Abstract: - Effective crime control requires accurate prediction for decision making in crime-control planning. In addition, the system should provide for the collection, organization and retrieval of a variety of data. Multiple types of data such as text (criminal data, property data, gang information, case information), graphic (photographs of criminals, pictures of crime scenes) and geographic (crime locations, details of the area) need to be accessed when and where they are needed, especially in time-critical situations. TELOCATE is a system that addresses these problems and provides integrated data and can be accessed by using wireless equipment such as Personal Digital Assistants (PDAs). This paper presents a design and implementation of a system using open source software such as Minnesota Map Server, PHP, PostgreSQL and PostGIS to provide crime information for police and citizens. User evaluations of the system allowed us to study the impact of TELOCATE on performance in crime control.

Key-Words: - Wireless GIS, Crime reporting system, Crime control system, E-Police, Open source software

1 Introduction

Electronic government-to-citizen (G2C) refers to the use of information technologies by government agencies to provide citizens with more convenient access to government information and services, and to improve the quality of the services [1]. The government needs to search for better ways to utilize Information Communication Technology (ICT) to improve government works and services for citizens. This concept has been applied to several government agencies including police work where it is referred to as E-Policing. E-Policing is the use of ICT in police work to improve effectiveness and efficiency, support frontline officers, and assist in local problem-solving initiatives to reduce crime and reassure the public [2]. The safety of citizens is the most important task of the government. Police officers spend a lot of their time on the streets patrolling and investigating crimes. To accommodate this mobility, wireless access is important [3]. In addition, geographical locations play an important role in crime control. It would be of value to the police officers to access geo-mapping data from anywhere and at any time.

Previous research has described information systems for police officers and other police-department staff [4, 5, 6]. This paper describes the TELOCATE system developed for wireless GIS in crime control. The system consists of mobile devices capable of accessing the Internet, with proper extensions for a GPS receiver and compact flash camera. Data can then be simply logged from the crime scenes and uploaded to a Geo-Database server. OpenGIS enables spatial data sharing and system interoperability, which leads to data integrity and timeliness and reduces data replication. Open Source software and freeware packages, such as Minnesota MapServer, PHP, PostgreSQL and PostGIS, were used to develop the system. Citizens can use the system to track their crime cases’ status, find important information related to their safety and other regular legal matters, report crime cases, find police stations and monitor crime data for incidents that have happened in their neighbourhoods. The police can use the system to record the crime data, crime location and crime scenes details, find information about criminals, crime case information, monitor crime and analyse the factors affecting crime risk in their areas of responsibility. Such a system, which can make information available on the Internet will ensure greater efficiency in crime control and better protection for the general public.
2 Methodology

2.1 Data preparation

The data were collected from the National Statistical Office of Thailand, the Royal Thai Police, the Bangkok Metropolitan Administration and the Ministry of Transportation. In this research, data from January 2000 to December 2003 was used. The data are divided into two formats; spatial data, which consists of data in map format, and non-spatial data, which consists of tabular data relating to crime, criminals and population.

2.2 Processes for analysis of factors affecting crime risk

Processes were constructed to systematically analyse the factors affecting crime risk. The processes can be summarized as follows (See Fig. 1):

1. Identify crime pattern characteristics. This step was derived from studying crime theory and consulting with police officers responsible for crime investigation and suppression. The purpose of this step was to identify the factors that were related to high crime risk in each district.

2. Establish the relationships between various crime factors. We have to consider which factors influence what and determine the relationships among them.

3. Determine the crime risk level. After the establishment of the relationships, we need to decide the crime risk level for each factor. The results of steps 2 and 3 were derived from expert elicitation in the field of crime control.

4. Recognize the crime data pattern using structured learning. Here, Hugin Researcher 6.3 software was used to recognize the crime data pattern.

5. Predict crime risk factors. The details of the model will be explained in the next section.

Fig. 1 The processes for analysis of the factors affecting crime risk

3 Model Description

3.1 Model of crime factors analysis

The model was developed based on the crime pattern analysis of Brantingham and Brantingham [7] and theory of crime control through environmental design [8, 9]. Pattern theory focuses attention and research on the environment and crime, and insists that crime locations, characteristics of such locations, the movement paths that bring offenders and victims together at such locations, and people’s perceptions of crime locations are significant objects for studies. Pattern theory synthesizes its attempt to explain how changing spatial and temporal ecological structures influence crime trends and patterns. The model was constructed and tested using Hugin Researcher 6.3 [10] software, which was also used to analyse the relationships within the data. A complete description of the model is described in detail in Boondao, Esichaikul and Tripathi [11].

3.2 Model of wireless GIS

The integration of police data and geographic data to build maps and enable geographic search using wireless equipment is a big challenge for the police services. It requires a multi-agency response and can be complex. Therefore, there is a need to develop a model to integrate data and services between various police divisions and to reduce the complexity of police services. The architecture of the system is illustrated in Fig. 2.

Fig. 2 Architecture of a Web-based Crime Control Decision Support System
The MapServer [12] is a system for developing web-based GIS applications. The core of the system is a Common Gateway Interface (CGI) application that allows developers to rapidly build and deploy web applications based on GIS databases using simple text-based configuration and presentation templates. The PostgreSQL [13] database server has been used to manage the attribute data and multimedia content. PostgreSQL is an Object-Relational DBMS, supporting almost all SQL constructs, including sub-selects, transactions, and user-defined types and functions. The database consists of tables that hold all the attribute data and spatial data.

The PostGIS [14] adds support for geographic objects to the PostgreSQL object-relational database. In effect, PostGIS “spatially enables” the PostgreSQL server, allowing it to be used as a backend spatial database for geographic information systems (GIS). Real time update by authorized users is also made possible. The users can access the system through a web interface (PHP) that enables online access to the GIS layers and attribute information.

4 Graphical User Interface

The graphical user interface design is a critical task for developing the TELOCATE system due to the limited screen space of PDAs. The user interface was designed to conform to the police officers’ expressed needs. Police officers often conduct searches based on incomplete information for example partial crime ID, partial criminal name, victim’s name and victim’s telephone number. Support for this partial matching is built into the TELOCATE system. The user interface of the system is shown in Figs. 3 to 7.

5 Application Scenarios

An Internet and wireless GIS based e-Crime system can be used to combat crime in the following ways.

5.1 Crime monitoring

Crime monitoring (Fig. 3) provides crime data for different types of crime, for example murder, robbery and gang robbery. This feature can help the police in crime control. Police can view which types of crimes are most common in certain areas of Bangkok. Moreover, the police can view which types of crimes are frequently linked. For example, murder is often linked with robbery and drug addiction with burglary. The police can query when and where each particular crime case has occurred. Citizens can also view crime data and may see for themselves that certain crimes are much more common in one district than in others. This could increase the probability that they might take precautions to protect themselves from crime.

![Crime Query](image)

**Fig. 3 Crime Monitoring Screen**

5.2 Crime investigation and crime reporting

Due to the difficulty of crime investigation, the police need support from witnesses. It will be easier for the witnesses to access the police if they can tell the police where, when and how a crime occurred without having to go to a police station. Citizens can submit information about the type of crime, location, date and time and also provide their personal details so that police can contact them to give help and ask for more information.

This type of online crime reporting (Fig. 4) is a new phenomenon and may reduce lot of problems faced by the general public in visiting police stations and reporting. This will save time and make the process well documented and reduce the workload on the police.
5.3 Find a police station, track a crime case’s status and law related to crime
Citizens can use the system to find a police station (Fig. 5), track their crime cases’ status, find important information related to their safety and other regular legal matters.

5.4 Real time crime case/criminal record
The police can enter real time crime data or record criminal/suspect data (Fig. 6) using online crime and criminal/suspect recording. When they go to the crime scene they can record data such as crime ID, crime case, crime type, complainant, criminal, latitude, longitude, picture of the crime scene, behavior of the criminal, date, time and place where the crime occurred. This will help the police to record crime data more accurately by using the Global Positioning System (GPS) connected with the system to record the crime point. For online criminal records, police can record data about a suspect for example id card number, name, nickname, gang name, date of birth, picture of the criminal, nationality, race, religion, education, occupation, address, phone number, scars, weapon used, vehicle used, behavior, places frequented regularly, height, weight, hair, eye colour, known associates and accomplices.

5.4 Searching for criminals
Police in the field can access details of a criminal using wireless GIS (Fig. 7). The system will provide the criminal’s record, for example: id card number, name, nickname, gang name, date of birth, picture of the criminal/suspect, nationality, race, religion, education, career, address, phone number, scars, weapon used, vehicle used, behavior, places frequented regularly, height, weight, hair and eye colour. The search function is important when the
police have only limited data. For example, if police are informed by the witnesses that the criminal is about 40 years old with a scar on his left cheek, the police can use this data as input to the system, which will provide them with a list of criminals who are about 40 years old and have scars on their left cheek. The police can then review the list obtained to select the most likely suspects.

5.5 Searching for a crime case and a criminal’s record
Police can also retrieve data about a crime case and a criminal’s record, whenever and wherever they need it. This will help police in searching a criminal’s crime history. The police will know how many cases that a criminal has been involved in. The system will provide the criminal’s crime records. Police can select any case that interests them from the list to see more details.

5.6 Crime risk factors analysis
The system can be used for analysis of the factors affecting crime risk as shown in the DSS section of Figure 2. The analysis is accomplished using a Bayesian Network. Details of this analysis are given in Boondao, Esichaikul and Tripathi [11].

6 User Evaluation for TELOCATE
The goals of the usability evaluation were to examine the initial design ideas behind TELOCATE, in order to see if the user interface design could be improved, and to compare its overall usability against an existing system. The system was tested by the police officers of the Command, Control, Communication & Information Center, Metropolitan Police Bureau, Royal Thai Police. The series of items that comprised the usability questionnaire were based upon a number of widely used measures [15, 16]. Items on the questionnaire used to assess and compare the TELOCATE and POLIS system were based upon user perceptions of such widely used measures of usability as: effectiveness (impact of system on job performance, productivity and effectiveness of information), ease of use (measures of effort required to complete a task, ease of learning how to use the system, ability to navigate easily through the different screens and satisfaction with the interaction), and efficiency (speed of completing tasks, organization of the information on the screens, ability to find information and the interface design). After a usability questionnaire on TELOCATE had been completed, a brief interview on the TELOCATE experience concluded the study.

Both survey-data data and interview analyses support a conclusion that use of TELOCATE provided improved performance over use of the current POLIS system due to its more flexible way of searching for information and its ability to be accessible from anywhere and at any time.

7 Conclusions
The TELOCATE system was developed for wireless GIS in crime control. Features of the system are described which were developed for real time crime access to help the Thai police to be more effective and efficient in crime control and also provide services to the citizens. The system has used open source software such as Minnesota MapServer, PHP, PostgreSQL and PostGIS. Data that were used in the system were in two formats; spatial data, which consists of data in map format, and non-spatial data, which consists of tabular data relating to crime, criminals and population. The system can be used in the area of crime monitoring, investigation and reporting, real-time crime case/criminal records, searching for criminals, searching for crime cases and criminal records and crime risk factor analysis. The user evaluation of the
system supports a conclusion that TELOCATE provided improved performance over the use of the current POLIS system by introducing a more flexible way of searching for information and allowing access from anywhere and at any time. Developing the geographic profiling for determining the most probable area of the residence of the offender is the next stage of the study.

References: