WEB MAPPING OF CRIME RECORDS COVERING TAOPOON POLICE AREA

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ABSTRACT

This article describes about the development of an interactive crime map of Taopoon police station. The purpose of this study was to develop a web-based map system to display unsafe or hot spots within the Taopoon police area. All crime records are accompanied with time and place. This characteristic is ideal for combining crime records with web mapping. Implementation of Google Maps API was selected for this system. The development and implementation processes are together called web mapping. The newly developed system is aimed at both general users and operational staff including the administrator. The system provides several benefits. Such benefits are internet access for all types of user, informing crime incidents to the public, better understanding of crime patterns based on crime type, time, and region. Graphical and conclusive report is another available feature for further data analysis. Crime records were collected from Taopoon area's real crime incidents from January to March 2009.

Index Terms—*Web Mapping;Crime;Google Maps*

1. INTRODUCTION

IT technology can be applied to many police needs, such as onboard computing with voice command, instant license plate recognition, and centralized information system. Royal Thai police bureau has been implementing IT systems to its divisions and police stations. Some municipal police stations hire outsource firms to create and maintain their websites. Each police website itself is designed mostly for public relation but it has little to offer beyond that. There are types of data stored in police database which is related to local police websites. One typical data is crime data or crime record.

Each crime record is generally categorized by date, location, and crime types such as homicide, assault, burglary, vehicle theft, kidnapping, gambling, sexual assault, weapon violation, drug violation, and other illegal activities. This data comes from victims filing out police reports or arrest reports by police officers. The data is kept in a police database for later reference such as daily report, monthly report, and case references. As a result, utilization of crime data was exclusively for police officers. This approach undermines capacity of crime data to alert for more public awareness as well as solid guideline of crime patterns at specific place and time. Because of the characteristics of crime records and availability of free development tools, transforming the crime records and related information into an interactive map based on GIS technology should be pragmatic and useful for both police use and public use. Purposely, an interactive crime map of Taopoon police station was developed based upon all available data collected from interviewing police officers and real crime incidents of three month period from January to March 2009.

2. RELATED LITERATURE

Web mapping is the process of designing and implementing maps on web page or even on mobile devices. There are plenty of tools to do web mapping of Taopoon police area, Google Maps is one of the better free tools available. Google Maps API allows developers the opportunity to build arrays of applications on top of Google Maps [8]. In other words, Google Maps API is a web service tool to build web maps. The web map is an interactive and data visualized map. It runs on a web page and it retrieves data from linked database. Even though web maps generated by Google Maps API have limited analytical capability, that capacity is still sufficient for a certain level of this system development in terms of data presentation and data comparison.

Google Maps is a popular Web GIS application. Web GIS is an online service that serves data through browsers. GIS is the field concerned with the underlying concepts of geographic information [2]. This means that the data in use is spatial data which is referenced to locations on the earth. Google Maps API allows developer to embed Google Maps in web pages with JavaScript [1]. Google Maps API is a powerful and easy to implement into web site with many of Google Maps features. Google Maps also visualize attribute data or numeric data, which is pulled from database, to be displayed in clear format such as feature of typical information window. Google Maps is also a well known AJAX application. With AJAX, requests can happen more often and result in smaller responses of non-HTML data [5]. XML is used extensively to upgrade communication between client and server. Browser converts XML into map imagery [6]. Google Maps offer satellite pictures as well as the usual abstract map representations. User can pan, zoom, and change location with no refresh on the web page.

Related literature offers examples of GIS-based system development that have collaborated interactive

maps onto web pages [3,4,7,9]. Google Maps were collaborated with a database system to provide information of government and individual places in Chiang Mai [3]. Many utilizing approaches can be arranged such as integrating the system with the tourism authorities of Thailand's web site to represent more information to users. Groups of user were categorized into three groups such as officer, member, and client. Officer manages and maintains all data. Member manages and edits location and descriptive information about places. Client is typically a web visitor. Google Maps has not been completely developed in some Chieng Mai area. Thus, some places required coordinate estimation. Similar problem still currently occurs in Bangkok's web map as well.

Similar to the devlopment of Taopoon police's crime map, the graphic information system (GIS) for Chiang Mai police criminal reports and statistics was developed [4]. The purpose was to assist in the managing and administrating of criminal data. This system development helps fulfilling the weakness of the old system by transferring paper record application into database system and linking criminal records to the GIS map. The development tools were commercial ones such as Autodesk Mapguide and Autocad Map. The maps were built from real aerial photographs so the system was quite accurate. This development approach was fully applied GIS technology. Every pinpoint location was well synchronized with Mapguide server. Crime reporting system was also well developed.

Recently literature shows other similar approaches of Google Maps implementation. The development of the database management system by using GIS for Raks Thai Foundation offers user an option to graphically visualize data for quick search of ongoing projects [7]. The system was built with Google Maps API and a GIS software. The system development deployed distributed client/server and GIS approaches to displaying data about Raks Thai Foundation's particular projects via Google Maps. The main purpose was providing ability to manage and connect between database and the whole website embedded with Google Maps. This is a primary concern of Taopoon crime map's development as well.

Another literature is the development of a GIS for the management of the national elephant institute [9]. The system is a web application with Google Maps features. The web application helps officers to locate elephants in the elephant nurturing zones and upgrade data management more systematically with DBMS. This is a creative option to apply Google Maps onto web site for specific purpose.

3. METHODOLOGY

The methodology to develop the system can be divided into five phases as follows.

3.1. Study Feasibility of the System

This phase is about collecting data and identifying possible problems and solutions involving available data and real world processes. Data in this research is collected from interviews and daily police report of crime cases. They were collected from Taopoon area's real crime incidents between January 2009 and March 2009. Subsequently, development technology and tools such as ASP.NET with VB 2008, Visual Studio, Google Maps API, SQL Server, and related software were selected. Real Taopoon police map was in plan to be converted into Google Maps format [10].

3.2. Study Analysis and Design

System flowcharts and dataflow diagrams were created. System flowcharts are functioned based on user roles such as general user, operator, and administrator. General user is a visitor. Operator works as a data entry. Administrator or admin manages and maintains the system and entire database. In addition, administrator can set crime status for display purpose. For example, a crime case without administrator approval will be on hold and unable to be displayed on Google Maps. Such crime case is a case under investigation or awaiting other evidences.

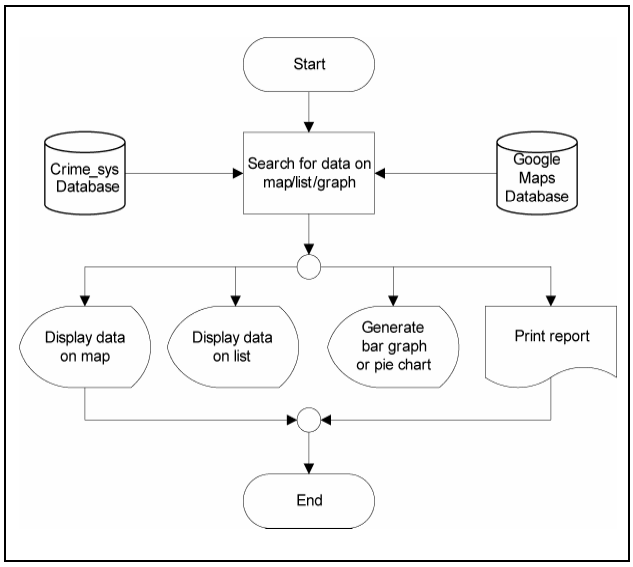

Figure 1. General User Flowchart.

In Figure 1, General user functionality is defined. General user can do searching data on map and web pages. Generating conclusive report and graph is also available.

After flowcharts were well settled, data flow diagrams were created. The diagram helps developer to under stand all inputs and outputs within the whole system and each module. Involved processes are user management, user authentication, data manipulation, data approval, and data retrieval. User management process is about managing user information such as add, update and delete user data or user role. User authentication process aims to verify valid user either administration or operator. Data manipulation process is about managing all data except user data and user role. Data approval is a process for data reviewing. Only approved data upon administrator confirmation will be displayed on Google Maps. Last but not least, data retrieval is a process that responses to a search input and display data on Google Maps and web as well as reports with a graph. Data retrieval process is shown in Figure 2.

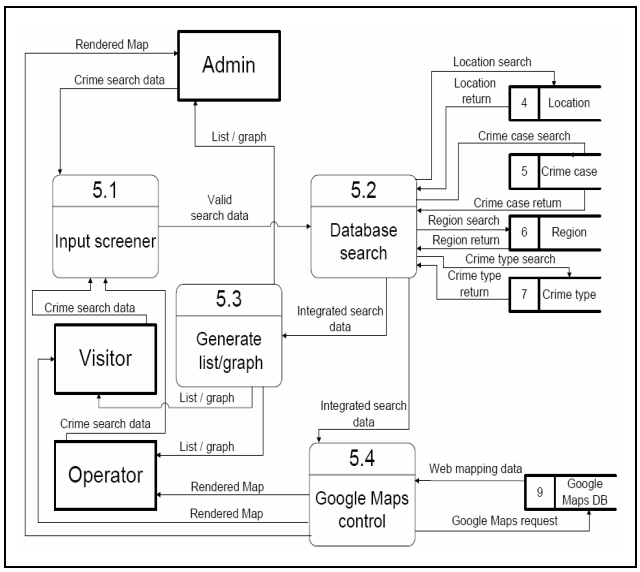

Figure 2. DFD Level 2 Data Retrieval.

3.3. Database Design

Entity relationship diagram (ER-Diagram) and data dictionary were created. The ER-Diagram was created along with data dictionary to define entities and attributes for the new system's database.

3.4. User Interface Design

After designing the system database, the next step is to design the user interface and screen layout of the system. The layout of the user interface is purposely designed for three groups of user.

3.5. System Evaluation

After developing the system, the system will be tested and evaluated. The evaluation process is done via questionnaires to measure satisfaction level of evaluator upon system tests. The researcher arranges the system test and evaluation into three groups of user. Seven IT experts performed usability test, ability test, and security test. Five police officers also performed the same number of tests as IT experts. However, assessment requirements for police officers staff users were less technical than experts. Ten general users general knowledge of the internet performed only usability test and ability test.

Descriptive Statistics methods are used afterward for analyzing evaluation results. Evaluation results were measures by using mean value and measures the dispersion of result values using standard deviation.

4. RESULT AND EVALUATION

The system functionalities are grouped slightly different for the three groups of user which consist of general user, operator and admin. User interfaces are similar for all groups of users but only admin can access all functions. The operator has less functions than admin, general users have only basic display functions. Admin can control crime record status and check user logs. Main page layout which opened for all groups of user is shown in Figure 3. Three police patrol were divided into subsections by different colors. Each location marker as one crime incident represents with different colors based on crime type. Search input can be done via right menu bar which contains many different input spaces. Graph and brief report can also be generated as shown in Figure 4.

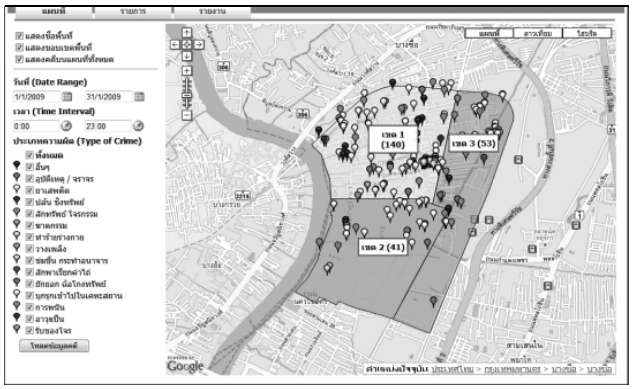

Figure 3. Main Page Layout.

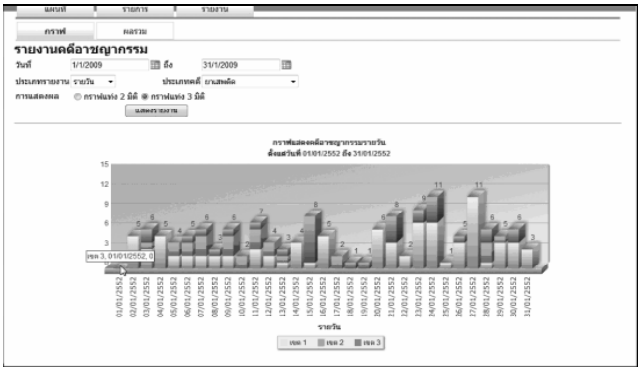

Figure 4. Bar Graph of Crime Incidents within One Month Period.

According to collected crime records, subsection area number one has crime problems more than other areas due to higher numbers of poor vicinities. Area number two has lower crime records because the area is packed with military compounds. Area number three covers mostly railroad and partially military compounds. Its crime record's number is in the middle. Drug violation is the most committed crime in all areas. System evaluation results are measured with mean value ($\overline{x}$) and standard deviation (*S.D.*) as follows.

Table 1. Overall Expert's Evaluation.

No.	List of Assessment	Summary Result		
		Mean	S.D.	Meaning
1	Ability test	3.80	0.55	Good
2	Usability test	3.50	0.53	Fair
3	Security test	3.74	0.41	Good
	Conclusion	3.68	0.50	Good

Table 2. Overall Operator's Evaluation.

No.	List of Test	Summary Result		
		Mean	S.D.	Meaning
1	Ability test	4.05	0.40	Good
2	Usability test	3.79	0.43	Good
3	Security test	4.11	0.58	Good
	Conclusion	3.98	0.47	Good

Table 3. Overall General User's Evaluation.

No.	List of Test	Summary Result		
		Mean	S.D.	Meaning
1	Ability test	3.91	0.71	Good
2	Usability test	3.88	0.80	Good
	Conclusion	3.90	0.76	Good

5. CONCLUSION AND FUTURE WORK

5.1. Conclusion

All crime records are accompanied with time and place. This characteristic is ideal for combining crime records with web mapping. Web mapping consists of development and implementation processes to build an interactive map run on a website. Google Maps API was a major tool to embed Google Maps which is dynamic and interactive to user requests. The system development originated to make more use of available crime records. The several benefits were anticipated for police officers and local residents.

The system development was done sequentially started from feasibility study to system evaluation. The system were tested and evaluated by three groups of user which were expert, staff user, and general user. The evaluation process is done via questionnaires to measure satisfaction level of evaluator upon system tests with slightly different series of questions.

System evaluation from expert's points of view overall concluded mean value = 3.68 and SD = 0.50. System evaluation from staff user's points of view overall concluded mean value = 3.98 and SD = 0.47. System evaluation from general user's points of view overall concluded mean value = 3.90 and SD = 0.76. The results showed that the overall satisfaction level equaled "Good" for this system.

5.2. Problems or difficulties

During developing this system, there were problems or difficulties as follows. Web browser compatibility caused different effect on how a web page looks like. Limitation of Google Maps API caused a problem while finding an exact location. Google maps of Bangkok metropolitan area are still being improved. Some geographical details are missing such as some location names or disputed multiple names.

5.3. Recommendations for future work

Recommendations for future work are described below. While collecting a crime record at the location, police officers should add attributes about latitude and longitude to make the system more accurate. GPS devices are required in this case. Police officers might create a master table to collect latitudes and longitudes for all landmarks in the policed area or spots that are crime-laden. This will save time during adding new crime records to the map. Development of a mobile version would be a fine approach of more view of data presentation for people on the move. VDO file or a photo can be added to info window for vivid detail. Data mining technology can be applied to extract crime patterns systematically.

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