Inquiring Prescriptions Using Geographic Information System (GIS)

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Abstract

Geographic Information Systems (GIS) is considered to be one of the most important technologies provided by the Internet in our era. GIS enables institutions and individuals to plan and make decisions in many fields. GIS assists in accessing new and updated information on planning process. GIS also enables determining distances such as length, width, area on a map, and allows analyzing and processing a large amount of data for the search of geographical characteristics of locations. This paper explains the concept of dispensing prescription through the specific code of drug on an electronic system using GIS technology. The proposed methodology aims to inform patients of all the prescriptions dispensed and to help individuals inquiring about prescription at the nearest pharmacy through GIS technology. This proposed methodology is considered significant in some cases, as the patient does not know price, specifications and pharmacy location where the drug required is available, thus increasing the time and effort cost that is spent searching for the prescription.

1. Introduction

No doubt, technology has a huge impact on world of medicine. Developments in technology range from those that improve patients' comfort to those that prolong patients' lives. Perhaps, one of the most interesting technologies that has appeared on the scene is the one that aims to process geographic connections more efficiently. Geospatial technologies constitute a subset of information technologies, including the Global Positioning System (GPS), satellite-based Remote Sensing (RS), and Geographic Information System (GIS) [1]. GIS is a specific type of information technology that can help understanding: "what", "when", "how" and "why" in the world by answering the question "where". GIS is basically related to maps [2].

Saudi Ministry of Health provides many electronic services such as (Mawid); it is an electronic service provided by Saudi Ministry of Health to enable beneficiary to book appointments at Primary Health Care centers, managing those appointments by modifying or canceling them, and also managing his other appointments at any hospital he is referred to. The portal also contains the service (E-Prescription) that allows user to dispense drug at commercial pharmacies through consultancy via Ministry of Health's channels remotely. The user can contact the call center (937) at Ministry of Health or use the (Mawid) application to obtain an electronic prescription that can be dispensed at the nearest

pharmacy to the patient without visiting a doctor [3]. Despite services provided by the Ministry, there are many problems, including that one facing pharmacy's doctor; does prescription belong to user? Who is the doctor who issued it? is it covered by insurance? There are also problems related to user's questions such as; at which pharmacy the prescription is available? To what extent the prescription is available? Are all drugs in the prescription available in one place? How much does the prescription cost? How the prescription can be inquired about? this can be achieved by designing an electronic system containing services for user, including the service of inquiring a previous prescription. The system also comprises the service (Dawaee) that aims to identify prescription information, its cost and available centers nearest to user by using GIS technology.

The user signs into the query link on the portal; he enters the ID No. and the prescription No. or the scan of external barcode of the box, then determines the search area. Thus, the user can purchase the prescription through the system entering card No. and password. GIS is based on a geographic database; the system manages the database information, analyzing and displaying them on geographical maps [4]. GIS determines the nearest to the manufacturer location, where the portal displays the scanned information, all-inclusive cost and quantity of drug available at pharmacies in the area.

The main objective of this research is to design an electronic system inquiring and determining prescription location using GIS technology. This paper is proposed to achieve the following objectives:

Objectives of the Proposed System:

• To determine health trends

• To use personal technology

• To improve healthcare quality

• To facilitate and speed up information access and making decisions.

• To enable display comprehensive detail of product.

• To allow visual representation of data on portals.

• To report prescription issuance, date and dispensing status.

In order to achieve these objectives, an electronic application is required to be designed to locate electronic prescriptions. The system allows user to inquire prescription through entering its No. or barcode. The system displays

specifications of drug and determines the location where the prescription is available, how it is issued and how it is paid using GIS technology.

GIS helps people to deal with problems in space and time dimensions, and in digital maps form instead of the dimensionally restricted data tables and charts [5].

The user enters the ID No. and the prescription No. or the box barcode scan and then presses the button (query). GIS technology analyzes the input data and outputs them as maps, displaying the nearest location where drug is available, showing the available quantity and the electronic payment method.

Figure (1) shows the components; GIS consists of:

- Network: It is defined as a means connecting a number of devices (may be two or more), aiming to exchange information and data (for example, the Internet).

- Physical devices: Through which the user signs into the system, (such as, laptop and cell phone).

- Software: It is the programs according to which GIS devices operate using Arc GIS desktop and HTML to design pages.

- Individuals: They are responsible for designing, programming, outputting results, validating data, transforming and disseminating information.

- Procedures: It is a set of administrative procedures related to control, supervision and regulation [6].

Figure 1. Illustrates Electronic Pharmacy System Components Using GIS

2. Literature Review

GIS is a program that enables (1) geographic information to be captured from a number of channels (e.g. remote sensing), (2) interlinking of geographical and tabulated data, (3) geographical and tabulated data interpretation, and (4) the configuration of the overall geographical map [7]. The GIS facilitates data processing, geospatial information processing, simulation, scientific correspondence and coordination in the research field of science. GIS provides significance for several Geoscience domains. The demand for

GIS technology experts in the fields that use geospatial knowledge has not ceased growing since the first computer-based GIS was developed in the 1960s. Earth science includes a wide varying variety of scientific fields from geology, geoscience, hydrology, oceanography, climatology, temperature, and environmental science. Earth science covers the branches of research which address dynamic Earth parameters through the use geospatial knowledge which are nearly difficult to overcome without GIS [8].

The international market growth for GIS may increase in 2020 from $52.6 billion to $96.3 billion by 2025, at a rate of about 12.9% of the Compound Annual Growth Rate (CAGR). The main factors of expansion for the industry are the rising amount of GIS applications which are focused around Artificial Intelligence and Machine learning. The reason is the smart city and urban development, implementation of IoT sensors around sites and improvement in Big Data Management by optimizing workflows for organizations [9].
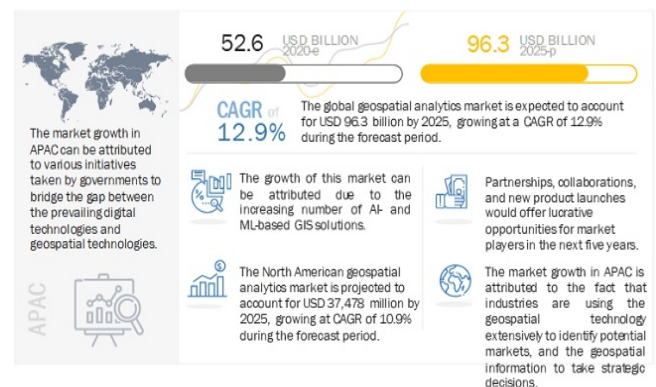

Figure 2. Attractive Opportunities in the Geospatial Analytics Market

GIS facilitates nearly all geographical information process and support data structures, including collection, processing, managing, evaluation, modelling, simulation, publishing and preservation. In recent years, a lot of work has been concentrated in using the capacity of the web to facilitate the exchange of geographical knowledge [10].

The GIS used today has been traditionally not developed to accommodate digital information and thus has very limited capability compared to huge amounts of data, very complex model, terminology and dispensing demands. While several of the GIS are achieved, the two-dimensional mapping of extremely detailed contour surfaces and colour schemes are unable to adequately present its multi - level and versatile geographical dynamics [11]. Thus, in terms of graphical symbols and colour distribution, the mapping function of GIS is not appropriate for the purpose of mapping and must therefore be modified in accordance with the applicable guidelines for spatial planning or accompanying mapping applications and GIS databases [12]. Digital image incorporation within a GIS environment is a possible solution in which multiple grid maps from the same sector are

inscribed together in a single, multidimensional database. This procedure is also used to blend visual images of various spectra, monitoring periods and detectors. The possible influence of distant sampling to the ecological study is practically limitless in conjunction with data collection surveys [13]. One such suitable application of GIS is the market research of Land prices since these measurements are dependent on geographical similarities and the characteristics of each house with the help of data sampling. The UK also has a modern state and local tax mechanism, the Council Tax, associated with capital property prices. GIS-embedded geographical model presents an innovative way to assess reliable capital prices and predicts any opportunities for using GIS to increase local revenue [14]. GIS-MIS network is a modern application that incorporates Geographic Information Systems (GIS) and Management Information Systems (MIS) into the web-based environment i.e., internet. This network is used in real-estate systems enabling users to access real-estate details and perform real-estate marketing online [15].

In today's society, pharmaceuticals are regarded as healthcare facilities where people can take leverage of medications and the services provided by trained workers. Often the pharmacist is able to play the position of general doctor, particularly in rural regions [16] since citizens have no alternative or are unable to visit another healthcare facility or expert in the region due to long distances and significant expenses [17]. Thus, almost all of the instances the first source of interaction with the patient is the pharmacist who is consulted well before any specific practitioner [18]. Consequently, geographical availability is critical if the increasing influence of pharmacy is taken into account [19]. In 2003 the Fair-Trading Office (FTO) of UK suggested the need to deregulate the pharmaceutical healthcare sector. It proposed to loosen the laws regulating the presence of pharmacies in the locality, particularly enabling the use of internet and mail-order for reaching pharmacies as it can prevent wastage of national health system money as well as reduce expenses for the patients [20].

A spatial GIS research on the delivery of pharmaceuticals in the city of Craiova and regional connection to these healthcare centers by the public is evaluated. In order to determine the pharmacies' spatial variability, concentrations, and geo-accessibility, quantitative data were interpreted in GIS environment with ArcMap software [21]. Even so, one must still consider how inadequate is spatial connectivity, since usability entails several things: closeness, accessibility and functionality [22]. During longer operating periods pharmacy can potentially become the most publicly available health service, even without a medical checkup [23]. Community pharmacies provide access to pharmaceutical care for the majority of residents which is comprised of 73% active pharmacists [24].

In addition to operating hours, connectivity is also very critical in respect to proximity and time. Around 98% of EU residents will register at a pharmacy within half hour and 58% have their pharmacy at around a distance of 5 minutes. The estimated European pharmacy concentration in 2016 were 31 for 100,000, compared to just 40 for 100,000 at the state level. With 7,932 medicines in Romania and 1,818 pharmacies in general, there were the identical concentration as Ireland. Currently, about 2,500 people have one pharmacy [25]. Therefore, this needs to be accounted for when suggesting a possible pharmacy location to the patient.

3. Proposed Methodology

In this field, various methods are proposed to use devices applications remotely. In this paper, an incremental model system is proposed including the development and requirements phase and the design phase finishing up the final phase. It is shown in Figure 3. The design phase is the testing and implementation phase.
The paper aims mainly to investigate the inquiring process of an electronic prescription. The programmer, in order to apply this proposed methodology, designs, implements and tests all system components, a system operating on GIS technology needs to be developed.

3.1. Use Case Diagram

Figure (4) shows the use case diagram for the proposed system. In figure (4), the first actor represents the system user inquiring an electronic prescription or searching by barcode and paying electronically. The second actor is the system itself performing the search process and displaying the prescription, its cost and available quantity, and determining the nearest place to the person location for acquiring it.
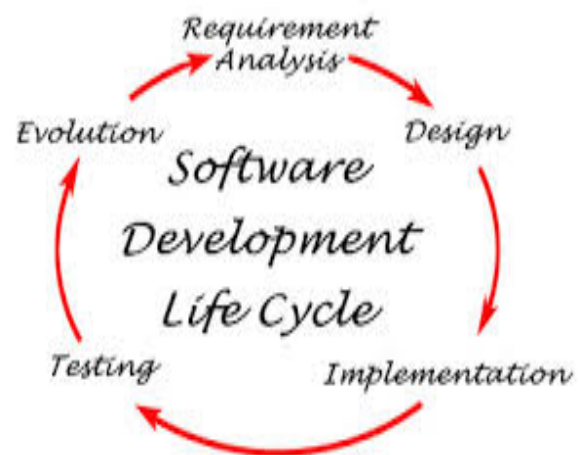

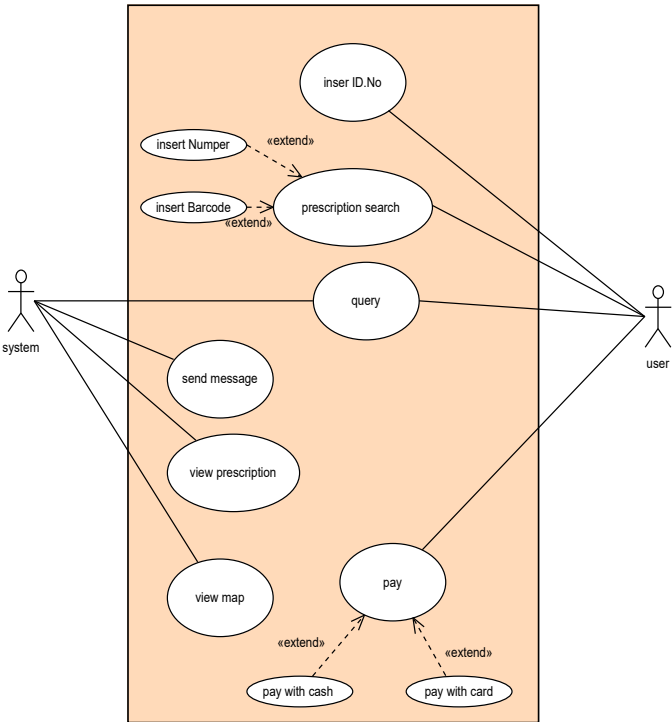**Figure 3. Schematic Representation of an Incremental Build Model**

Figure 4. Use Case Diagram for the Proposed System

Figure 6. A main Interface Locating Drug

Figure (6) shows a screen displaying the prescription specifications and identifying the nearest location and available quantity of drug. The screen contains icon inquiring another product, icon reporting prescription dispensed, and the button for payment (Pay).
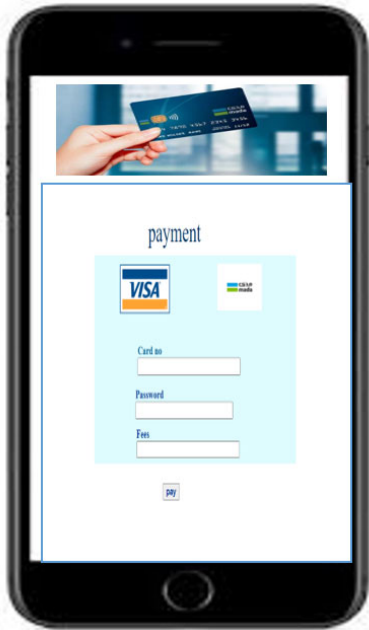

Figure 5. A Main Prescription Inquiring Interface

Figure (5) shows a screen inquiring an electronic prescription; the user enters the ID No. and the prescription No. or the scan of drug barcode.

Figure 7. Electronic Payment Interface

Figure (7) shows a screen displaying the process of prescription purchase via electronic payment. The user enters the card No. and the password. The screen shows the button (payment).

Figure 8. A Prescription Reports Screen

Figure (8) shows a screen displaying prescriptions reports; their place and date of issuance, and dispensing status. Patient enters it via the ID No.

4. Conclusion and Future Enhancements

GIS primary goal is to enhance the effectiveness in judgment and organizing of information by providing an effective way to transmit and interpret data, eliminate redundant data, integrate information from multiple databases, evaluate spatial references for data generation, and rapidly renew information as more data arrives. GIS is integrated in pharmaceutical network in this project which assists healthcare facilities as well as improves the efficiency in decision making for patients when buying medicines. It arranges geographical details such that a person who reads the provided map may gather details pertaining to a particular drug or provides its accessibility information with optimized navigation and ease in its acquisition with different payment methods.

5. References

[1]   M. Goodchild, "Information Technology as Megaengineering: The Impact of GIS," in Engineering Earth, 2011, pp. 37-47.

[2]   M. S. Jonathan E. Campbell, "Introduction to Geospatial Technology," in Geographic Information System Basics, 2012, p. 8.

[3]   Ministry of Health – Kingdom of Saudi Arabia, "E-Prescription Service," [Online]. Available: https://www.moh.gov.sa/en/eServices/Pages/Prescriptions.aspx. [Accessed 2020].

[4]   C. Dempsey, "Mapping and Geographic Information Systems (GIS) : What is GIS?," GIS Lounge, 1999. [Online]. Available: https://researchguides.library.wisc.edu/GIS. [Accessed 2020].

[5]   R. R. Mohammad, "GIS) modeling approach to determine the fastest delivery routes," vol. 2, 2016, p. 557.

[6]   H. Abouelkacem, "GIS in health disaster management," in The Second International Conference on Economic Intelligence, 2014.

[7]   B. S.M.Gandhi, "Chapter 10 - Geographic Information System and Common Earth Model," in Essentials of Mineral Exploration and Evaluation, 2016, pp. 257-269.

[8]   W. Zhou, "GIS for Earth Sciences," in Encyclopedia of Geology, 2nd ed., Academic Press, 2021, pp. 281-293.

[9]   MarketsandMarkets Research Private Ltd, "Geospatial Analytics Market," 2020.

[10]   M.F.Goodchild, "GIScience and Systems," in International Encyclopedia of Human Geography, University of California, Santa Barbara, CA, USA, Elsevier Science, 2009, pp. 526-538.

[11]   A. J. S. S.Selvam, "Chapter 1 - Fundamentals of GIS," in GIS and Geostatistical Techniques for Groundwater Science, Elsevier, 2019, pp. 3-15.

[12]   L. H. Z. HuangXianjin, "Comprehensive Geographic Information Systems: 2.20 - Application of GIS-Based Models for Land-Use Planning in China," in Earth Systems and Environmental Sciences, 2018, pp. 424-445.

[13]   R. DeFries, "Remote Sensing and Image Processing," in Encyclopedia of Biodiversity, 2nd ed., Academic Press, 2013, pp. 389-399.

[14]   ,. G. H. D. M. Paul Longley, "The predictive use of GIS to model property valuations," International Journal of Geographical Information, vol. 8, no. 2, pp. 217-235, 1994.

[15]   L. M. H. P. Chengda Lin, "Applications And Research On GIS For The Real Estate," 2001.

[16]   A. M. M. Alina Stefanache, "The Rural Pharmacy and Rural Health Services in the Perspective of the Individual's Community Protection," Revista de Cercetare şi Intervenţie Socială, no. 35, pp. 80-92, December 2011.

[17]   E. M. Adam Oliver, "Equity of access to health care: outlining the foundations for action," Journal of Epidemiology & Community Health, no. 58, pp. 655-658, 2004.

[18]   F. J. O. R. Eades CE, "Public health in community pharmacy: a systematic review of pharmacist and consumer views," BMC Public Health, vol. 11, p. 582, 2011.

[19]   D. M. V. L. C. P. a. D. C. Joanne Turnbull, "Does distance matter? Geographical variation in GP out-of-hours service use: an observational study.," The British Journal of General Practice, vol. 58, no. 552, p. 471–477, 2008.

[20]   House of Commons Health Committee, "The Control of Entry Regulations and Retail Pharmacy Services in the UK," 2002–03.

[21]   "Using GIS methods to analyse the spatial distribution and public accessibility of pharmacies in Craiova city, Romania," Bulletin of Geography: Socio-Economic Series, vol. 45, no. 45, p. 125 – 132, 1 November 2019.

[22]   D. H. J. F. J. D. G. M. a. I. S. S. Michael R. Law, "The geographic accessibility of pharmacies in Nova Scotia," Canadian Pharmacists Journal, vol. 146, no. 1, pp. 39-46, June 2013.

[23]   T. H. S. K. G. S. H. Karen Horon, "Should Pharmacy Technicians Provide Clinical Services or Perform Patient Care Activities in Areas without a Pharmacist?," CJHP, vol. 63, no. 5, pp. 391-394, 2010.

[24]   Parliamentary Office of Science and Technology, "Changing Role Of Pharmacies," July 2005. [Online].   Available: https://www.parliament.uk/globalassets/document s/post/postpn246.pdf. [Accessed 2020].

[25]   S. A. Cristiana Vîlcea, "Using GIS methods to analyse the spatial distribution and public accessibility of pharmacies in Craiova city, Romania," Bulletin of Geography. Socio-economic Series, vol. 45, no. 45, 22 September 2019.

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