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The Role of GIS in Information System, Management and Decision Making in Hospitals and Ambulance Centers

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Mini Review Article

Abstract

The exclusive capabilities of Geographical Information System (GIS) can be distinguished in combining diverse and very different information sources, in real-time storage and retrieval of descriptive and local information, in evaluation and analysis of time trend of incidents in form of statistical and spatial modeling and in positional assessment on the effects of development. Above descriptions show that GIS has grown as the most powerful tool for management, decision makings and optimized and rapid access to the information required for the hospitals and ambulance centers. suitable readiness for effective response and rapid reaction to the conditions of the natural disasters like industrial incident and human made incidents, e.g. urban and road accidents is the objectives and responsibilities of hospitals and medical centers. Moreover more than eighty percent of the required information in ambulance centers are positional information or information that are somehow dependent to location. Hence, application of Geographical Information System technology will be very considerable and beneficial for hospitals in order to displaying the location and region coverage and to lead the teams toward the region, to make appropriate decisions in crises and disasters and for emergency management (especially in information related to HSE of industries). Also in the analysis and assessment of hospitals' information and injured that are referred to hospitals, using GIS technology will be improve applications of Information Technology in hospitals and emergency centers in the following fields: -locating new areas for the construction of hospitals in according to the maps and different layers of data, analyzing reserved equipment and facilities for high risk situations, routing in order to provide the most rapid and timely aid, capitation of population of the region in terms of equipment and hospitals' beds, appointing places in danger of crisis and for emergency aid and finally creating patterns of diseases dominance and health problems in the field of hospitals for Planning and decision making based on evidence and documents.

Keywords: Geographic Information System, Hospital, Emergency, The spatial information

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Introduction

Specifications of Geographic Information System consist of: a coherent and organized collection of hardware, software, professional

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forces, and reference location data. These elements are used for gathering, saving, updating, retrieving, integration, displaying and analysis of reference location data. [1] also its application for optimum decision making and proper planning for users, managers and planners has caused national academy of science (NAS) to express in its comprehensive report that "tools and data related to Geographic Information System (GIS) and Geographic Positioning System are a fundamental parts in every stages of management of emergency centers and hospitals that includes planning, collection geographical information to feed back and betterment in reduction of future incident effect." [4]

In fact, by the use of its special tools and techniques GIS starts to evaluate proposed region or location and then prepare the necessary maps from these areas and collecting the descriptive data related to surveying topic, process them and connects local data to descriptive data. Then a topographic database (TDB) with the capability of searching and retrieving information will be created. [1]

In this paper, we try to introducing the role and applications of Geographical Information System in system of information, management and decision making in hospitals and emergency centers. Also we show how using this system will cause saving time and costs of these centers, how it will save the lives of referrers, how it will accelerate the process of successful planning for managers and decision makers and eventually how it can ensure successfulness of programs and projects.

Geographical information Technology is based on Spatial Data Infrastructure (SDI) containing basic information, accurate and updated based on desktop systems, based on Internet and Intranet, based on management Information System (MIS), based on mobile GIS and based on information catalog. All these infrastructures are applied in sections of hospitals, Rescue teams, and in Safety and emergencies centers and they be used as a part Comprehensive system of health management.

GIS and response to the question of managers and decision makers

Reference spatial information: The first question is what kind of information is "the reference spatial information"? Having answered this question it could be specified that what kind of stuff (Information) we have within a single location? A location may describe by different properties, for example name of location, address, postal code or its geographical coordination (latitude and longitude). [1]

In many of events and accidents, position of hospitals or emergency centers and the victims, plays major role in the rescuing and giving response to the victims. [4]

Positioning: One important application of spatial information system is positioning and identifying the Possibility of events with respect to a series of certain parameters. This means that the GIS can specify the places that have the same certain conditions, for example to point out the locations in which the average rainfall is higher than 300 millimeter or the locations in which we have high prevalence of malaria. In analysis and inspection of hazards and risks that hospitals may be exposed to them, one of the most important issues which must be considered is position of hospitals in terms of mode of facing with a crisis and events in the study area. And if we have such crisis or disasters, hospitals and emergency centers must have facilities, equipment and sufficient preparation for the quick response to injuries. [5]

Also one other application of the system we can cite here is, locating new places for the construction of hospitals and health centers with respect to the parameters such as, distribution of existing medical centers, region population, incident potentiality, fee of territory and ...

Modeling and assigning spatial Pattern for incidents: By using data and collected information related to happened events in a particular area, we can outline a spatial pattern for a series of particular events. For example, whether the most road accidents occur in certain areas? And whether a certain disease is prevailing more in areas with specific geographical features? [4]

Aid in crisis Management: This item studies the events that may exist under certain conditions via modeling. In other words, it Predicts events and the consequence. For example, if a toxic substance gets into the surface water resources of an area what would be the volume and speed of contamination? Or in case of incidents and natural disasters such as floods and earthquakes, what would be the rate of spread of pandemic infectious diseases? [3] , [4]

In these cases we can use the Spatial information system and identify the most suitable areas for housing disaster victims and the nearest therapeutic areas and rescue centers for them. For example, to specify area of green open spaces for the settlement of disaster victims, rescuing and emergency air landing.

Non spatial questions: We have questions like "what is the average number of hospitals that we have for a certain number of the region's population?" and "with respect to population of a region and its existing medical center, how many beds should be considered for the construction of hospital in the region?". Although we do not need to know specific information such as: longitude and latitude location and address and distance of points, but these questions can be answered by the GIS as well.

Spatial questions: There are questions such as, "what is the nearest rout to providing rescue for a certain point?" or "whether the distance between the medical centers are in accordance with the existing standards?" In order to answer such questions, it is essential to know their spatial information. [4]

Applications of GIS in Hospitals and emergency centers:

The information resulted by GIS application in hospitals and emergency centers can be divided into two parts:

Information that is used in Information System of hospitals and emergency centers:

Increasing in performance of health and medical services: Research studies in hospitals are carried out to improve performance and to optimize hospital services and to fight against diseases in order to promote the level of health in the society. In this field the GIS can be considerably helpful for the researchers in order to understand the manner of distribution and spread of diseases and their relationship with environmental factors such as climatic conditions, water quality, hygienic status, industrial and agricultural activities and environment pollution factor. In this subject they will search for disease symptoms in the range of hospitals based on different criteria such as: local, descriptive and conditional. Then they predict and prepare required services for dealing with these effects. In this subject also they enter exact address of the patient to the GIS software and in the next stage they will add basic map of the region, after that the distribution map of the specific disease in the region is prepared. We can use this map for finding a general view of areas that are affected by disease or path of the progression of the disease.[3]

Evaluation of the risks of spreading infection: The risk of spreading infection due to health aid (HAI) is one of the concerns of the hospital system. These risks could be derived from natural factors such as age, severity of disease, overall health status of patient and or be resulted from external factors and hospital environment including medical care, medical equipment and even the immediacy of patients with other patients in the same room. Spatial information system can collect descriptive data and spatial data of patients that are infected with infectious diseases in hospital environment and prevent

the risk of spreading infectious diseases in Hospitals which is one of the major factors in giving services to patients.

Evaluation of Beds Occupied Ratio: Appointing Bed Occupied Ratio (BOR) in crisis situations in which we need statistical information about hospital status for providing the services to the injured people of accidents and natural disasters is one of spatial information systems services. For complting information SIS can be effective in health information systems (HIS) of hospitals by following admission status, patients discharge status and the occupied beds in hospital. [4]

Integration of various satellites positioning system: Because life and death of injured people in accident depends on seconds, existence of a spatial information system is a necessity for emergency centers. Regarding this filed spatial information systems is facilitate the following applications:

To assign critical areas and disasters probable areas in order to provide timely and rapid aid In cases of emergency and crisis, using satellite locating system (GPS) in ambulances, evaluation of services of lifeguard centers in terms of limitations and conditions with using data from the reference spatial data, rapid positioning of lifeguard centers and hospitals near disaster probable area, appointing possible points for transmitting rescue and urgency group to search for victims of disastrous events in which we buildings is destroyed.

Finding the best place to build an emergency medical center with respect to the GIS data in locations in which we have highest rate of road accidents is among applications of GIS in the information system of emergency centers.

Information which are used in management and decisions making system of hospitals and emergency centers:

Assist in special disease and incidents: In the early 21st century, the prevalence of different diseases such as H1N1 virus or incidence of natural disasters such as earthquakes and floods in some areas showed that hospitals and lifeguard centers with respect to their existing facilities was not able to meet the demands arising from these events. In order to achieve correct and rational decision making and planning in these Conditions, using some of public centers and buildings or constructing prefabricated hospital as secondary care centers are the best options for accelerating the improvement of capacities of nursing and medical care. In this issue GIS maps gives spatial information regarding locations of the proper buildings and places for this conditions and plays a major role in planning and management of hospitals and medical centers

Assist in the management of trauma centers: In hospitals or trauma centers, planning and management are very important for rapid audit and treatment of trauma patients to reduce mortality caused by accidents and unexpected events. A hospital or comprehensive trauma center, must prepare the possibility of offering services to a large number of trauma patients with provision of rapid and high quality nursing facilities. In fact, a trauma hospital usually includes a network of emergency medical services and ground and air ambulance with possibility of establishing contact with one or more trauma centers. In this field, to determine optimum locations for the establishment of trauma centers so that the maximum numbers of people that are exposed to severe injuries and accidents have been treated in the shortest time, is considered a major challenge for planners and managers of hospital emergency. In this regard, spatial information system with the use of spatial data and overlapping functions (Overlay) in according to the reference spatial data and the people who have uppermost need to the services assists planners and managers in hospitals to determine the most optimal location for construction of these centers. Because of Special training in these centers and special equipment and resources needed for these centers, large expenditures are imposed to the managers and decision

makers of these centers. So the logical and true decision making before the construction of these centers, In addition to reducing mortality from injuries and accidents in their covered region, will cause optimization of costs and more profitability for these centers as well. Also, using web-based software of the Spatial Information System like Arc-IMS and Arc-SDE, we can provide accessibility for users to locate hospitals and trauma centers as well as ambulances and helicopters of these Centers [4]

Crisis Management: One of the complications and problems in emergency centers is management of crisis and accidents and in this respect the GIS maps can play basic role in decision making and timely shipment of rescue ambulances to disaster area. In procedure of crisis management, in urgency centers we would have need to build some prerequisites with the use of spatial information system. These steps include providing maps of roads and lanes and specifying rescue bases on it with the use of GIS software. Moreover, all rescue vehicles like ambulance, fire extinguisher, police, etc must be equipped with required devices to send their positions to the control center online. As soon as coordinates of the location of the incident received by control center, software box linked to the AVL software determine the closest rescuer vehicle. Also GIS contribute to the urban rescuing in metropolises, determining the best way for ambulance to reach the scene by the use of NETWROK ANALYSE process, routing Data, urban traffic data transmission in management of crises and accidents in emergency centers.[2], [3]

Positioning and constructing health centers: Construction of hospitals and for providing health and medical security needs of a region depends on numerous factors and conditions including following:

Population distribution of that region, prevalence disease in that region, number and manner of activities of other hospitals in that region and their geographical distribution, geological assessment and regional survey for the location of construction site, to specify geographical features and phenomena of every specific region close to disaster areas

In this regard, by evaluation of spatial data and drawing required maps for each case, spatial information system helps managers and planners of hospitals in the decision making to determine the optimum location for the construction of hospitals.

Currently one of the most important rings in the medical network of referral system in the country is its association to the hospitals. In recent years some efforts had been carried out In this regard, but many of them have not been successful, because some parts of the country implementation of referral system, is practically faces difficulties. One of these difficulties returns to improper determination of hospital construction location, For example, there are hospitals that are constructed in areas with lack of referral, or specialized hospital has been built in a city that has not a general hospital. These Problems illustrates the importance of spatial information system to be implemented and used in the decisions making of planners and managers of these centers.

3-2-5- displaying information: Regarding application of maps and reference location data generated by Spatial information system in hospitals, this system as a support of decision making system will help hospital managers with directions, planning and fulfilling hospital responsibilities by the following applications:

Analyzing and monitoring of information in displaying positions of hospitals and emergencies centers, displaying different densities for occurrence of diseases in the geographical area, appointing limits of diseases for prevention and management planning on the prevalence of diseases and appointing possibility of their spreading to neighboring areas [3]

Execution suggestion in the field of GIS application in hospitals and emergency centers

1- a proper and unique database, should be prepared by using spatial information system for all hospitals and emergency centers in the country. In this database we should provide and analyze all spatial data and descriptive data required for hospitals and emergency centers with respect to the location of each hospital.

2- By providing dynamic web based maps; we should provide access for managers and users to these maps and help them to find the nearest and most appropriate hospital. And as a consequence, the problems that existing crisis management of accidents and disasters has faced them will be reduced.

3- By using data derived for spatial information system, in all over the country, we recommend locations for construction of new hospitals as the optimal locations.

4- Better utilization and more application of various capabilities of the technique and tools of GIS and network analysis in planning of hospital and emergency centers' managers and acquainting them with the application and the role of GIS in decision making.

5- Using the GIS in the system of emergency medical service (EMS) in order to optimize their services and accelerate and appropriate their response to victims should be considered as an integral part of these centers. Also, using this Information should be considered as a principle in the programs and managers' decisions in hospitals and emergency centers.

Discussion

One of the most important benefits of using GIS In hospitals is collecting and classification of dispersed data in form of digital information which accelerates searching and retrieving endeavor. Also with the unique features of the GIS, we can easily integrate descriptive information of hospitals and emergency centers with spatial and geographical data. Moreover, we can draw all types of querying, reporting, investigating the trend of distribution of diseases and their affecting factors on digital maps.

Important and emphasized point regarding the GIS application in hospitals and emergency centers is that we can organize information and manage planning in critical condition and improve reports and analyzes gathering. Besides, we can follow standardization of unique codes for all features including both descriptive and spatial and we can help planners and managers in decision making and critical planning by timely information.

Conflict of Interests

Authors have no conflict of interests.

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