King Fahd University of Petroleum and Minerals

Electrical Engineering Department

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Term paper

GIS application in health care

(Emergency Medical Service)

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Introduction

Health care can form a significant part of our life. It carry wide meaning and contain many departments, systems and important service for example 'Emergency medical services". Emergency medical services are very important components of health care. Patients need to be rapidly transported to the hospital. This can be accomplished by the efficient management of ambulance and reduce ambulances response time. Unavailability of ambulance at the center closest to a call response time can make response time becomes a random variable causing considerable variation in response time performance. In urgent call situations, it is important to deploy a limited number of vehicles in any way to that response time standards are met. Assessing ambulance performance can be affected by many variables such as ambulance travel time and ambulance availability. Understanding why an ambulance service has not met performance standards in a particular area is essential to inform better deployment decisions.

GIS (geographic information system) has the ability to communicate with other programs such as web-browsers, spreadsheet database systems .It also provides us a lot of information about people and accidents in the past

Research Objectives:

The objective of this paper is to explain how GIS work to improve health care and their services exactly Emergency medical services and systems of health and what the role of GIS(geographic information system) and that using in improving and assessing these services for example the ambulance service performance or . local health care planning …

Methodology:

The research methodology of this paper will focus on acquiring the knowledge through an extensive literature review about GIS health application and improving and

assessing service performance levels . In addition , I will include a case study about application GIS in health care as example for this topic

What GIS

Mark Landry defined Geographic Information Systems (GIS) as “a database with legs that allows a person to interlay and visualize information…and to analyze trends and relationships spatially.”

In other hand a geographic information system (GIS) is a technological tool for comprehending geography and making intelligent decisions.

Geographic data are organized by GIS so that anybody reading a map can chose data necessary for a specific project or task. GIS program is able to process geographic data from a different types of sources and combine it into a map project. Many countries have an plenty of geographic data for analysis.

GIS maps are interactive. On the computer screen, map users can check a GIS map in any direction,zoom in or out, and change the nature of the information contained in the map.

GIS allow the user to examine relationships among a wide variety of factors, including health data, population characteristics, environmental conditions, and more.

Despite the many advantages of geographic information systems, there are some barriers to overcome. Relying on existing data sources can often be problematic as can collecting and integrating enormous amounts of data, sometimes from various sources

Health GIS

A Health Geographic Information System (GIS) is an innovative structure to access, integrate, visualize and utilize information that use to inform decisions affecting child and health care of maternal. Health GIS analyses incorporate statistical, demographic, health ability, and spatial data from health information systems, observation, surveys and maps. Customized queries and analyses can focus on geographic reference points of interest—such as health facilities, towns, or administrative districts, or a specific group of interest—such as children under the age of five. For example, a GIS analytical approach

can reveal relationships and trends that might not be clear when the data is viewed in tabular format. Epidemiological data could be mapped, permitting users to detect and explore any potential spatial patterns of disease outbreaks.. GIS is playing an important part in health care and management around the world. The capacity to spatially link health, population and environmental data into one system creates a powerful tool that gives public health specialists the ability to analyze health data in a clear, suitable and easy to comprehend form.

Application of GIS in The health (System .service .planning)

We mean by application of GIS is the fields that we can use GIS in the health . there are many health fields that we can use GIS in, such as health planning ,health system and health service

Health care service

Health service one of important part such as emergency medical service. We use GIS to improve these services for example emergency vehicles .

Health care planning:

Health care planning is a challenging field that depends on spatial data such as location and characteristics of health centre demand. Today, health planners have several tasks to cover to assure that health services are provided at the best location. Epidemiology and accessibilities are two important issues in local health planning.

health care system :

We mean by health system is the systems that the health need it in the work .GIS application is more important in this field to improve these systems .

Sample health GIS application in health system :

- accessibility and access to health care
- Objects resources
- study program interventions
- Mapping of registry
- Disease supervision

- Promote knowledge
- Evaluate population at risk
- Evaluate equity and efficiency of health service
- Combine with Health Information Systems to support evidence-based decision making

Emergency Vehicles Allocation:

There are many studies about GIS application in health care one of these is about Emergency Vehicles (ambulance) location .

We use GIS, to determine the best base stations for Emergency vehicles. GIS technology is used to manage and organize spatial data and to image solutions using maps. By this application we can find the best possible location to park an emergency vehicle, or the place to keep it, so that it serves the largest part of the population in the shortest time. In this section we will explain one GIS application used for emergency vehicles as case study. This study was done in Funen Danish island .

Improve emergency respond:

A case study (Funen Danish island):

Solving location-allocation problems is not a new discipline (Christian, 2002) . Actually, it has a long history and it was used to find a good place to settle near resources such as wood, food and water. Despite this long history , many are still difficult to solve to optimality if not impossible.

In this paper, we will focus on finding placing ambulances on the Danish islands of Funen, Tasinge, Thuro, Sio and Langeland.

The ambulance access to these islands is easy, because they are connected by bridges.

We will talk basically about Funen, because ambulances rarely move off it to assist other regions in Denmark.

data of these islands has been provided by Flack Company (the leading provider of ambulance services in Denmark)

The role of information system (GIS) and global positioning system (GPS) is to identify the positions of current available ambulances and to dispatch the ambulances so that they will reach the locations of accidents as quickly as possible.

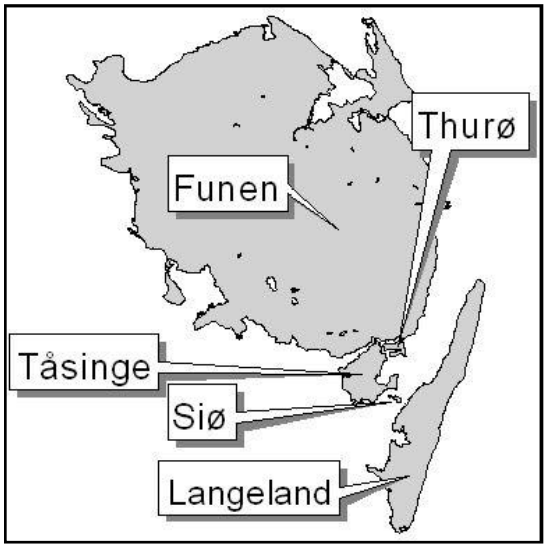

Figure 1. The island investigated in this paper

GIS data include: a road network, demographic data, ambulance duties, accidents and Falck-resources (number of vehicles, garages etc.).

Working with Data:

Features such as road network, accidents and the outline of Funen Island are collected in themes (layers). We can gather features in a stack. This means that the features in the top theme will cover the themes beneath. An example of Falck garages on top, then the road network with speed limits above 70 km/h at the bottom the theme representing outline of Funen. This can be seen in figure 3.

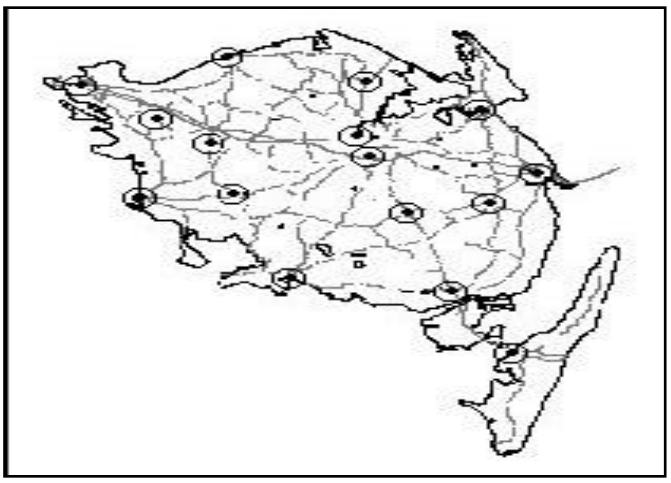

Figure2. Geograhic data from Funen.

We can switch on and off themes. We Can also determining all accidents within **ten** kilometers of a Falck garage or locating all the highway approaches close-by .I addition we have the ability to snap one feature to another feature.

To calculate the distance between two points on a road, the points actually have to be on the road.

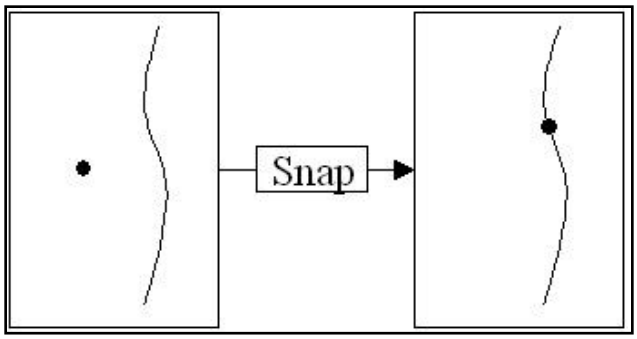

Figure 3. Snapping a point to a line using "snap to boundary"-rule.

Using GIS for determining the suitable placement of ambulances :

GIS has the ability to communicate with other programs such as web-browsers, spreadsheet database systems .It also provides us a lot of information about people and

accidents in the past. This will make it very powerful tool in any environment that deals with data that has a geographic dimension.

Ambulances should be placed at a kind of static placement Falck stations, by using allocation ambulances so that a certain response time can be met for 95% of the accidents.

Data:

The major elements of data include the following:

- **Accidents:** They are placed on the network using a process called geocoding. The following time information are available: the time of the call, the time that the ambulance reaches the accident and the time when the ambulance is available again.
- **Road Network**: It contains information about one way street speed limits, travel time, and information about which addresses belong to which road.

Accident Analysis:

for handling 60,000 accidents at a time, It is essential to understand the data. Also, it will be difficult to comment on solutions to the ambulance allocation,if the accidents were just numbers in a table, and to find ideas about how to improve the allocation.

There are two items contract with accidents:

1) Accidents in general.
    a. Where do accidents happen and when.
2) Dividing data into time periods.
    c. Do the accidents differ as to where they happen and when?

Geography:

Most of accidents happen in towns, since this area is full with as shown in Figure 4 and Figure 5.

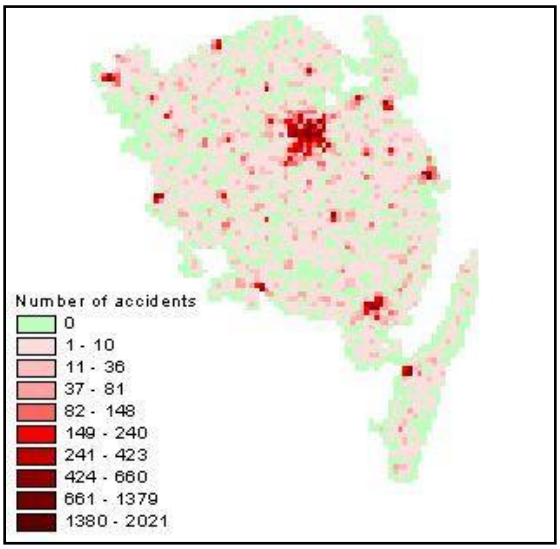

Figure 4. Accidents per km2 over the period.

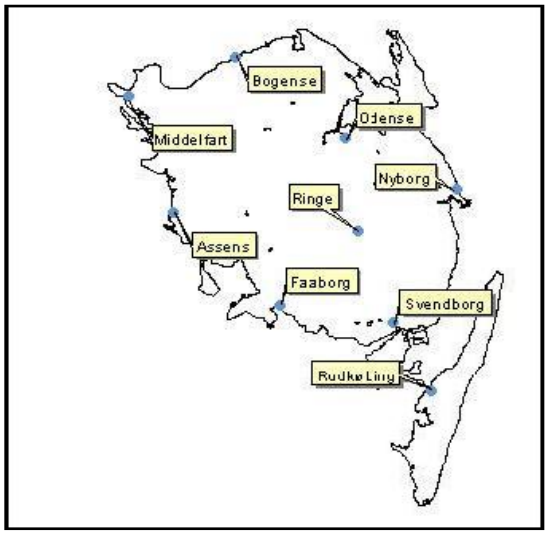

Figure 5. Positions of major towns on Funen.

These figures identify the positions of towns on Funen in a grid cells. Each cell is one by one kilometer.

Areas where there are no roads such as lakes and sea will not be considered.

Time:

Figure 6 represented number of accidents over year.

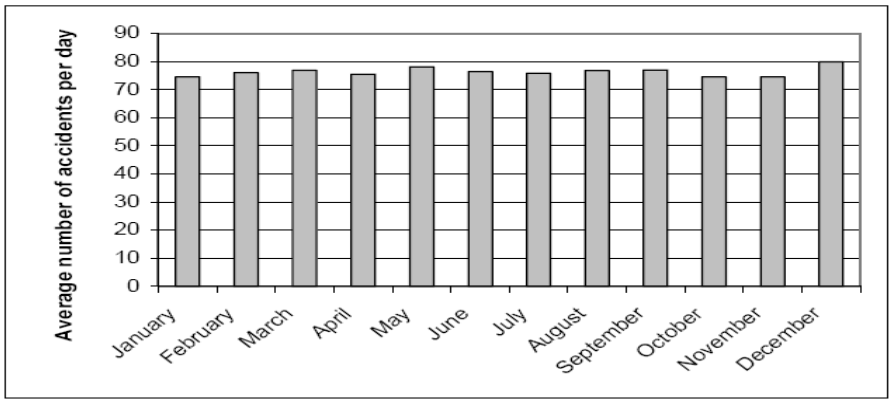

Figure 6. Average number of accidents per day in a standard month.

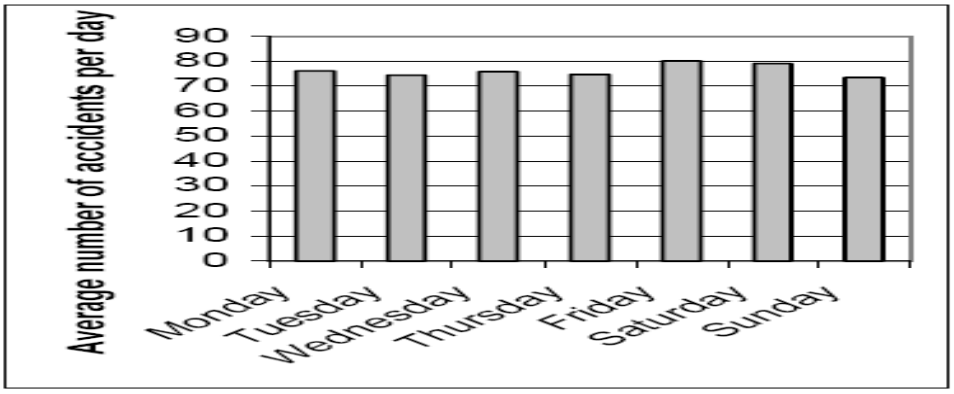

Figure 7. Average number of accidents per day.

According to **Figure 6**,there is no considerable difference in the number of accidents over the year. December has the largest number of accidents (76,3 accidents per day) .

Figure 7 show us that there is a considerable deviation when looking at days.

Friday has the most average of accidents and Sunday has the lowest number of accidents.

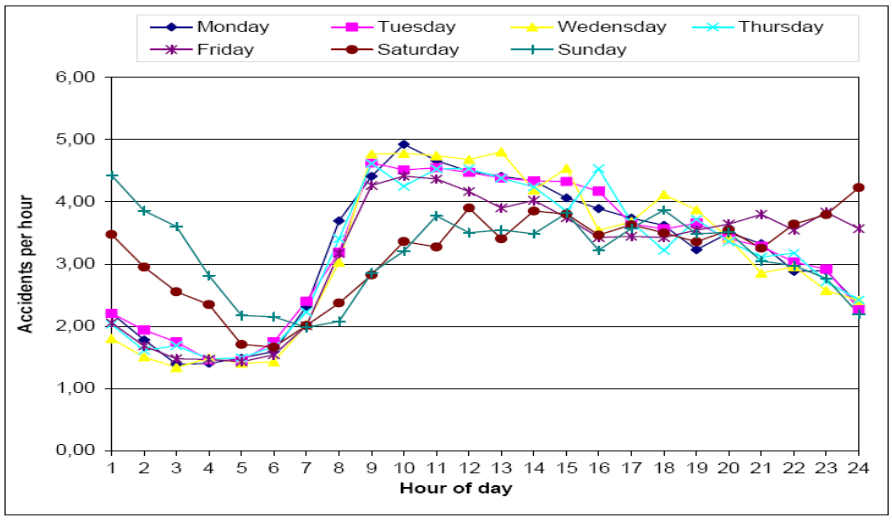

Figure 8. Average number of accidents per hour over a mean day.
Hour of day 1 if from 0 am to 1 am..

If we took the number of accidents over the week on an hourly basis, rather than on a daily basis, the variation will be more different as shown in **figure 7**. The lowest number of accidents happen when people are at sleep(Christian, 2002). But the highest number of accidents happen in working hours between **9 am** and **2 pm** in the weekdays .

Visual Inspection of Accidents:

The visual inspection is carried out using the grid features of spatial analysis. Each grid is a square of one by one km, i.e. one km2(Christian, 2002). Areas that are not contain roads such as lakes and sea will not be considered. There are different in accidents that happen in"summer weekends" compare with that happen in "winter weekends "as shown in **Figure 8**. In addition, accidents in "fall at work". are different from accidents in "summer weekends" as shown in **Figure 9**.

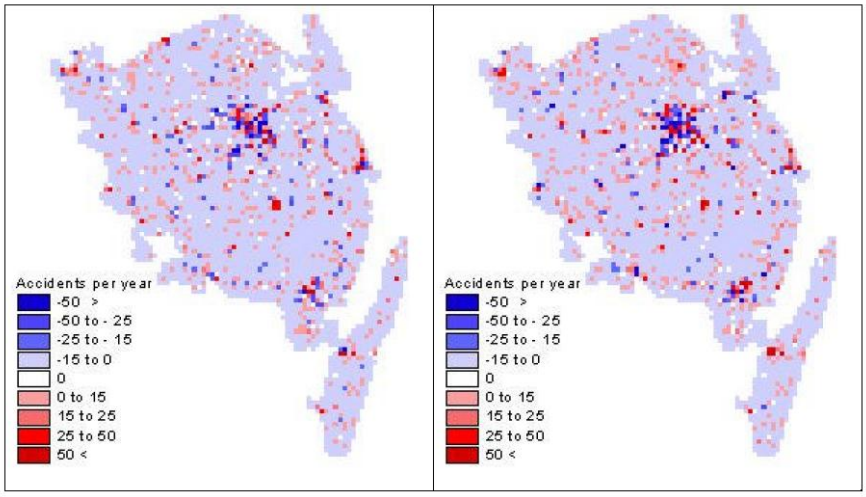

Figure 9. Accidents per km2: "summer weekends" minus "winter weekends".

Figure 10. Accidents per km2: "summer weekends" minus "fall at work".

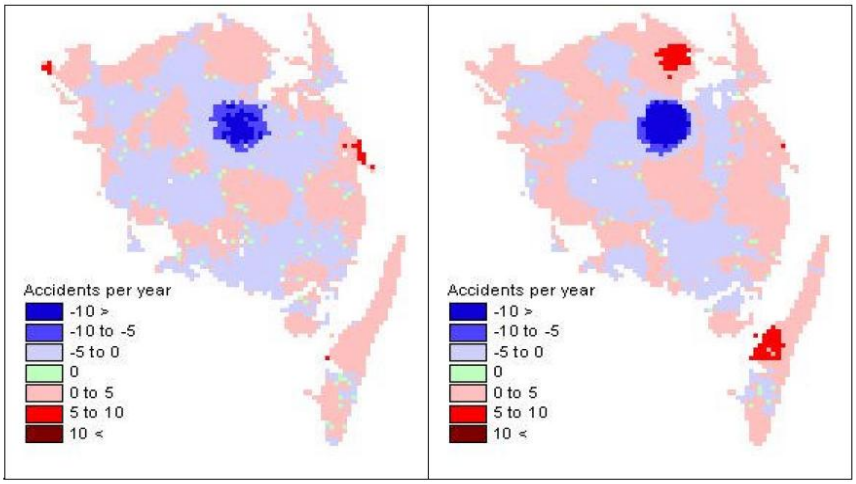

Figure 11. Accidents per km2 (mean within five km radius): "summer weekends" minus "winter weekends".

Figure 12. Accidents per km2 (mean within five km radius): "summer weekends" minus "fall at work".

When taking accidents per km2, it is very difficult to see any significant differences as shown in **Figure 9** and **Figure 10**. So, it is better to use cells within five kilometers rather than one kilometer as shown in **Figure 11** and **Figure 12**.

Best Results for allocation of ambulances on Funen:

The figure below explain the best result for allocation of ambulances on Funen by using Multi facility location allocation problem solution method for MFLA, p-median and p-center , as the following:

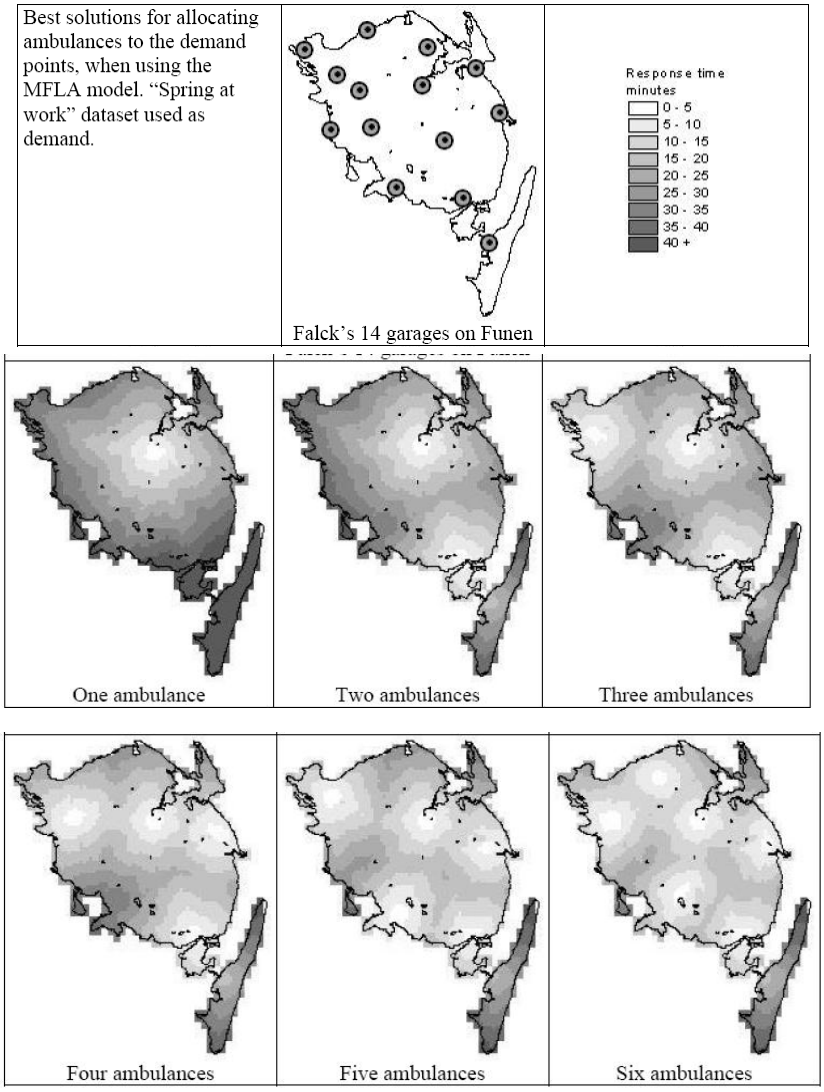

Figure 13. Best Results for allocation of ambulances on Funen.

Assessing ambulance response performance:

GIS-based approaches have been adopted successfully to analyse the quality and timeliness of a range of emergency services including ambulance, fire, and police dispatching(Jeremy P,1999).

Now we will present a GIS-based application for Improving the ambulance service performance and achieving the following aims:

- Evaluating and improving EMS vehicle response, by presenting an **analytical model.**
- Design and implementing a valid **GIS- based framework** to assessing EMS vehicle response.

Framework of GIS:

In the figure below, there are 11 components, including ambulance call data, spatial data, the system user, a graphical user interface, statistical analysis, spatial models, performance indicator calculations, built-in GIS functionality, mapping, evaluation, and decision making. The interaction between these component are described by framework. Under this term, planners can better target when, where, and for what type of calls ambulance response performance must be improved.

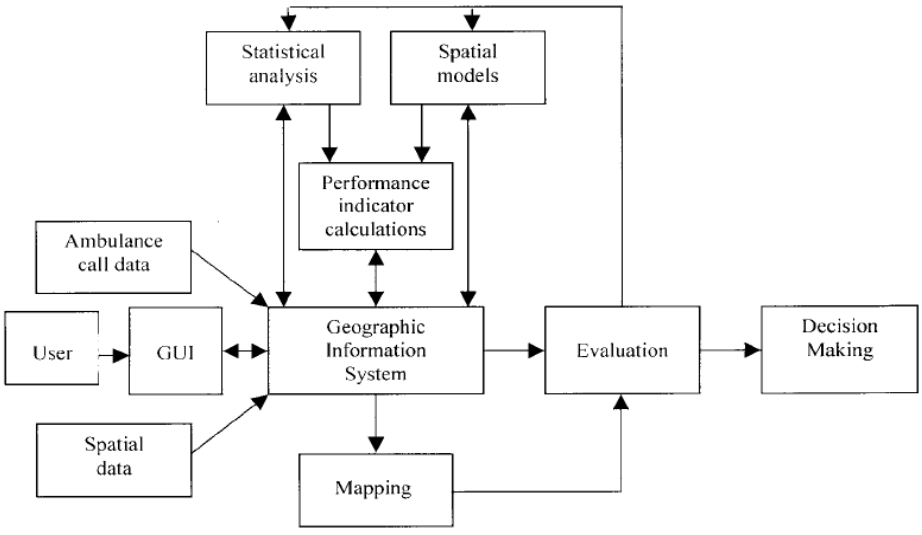

Figure 14: A GIS framework to evaluate ambulance response performance..

Improving Response Case Study–Mecklenburg County, North Carolina :

This study has done by Mecklenburg Emergency Medical Services Agency, better known as MEDIC that provides paramedic-level ambulance service to all of Mecklenburg County including Charlotte, North Carolina where population approaches one million people living, working, and commuting during business hours of the week. There are more than 70000 service requests are responded in year by emergency medical service. In order to help ensure rapid response times, ambulances are frequently moved around the county to respond to emergency calls. This way carry challenge for emergency medical service , so MEDIC personnel use GIS software ,GPS and mobile computers to get to an incident location .

When an ambulance is dispatched to a call, the system displays information about the call and suggests a route that is based on shortest travel time. After completing evaluation and patient care at the scene, paramedics touch the Depart Scene button, choose a hospital from a list, and the system routes them to that hospital This system has reduced overall response times by 15 percent

Conclusion

Health care is an important part in our live. It has many application systems planning and services. These application need to improve by using specific technological tools,one of these tools called GIS. Emergency medical service one of these health application that need to improve by GIS especially emergency vehicles. GIS play important role in improving the emergency respond during determining the quickest route .

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