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GIS-Enabled Heath Services Call Center System

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1. INTRODUCTION

E-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies [1]. The Internet and emergent telecommunications infrastructures are transforming health care management as well as the dynamics of health care service markets. Convergence between enterprise intranets and the Internet contributes to development of services such as content distribution and access infrastructures directly offered on the Internet [2].

Today, primary care physicians are a critical-means by which many patients access their health care system. The lack of adequate patient access to physicians can lead to delayed diagnosis and treatment, resulting in disease progression and increased cost of care [3]. To operate efficiently and effectively, health service providers must determine if there is adequate physician coverage for different types of health services and whether available physician services match patient preferences and needs. Consequently, there is the need for a system to manage health services by health care providers, insurance companies, and government agencies.

One system that lies at the intersection of these emerging technologies and management needs is the Geographic Information System (GIS). A GIS is a group of procedures that provide data input, storage and retrieval, mapping and spatial analysis for both spatial and attribute data to support the decision-making activities of the organization [4].

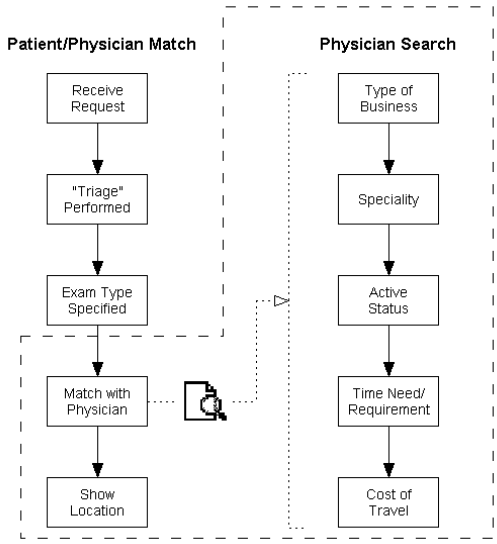
The company in this study and its divisions provide an array of disability evaluations, management, and information services nationwide. This project examined the use of spatial (i.e. GIS) software to assist the company in planning and marketing their healthcare services more efficiently and effectively.

2. PROBLEM

The problem for the company was to improve the accuracy and reduce the time needed to set an appointment location and date for a claimant with a physician. The workflow for this process is illustrated in Figure 2.1. Here, the case manager receives a request for an appointment. These requests are "Triaged" and the required exam sheets are generated using an expert knowledge base. Based on constraints such as physician specialty, availability, contract type, and location, an appointment is made for the claimant with the physician that is the "closest fit". Furthermore, distance, and travel-time to the physician must be minimal, with minimal travel-time being the higher priority.

In this process, the company is satisfied with its efficiency up to "Match with Physician" step. However the last two steps, which we term "Case Manager Scenario", are conducted using paper-based information and a number of mapping websites (Yahoo Maps and MapQuest). This process negatively impacts the time a case manager interacts with a claimant significantly. Therefore, the following system objectives

Figure 2.1– Claim Process



were identified during the initial requirements analysis meeting with the company:

- Link physician appointment availability with claimant preference in real-time
- Display claimant and physician data on a map
- Find the fastest routes to physician office

The company was advised that the proposed GIS solution would not only solve the problems outlined above, but would also allow them to do the following:

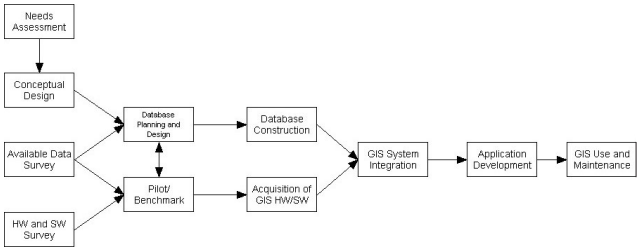
- Align claimants with physicians to determine underserved areas
- Query and summarize data by geographic area
- Generate demographic reports for identified service areas
- Determine market areas based on claimant and physician locations
- Create service areas based on drive times

Although these items became part of the overall objectives of the project, they were not undertaken at this time.

3. SOLUTION

To develop a solution for the Case Manager Scenario (CMS), the following GIS planning process, illustrated in Figure 3.1, was used:

Figure 3.1 GIS Planning Process



The GIS planning process, also known as the GIS development cycle, is a set of eleven steps starting with a needs assessment and ending with the on-going use and maintenance of the GIS system [5]. Though the steps illustrated here are presented as a logical progression – each step being completed prior to the initiation of the next – this is not the only possibility. Some of the activities in the process may happen concurrently, or may be approached in an iterative manner, or may need to be restructured depending on the size and resources available to plan the GIS. The GIS development cycle is based on the idea that one first decides what the GIS should do and then decides how the GIS will accomplish each task. The tasks for this project involved steps 1, 2, 3, 4, 5, and 6 as outlined below.

3.1 Needs Assessment

The GIS needs assessment is designed to produce two critical pieces of information:

1. A list of GIS functions that will be needed
2. A master list of geographic data

For this project, these two information sets were extracted from a series of user interviews. Users were asked to make a list of GIS application descriptions, data, and management processes they considered important to insure the success of the new system. Standard forms were used to document the results of these interviews [5].

3.2 Conceptual Design

The conceptual design of a GIS is similar to that of database design. In addition, the conceptual design of the GIS includes the identification of the basic GIS architecture (type of hardware and GIS software), estimates of usage (derived from the Needs Assessment), and an estimate of the size of the GIS. Moreover, this design is completed with reference to the existing data processing environments (legacy systems) that must interface with the GIS.

Information regarding the company's hardware and software infrastructure was collected. In addition, the existing local area network/wide area network (LAN/WAN) configuration was reviewed. This information was then used to ascertain the suitable GIS product for the company. This is further described in section 3.4.

3.3 Available Data Survey

This task documents the tabular and digital data within the organization as well as data available from other sources. The documentation prepared at this point must be sufficient to evaluate each potential data source for use in the GIS. In addition, the information collected at this point will also form part of the metadata for the resulting GIS database.

In this project a range of spatial data offerings along a number of dimensions were reviewed. Several spatial data vendors and their products were analyzed. For the company's spatial data needs, GDT was selected as the spatial data provider. GDT produces a number of data resources that can be used to create spatial products and services [6].

3.4 Hardware/Software Survey

During this activity, the GIS functionality of each commercial GIS application is documented for evaluation. In addition, a review of the current system hardware and LAN/WAN configuration, which was conducted in section two above, is used to evaluate the GIS. This helps to establish an optimal network configuration and establish hardware needs for the users.

A survey of the available GIS applications was conducted. GIS software vendors and their products were analyzed and rated along a number of dimensions as shown in Table 3.4.1. Based on this review, ERSI's ArcIMS was determined to be the most cost-effective offering for the company. [7, 8, 9, 10, 11, 12, 13]

3.5 Database Planning and Design

The detailed database planning and design task includes the following activities: developing a logical or physical database design based on the data model prepared earlier, evaluating the potential data sources, estimating the quantities of geographic data, estimating the cost of building the GIS database and preparing the data conversion plan. Concurrent with the detailed planning of the database, pilot studies and/or benchmark testing can be conducted. The information gained from these studies and tests are used to estimate the size of the equipment (e.g. disk space, memory, network configuration) needed and to determine if additional application development will be necessary.

The company provided a sample physician database for this project. This sample database was geocoded into a spatial database using ESRI's ArcGIS 8.2. Based on user requirements a map interface was developed using ESRI's ArcIMS 4.0. These applications were installed on the server in our GIS test lab hosting a Windows NT environment. The developed application is accessible through the Internet from any location for company use only.

3.6 Pilot Study and Benchmark Test

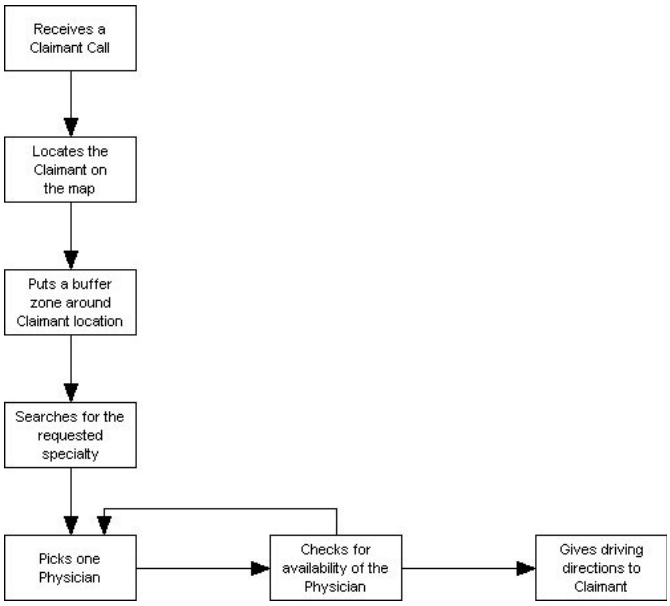
Pilot studies and benchmark tests are intended to highlight the functionality of the GIS software. These tests are useful in demonstrating to users and management what the GIS will do for them. In addition, any performance issues with the GIS can be determined.

For this project, the pilot study consisted of a CMS demonstration. This demonstration allowed users to visually display claimant and physician data on an interactive map. The new CMS, illustrated in Figure 3.6.1, was developed using the information collected during the Needs Assessment phase. This demonstration was completed successfully. The final product is now accessible through the company's Extranet from any company location.

Table 3.4.1 – GIS Software Comparison

VENDOR	Autodesk	Cadcorp	ESRI	Intergraph	Laser-Scan	MapInfo	ObjectFX
Product (Function 1)	MapGuide	MapServer	ArcIMS	GeoMedia Web	GothicIntegrator	MapXtreme	ObjectFX
Product (Function 2)	Map		ArcGIS	GeoMedia		MapInfo	ObjectFX
FUNCTIONS							
1 - Search/Display Geocoded Data in real-time							
Single Client Version (Desktop)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Multiple Client Version (Web-based)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2 - Spatial Analysis							
Single Client Version (Desktop)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Multiple Client Version (Web-based)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CHARACTERISTICS							
Acquisition Cost	Medium	Low	Low	High	High	High	High
Maintenance Cost	Medium		Free – 1yr	NA	NA	Low	
Platform Supported							
MS OS	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linux	NA	Yes	No	No	Yes	NA	Yes
Unix	Solaris	No	Solaris	No	Solaris	Solaris	Solaris
Java	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Database Interaction (Live or Prepared Data)	Live	Live	Live	Both	Both	Live	Live
Databases Supported							
MS-SQL	Yes		Yes	Yes			
Oracle	Yes		Yes	Yes			
Others				MGE, CAD, Access, ArcInfo			
ADDITIONAL SPECIFICATIONS (scale 1-10)							
Ease of Use		9	9	10	9		8
Implementation		7	8	6	7		7
Innovation		8	10	10	8		8
Interoperability		9	8	10	9		9
Scalability		9	10	8	9		8
Security		8	7	5	8		7
Suitability		6	10	8	6		8
Support		7	10	10	7		7
Training		7	9	8	7		9
Value		8	9	8	8		8

Figure 3.6.1 – Case Manager Scenario



Benchmark testing of the application developed in our GIS lab was conducted at the company's headquarters in a purpose-built environment hosting a Microsoft Windows 2000 Server. This environment also involved the company's main Oracle database.

At the end of the test implementation, a manual was prepared outlining the steps required to implement the new CMS on the server side. This manual also included the steps necessary prepare the client side for the new CMS as well.

4. CONCLUSION

In this project, a GIS-enabled Health Services Call Center System was developed and installed on the company's servers. A successful prototype of the new CMS was implemented using this system. One important achievement of this project was the development of a live connection with this system and the company's Oracle database. This database, which is updated on a daily basis, enables the company to exchange information with other company locations in real time. Consequently, users using the new system are able to view the latest data, geocoded on a map, from any company location.

Using an Internet based application (ArcIMS 4.0) for use within a company Extranet was one identifying characteristic of this project. Another is the fact that this shared information is now in a visual format. This visual format has not only facilitated a more effective decision-making process but has also decreased the time required to set an appointment location and date for a claimant with a physician. It is anticipated, that in the future, this system will enable the company to conduct some of the more complex GIS analysis identified during the initial requirements analysis meeting. It is expected that these "secondary" benefits would substantially add to the overall business value that this GIS has to this health care enterprise.

5. REFERENCES

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