical user interface (GUI) is used as a platform with which to manage a transportation path on the map by calculating all possible paths between accident and ambulance, and between accident and hospital. The shortest overall path can then be selected based on the obtained map coordinates.

Keywords: Ambulance Management System (AMS), GPS, GSM, MATLAB GUI.

ÖZ

BİR MATLAB GRAFİK KULLANICI ARAYÜZÜ İLE AMBULANS YÖNETİM SİSTEMİ

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Verimli bir acil ambulans hizmeti yaralı kişilere ulaşmak ve mümkün olduğunca hızlı bir şekilde en yakın hastaneye ulaştırılması için sağlanmalıdır. Bunu yapmak için, ambulans sürücüsünün en yakın hastaneye en kısa yolu takip ederek kaza yerine ulaşabilmesi için en kısa yol ağını seçmesi gerekir. Son birkaç on yıl boyunca, böyle bir yolun seçilmesinin yardımcı olmak için farklı CBS tabanlı sistemler geliştirilmiştir. Bu tez Irak'ın Kerkük şehri için bir ambulans yönetim sistemi (AMS) tanıtmayı amaçlamaktadır. Kaza yeri ile ambulans ve kaza yeri ile hastane arasındaki olası tüm güzergâhları hesaplayarak harita üzerinde ulaşım hatlarını da sunabilen ve uygun yolu bulabilen bir MATLAB grafik kullanıcı arayüzü (GUI) bir platform olarak kullanılmıştır. Bütünleşik en kısa yol, elde edilen harita koordinatlarına göre daha sonradan seçilebilmektedir.

Anahtar Kelimeler: Ambulans Yönetim Sistemi (AMS), GPS, GSM, MATLAB GUI.

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LIST OF ABBREVIATIONS

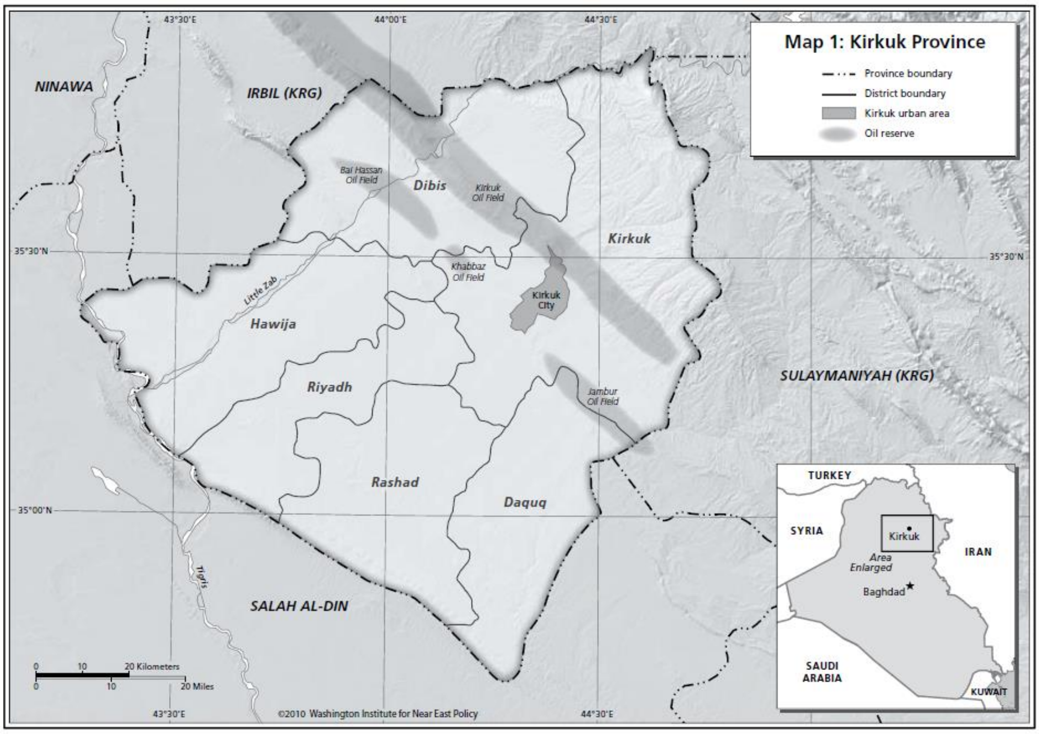
AMS	Ambulance Management System
ACO	Ant Colony Optimization
DCM	Double Coverage Model
DSM	Double Standard Model
DBMS	Data Base Management System
EMS	Emergency Medical Services
FCFS	First-Come-First-Served
GIS	Geographic Information System
GIS-T	Geographic Information System Transportation
GPS	Global Positioning System
GSM	Global System for Mobile Communication
GUI	Graphical User Interface
GA	Genetic Algorithm
HLM	Hypercube Location Management
ITS	Intelligent Transportation System
LR	Lagrangian Relaxation
MCLM	Maximum Coverage Location Model
MMCLM	Modified Maximal Covering Location Model
MEXCLP	Maximal Expected Covering Location Problem
MALP	Maximal Availability Location Problem
MLSCM	Modified Location Set Covering Model
OR	Operations Research
RTH	Rescue-To-Hospital-Time
RTT	Rescue-To-Transfer-Time
RDS/TMC	Radio Data Systems/ Traffic Message Channels
RTC	Road Transportation Corporation
SL1	Service Level 1
SCM	Set Covering Model
TEAM	Tandem Equipment Allocation Model
TS	Tabu Search

CHAPTER 1

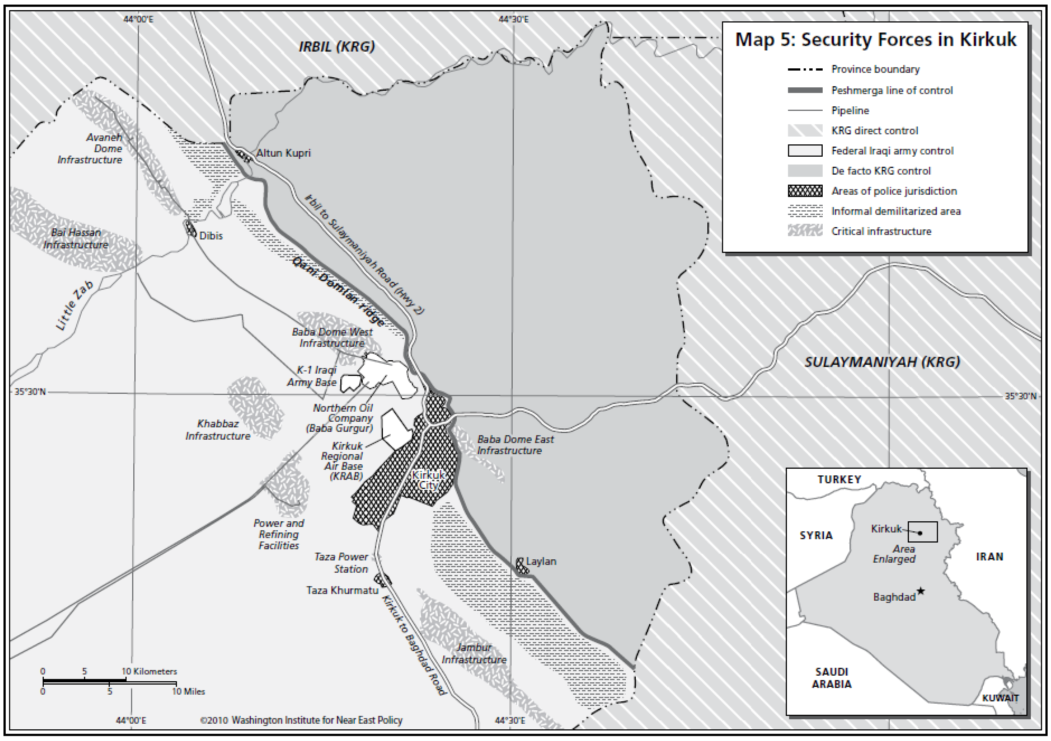
INTRODUCTION

1.1 The Study Area

Kirkuk, a metropolitan city with approximately one million inhabitants, is currently facing the impending threat of a catastrophic war. During and in the aftermath of such an event, thousands of injured people would likely be seeking medical assistance and would need to be transported by ambulance from the accident site to a hospital. Patient transportation in daily emergency situations is a widely studied problem, with the initial deployment and dispatch of ambulances a particular focus in the literature. In everyday emergencies, since the number of injuries is not so high, patients are typically served on a first-come-first-served (FCFS) basis. However, in a mass-casualty incident such as those experienced during war, the sudden surge in requests to the emergency services, often beyond the latter's response capacity, complicates the problem. The present study area encompasses the city of Kirkuk, which contains 49 residential districts. According to the latest census of 2012, the city has a population of 844,811 inhabitants [1].



(a)



(b)

Figure 1. Map of Kirkuk showing (a) Kirkuk province, (b) Security [2]

Disasters can be classified as either natural or man-made, with disaster management activities falling into one of four categories: mitigation, preparedness, response, and recovery [3]. Emergency response is particularly critical since the lives of many people depend on the provision of quick and effective services. Transportation of patients to medical facilities is one example of a post-disaster response activity, for which pre-disaster preparedness increases its effectiveness. There are many uncertainties when preparing for a disaster. In the case of war, some of these uncertainties include the scale of bombing, the number of injuries occurring in each neighborhood, road and traffic conditions, and the outcome of the rescue efforts that generate the patient arrival stream. Despite the criticality of disaster preparedness and planning, few studies have been carried out which examine the related uncertainties affecting disaster response activities [3].

1.2 Objective of Study

The objective of this thesis was to assess the expected performance of the current medical emergency response system in response to the expected major war in Kirkuk.

Specifically, the aim was to evaluate ambulance dispatch strategies using the MATLAB Graphical User Interface (GUI). In addition to assessing the 'sufficiency' of the city’s existing resources and response strategies, the study focuses on evaluating various improvement options, such as increasing the number of available ambulance units and establishing temporary emergency units in order to respond to the needs of war victims.

Two performance criteria were employed in evaluating system performance. The first of these is related to the overall effectiveness of the response system and is measured in terms of the average rescue-to-hospital time and average rescue-to-transfer time (i.e., patient transfer out of the hospital emergency department). Whereas rescue-to-hospital-time (RTH) spans the time from the moment of patient rescue until their arrival (via ambulance) in the hospital, rescue-to-transfer-time (RTT) includes any time spent in the hospital emergency room. The second performance criterion employed was service level, which can be divided into two categories: SL1 and SL2. These categories are similarly based on the time taken for the patient to reach the hospital and subsequent transfer out of the emergency department, respectively [4].

Due to the high number of injuries typically encountered during wartime, the ambulance service system in Kirkuk is expected to be overwhelmed. Services will also likely be impeded by adverse road and traffic conditions, either in the form of traffic congestion or the partial or total destruction of roads, which may be blocked by collapsed buildings. Specialized dispatch policies may be necessary in such an extra-ordinary environment.

We aimed to capture the above-described post-disaster conditions realistically by using previous war risk analysis and actual road data, and incorporate them into the policies.

In the developed GUI system, an ambulance is assigned to the patient whose location is nearest based on the expected travel times. However, ambulances are also assigned based on the severity of patients' injuries, with those more critically injured served first.

The data set used in the simulation model for the city districts is based on GPS reporting and a road map of Kirkuk.

1.3 Study Aims

In the present thesis, the most likely war scenarios are identified and damage estimates given. Accident data in the GPS report are employed to estimate the likely number of injuries; injury data are also sent to hospitals via ambulance. This system was designed via the use of a Graphical User Interface (GUI).

1.4 The Importance of the Study

The rapid transportation of the injured to hospital is essential in order to save lives. In the present study, a method with which to achieve this is investigated via simulation based on a MATLAB GUI.

The combined use of this GUI and GPS should enable patients’ locations to be established rapidly, potentially covering the entire urban area of Kirkuk.

1.5 Study Structure

This thesis comprises 5 chapters. Chapter 1 contains an introduction to the issue. Chapter 2 contains a literature review, including previous studies examining ambulance management systems. As the city of Kirkuk has thus far been subject to very little investigation, a considerable amount of information was obtained via experimental research carried out in the municipality.

Chapter 3 discusses the role of the Geographic Information System (GIS) in transport planning.

Chapter 4 discusses the methodology employed in the present study, including work on MATLAB programming languages. Finally, Chapter 5 contains the conclusions reached.

CHAPTER 2

LITERATURE REVIEW

2.1 Background

Since the effective planning of an Emergency Medical Services (EMS) system is a crucial issue throughout the world, the subject has attracted attention from a great many researchers, with an enormous number of publications available in the literature. Different OR (Operations Research) techniques, heuristics and meta–heuristics have been proposed for solving multiple variations of this problem. Thanks to advances in OR methodologies and computer technology, such problems can now be efficiently solved using a range of different methods.

EMS station planning models are classified in the literature in various ways. One basic classification involves their division into deterministic and probabilistic cases. In deterministic models, ambulances are always considered available to respond to a service request if they are located within the response zone for the demand points. However, under real-life conditions, ambulances may be busy depending on the arrival time to the demand points and service duration. In such cases, the same or different busy probabilities can be assigned to the service systems and are considered at the time of service request.

The most basic deterministic model is the Set Covering Model (SCM) described in [4]. The objective of this model is to find the minimum number of EMS stations covering all demand points. One of the main characteristics of SCM is its ability to geographically cover all demand points by at least one service station, without taking into account the populations of these points. Due to the importance of SCM in the literature, all other deterministic models are generally based on this model. However, as stated by Brotcorne et al. [5], there are some circumstances that SCM does not consider, such as the fact that when an ambulance departs in response to a call for aid, other demand points serviced by this ambulance are no longer covered (at least until the ambulance is available once more).

Church and ReVelle’s [6] Maximum Coverage Location Model (MCLM) was developed for EMS planning involving a limited number of stations. The aim of this model is to maximize the total population or number of demand points covered by the stations. By using MCLM, the efficiency of the available services (rate of total coverage) can be easily measured. Moreover, the extra cost of establishing more stations and extra coverage offered by these new stations may be compared as part of a strategic decision-making process. Various models based on SCM and MCLM are discussed in the literature. Schilling et al. [7] proposed the Tandem Equipment Allocation Model (TEAM) as an extra add-on for MCLM. TEAM is aimed at maximizing the population covered by two dissimilar service types, where the number of stations for both service types is limited. This model also includes a constraint with respect to the precedence relationship of the two types of service; if a service type is assigned to a demand point, the other service must also be assigned. SCM, MCLM and TEAM all imply single coverage of demand points by the emergency service system. Therefore, if an ambulance is full/busy serving a demand point, other demand points covered by this ambulance will no longer be covered, as stated earlier. To overcome this drawback, multiple handling models are outlined in the paper, considering both location planning and ambulance-related constraints. The Improved Maximal Covering Location Model (MMCLM) developed by Daskin and Stern [8] is aimed at maximizing both population coverage and demand points covering multiple time periods. Two dissimilar alternatives for MMCLM are presented in Hogan and Revelle’s [9] Double Coverage Model (DCM). In the first DCM variant, the populace covered at least twice is maximized given a limited number of stations. In the other variant, given a limited number of both stations and ambulances, the demands covered once or multiple times are maximized according to the weights assigned to demand points. As can be seen from the above review, all three types of MMCLM are based on the multiple coverage of demand points with a single critical travel-time restriction. Gendeau et al. [10] introduced the Double Standard Model (DSM), which maximizes the demand covered multiple times via the use of two dissimilar travel-time limitations, with the overall objective being to maximize the demand provided for at least twice in the shorter travel-time boundary.

The constraints include a set covering requirement of all demand points within the longer travel-time limit and a given percentage of the population to be covered within the shorter travel-time limit. An important difference between DSM and other deterministic models is the assignment of multiple ambulances to the same station. However, there is an upper bound on the number of ambulances assigned to each station. Probabilistic models in the literature vary according to their objective functions and constraints. Daskin [11] proposed the stochastic model known as the Maximal Expected Covering Location Problem (MEXCLP). In this model, an equal busy probability is assigned to all vehicles. This probability depends on the frequency of calls per day and the total service time needed to answer these calls. There is also a limit on the service provided per day by the limited number of vehicles. Thus, the expected coverage of demand points is maximized for a given number of ambulances, where the objective function increases in a diminishing way as the coverage number for each demand point increases. ReVelle and Hogan [12] developed two different probabilistic simulations. The Maximal Availability Location Problem (MALP) is characterized by a reliability factor which depends on the busy probability assigned to all ambulances equally, as in MEXCLP. In this case, the probability of having at least one service respond to the demand point is equal to or greater than this factor. Thus, the lowest number of ambulances needed by each demand point is determined using the reliability factor, with this number being equal for all demand points. As in the other models, MALP restricts the total number of stations and ambulances. The objective of MALP is to maximize the total population or demand points covered using the fewest ambulances. The second type of MALP differs from the first in terms of the minimum number of ambulances required by every demand point. Both MEXCLP and MALP assume that ambulances are independent of each other while assigning busy probabilities. Batta et al. [13] extended MEXCLP by taking into consideration ambulance inter-dependency, assigning different busy probabilities to each demand point.

As an extension to SCM, Ball and Lin [14] proposed the Modified Location Set Covering Model (MLSCM), based on the minimization of ambulance fixed costs. This model is characterized by a lower bound on the proportional coverage of demand within the shorter time limit and an upper bound on the number of ambulances assigned to each station. There is also an upper bound on the busy probabilities in order to avoid high probabilities of not responding to calls.

In addition to all of the above stochastic models, Marianov and ReVelle [15] introduced a queueing model as an alternative extension to SCM. Further research examining the dynamic relocation of ambulances has also recently gained momentum in the literature.

Based on the models proposed in the literature, several applied studies have been conducted aimed at the planning of EMS station locations. However, real world instances with a large number of demand points and potential locations cannot be solved optimally using OR techniques such as the branch-and-bound, branch-and-cut and cutting-plane methods. Hence, various heuristic and meta-heuristic methods have been developed in order to obtain efficient solutions to such problems. For instance, Gendreau et al. [10] proposed a TS algorithm for the location planning of EMS stations in Montreal. TS provided good rapid results in comparison to those obtained via a branch-and-bound algorithm with a limited number of iterations. Harewood [16] discussed EMS planning in Barbados based on the use of simulation techniques. Doerner et al. [17] proposed the employment of ant colony optimization (ACO) in order to plan EMS stations in Austria, and compared their data to those obtained via the TS approach of Gendreau et al. [10]. The obtained results revealed that the use of TS provides a better end product compared to that achieved via ACO, especially for large problems within a very short time frame. Jia et al. [18] proposed a Genetic Algorithm (GA), a Lagrangian Relaxation (LR) approach, and greedy heuristics for EMS planning in Los Angeles, comparing the relative performances of these three methods. In another recent study, Rajagopalan et al. [19] used TS in developing the Hypercube Location Model (HLM), a stochastic model considering queued calls. In this case, TS is implemented for dynamic ambulance relocation.

As TS can provide good results within a short time frame, it has become a popular metaheuristic method in recent years for solving combinatorial optimization problems. In addition to the applications mentioned above, it has been applied to the Vehicle Routing problem (Gendreau et al., [20]), scheduling problems (Ferland et al., [21]), the Travelling Salesman problem (Gendreau et al., [22]), graph theory problems (Osman, [23]), and production planning problems (Bock and Rosenberg,

[24]), to name but a few. TS has also been implemented in bioinformatics, finance, location and allocation, artificial intelligence, and telecommunications problems.

In cases of minor explosions or other small-scale unexpected events, an ambulance is required in order to transport those injured to a hospital. In such scenarios, ambulance deployment and dispatch is a simple problem, because in general, ambulances are not overwhelmed by the requests. FCFS policy is thus implemented by assigning the closest idle ambulance to the nearest request. However, in the case of a post-disaster situation, the dispatch problem can become highly complex. During and after a catastrophic disaster event, the ambulance service is often unable to answer all requests on an FCFS basis due to the heavy patient load. Consequently, whereas a great number of studies have examined everyday emergency dispatch problems, few have investigated a post-disaster scenario. One of the most recent medical review papers was written by Brandeau et al. [25]. In their review, the authors examined a large cross-section of best practice guidelines for the diverse models used in health sector responses to disasters, categorizing the related literature based on disaster, modeling methodology, geographical setting, and purpose of study. This review paper thus represents a useful tool with which to understand the different approaches employed in disaster management. The authors concluded that the models should address real-time situations, be designed for maximum usability, and must perform good model reporting. The present study draws on the fundamental conclusions reached in this latter review in terms of the use of MATLAB GUI programming.

2.2 Emergency Management Strategies for Non-Disaster Situations

Many studies are available in the literature regarding everyday emergency medical services. For example, Haghani et al. [26] developed an optimization model for flexible dispatching strategies that take advantage of real-time traffic information. The authors formulated their problem as one of integer programming, with a simulation experiment conducted in order to provide a conceptual design for a real-time EMS system. In the simulation, alternative task strategies were analyzed in order to test the performance of this model under various conditions, including different explosion occurrence rates, route alteration strategies and dynamic travel periods. Two of the studied ambulance dispatching policies are also examined in the present study: FCFS and nearest origin assignment. Although their model does not include the analysis of post-disaster situations, it does provide a useful insight into emergency vehicle dispatch. In our case, no real-time traffic information was available and thus the direct application of Haghani et al.'s model to the present problem was not feasible.

Andersson and Varbrand [27] is one of the most recent papers to investigate emergency response planning. The authors describe the development of decision support tools aimed at automatic ambulance dispatch and dynamic ambulance relocation, explaining the ambulance dispatch problem in terms of choosing which ambulance to send to a potential patient. The authors also developed an algorithm based on call priorities, and attempted to establish a decision support tool based on this algorithm in order to minimize waiting times. Although the first part of Andersson and Varbrand's work is directly related to the present thesis, their algorithm is not suitable for large-scale incidents. The above authors' second contribution is the dynamic ambulance relocation problem, which arises during ambulance operational control. In their attempt to evaluate a set of ambulance station locations, Andersson and Varbrand argue that not all ambulance calls are urgent and that non-urgent journeys can be ordered several days in advance, making it possible to perform some sort of transportation planning. The authors then perform computational tests using a simulation model to show that the developed tools are beneficial in reducing patient waiting periods.

Maxwell et al. [28] claim that the increase in both GIS availability and computing power portability have created ideal conditions for the analysis of real-time ambulance redeployment and subsequent practical implementation.

In such an emergency medical service system, real-time ambulance redeployment decisions can be made via the use of approximate dynamic programming, often based on redeployed idle ambulance locations and considering the delay threshold in order to maximize the number of calls reached.

When formulating a dynamic program that includes a high-dimensional and incalculable state space, difficulties arising from these factors can be overcome using approximations to the value function parameterized by a small number of parameters [8]. Such a system has offered a solution to the problem of ambulance management and emergency incident handling in Attica, Greece [29]. All of the above-mentioned case studies are based on the use of GPS, GIS, and Global System for Mobile Communication (GSM) technologies. Such methods are aimed at achieving a drastic improvement in the way emergency incidents are handled, hopefully leading to a minimization of ambulance response times.

Health service quality can be affected significantly via the application of GIS software (such as ArcGIS version 8.1.1). Uses include linking spatial data with attributes, such as ambulance locations and accident sites, with the ambulance drivers then provided with the best route (i.e., in order to reach their destination on time). Training should be given to ambulance drivers regarding system usage [30].

2.3 Emergency Management Strategies for Disaster Situations

A number of studies have previously examined casualty transportation by medical emergency services during a disaster scenario. A dynamic integer programming model is here performed for the post-disaster patient transportation problem, with the results used to determine the locations and capacities of post-disaster temporary emergency hospitals to be opened after any war-related incident which may take place in Kirkuk. Decision-making regarding patients' transportation to hospitals is also performed dynamically, with the capacities of emergency units and the locations of ambulances updated continuously. Haghani and Oh [31] addressed the issue of a multi-commodity, multi-modal network problem with time windows for post-disaster operations. The authors essentially deal with defining the detailed routing and arrangement of the available transport modes, the delivery schedules of the various commodities at their destinations, and the load plans for each of the transportation modes. Two heuristic algorithms were developed, one of which deals with utilizing the inherent network structure of the problem with a set of side constraints, and the other solves the problem with an interactive x-and-run heuristic. Fiedrich et al. [32] considered the overall logistics problem for a post-disaster scenario, with the main goal being to minimize the total number of fatalities. For this purpose the authors developed a dynamic optimization model known as ALLOCATE, which classifies operational areas into SAR (search and rescue), stabilizing and immediate rehabilitation, as well as depots, hospitals and crossroads. Fiedrich et al.'s model is characterized by several factors including survival rate of trapped victims, probability of secondary disasters, survival rate of rescued persons without medical treatment, transportation time, and time to complete the work. The authors do not provide an exact method, but propose the use of different heuristics to solve the model, of which simulated annealing is considered the best. Barbarosoglu and Arda [33] also developed a multi-commodity, multi-modal network flow formulation in order to describe the flow of material within an urban transportation network.

Essentially, their paper proposes a two-stage random programming model to plan the transportation of vital first-aid commodities to disaster-affected areas during an emergency response. The authors address the problem of planning the transportation of vital first-aid commodities and emergency personnel to disaster-affected areas by developing a generic modeling framework. Due to the uncertain nature of a post-explosion situation, the authors' treated this problem as random, with its randomness arising not only from demand but also from supply and route capacity. Yi and Kumar [34] used a heuristic model in combination with an Ant Colony Optimization Algorithm to solve the post-disaster transportation problem. The authors combined the transportation of both patients and supplies. Gong et al. [35] have described the concept of "data merge" as the science of professionally organizing and inferring massive amounts of data. The latter authors used this concept as the basis of their development of a dispatch and routing method for emergency vehicles in a disaster environment. In their model, the authors consider patient priority, cluster information and distance as the influencing factors. Information regarding fatalities and road status is reported by sensors, with data for each patient collected including location and injury. Fatalities are classified into three priority categories of severe, moderate and mild injuries, with information on each road composed of condition and the probability that this information is correct. In addition, the authors also considered the role of hospital waiting times. Gong and Batta [36] also considered ambulance allocation and reallocation models for a post-disaster relief operation, using a deterministic model in order to allocate ambulances to each cluster. The latter problem differs from Gong's PhD thesis [37] by adjusting a set of ambulances to serve only one cluster until that cluster no longer exists (i.e., when all injured parties in that cluster have been served). The authors also studied the problem of dynamic ambulance reallocation between clusters as the disaster evolves.

2.4 Triage

Triage is the process of prioritizing patients based on the severity of their injuries. Patient handling must be carried out efficiently when resources are insufficient for the immediate treatment of all individuals.

Jenkins et al. [38] have argued that mass-casualty triage first developed as a wartime necessity, and became a civilian tool only later. Although several different triage tools have been developed, evidence to support the use of one triage algorithm over another is limited. The reason for this is that no study has yet evaluated existing mass-casualty triage algorithms regarding ease of use, reliability, and rationality when biological, chemical, and radiological agents are introduced. The purpose of Jenkins et al.'s paper was to explain the expansion of mass-casualty triage and those algorithms that have been developed for citizen populaces. The authors also review those algorithms based on their reliability and validity, and discuss the need for empirically derived and validated examples.

2.5 Other Related Topics

Although coverage problems are not directly related to emergency vehicle dispatch problems, some papers provide a degree of insight. One such paper was written by Batta and Mannur [39], who propose a coverage criterion that is suitable for two types of application:

(i) The location of fire trucks in a geographical region in which some demands require numerous trucks, and (ii) the location of ambulances in an environment in which huge demand leads to the unavailability of the most desired response unit. The authors claim that their models were explicitly designed to address different coverage requirements for demands, depending on how many units are required to respond to a particular demand. Consequently, they classify priority issues for the critical demands that have stricter coverage requirements.

Several review papers exist in the emergency management literature, including that written by Simpson and Hancock [40]. In their paper, the authors review the role of operational research in emergency response, highlighting the fact that most such studies assume emergency services to be well organized. However, much of the emergency response field is not well structured. As a result, whereas most emergency responses require the management of disorganization, operations research has traditionally focused on the management of organization. The authors note that the emergency response field could be a growth area over the next fifty years.

Queueing models are considered important tools in determining patient waiting times in a disaster area. One of the first papers to focus on modeling emergency dispatch queuing models was written by Larson [41], who proposed the hypercube queuing model that has since become essential in planning emergency service systems. In [41], an exact solution for the queuing model is provided for multiple (at most 15) servers, with performance measures including mean response times, server workload, and the fraction of dispatches for each server to each region. Following on from this initial work, Larson [42] later proposed an approximate hypercube model aimed at providing an approximate procedure for computing selected performance measures for urban emergency service systems. This latter model is also applicable for more than fifteen servers and is highly useful for the analysis of ambulance deployment and redeployment problems.

2.6 Contribution of this Study

The present study reports on a GUI simulation of patient transportation by ambulances in 49 regions of Kirkuk, with the objective being to assess the performance of different ambulance dispatch strategies. Observations made in the city have revealed that it is essential to teach triage principles to both rescue teams and military units, together with an increase in intensive communication between ambulance dispatchers or drivers and hospital coordinators. In addition to assessing the 'sufficiency' of current resources and response strategies in the city, we are interested in evaluating various improvement options, such as increasing the number of available ambulance units and establishing temporary emergency units in order to respond to the needs of disaster victims.

CHAPTER 3

THE ROLE OF GIS IN TRANSPORT PLANNING

3.1 Background

In contrast to other graphics- or management-based systems which typically focus on data illustration, Geographic Information Systems (GIS) are used for the storage and analysis of spatial data. A variety of different fields use such information technology to process geographic material, including civil engineering, cartography, and remote sensing. Transportation networks are used for the movement of commodities, services and people, with the form, proficiency and capacity of these networks impacting on both quality of life and environmental perception. The use of GIS in transportation problems thus represents more than just the scope of their functionality [43,44].

GIS offers a real opportunity to unify transport planning with the enormous data-processing abilities inherent in modern technology. Indeed, telematics products and services for distinct means of transport are based on a mixture of digital maps, traffic message channels (TMC), radio data systems (RDS) for the transmission of traffic data, Global Systems for Mobile Communications (GSM) and Global Positioning Systems (GPS) for the communication of portable data. Mobile telephone communications and other extra sensors are also needed to obtain real-time travel information [44].

3.2 The Role of Databases in GIS-Transportation

The creation of spatial databases for GIS-based transportation is one of the most costly tasks in terms of both economy and time, especially in relation their use in an ambulance management system. The following steps are typically followed to create a geographic database:

- Spatial database maps of transport infrastructure must be created to include health services in any region.
- Attributes are compiled, including information regarding traffic flow.
- Large-scale data are needed for both transport and real-world object attributes.

GIS-based transportation data are collected from a range of different sources, such as GPS, aerial photography, remote sensing, etc. The above components are used for the processing of information, with any delay in development potentially resulting in complications which may be difficult to resolve.

Thanks to the emergence of GPS, video logging, remote sensing, signal communication systems and cellular telephones in GIS applications, geo-localization techniques are currently undergoing a major revolution [45].

3.3 GIS and Transport-related Fields of Application (GIS-Transportation)

GIS is commonly applied to three major disciplines of transport:

3.3.1 Transport planning

GIS is used in a variety of transport planning areas applicable to ambulance management systems, including accessibility studies, multimodal transport analyses, integral transport planning, assessing the environmental impact of new infrastructure policies, pollution control, risk planning and management, and the construction of new roads.

3.3.2 Navigational and logistical management

GIS is employed in a range of fields applicable to assisting ambulance drivers make better decisions regarding their journey to the nearest hospital, including route planning for car navigation systems, meteorological risk control, traffic control, passenger assistance systems, vehicle fleet control, and emergency management.

3.3.3 Management of infrastructure

GIS is used in various different infrastructural management areas, including road and motorway management, railway network management and airport management, as well as to build road network models offering the ability to identify the shortest or quickest route within a network. GIS can also be employed to compute distances between sets of origin and destination points, with position-allocation tasks used to determine site positions and to allocate demand. Street addresses can be changed to map X-Y coordinates. The ability of GIS to analyze spatial networks allows its use in decision support systems aimed at directing and controlling traffic flow. Historic data concerning ambulance locations, incident distributions and road traffic quality can be highly useful for the routing of ambulances in the future. Data regarding events such as roadworks and political/public demonstrations, which also impact road traffic, can also be made accessible from municipal authorities and/or the police [43,44,45].

Furthermore, ambulance, hospital, and staff information can be stored in database management systems (DBMS) to be used by the GIS whenever necessary.

GIS is mostly employed today in operational research as a one-way data feeder for mathematical models, successfully providing distance and time information for emergency service districting and location problems. The complexity of Arc routing problems can be solved via the improved integration of mathematical formulae into existing GIS data models. Although the rise of GIS usage in transportation (GIS-T) has created new paradigms in transport planning, including the desegregation of spatial locations, certain challenges remain regarding the storage of temporal data within applications.

A graphical user interface (GUI) enables the display and analysis of graphical objects; data storage and processing provides easier integration with mathematical optimizers. A variety of object-oriented modeling languages offer libraries of .dll files or tools for the efficient combination of the different geographical data processing techniques employed in vehicle routing analysis. However, the effectiveness of the combined use of GIS, GPS and modeling languages depends on the capacity to handle the typically huge amount of data related to the problem. Road networks are generally monitored by police and/or Road Transportation Corporation (*RTC*) patrol vehicles. In most cases, the aim of such monitoring is to immediately identify any incidents occurring on the network so that a response can be planned very carefully. However, as many incidents call for patrols to leave their planned route in order to reach the accident location, most routes are not completed and thus new ones must be continually re-planned. A bridge has been built between two distinct fields which has allowed the use of active data within robust and powerful mathematical algorithms, producing solutions and satisfying both operational constraints and human requirements. Various forecasting methods, including historical profile approaches, neural networks, non- time series models, traffic simulation models, parametric regression models and dynamic traffic assignment models, are being developed by researchers in the field of intelligent transportation systems (ITS). One of the most critical elements of ITS is the forecasting of travel times. However, an accurate forecast is extremely difficult to accomplish due to the complex nature of traffic networks, with future travel times depending on various network features including speed, traffic flow, incident occurrence, and jams [43,44,45].

3.4 ArcGIS

Many organizations use GIS in order to obtain better information for improved decision making. GIS is able to present real-world objects on a map, with easy to use spatial tools available with which to perform highly complex tasks. In GIS programs, spatial objects can be represented as points, lines or polygons. One of the most popular GIS software programs is ArcGIS, developed by ESRI software solutions. ArcGIS desktop comprises four main applications of interest: ArcMap, ArcCatalog, ArcToolbox, and ArcObject [30].

1- ArcMap: This application is used to explore and analyze both spatial and non-spatial data.
2- ArcCatalog: This application is used to manage spatial data.
3- ArcToolbox: This application contains tools with which to perform GIS tasks.
4- ArcObject: This application is used to build systems such as the ArcMap application.

3.5 ArcMap and ArcObject

ArcMap and ArcObject are employed in order to perform the following tasks with geographic data:

* Perform an analysis
* Explore and edit
* Create maps, graphs and reports, etc
* Build a new system

The ArcMap and ArcObject working model consists of the map display area, table of contents, as well as a number of toolbars and menus for working with the map and its attribute data. ArcGIS extensions allow GIS users to increase the functional competences of ArcView, ArcEditor and ArcInfo, with specialized GIS tools available for tasks such as raster geoprocessing, 3D visualization, and geostatistical examination [30].

3.6 Methodology

3.6.1 Analysis (GIS/GPS/GSM)

The effective organization of ambulances in order to achieve immediate transportation of patients from accident site to the nearest & most appropriate hospital plays a pivotal role in health services offered to citizens. Effective routing and organization of ambulance systems is aimed at minimizing response times and thus improving how emergency accidents are dealt with. The Ambulance Management System (AMS) algorithm is an integration of Matlab GUI, GPS and Global System for Mobile Communication (GSM) technologies. A GPS receiver is installed in each ambulance in order to determine its real-time position (x, y co-ordinates) based on a satellite signal; this information is forwarded to the hospital via a GSM modem and network. This network system can be used to transmit suitable data including a route map, directions and voice messages. Every ambulance is also equipped with a computer or mobile data terminal (Personal Digital Application) on which to view the route computed by the AMS operating at the hospital. The hospital (or base station) can also exchange data with the ambulance via the network, with one computer dedicated to such communication and another to the AMS user interface. The main functions of the hospital-based GIS (AMS) are as follows:

• Determining incident and ambulance locations.

• Depiction of both accident and ambulance on the city road map.

• Selecting the nearest ambulance to handle an emergency incident.

• Routing an ambulance to the incident site and from there to the closest hospital.

• If an accident occurs during peak traffic hours, the ambulance will be directed to follow the fastest route comprising both minor & major roads (i.e., an alternative to the regular fastest path using only major roads).

One of the most important bodies required for public safety is an efficient and effective emergency transport and care system. Emergency hospitals should provide immediate care for patients suffering sudden and serious injuries. Although patient transportation to a hospital may seem quite simple, AMS preferably combines technology, strategic planning and clinical proficiency to ensure an immediate and efficient response to each and every call for help. Clearly, in any AMS, time is the most important factor in saving human lives. In AMS-based routing, the ambulance location is the starting point and the nearest hospital the final destination; accident site, ambulance location, major & minor roads, and hospital location information are coordinated to obtain a satisfactory end result [43].

3.7 AMS Information for Decision Making

As decision making is one of the most challenging roles facing managers, the tremendous development in information systems and related technologies means that such systems are now frequently employed by senior management in business organizations in order to help speed up the decision-making process.

Decision support systems for the most important information systems are now completely dependent on computer technology, ever since the IT revolution which took place during the 1970's. Such systems' main focus is simply to provide appropriate support in order to improve the quality of decisions, achieved by integrating model data and software. As the nature of the data used is of maximum importance, the development of informatics techniques has resulted in companies using such systems having a competitive advantage relative to their competitors.

Depending on the importance of these varied applications for individual institutions, the effective implementation of such systems depends on several factors, the most important being the support of senior management, which provides support in various areas of economic analysis, statistics and operations research. Within this context, the dimensions and mechanisms of decision support systems may vary in both area and application. The following sections provide a brief outline of the concept and importance of decision support systems [43].

3.8 The Concept of Decision Support Systems

Decision support systems are generally based on the following three basic concepts:

* System: In the context of general systems theory, the system is seen as comprising a regular set of parts or sub-systems which are interconnected and interacting with each other.

* Support: The support provided by these systems to the decision maker or team.

* Administrative decision: Trade-offs are made among the alternatives proposed, with resolution generally linked to the process of decision-making as a logical product of this process.

Decision support systems essentially represent the interaction between a human element and information technology in the production of information related to the needs of users. The goal of this interaction is to provide the support necessary to simplify the decision-making process.

There are those who suggest that decision support systems represent an extension of the information management systems that provide managers with the tools and data they need to make decisions. However, whereas most information management systems use structural information and create routines needed for managerial decision-making, AMS managers employ decision support systems to solve problems which are often unstructured and non-routine.

Nevertheless, there remains a consensus amongst IT experts that decision support systems can provide full support to both the semi-structured decision-making associated with most centralized departments, whilst also making a difference in finding solutions (i.e., a strategy) to non-structural problems related to AMS.

In summary, the fundamental idea underlying decision support systems is to provide a useful tool with which to analyze data via the use of models and databases, with the ultimate aim of identifying possible solutions to the problems presented [18].

3.9 The Importance of Decision Support Systems

A variety of different and sophisticated decision support systems have been developed because of the need for tools that are able to support complex decisions that are subject to the conditions of risk and uncertainty. The best systems are an effective mix of human intelligence and computer software that interact strongly with each other in order to solve complex problems.

The importance and benefits of these systems can be summarized as follows:

- Support other information systems by integrating technology and operations research within the framework of efficient decision-making.
- Increase the number of alternatives and the ability to make an optimal choice from a range of alternatives, providing a more sensitive analysis and a more rapid response.
- Provide support for a series of successive and interrelated decisions, in all stages of the decision-making process.
- Provide a better understanding of a business, enabling decision-makers to identify relationships which can then be used to prepare a comprehensive picture of, for instance, a health service.
- Enable a quick response to unexpected situations, including an easy review of different models and variables.
- Provide a set of tools and techniques for the preparation of various analyses for specific purposes.
- Improve communication and process control, with communication channels documented and improved, and plans more consistent and following standardized calculation procedures.
- Save time and costs by decreasing the amount of office work and reducing overtime.

- Enable better decisions and teamwork, as well as better and more efficient use of data resources.

It could be argued that the use of decision support systems has, since their inception in highly sophisticated informatics techniques, provided organizations with an important competitive advantage over their competitors [46].
Forkuo and Quaye-Ballard [44] proposed a GIS-based fire emergency response system for urban fires in Ghana.

CHAPTER 4

IMPLEMENTATION

4.1 AMS using a MATLAB GUI

Rapid patient transport to hospital via ambulance is essential in order to save human lives. Fig. 2, shows just one example of the many types of ambulance used around the world.

Figure 2 A type of ambulance

4.2 Kirkuk Ambulance Dispatch System

In the Kirkuk ambulance dispatch system, calls are connected to the ambulance phone or mobile phone. Once the patient’s location has been established, the system works via GPS or the Internet to determine the x-axis and y-axis coordinates of the nearest ambulance. If this ambulance is busy the system connects to the next nearest. This system is represented graphically in Fig. 3.

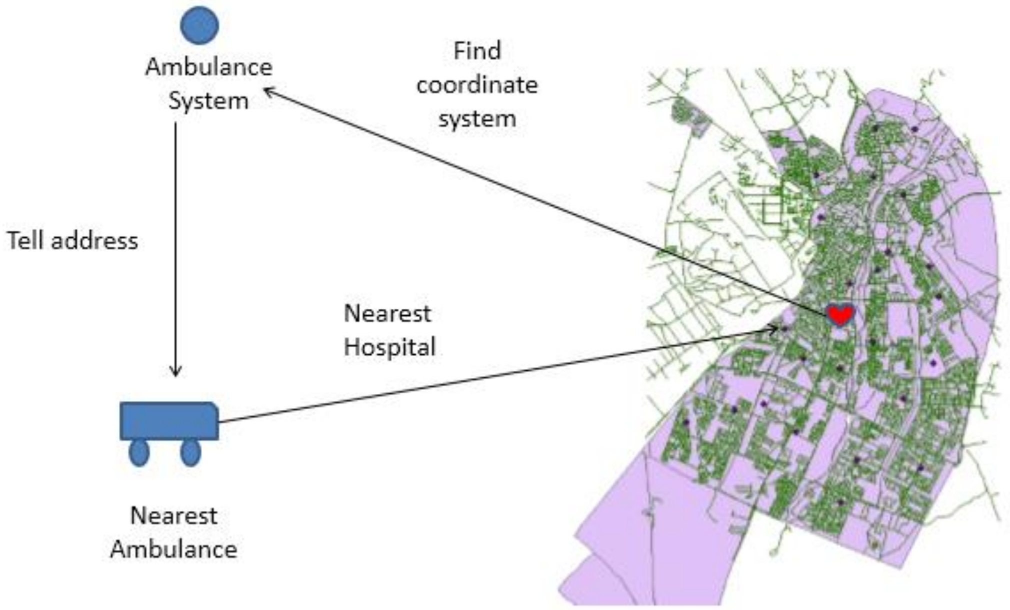


Figure 3 Kirkuk ambulance dispatch system

4.3 Ambulance Management Communication System

After collecting the patient, the ambulance connects to the nearest hospital via GPS and GSM. This is shown graphically in Fig. 4.

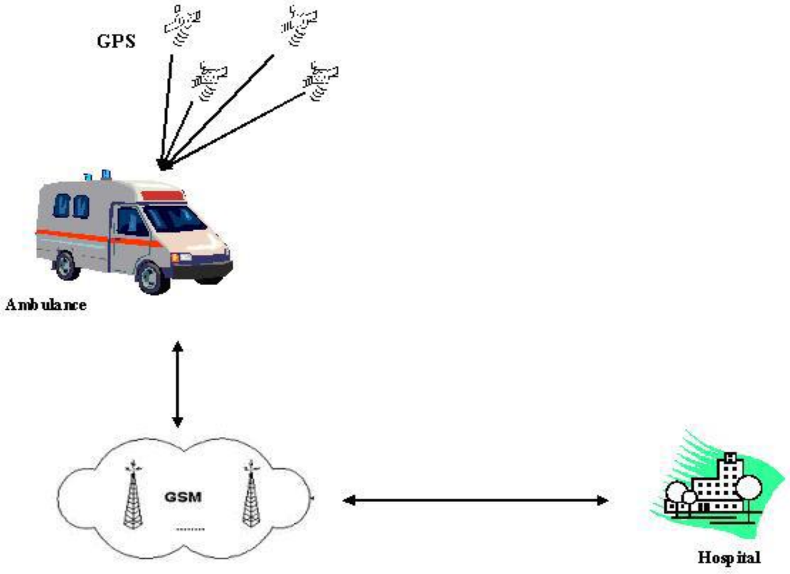


Figure 4 Ambulance management communication system

4.4 Kirkuk Map

Kirkuk is one of Iraq's so-called 'oil cities' and is bordered to the northwest by Erbil, to the northeast by Sulaymaniyah, to the southeast by Diyala, and to the southwest by Baghdad (the capital of the Iraq republic) and Salah Al-Din. Kirkuk is composed of 49 districts. A map of Kirkuk is shown in Fig. 5.

Figure 5 Kirkuk map

4.5 Kirkuk Traffic

Fig. 6, provides a general illustration of traffic in Kirkuk. Ambulances should select an empty or less busy route when transferring a patient to hospital (although this concept is under debate).

Figure 6 Traffic in Kirkuk

4.6 Kirkuk Road Network

In this section we present a road map of Kirkuk and discuss how it can be displayed in a MATLAB GUI. The road map used here was obtained from the Kirkuk Municipal Authorities. Fig. 7, shows a map simply illustrating the road network in Kirkuk.

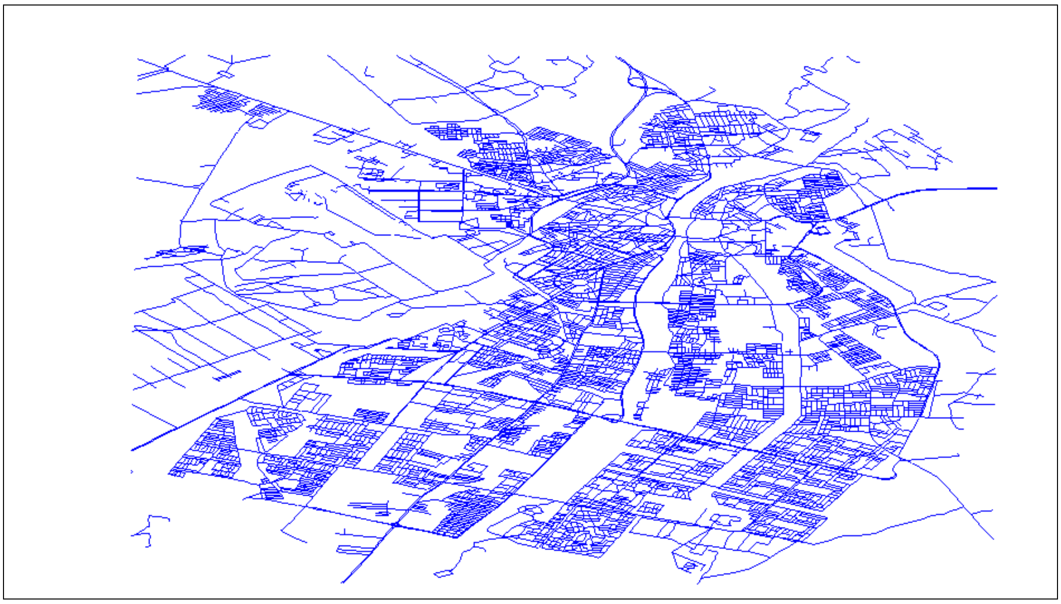


Figure 7 Map of the road network in Kirkuk

Fig. 8, illustrates the relationship between routes and districts in Kirkuk; the right-hand map displays only the districts, while the left-hand map shows both the routes and districts.

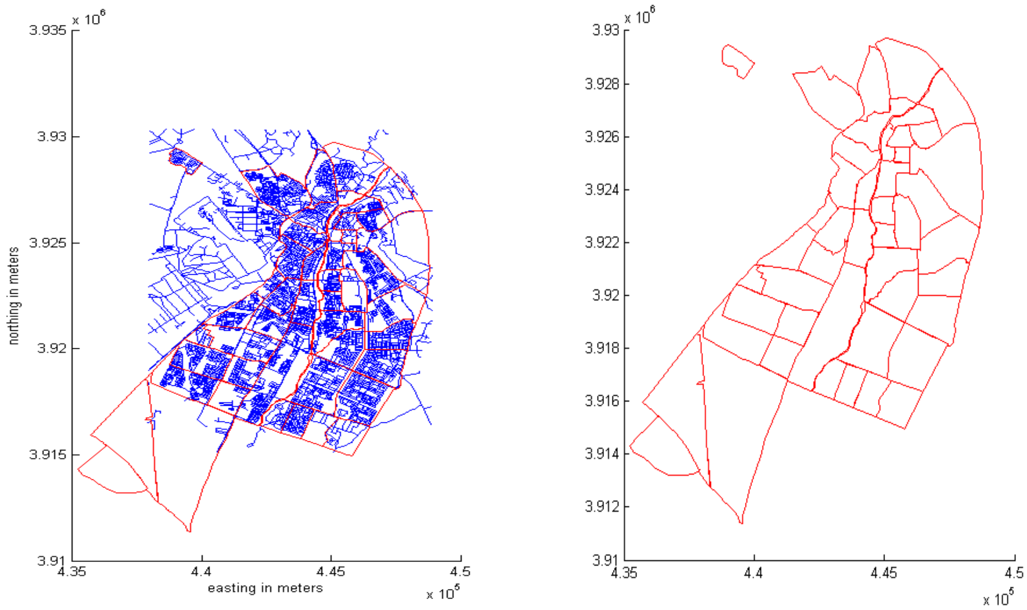


Figure 8 Routes and districts in Kirkuk

. In this here we show whole the Kirkuk hospital as we can see the red colour.

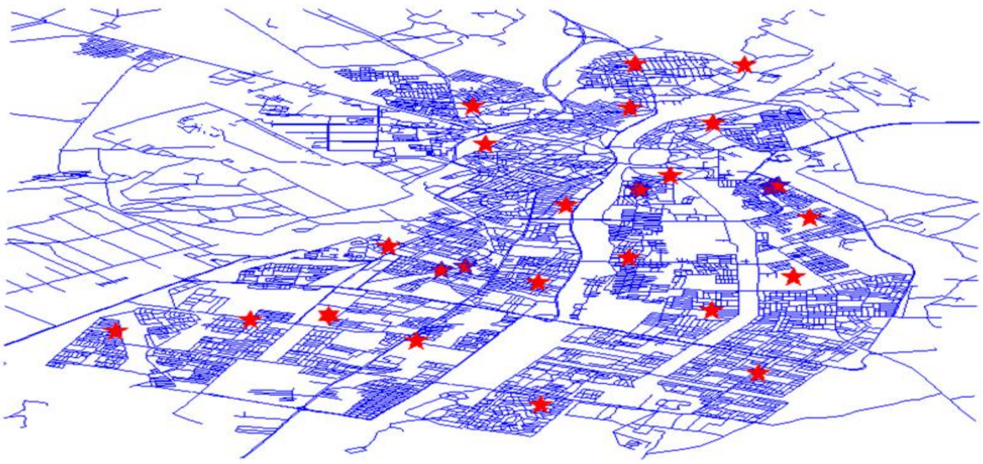


Figure 9 Kirkuk hospitals

This section describes the location of the city and its relationship with other adjacent cities in Iraq. A city's location has a significant impact on its growth, including the number of jobs provided, depending on the size of its region [47]. Two types of location system are typically recognized: astronomic and geographic [45]. Kirkuk is situated astronomically at 44°26'27 "E - 44°17'10 "E longitude and 35°30'34 "N - 35°20'5 "N latitude [48]. Geographically, the city (also known as AL-Tamim) lies at the center of Kirkuk province in northeastern Iraq, as shown in Fig. 10.

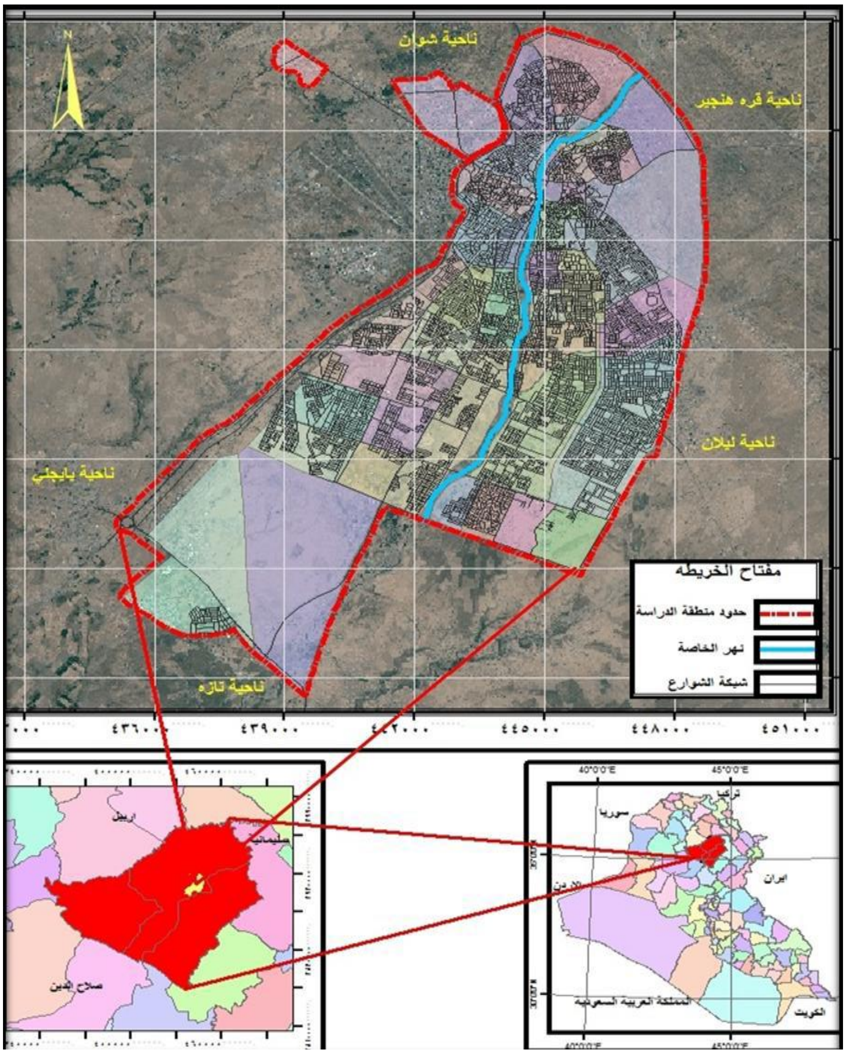


Figure 10 Maps showing Iraq and the relative locations of Kirkuk province and Kirkuk city.

The city itself comprises a total of 49 residential districts Fig. 11.

Figure 11 Residential districts in Kirkuk city

In terms of its location relative to other cities in Iraq, Kirkuk is situated around 255 km north of the Iraqi capital of Baghdad, 120 km west of Al-Sulaymaniya, 120 km east of Tikrit, 180 km southeast of Mosul, and 96 km southeast of Erbil [49]. Kirkuk

Province is characterized by highly fertile land due to its location in the so-called undulating zone below the Zagros Mountains. The city also lies on the ‘Sea of Oil’ and close to other important minerals and metals. Kirkuk city itself is connected to other cities and countries via the main road network [43].

Table 1. Hospitals and Small Health Units in Kirkuk City

Type of health service	Number of health institutes
Large hospitals	5
Small health units	24

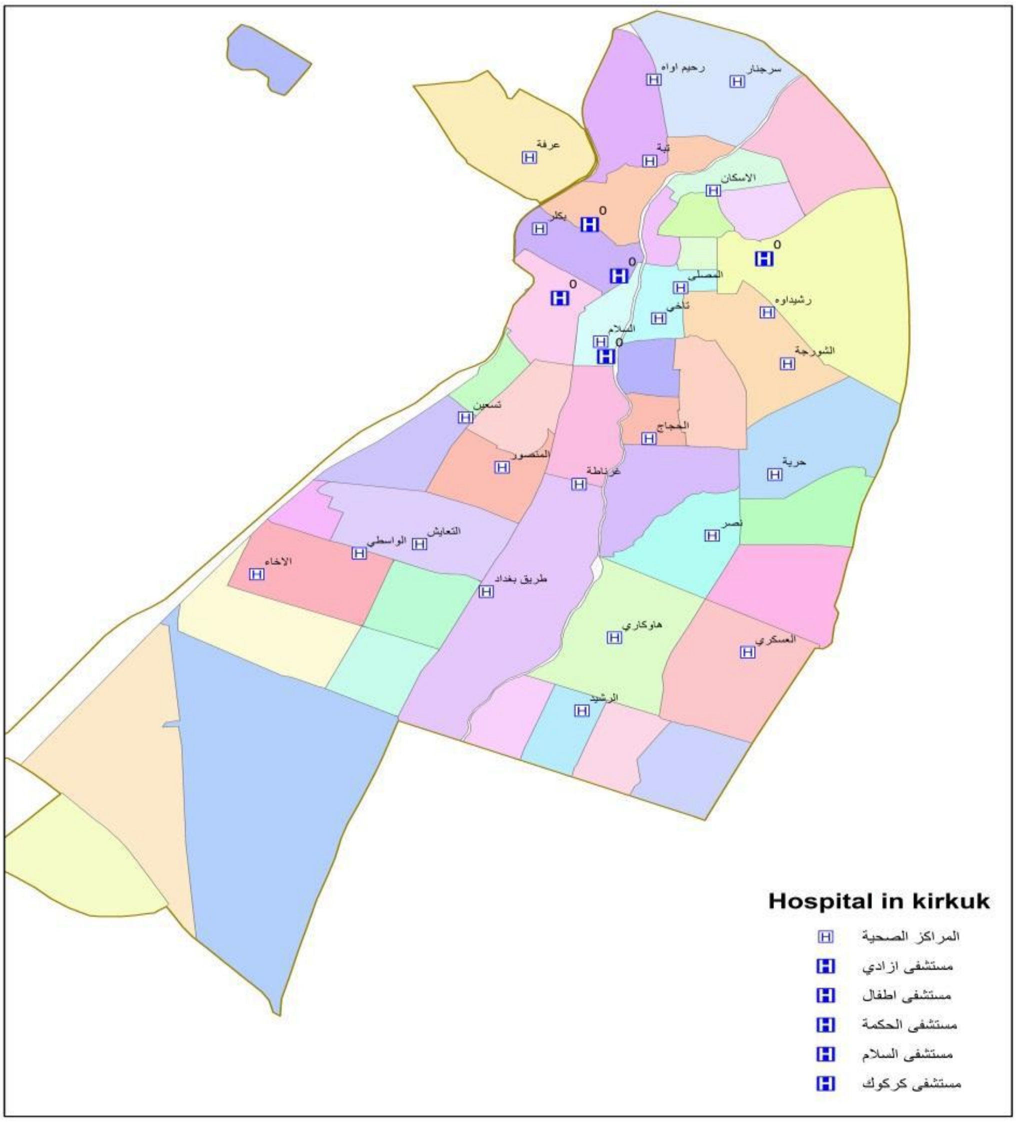


Figure 12 Hospitals and small health units in Kirkuk city

4.7 Use Case Diagram for AMS

The developed Ambulance Management System has been designed not only for use in Kirkuk city, but also for other cities and countries currently experiencing similar problems. The structure of the Ambulance Management System is shown in Fig 13.

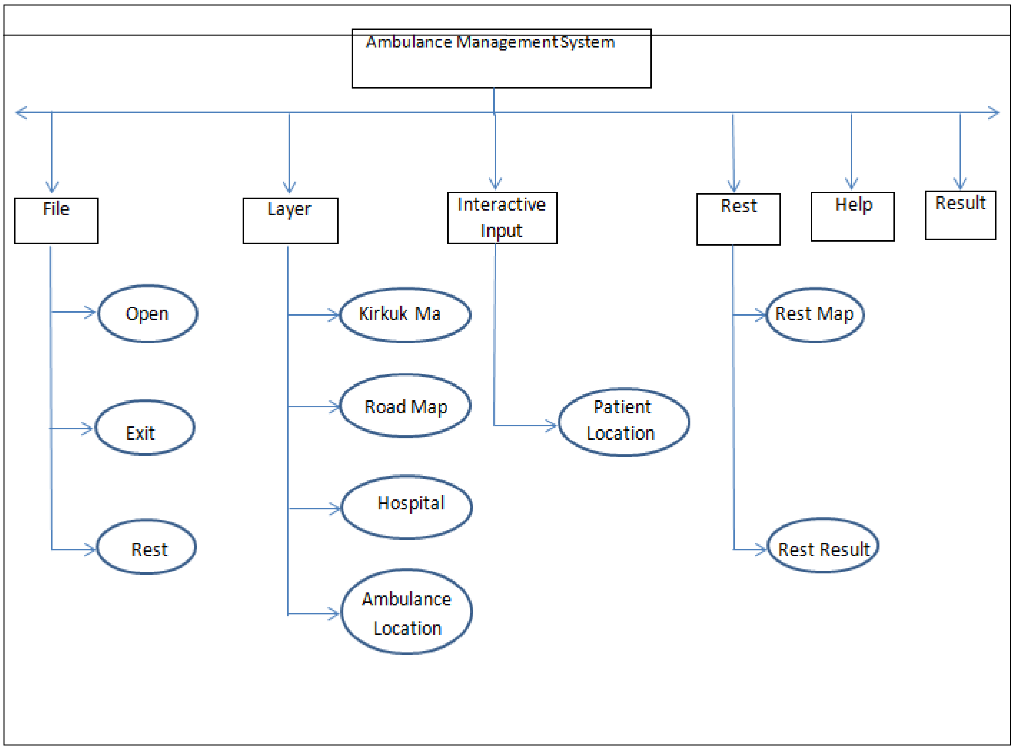


Figure 13 Ambulance management system structure

4.7.1 General Project Use Case Diagram

In the AMS developed in the present thesis, any user can access the main system functions, which are the *file*, *save*, *print*, *zoom* and *layers* instructions. The *about* function contains information regarding the researcher and shape files used in the thesis. Fig. 14 shows a diagram illustrating the general system functions.

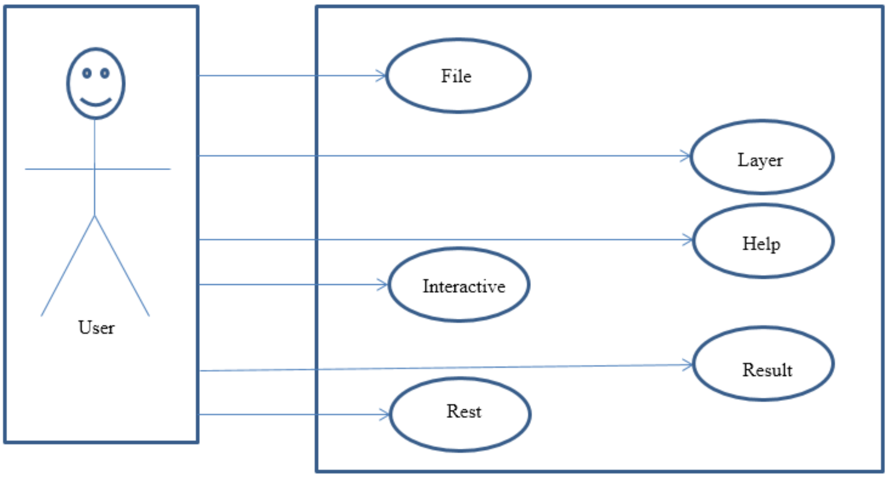


Figure 14 General system functions

4.7.2 File Use Case Diagram

System users can open and close the application via the *file* command. The *open* instruction opens the shape file in the current folder, showing the base schematic of the figure. The *close* instruction closes the current file without closing the entire application. Finally, the *exit* instruction is used to turn off the application. A diagram illustrating the available file operations is shown in Fig 15.

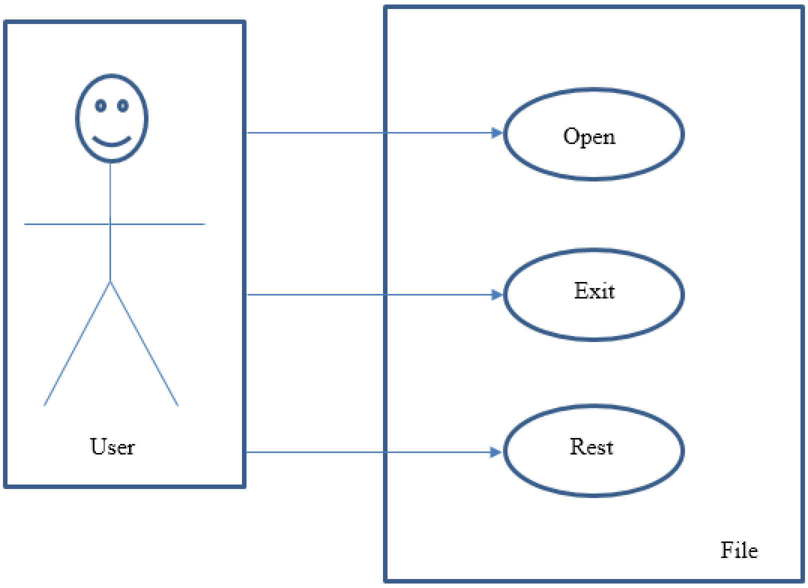


Figure 15 AMS file operations

4.7.3 Save Use Case Diagram

Using the *save file* option, users can save files under the extension *.shp for use in other applications or to make modifications to the worksheet. Pictures can also be printed to produce hard copies. Fig. 16 shows a diagram illustrating the *save* operation function.

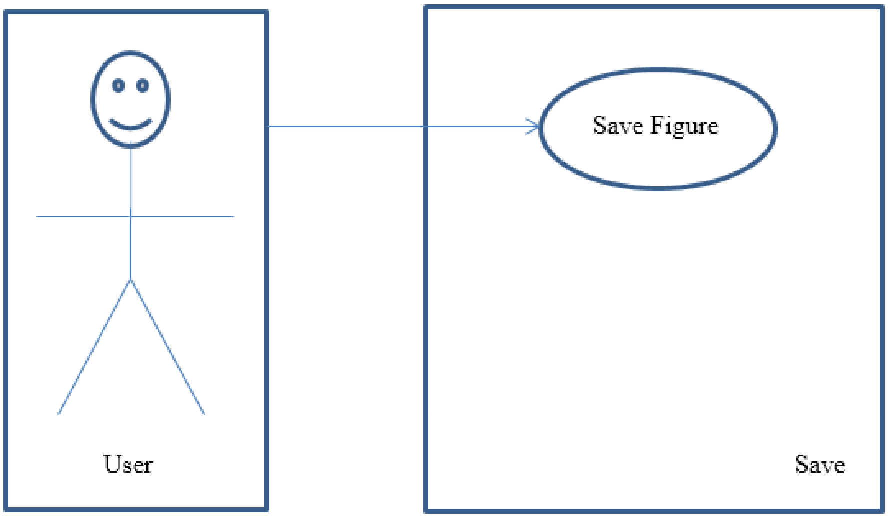


Figure 16 AMS save operations

The *layers* option illustrates all application structures together, including important shape files such as hospitals, street maps, and ambulance locations. All the available *layers* operations are shown in Fig. 17.

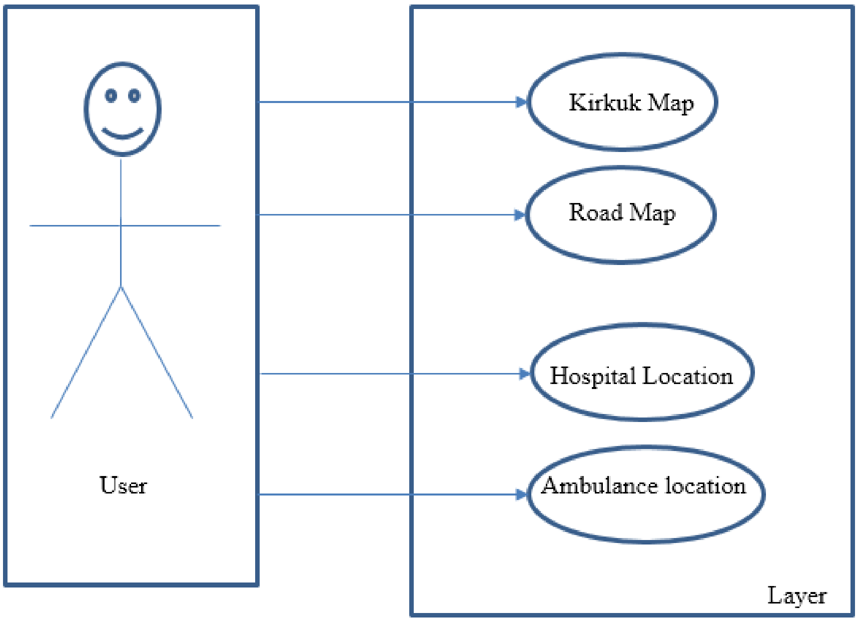


Figure 17 AMS layers operations

The sample code in Fig. 18 below shows the Kirkuk street map MATLAB command.

```
function pushbutton1_Callback(hObject, eventdata,
handles)
[dosyaadi,dosyayolu]=uigetfile({
 '*.shp','Shape Dosyalar (*.shp)';
 '*.*','Tum Dosyalar'},'Load Kirkuk Map : ');

kirkuk = shaperead([dosyayolu dosyaadi]);

for k = 1:numel(kirkuk)
    K(k).X = kirkuk(k).X;
    K(k).Y = kirkuk(k).Y;
end
for i = 1:numel(K)
    plot(handles.axes1,K(1,i).X,K(1,i).Y,'k')
    hold on
end
xlabel(handles.axes1,'easting in meters')
ylabel(handles.axes1,'northing in meters')
```

Figure 18 Sample code for map loading

This command function opens the folder from whose contents the related shape file can be selected. After selecting the file this map is shown in the main display area, ready for any further work.

4.7.4 Print Use Case Diagram

When the program is run, the user can print the result of any simulation by simply clicking the print icon, which is active for every printer installed. A diagram illustrating the *Print* operation is shown in Fig. 19.

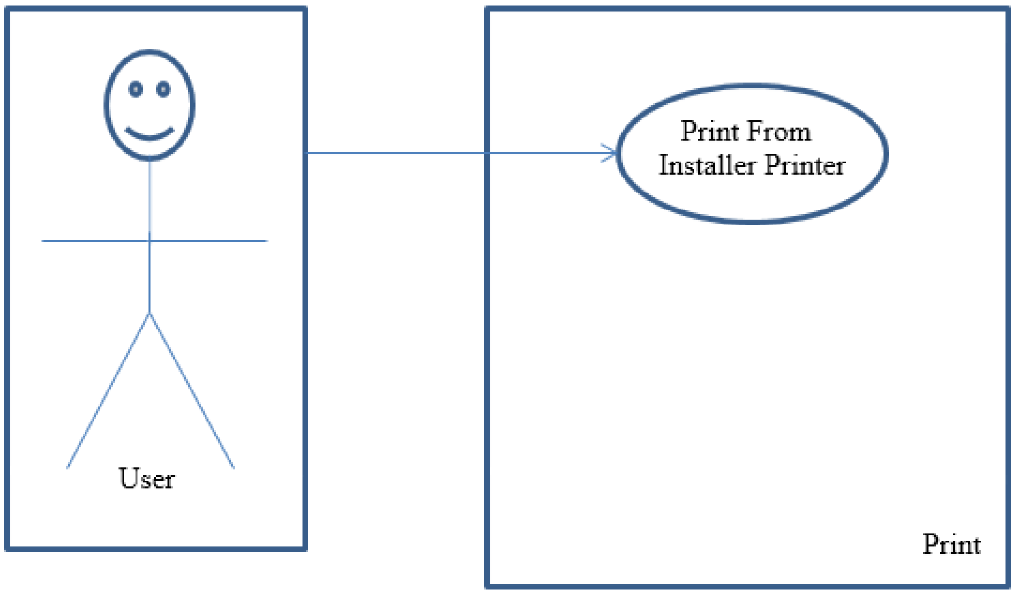


Figure 19 AMS print operations

4.7.5 Zoom Use Case Diagram

Users can zoom in or out on the map using the *zoom in* and *zoom out* operations, respectively, as illustrated in Fig. 20.

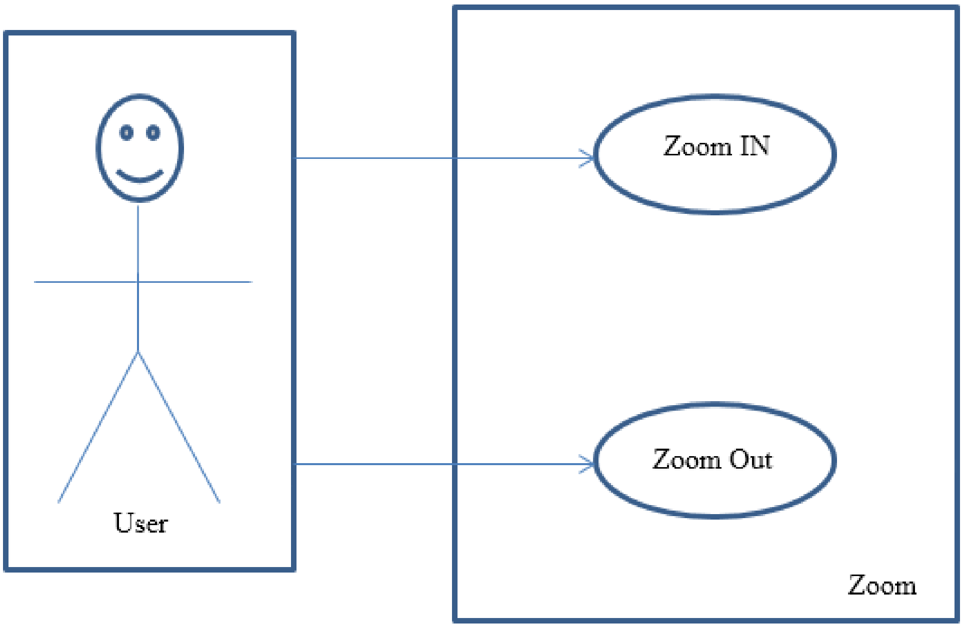


Figure 20 AMS zoom operations

4.7.6 Reset Use Case Operation

To reset all figures and maps, users can select the reset button. Maps can then be reloaded blank, with patient, ambulance and hospital information removed and reset. This option is illustrated in Fig. 21.

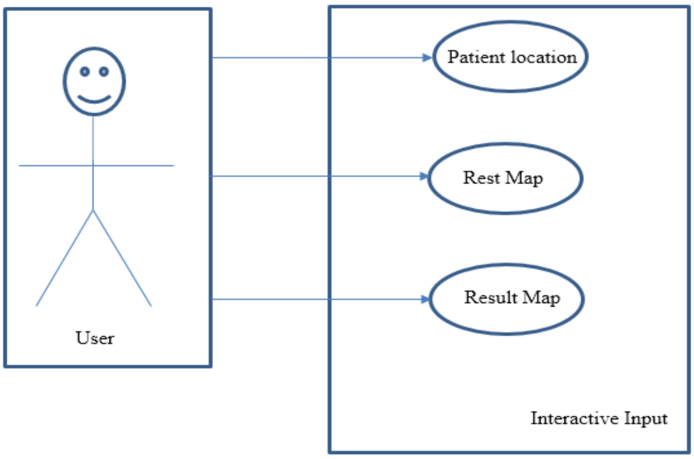


Figure 21 AMS interactive operations

4.7.7 Performance Requirements

The proposed AMS can be applied to every type of map, including street maps or those illustrating data such as hospital, ambulance and patient locations. When the user wishes to change the location, for example by zooming in or out, the system is not disturbed for other applications such as selecting another patient location. This feature was included as additional patients will likely call the ambulance center to request an ambulance. In such cases the system operator enters the new patient location in terms of X- and Y-coordinates and a new ambulance is assigned. In the developed system, GPS data is used to locate ambulance and patient. The AMS should thus be supported by real GPS data which are accurately transformed into the X,Y system, without which incorrect results may be produced.
The MATLAB software program was selected for the simulations, as it is generally considered one of the most powerful and is widely used in engineering and other fields.

4.8 Software System Attributes

4.8.1 Easy Installation

An executable file was created for easy installation of the system on any computer without significant effort. High computer specifications are not required; only the data to be used must be available in order to obtain the results.

4.8.2 Usability

The system is designed for all typs of user; no specialized qualifications are necessary. Unlike ArcGIS, which requires at least a computer engineering certificate to be understood in detail, the proposed AMS is helpful for those working in the education service fields who may not possess such knowledge.

4.8.3 Reliability

The AMS can be completely trusted; wrong information is never declared, only correct results. The system interface is shown in Fig. 22.

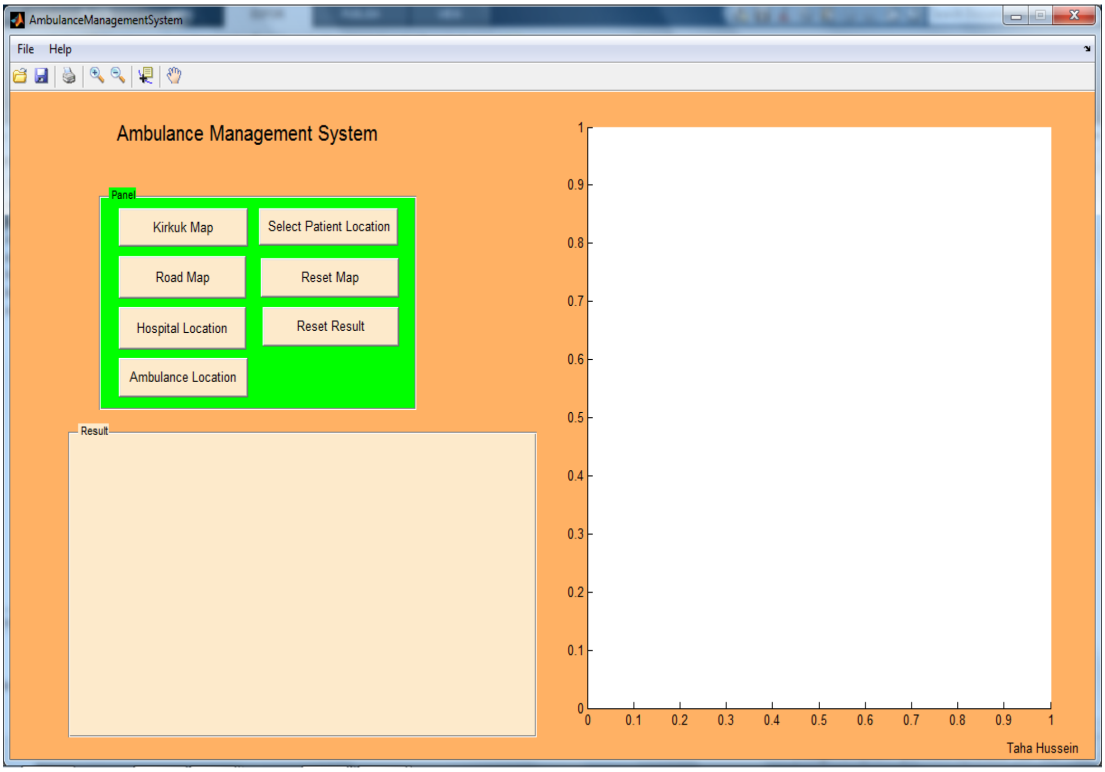


Figure 22 The proposed software system, designed in MATLAB

This GUI was created for the simulations by writing code in MATLAB.

When an accident occurs in any district in the city, the municipal traffic authorities are made aware of the coordinates of the accident location, which are then used in communication with hospitals, police and fire stations.

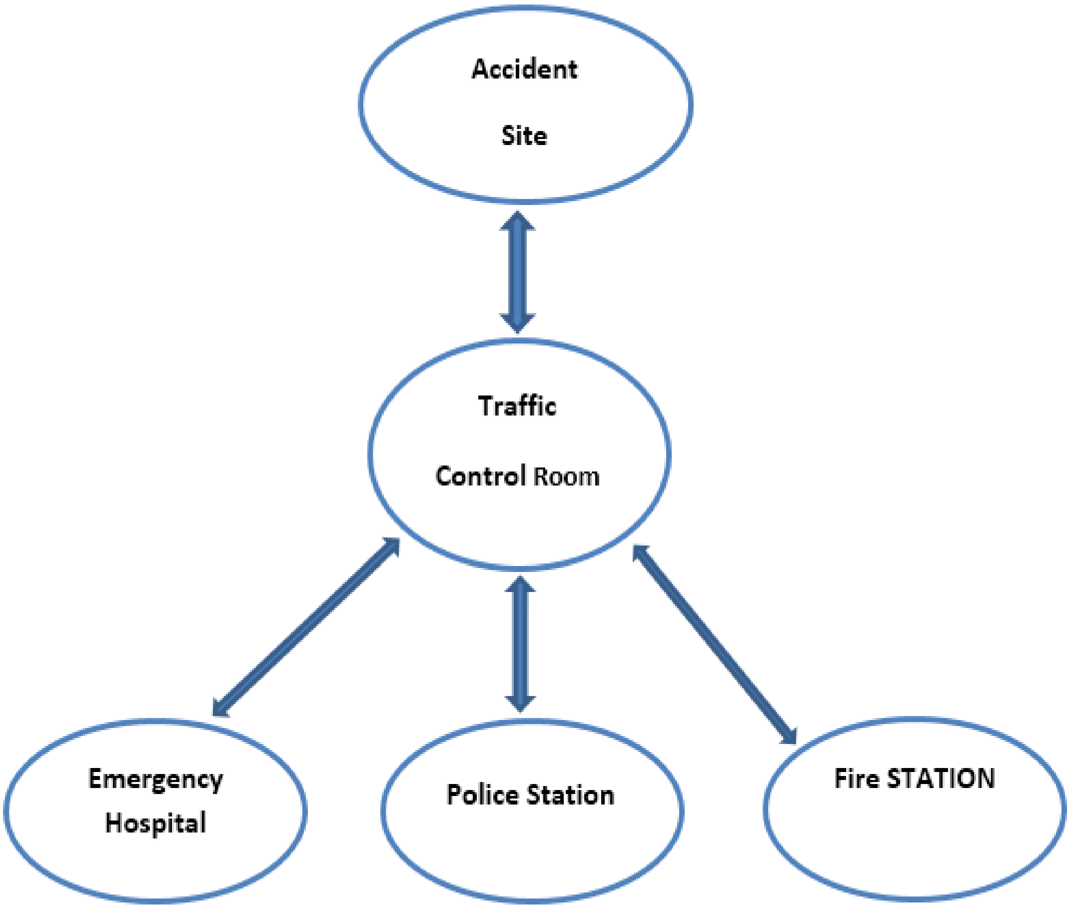


Figure 23 Information flow after an accident occurring on the road network [43]

After an accident, the x- and y-axis coordinates are also collected for subsequent use in the AMS MATLAB GUI.

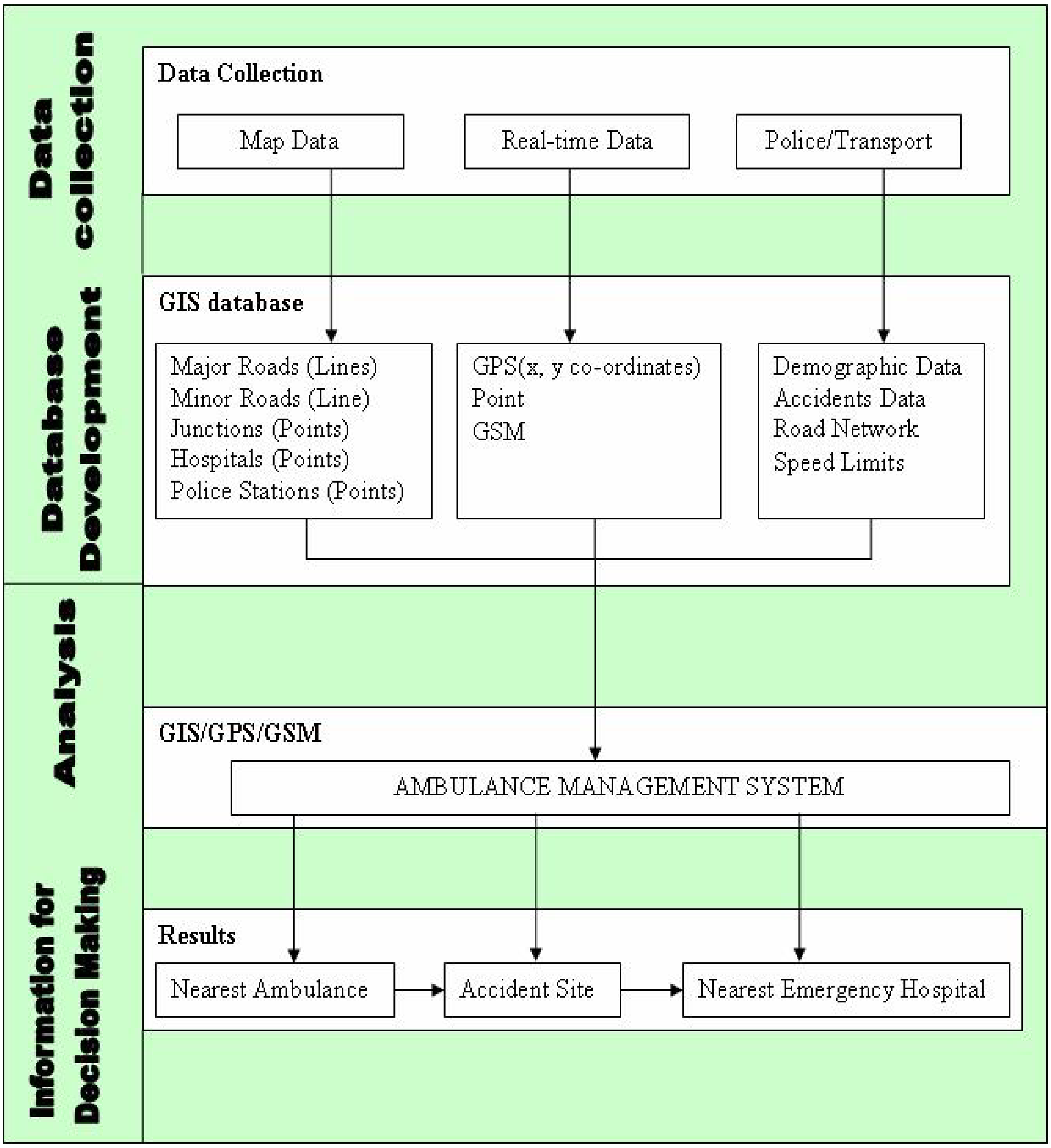


Figure 24 Data collection [43]

After an emergency call is made, for example to 108 in Kirkuk, the answering operator dispatches communications with all emergency services (i.e., fire, police and hospitals). Following this, the AMS is connected to the GPS and GSM networks, with the accident location's x- and y-coordinates used to determine the nearest ambulance.

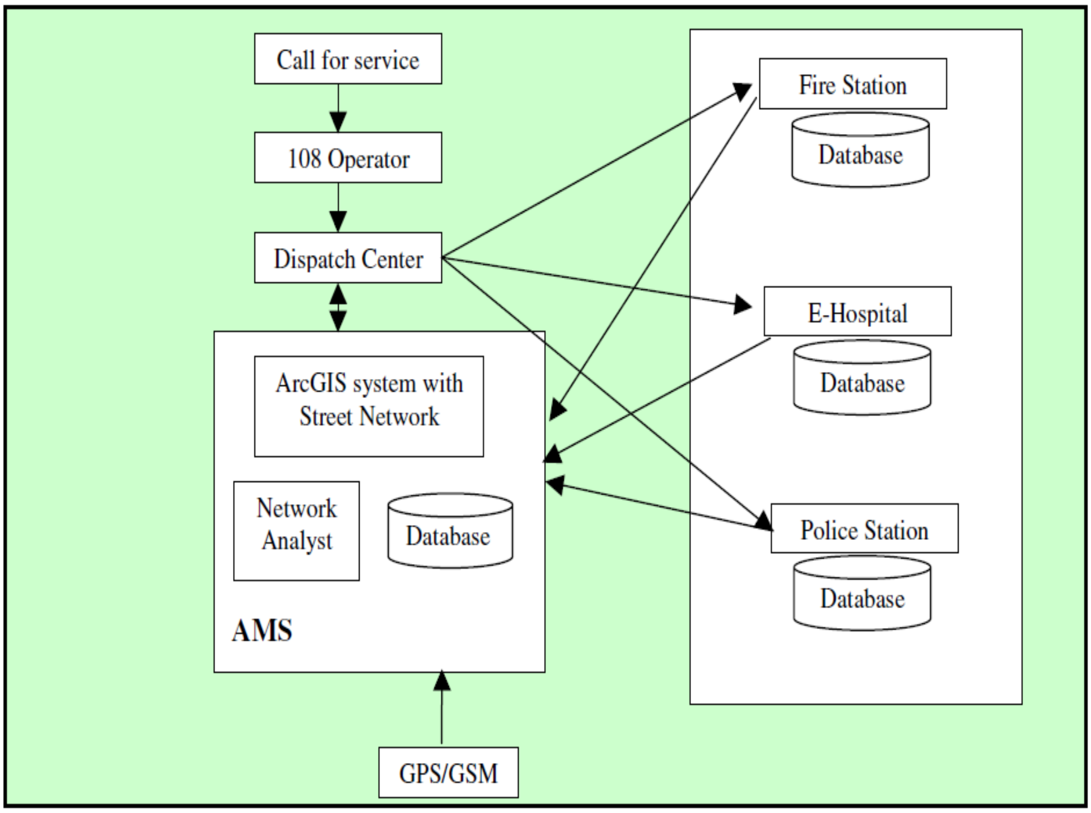


Figure 25 Information flow after calling the service [43]

Fig. 26 below shows the on-screen display after running the developed AMS program. The first step is to select the Kirkuk Road Map button, and then from personal computer the Kirkuk map is selected as the shape file; this loads the Kirkuk road map (here shown in blue) into the axes section of the GUI. The user then loads the hospital locations (here shown in red), which are determined via GPS and saved in shape file format, followed by the ambulance locations (magenta).

Finally, the user selects the "Select Patient Location" button and inputs the appropriate data.

After selecting this button the locations of the nearest ambulance and nearest hospital appear on the map; the user can then inform the ambulance and hospital centers.

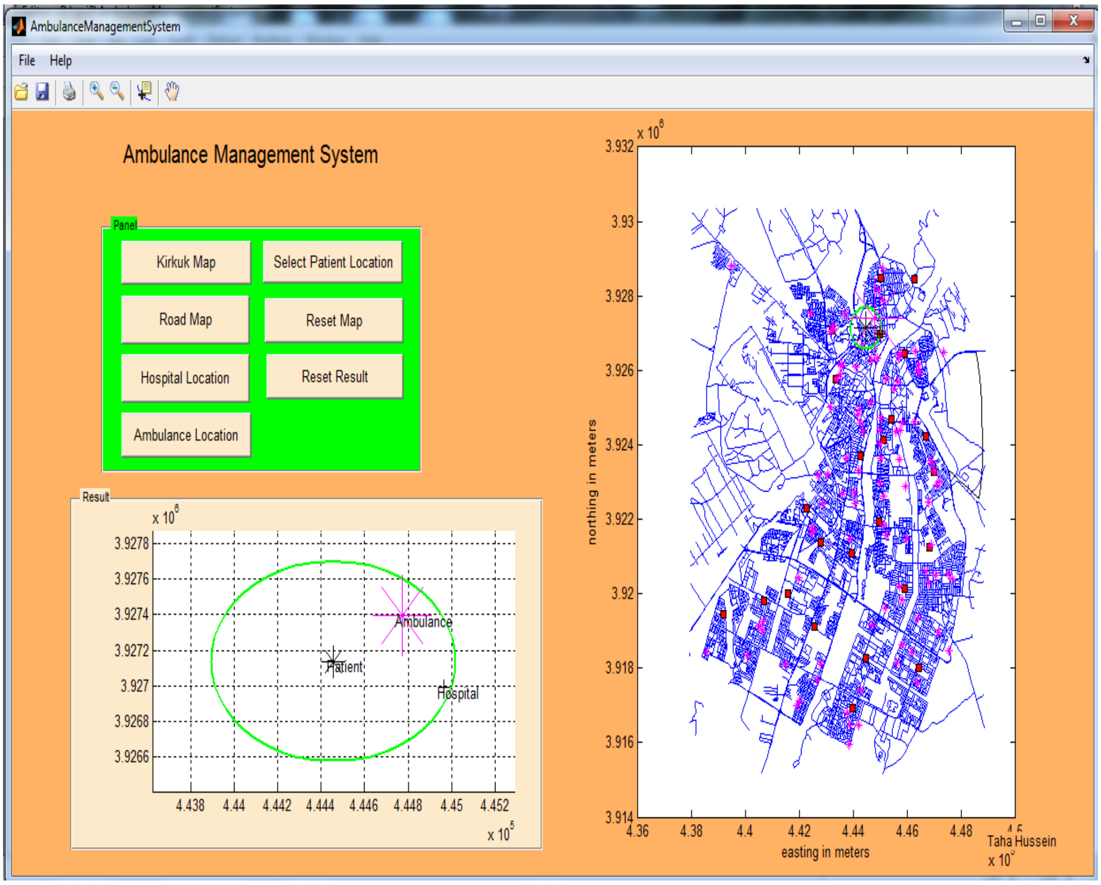


Figure 26 Map showing ambulance, hospital and road locations after running the system

Users can also zoom in on the location of the patient (as well as that of the nearest ambulance and hospital) by pressing the zoom button. This feature is illustrated in Fig. 27.

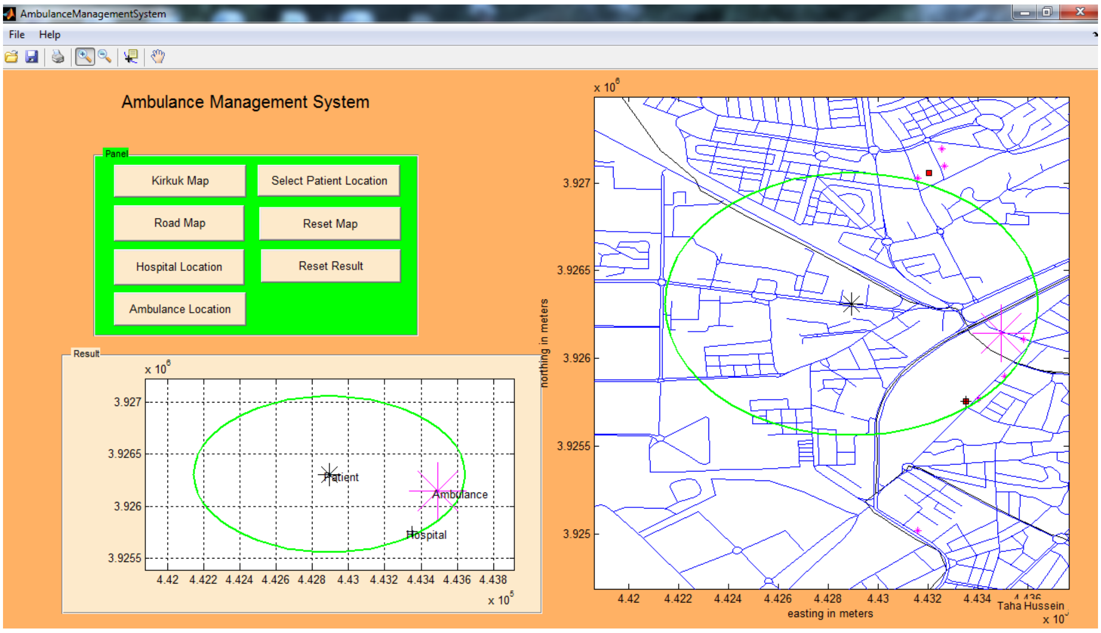


Figure 27 AMS display after zooming

Exact GPS location data (i.e., object coordinates) can be observed by selecting the data cursor button. This feature is shown in Fig. 28.

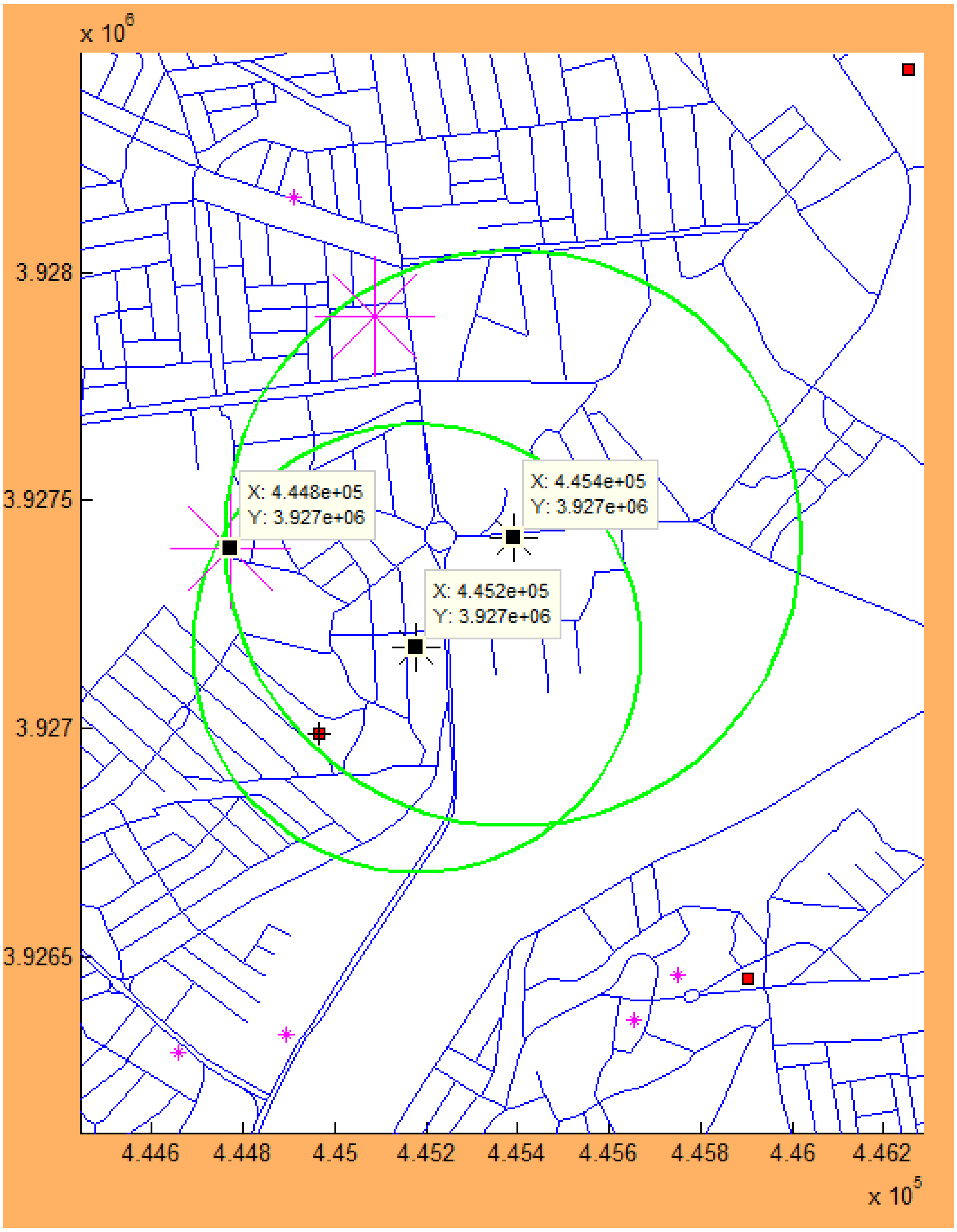


Figure 28 AMS display after selecting the data cursor button

Table 2 shows the difference in patient distance between the nearest and farthest ambulances. In this case the ambulance furthest from the patient is located inside the hospital.

Table 2 Difference in Patient Distance Between Nearest and Farthest Ambulances

Coordinate / Name	X (m)	Y (m)	Distance to patient (m)	Total Distance between patient ambulance and hospital
Patient	$4.448*10^5$	$3.925*10^6$	-	-
Hospital	$4.454*10^5$	$3.925*10^6$	600	-
Ambulance	$4.447*10^5$	$3.925*10^6$	100	600 + 100 = 700
Ambulance in Hospital	$4.447*10^5$	$3.925*10^6$	600	600 + 600 = 1200

Fig. 29 Shows the above comparison presented in map form.

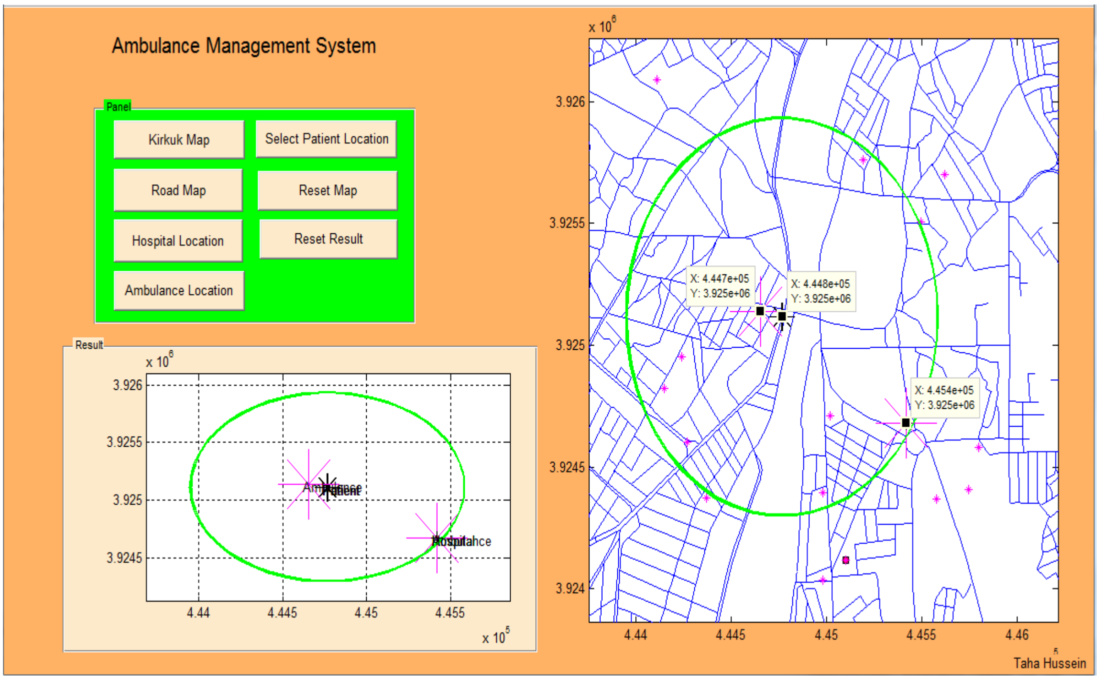


Figure 29 Map-based comparison of difference in patient distance between nearest and farthest ambulances

CHAPTER 5

CONCLUSION

During the course of the present thesis it was found that the number of hospitals and small health units currently serving Kirkuk is insufficient. As a result, the ambulance service cannot carry out its duties efficiently. New hospitals and/or small health units must be built in many of the city's districts, especially in the south and southwest. New criteria should be applied to ambulance distribution, similar to those used in other Middle Eastern and European countries. Ambulances should also be supplied with new GPS instruments in order to enable the service to make better decisions, thereby increasing the chances of saving patients' lives. A new database should be built containing city data such as schools, infrastructure and police stations, etc. to help health institutions find the best way of serving citizens. Field research undertaken in the city has revealed that Kirkuk lacks many of the immediate resources required for an effective ambulance system; indeed, the present thesis is aimed at overcoming these obstacles to proper service provision and as such is the first study in the province to do so.

Effective emergency services must be able to perform to the highest level in the minimum time. As patients' lives are at stake, emergency hospitals must be available at all times. The present thesis used a road map of Kirkuk to assist in directing ambulances to accident locations. Many GIS applications are now available that have been developed specifically for such a purpose based on GPS and other real-time technologies. Such technologies are highly beneficial and play a major role in explaining the routing problem. Here the MATLAB software program was used to construct a GUI system with which to identify the nearest ambulance and hospital on Kirkuk's road network. This interface is designed so that it finds the accident location on the road map, and uses this information to locate the nearest ambulance and hospital using real-time technologies. The proposed system identifies the shortest route from the nearest ambulance to the accident site, with the fastest route on both major and minor roads then formed.

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APPENDIX A

CURRICULUM VITAE

PERSONAL INFORMATION

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EDUCATION

Degree	Institution	Year of Graduation
M.Sc.	Çankaya Univ., Computer Engineering	2015
B.Sc.	Technical College in Kirkuk	2004
Institute	Technical Institute in Kirkuk	1991
High School	AL-Makarem Secondary School	1988

WORK EXPERIENCE

Year	Institution	Position
2004-Present	Kirkuk Univ., Collage of Science	Employee
1999-2004	IRAQI READ CRESCENT SOCIETY/ KIRKUK	Teacher

LANGUAGES

Arabic, English, Turkish

HOBBIES

Swimming, Computing, Volleyball, Music.