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Development of a Decision Support System with Risk: Supporting Police and Government in Crime Prevention

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Abstract: In recent years, governments focus on reducing crimes due to its impact on social, economy and politics of a country. Many efforts and initiatives have been taken in order to support decision-making in handling crimes based on the identified criteria. The aim of this research is to analyze crime based on spatial attributes and temporal attributes. Certain locations and time intervals have higher risk of crime occurrences than the others and these affect different types of decision makers. Risk can be considered in decision-making processes through the crime hotspots. System architecture and developed prototype called SCRIVIS-DSS have been tested with Royal Malaysian Police (PDRM) officers. Results of usability study shows that the top three highest score ranking is obtain for decision support system potential, data presentation and system consistency, followed by the other evaluation criteria.

Key words: Evaluation, consistency, PDRM, SCRIVIS-DSS, hotspots, attributes

INTRODUCTION

Decision Support System (DSS) is a management information system that can assist its users that are the managers in making critical decisions. DSS is also aims to support decision-makers in variety fields using computerize analysis. Some of the recent literatures are DSS in distributed clinical DSS (El-Sappagh and El-Masri, 2014), DSS in intelligent systems (Ngai *et al*., 2014), DSS in knowledge agriculture (Dutta *et al*., 2014) and DSS in forest management (Segura *et al*., 2014). DSS proposed by (Yang *et al*., 2014) elicit preference multi-attribute while (Mattiussi *et al*., 2014) analyze multi-attribute energy supply. DSS can be defined and developed for many organizations including governments and law enforcements for many purposes and decisions.

Identifying the potential crime locations is a complex decision. Potential crime location identification is a kind of decision making process that requires criteria to be weighted and alternatives to be evaluated and ranked. It is the problem facing by the parties involved (Shamsuddin *et al*., 2012). The police forces in the United Kingdom are periodically compared with each other on their performance rank (Beynon and Barton, 2008). Computerize analysis can assist police officers on their tasks.

The aim of this research is to analyze crime based on these spatial attributes and temporal attributes. In this study, the spatial attributes are location index and distances. The temporal attributes are time interval, day of month, day or night crime and year. One of the ways to investigate these attributes is by observing the existing house breaking crime reports lodged. Then, the system architecture is designed. The developed system is called Spatio-temporal Crime Risk Visual Decision Support System (SCRIVIS-DSS).

DECISION-MAKING WITH RISK ANALYSIS USING CRIME HOTSPOTS

Risk is probability of event occurrences depending on its predicted trigger and conditions. Nowadays, research in area of science and management are very important for social and economic development. Decision-making and risk assessment is interrelated and intuitive approaches that have connections to each other.

Some research aims to analyze operational risks while the other aims to mitigate risks. Mabrouki *et al*. (2014), Miniati *et al*. (2014) and Kengpol and Neungrit (2014) proposed research methodologies explicitly that involve risk assessment and decision-making but they does not combine the risk analysis as the component in their DSS but it is being treated separately. Decision support methodology in risk management is written by Mabrouki *et al*. (2014). Miniati *et al*. (2014) introduce a new methodology by combining two existing methods.

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In crime management, the police must priorities use of resources. Since, a team cannot do everything at several places in the same time, the police must put the efforts into minimizing total risk of crime occurrences. For decision-making processes in predicting the target at-risk, it requires quantitative risks. This situation shows the needs of quantitative probabilities where crime occurs in terms of risk. Probabilities can also help the domain experts to understand the efforts required.

GEOGRAPHICAL INFORMATION SYSTEMS (GIS) IN DECISION-MAKING

Crime hotspot is one of the techniques to cluster the locations of previous crime incidents. It can ease pattern identifications and strategic planning. Police officers patrolling a place can focus their attention on specific locations. Unfortunately, measuring a hotspot is also a complicated problem. GIS can provide the technology requires for decision-makers and policy makers to provide insight of issues using visualization maps of crime hotspots. The crime related to the concern of population at risk needs to be addressed by the decision-makers and policy-makers.

The technology of GIS together with DSS can be used to solve problems and overcome the challenges in society today-crime prevention. Criminal events can be predicted either via spatial clusters or through time-series analysis as an alternative. Crime hotspots represent higher risk area or city where there were more crimes in the past occurred there according to historical data.

Potential area crime identification is dependent on many factors and constraints including concentration of land use, economic, building use and transportation (Shamsuddin *et al*., 2012). Wang *et al*. (2011) suggest that these factors shall be considered. Various sources of information including from government officials can be utilized.

POLICE DATABASE INTEGRATION WITH DIGITAL GOVERNMENT

Digital government is a new approach by governments for their data-sharing activities (Jasso *et al*., 2009). It involves a high level of computerization and in particular, heavy use of internet technology. Grid and cloud computing technology can be used to handle this kind of big data. It is crucial to correctly integrate the conceptual and technical issues of these approaches within the framework of digital government infrastructure. This will enable a safe and secure transfer of data.

Police departments should be alerted on the seriousness of crime situations. They can use the information to proactively patrol the locations of crime signaled by clusters as possibly looking for crime occurrences that might have not been reported. Realizing this situation, the issue address in this study is considering DSS and GIS technology to be utilized.

DSS in GIS environment can be utilized for identifying crime hotspots. Strategic plan and crime prevention especially police monitoring route and durations can be made based on this information. It can be used to represent danger estimation for risk of crime occurrence towards civilian houses based on the probability of crime event occurrence. Risk for police decision-making in this study is focused specifically for warning locations of crime hotspots.

Law *et al*. (2014) explore the Bayesian Spatio-Temporal methods to analyze patterns of crime occurrence at the local and small region level by applying property crime data in Canada. It estimates the risk in small region changes with time. In contrast, Beraldo *et al*. (2013) tests the relationship between time preferences and crime rates and found out that there is no evidence of a reverse effect from crime to time preferences. Similar aspect is other existing DSS with risk such as (Agostini *et al*., 2012) also utilized past events data in analysis.

SYSTEM ARCHITECTURE AND SYSTEM PROTOTYPE

The new system architecture of DSS with risk using Spatio-Temporal Method is proposed before decision-making processes. Risk scale is one of the outcomes included in DSS. These are applicable in order to determine the probability for estimating risk Fig. 1 simplified the illustration of this proposed system architecture.

The problem with the current approach of crime statistics reports can be overcome by spatio-temporal methods (Law *et al*., 2014). Crime statistics reports use crime rate and crime volume. Spatio-temporal method provides insights with map visualization to ease management for allocation of limited resources of police officers efficiently.

Dotted arrow and dotted box in Fig. 1 shows that the information details needs to go through pre-processing stages that includes certain calculation with mathematical formulas and does not being used directly from the collected raw data.

Results of usability study shows that in scale from 1-10, the highest average score is obtain for DSS potential. The next scores ranking from the highest to the lowest are data presentation, system consistency, screen ease, system capability, initial reaction and learnability. Figure 2 shows the latest version of the DSS with risk using Spatio-Temporal Method called SCRIVIS-DSS that has been successfully tested with police officers.

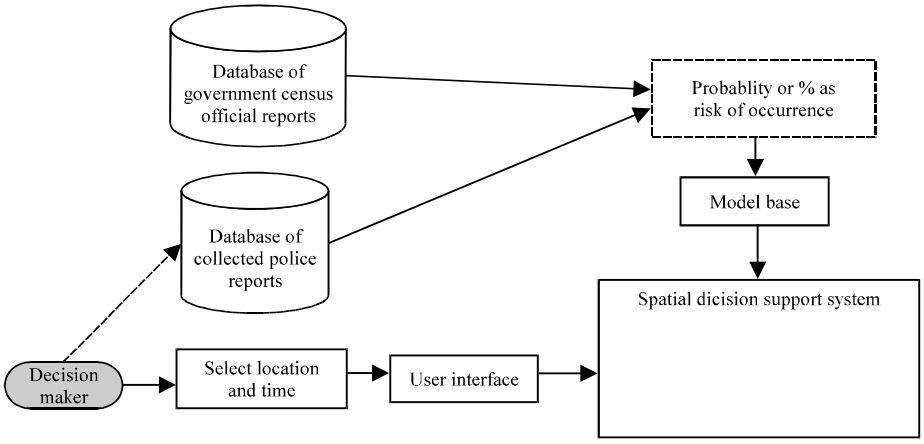

Fig. 1: System architecture of SCRIVIS-DSS with risk using Spatio-Temporal Method

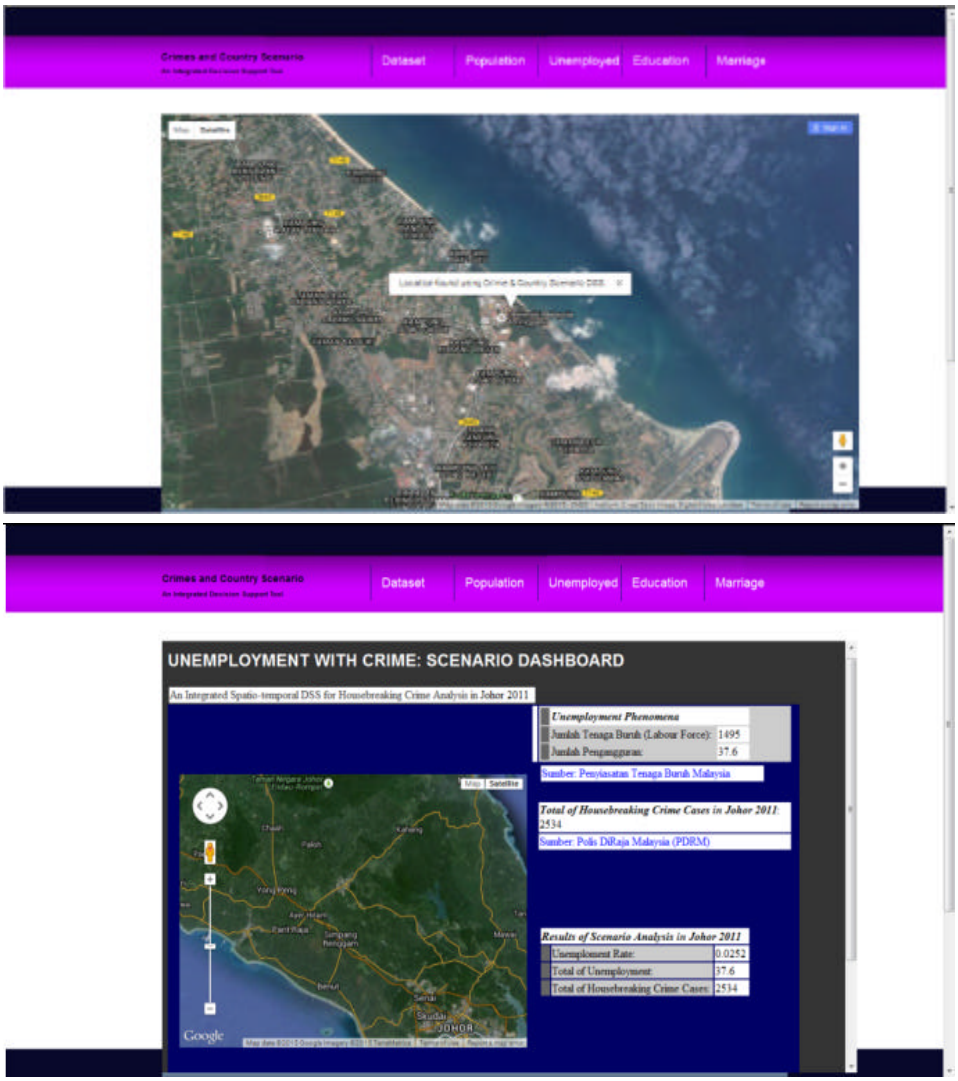

Fig. 2: SCRIVIS-DSS with risk using Spatio-Temporal Method (latest version)

CONCLUSION

Decision support system's functionality and applicability can be enhanced by considering spatio-temporal method together with risk scale in decision-making. This main idea is successfully designed, developed and tested.

SCRIVIS-DSS proposed in this study is also a framework that can be applied into numerous organizations. It can also conceptually generalize into other suitable case studies. It is expected to encourage the enhancement of the fundamental in DSS research. Crime analysis based on locations for decision-making with risk is a powerful tool and also easy-to-use because it contains mapping, analysis and relevant information details for police managers, police officers and crime analysts.

Results of usability study shows that in scale from 1-10, the top three highest score ranking is obtain for DSS potential with average value 9.67, data presentation 9.00 and system consistency 8.50, followed by screen ease, system capability, initial reaction and learnability.

LIMITATIONS

The system architecture of this DSS has limitations where it requires more training for daily routine use; hence, there are rooms for system improvement in future researches. This DSS can also be combined and implemented for other case studies in crime risk (Noor *et al*., 2014) in order to produce a more comprehensive and robust DSS framework for problem domain in crime investigations.

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