UML Modeling for Health Information Services Integrated with GIS

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Abstract— **Geographical Information Systems (GIS) have been used widely in many developed countries to map health related events and the results are used for planning of health services (such as locating health centers). As well as in assessing clusters of cases to look for possible introduce the best service for the population. The health service is reflecting the importance to any community over the economic and social development of the country, as one of the basic necessities of the population. The Fact of development of health services, a guide to the country's ability to achieve economic and social development and to lead the society and its functions efficiently. The paper aims to employ GIS technology in the preparation of a Geographic database of health services in the Kingdom of Saudi Arabia and then processed and analyzed spatially at the district level. For materials and research methods have adopted statistical data for the health services at the ministry of Health of KSA at the level of administrative units as a major source for the formation of health database. The paper also able to define the workflow for each activity using activity diagrams in UML model. The sequence and activity diagram for the above proposed model is presented. The class diagrams were effective in systematically organizing the information to be used in the health center service.**

Keywords- UML; GI; Health Information Services; Sequence Diagram; Activity Diagram formatting

I. INTRODUCTION

Contributed to information technology in today's world quickly exchange of spatial information of different types, and emerged digital technology; in the fields of geography which is known as geographic information systems (GIS), which now has an active role in accelerating the process of spatial development of the various life activities. GIS has also contributed to the development of rules of geographic information and the possibility of storing, processing, classifying and retrieving any kind of geographic data.

Models are playing very important role to understand real time problem. A model gives an overall idea about the actual problem in a very simple and clear way [1]. The object management group introduced the Unified Modeling Language (UML) for the software designers to develop useful, efficient, effective designs and quality model system for the industry people [2, 3]. The Unified Modeling Language (UML) is a modeling language that covers a large range of different application domains and which is used to design a scientific and research problems [4]. UML model is an accepting a view of actual real world problem and explaining it in the form of pictures and notations [5]. UML have nine standard diagrams for graphic representation of a system which represent the different points of view of the system. These standard diagrams are: classes, interaction sequence, objects, interaction-communication, and state, use, activities, components and display [6]. Some of the important domain oriented UML models are designed and shown in [7, 8, 9]. Geography always plays the important role in human's life. A geographic information system (GIS) is a kind of system which is used to capture, designed, store, manipulate, analyze and manage all types of geographically referenced data [10,11]. The geographic knowledge is applied to human routine tasks such as unfamiliar with the city or searching the exact street or station etc. [12]. Recently there are some important research papers about explaining the GIS system in a very effective and efficient way given in[13,14]. These are some other papers that are explaining and preventing accidents in a very simple way [15, 16].

II. OVERVIEW OF GIS

The phrase "geographic information systems" was first used in the 1960s to refer to a computerized system for asking questions of maps showing current and potential land use in Canada [1]. Since that time, a number of definitions have been proposed, with variations that depend on the perspective of the author, the specific application, the software availability at a given time, and the level of complexity appropriate for the intended audience. Some authors have begun to suggest that a different term, "geographic information science," might be advantageous in order to place greater emphasis on the underlying general principles and science and to be more independent of developments in software technology [17].

From a community health planning perspective, the Federal Geographic Data Committee (FGDC) definition provides a useful starting point:

A computer system for the input, storage, maintenance, management, retrieval, analysis, synthesis, and output of

geographic or location-based information in the most restrictive usage, GIS refers only to hardware and software. In common usage, it includes hardware, software, and data. When organizations refer to their GIS, this latter usage is usually what they mean. For some, GIS also implies the people and procedures involved in GIS operation [18].

The inclusion of "people" and "procedures" as part of the definition is essential for GIS applications in a public health context, given the need to link the science and methods of epidemiology to GIS maps. Without trained staff, one scenario is that the GIS software will not be used at all (given the time and staff constraints that exist in many public health agencies and organizations). Alternatively, without trained staff and standardized procedures, the technology may be used to develop maps that are invalid or misleading.

III. GIS FOR HEALTH INFORMATION SERVICES

The look of researchers to spatial data changes depends on the Geographic Information Systems GIS used in the development of management and growth of cities at various levels, on the contribution to provide comprehensive information on the location of services, and on the creation of alternatives planned to ensure a degree of efficiency of existing ones. This look should achieve a state of balance of spatial population density, according to sectors of the city, as it should move geographical services to the era of new technology in the field of research due to spatial geographic information systems GIS.

The concept of planning as a method or approach aims to study the potential and the resources available in the region or state or city, at various levels to achieve the goals during the given period of time. It is a tool characterized by its effectiveness in the use of methods of modern art, which are based on analysis, not intuition. The health planning is defined as an effective and essential to the adoption of modern scientific method in the development of health services, and to create and exploit resources efficiently [11].

Several advantages of GIS technology for public health practice, planning, and research are as follows:

- GIS technology improves the ability of practitioners, planners, and researchers to organize and link datasets for example, by using geocoded addresses or geographic boundaries). Geography provides a near-universal link for sorting and integrating records from multiple information sources into a more coherent whole. This ability to link datasets can help public health practitioners plan more cost-effective interventions.

- GIS technology provides public health practitioners and researchers with several new types of data. For example, with GIS technology, local public health departments can use global positioning systems (GPS) to receive signals from satellites to determine latitude-longitude coordinates for point locations not found in TIGER files, such as rural residences, wells, and septic tanks.

- GIS technology encourages the formation of data partnerships and data sharing at the community level. For example, to develop a map of motor vehicle injuries and fatalities in a community, a local public health department could develop data partnerships with the Department of Transportation (for information about traffic flow and accidents), local ambulance services (for information about injuries requiring transportation by ambulance to hospital emergency rooms), and the Medical Examiner's office (for information about fatalities) [19].

IV. UML CLASS MODEL FOR HEALTH INFORMATION SERVICES

A GIS Health Information Services (HIS) has been designed with the use of UML concepts and which is shown in Fig. 1. UML class diagram demonstrates the structure of the system by depicting classes, attributes and relationship. The complete GIS for (HIS) have been designed with attributes and functions. The different properties have been used like association, aggregation, inheritances etc in the form of sub classes and shown in the UML class model. In a UML class diagram Patients class has multiple associations with different Categories and Categories has a multiple associations with Patients class also. Similarly Patients class also has multiple associations with Nearby class and Health Service class and also has Multiple associations with both classes. Categories class has a single association with Health Services class and a signal association with GIS class. GIS class has multiple associations with Nearby class and a signal association with Location class and categories class. The Nearby class has a single association with GIS class and a single association also with Location class and multiple associations with Patients class. Finally the Location class has multiple associations with Nearby class and also with the GIS class. The diagram in Figure 1 shows that the label * refers to multiple associations and the label 1 refers to a signal association.

V. UML ACTIVITY DIAGRAM FOR HEALTH INFORMATION SERVICES

An activity diagram is a kind of flowchart that shows the flow of control step-by-step [17]. The activity diagram shows the various activities one by one with the moving for both controlled and uncontrolled activities. The UML activity diagram of the above model is shown in Fig. 2. The activity diagram represents the complete process of HIS. According to the activity diagram patient needs the information about the suitable health service within the city by looking in the Categories database. When the Categories get the information

from patient the system will connect to the GIS system through Internet and look for the exact location of the suitable health service. After the patient collects the detailed data for the Health Service such as the health center name, owner, capacity and details deception of the health services, the exact map location will be provided by GIS. Also the patient can look around for the nearest services like hotels, restaurants, bus station, ATM, etc.

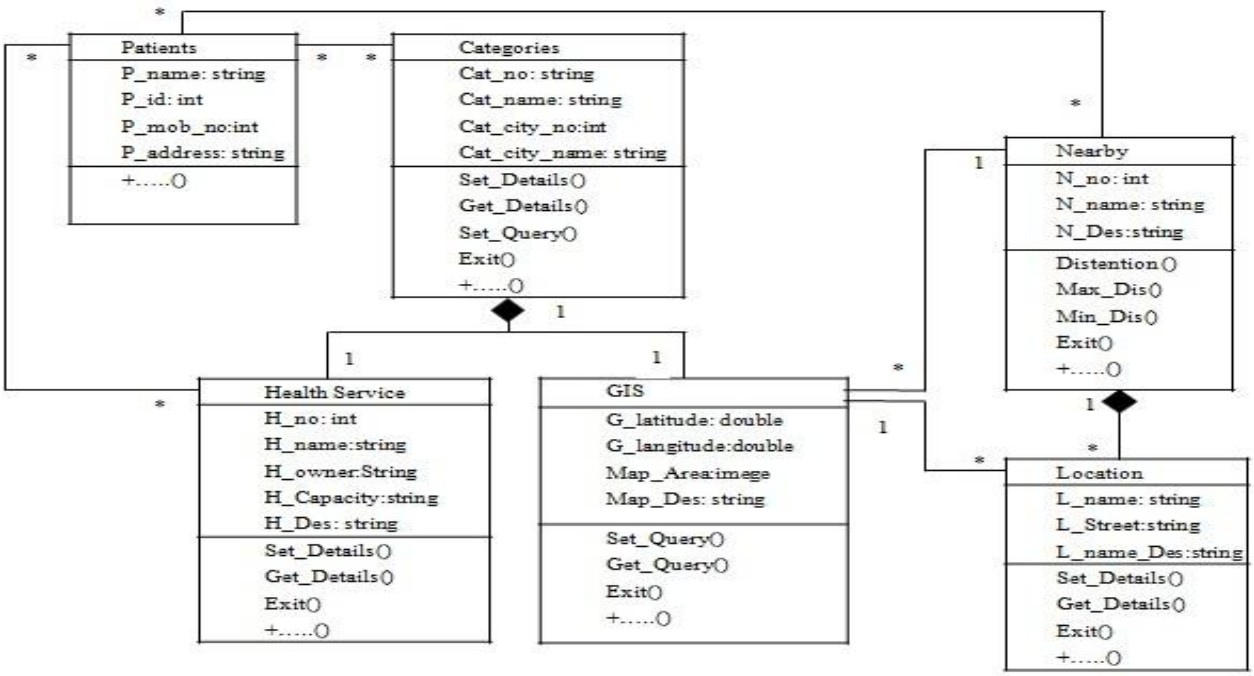

Figure 1. UML Class Diagram for Health Information Services

VI. UML SEQUENCE DIAGRAM FOR HEALTH INFORMATION SERVICE

The sequence diagram is representing the interactions between objects. It passes the message from top to bottom. The sequence diagram of above HIS UML model is given in Fig. 3. This sequence diagram of HIS has five important objects which are shown on the top of the diagram in the form of rectangle boxes with their class names. The five main objects are Patients, Categories, Heath Information System, GIS and Nearby. The communication between two objects is shows by an arrow and the message of that arrow. According to the sequence diagram given in Fig. 3 Patients send a query to the Categories to collect the best suitable health service. As response, the Categories give the requested data to back. When the patient knows the needed service he requests the map location using the GIS via Internet. The GIS system finds the exact location of the location after which the system searches the nearest service related for the patient request and returns the location for the nearest service back to the patient.

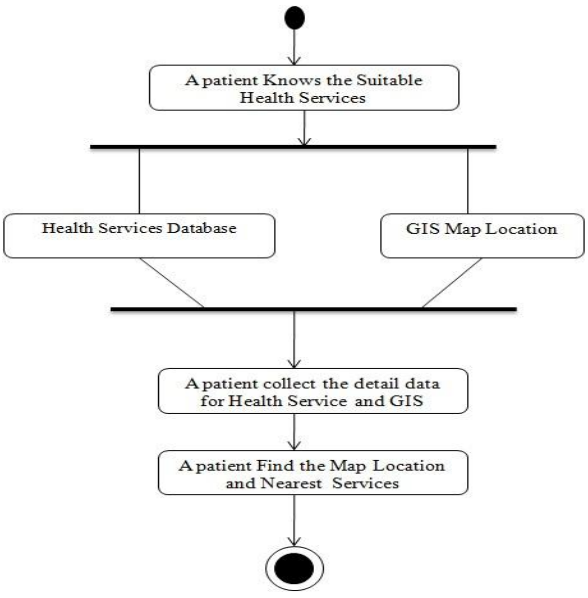

Figure 2. UML Activity Diagram for Heath Information Service

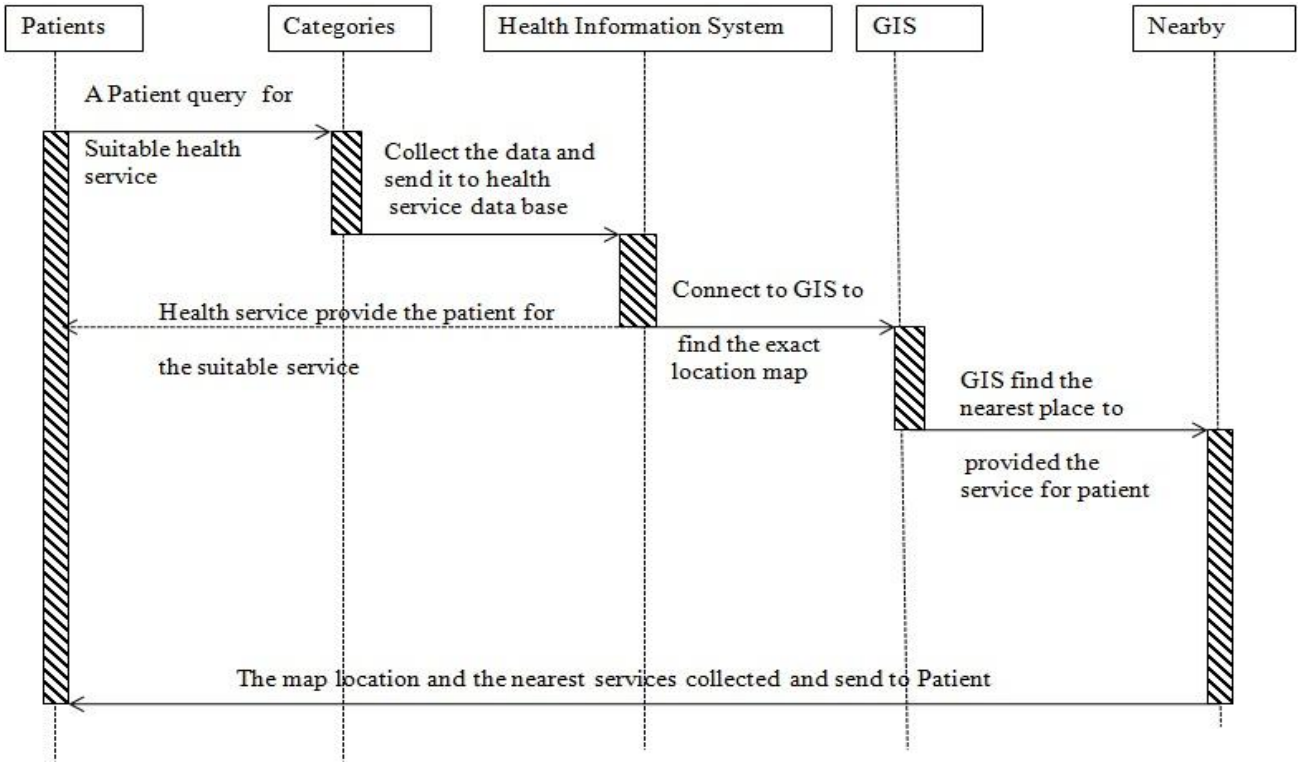

Figure 3. UML Sequence Diagram for Heath Information Service

VII. EXPERIMENTAL STUDY

Table 1 illustrates how much importance is given to health services in Saudi Arabia. We can see the big number of Health Centers by region. Examples in Riyadh there are 399 Public Health Centers (PHC, 74 hospital, 458 dispensaries and 1762 Pharmacies). The table also illustrates the geographical distributed the services in all regions of Saudi Arabia to cover the needs of the population. This is taken from the report issued by the Ministry of Health in Saudi Arabia for the year 2010 which is the latest report available in the website of Ministry [20].

The report shows some of the health services like the no. of hospitals, no. of Public Health Centers (PHC), no. of Dispensaries and no. of Pharmacies, other health services can show in [20]. In the table the no. of hospital includes the government and privets hospitals.

The Figure 4 gives a clear picture of the size of the health facilities distributed in all regions where the population was estimated for the year 2010 is 27,136,977[20].

TABLE 1 DEMONSTRATES THE HEALTH FACILITIES OF THE MINISTRY OF HEALTH COVERING ALL THE HEALTH SERVICES.

Region	No. Hospitals	No. PHC	No. Dispensaries	No. Pharmacies
Riyadh	74	399	758	1762
Makkah	18	84	101	374
Jeddah	38	93	343	998
Ta'if	16	112	69	235
Medinah	32	143	80	331
Qaseem	22	151	72	271
Eastern	40	124	167	497
Al – Ahsa	13	63	46	152
Hafr Al - Baten	6	38	24	73
Aseer	25	227	124	446
Bishah	7	76	19	76
Tabouk	12	67	40	173
Ha'il	12	93	21	146
Northern	8	43	23	42
Jazan	19	146	40	280
Najran	11	61	28	75
Al - Bahah	12	93	26	94
Al - Jouf	6	33	20	50
Qurayyat	4	16	7	25
Qunfudah	2	32	13	47
Total	377	2094	2021	6147

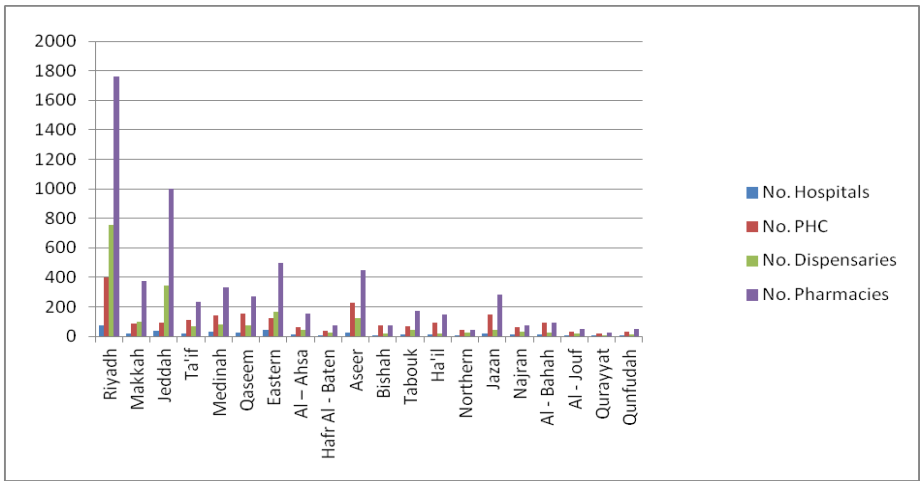

Figure 4. The Health Services by Region for Ministry of health in 2010.

VIII. CONCLUSION AND FUTURE WORK

From the above study the accomplished work shows that the UML is a powerful modeling language to solve scientific and research problems. In this paper a complete modeling of Health information services has been done through the UML. This model is simple and has a reusability property and can easily be enhanced, modified and updated according to the need of data. This basic work can be expended in the field of data mining using UML and expert system. Also the work shows that GIS used to determine the location and can be provides a near-universal link for sorting and integrating records from multiple information sources into a more coherent whole. This ability to link datasets can help public health practitioners plan more cost-effective interventions. GIS technology can be an extremely effective tool to help community decision makers visualize and understand a public health problem.

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