International Journal of Business and Technology Management
e-ISSN: 2682-7646 | Vol. 5, No. 2, 1-7, 2023
http://myjms.mohe.gov.my/index.php/ijbtm

A Framework of Spatial Decision Support System (SDSS) for Crime Investigations

Ahmad Faiz Ghazali[1*], Aishah Suhaimi[2], Noor Maizura Mohamad Noor[3], Astari Retnowardhani[4]

[1] College of Computing, Informatics, and Media, UiTM Cawangan Johor Kampus Segamat, Malaysia
[2] School of Industrial Technology, UiTM Cawangan Negeri Sembilan Kampus Kuala Pilah, Malaysia
[3] Faculty of Ocean Engineering Technology and Informatics, Universiti Malaysia Terengganu, Malaysia
[4] Master of Information System Department, Universitas Bina Nusantara, Indonesia

*Corresponding Author: faizghazali@uitm.edu.my

Received: 25 March 2023 | Accepted: 1 May 2023 | Published: 1 June 2023

DOI: https://doi.org/10.55057/ijbtm.2023.5.2.1

Abstract: *Crime investigation have gained attention among multidisciplinary domain experts due to severity of impact to strategic decision making and crime management. Current study develops decision support tools by introducing spatial decision support system for investigating crime. Spatial analysis can be integrated into decision support system for robust analysis. Spatial decision support system framework comprises of four main components; (I) database, (ii) knowledge-base, (iii) user interface and (iv) knowledge base. Spatial analysis involve location-based point in order to identify crime distribution. SCRIVIS-DSS is divided into three modules; from pattern identification module to information visualization module followed by decision making module. Therefore, this effort could be served as basis to spatial component to assist decision makers in crime investigation.*

Keywords: decision support system (DSS), spatial, visualization, framework, crime

1. Introduction

Decision support systems (DSS) can assist decision-makers in a wide range of fields and have been applied in problem domains of sustainability development goal (Ghazali et al. 2022), supply chain management (Suhaimi et al., 2021; Ghazali and Suhaimi, 2022), consumer research (Suhaimi and Ghazali, 2022), food security (Ghazali and Suhaimi, 2020), energy (Suhaimi et al., 2021; Ghazali and Suhaimi, 2022), smart city (Ghazali et al., 2020), crime investigations (Ghazali et al., 2016), and climate changes (Wenkel et al., 2013).

Numerous initiatives and attempts have been made in support of decision-making in the handling of crimes based on the identified risk factors. The issue with crime management is that police, who are specialists in the field, must give top priority to using the available resources, such as transportation or personnel. Since it is impossible for all police officers to be in two areas at once or vice versa, the police must make an effort to reduce the likelihood of crimes occurring at specific crucial locations.

By gathering information from a variety of sources, selecting pertinent and related knowledge wisely, and structuring the decision process effectively, the DSS concept has been applied in these numerous fields. On the basis of a study of all the available information, the decision-

making processes may entail conscious and unconscious consideration by the decision maker that can be estimated qualitatively or quantitatively.

The DSS can then be applied to the plans of numerous organizations, any private businesses, public colleges, or law enforcement agencies. The creation of appropriate decision alternatives necessitates a crucial process, such as taking into account recommendations from subject matter experts and data analysts who view the existing data from the point of data gathering to the point of data storage from various viewpoints.

At the very least, some of these anticipated results must be taken into account when developing DSS;

i. Evaluated DSS development and application in a focused problem domain.
ii. Made recommendations for how DSS can be used to solve contemporary crime problems.
iii. Encourage the use of DSS tools to help with decision-making
iv. Knowledge-based visualisations have the potential to be incorporated into either a spatial decision support system (SDSS) or visual decision support system (VDSS) in order to attain optimal operational decision-making in the study of crime.

Framework can serve as a clear guideline especially in a development of DSS, specifically tailored to the needs of specific problem domains. There are many DSS frameworks suitable for adoption and adaptation into multiple case studies if consultation with experts are made.

2. DSS Frameworks

Due to the multidisciplinary nature of DSS research, frameworks are frequently suggested in order to define and make clear the decision-making process which relates to spatial element. An application utilising GIS framework in a spatial economic tool called the Forest Investment Framework (FIF) has been created to allow the evaluation of important ecosystem services provided by planted forests in New Zealand (Yao et al., 2016). The following is a generic framework and set of decision-making tools for risk evaluation of chemical spills based on GIS (Jiang et al., 2012). Emergency environmental decision support system is the name of the DSS. Together, the independent system and another component created on a GIS platform function as a DSS. To show the value of the framework, the DSS also includes visual and dynamic danger information details.

Unfortunately, the traditional DSS has weaknesses for giving visual in order to give first insights and overall big picture of recent situation to decision makers. This weakness is frequently ignored and rarely given priority in DSS. Additionally, handling and condensing information from a vast quantity of data into a visual format is a problem for traditional DSS. On the other hand, traditional DSS have not paid enough attention to data organised by location. This is essential in some domains. Furthermore, despite the fact that it might influence decision makers' perception, the overall user interface design for the DSS's visual appearance to human users was not one of the major considerations when developing the DSS.

There are five different kinds of DSS: communication-driven, data-driven, model-driven, knowledge-driven, and document-driven. (Power, 2008; Power, 2005; Power, 2007; Power and Sharda, 2009). Any kind of model may be used in a model-driven DSS. The accounting and finance models, as well as the representational and optimisation models, might be to blame. Model-driven DSS place a strong emphasis on model entry and manipulation. The fundamental capability for a model-driven DSS can be provided by statistical and straightforward analytical

tools. Different equation and algebraic models are among the broad categories of quantitative models.

In order to improve public safety, a framework for crime prevention methods that incorporates a variety of computational models is crucial. By utilising the information that is currently available about offenders, such as social, geographic, and geo-social similarity features, Ester and Brantingham (2014) suggest this type of framework using supervised learning. The framework by Agostini et al. (2012) is divided into two sections: socioeconomic evaluation and risk assessment. Both of these modules are combined into the SYRIADE DSS framework that has been suggested.

As suggested by Winkler et al. (2010) for the assessment of global market systems' vulnerability to climate change, a framework can mix dynamic and static modelling. The suggested conceptual framework offers insight into the function of frameworks in the advancement of study and applications on a global scale. A structure can also act as a channel for information to keep businesses running smoothly. As illustrated by Noran, it can include architecture components and a series of steps that serve as a roadmap for what to do next. (2013). A few scholars refer to it as a "decision framework." (Arias-Hidalgo et al., 2013; Weenen et al., 2013). To illustrate how it can be used for defining criteria, a framework and technique for growth potential modelling that is based on the principles of innovation potential and growth were applied. Niekerk et al. (2016) suggested it with a combination of geographic information systems (GIS) into spatial crime investigation.

3. DSS Methodological Application into Spatial Crime Investigation

Investigations into crimes are rarely done with absolute surety. There is never a condition of absolute certainty because investigation officers gather, consider the likelihood and probability, assess the likelihood, and make decisions based on the evidence that is still available. Crime research becomes more dangerous as a result of its high risks especially when encounter with criminals directly, such as murder, robbery, and burglary.

Burglary is also known as breaking and entering or home burglary. It could also simply mean being in a place where you have no right to be. This unauthorised entry into a premise or structure with the aim of committing an offence may result in a violent crime rather than just a property offence.

Tools that can facilitate efficient and effective cooperation are desperately needed. Police agencies might learn about crime analysis in-depth and first-hand. Patrol officers, crime analysts, and detectives are the three categories of law enforcement personnel who actively contribute to the fight against crime. The most feared crime in South Africa, according to a poll published by online News24 (2014) on December 4th, is housebreaking.

Reporters in Pretoria were informed by Statistician General Pali Lehohla that at least 60% of the 30,000 households polled expressed dread of home invasion, home robbery, and street robbery. News24 (2014) noted that the cost of home security measures was in the billions of rands. Additionally, Lehohla said: "Crime is very costly. To guarantee their safety, adults must follow children to parks and schools. Walking is not secure or comfortable for people.

This demonstrates the high risk and damaging effects of housebreaking crimes on the public's confidence. Criminals favour choosing a home in an area where there is less chance of being

captured or recognised. (Tabrizi and Madanipour, 2006). As stated by Pollock et al., one of the anticipated outcomes of this study is to comprehend how the criminal chooses the appropriate target for break-ins. (2010). Those objectives might be connected to specific geographic circumstances.

3.1 The Component of Spatial DSS Framework (Spatial Analysis using GIS in DSS)

An emergency environmental decision support system is what the DSS is known as by them. A general framework and decision-making tools for risk assessment of chemical spills based on GIS are suggested by (Jiang et al., 2012). A independent system combined with another element created on a GIS platform functions as a DSS. The DSS also includes visual and dynamic hazard information details to show the effectiveness of the structure.

Numerous researchers have used geographic information systems (GIS) as a platform and structure for tracking and combating crimes, including (Balogun et al., 2014). A good method to learn about the actual and current conditions affecting civilians is to look at a study on workplace risk conducted by Fetzer (2011) using the standardised and well-known National Crime Victimization Survey. The processing and manipulation of geographically referenced data for visual output is known as crime mapping (Oatley et al., 2006). The specific individual can learn information from this kind of mapping.

3.2 Spatial Multi-Criteria Decision Support System

Ahmadisharaf demonstrates spatial probabilistic multi-criteria decision making for flood control. (Ahmadisharaf et al., 2016). The main difficulties implementing SDSS were addressed by (Ferretti and Montibeller, 2016). They also employ current tools rather than creating novel DSS. A benefit of new study is the creation of a new tool or prototyping. Ezzati et al. (2016) merely improved on the already-in-use tools for analysing and visualising maps. Additionally, Palmisanoa et al. (2016) used pre-existing tools as opposed to creating new ones from inception. The most crucial factor is whether the study's goals are met. According to the MC-SDSS categorization as specified by the GIS-MCDA integrations (Chakhar and Mousseau, 2008).

In a spatial decision support system (SDSS), visualisation can make it easier for decision makers to visualise data, which can help them make more general or specific choices for an organisation. As a result, integrating visualisation techniques into DSS is a potential way to increase system efficiency and give decision-makers greater understanding of the data they are analysing.

More consideration should be given to the visualisation of information in the DSS user interface because it could influence and support the decision makers' decision-making processes. Thus, the goal of this research is to fill in these gaps so that no barriers exists in the analytical approaches used and presented.

Spatial and Non-spatial Crime Visualization-based DSS (SCRIVIS-DSS) consists of pattern identification module (focused on spatial visualization) that aims to identify patterns from the collected data, while information visualization module (focused on non-spatial visualization) besides Decision making module which is where the decision making process is performed based on visualization dashboard presented to domain experts. Its applicability to provide guidelines is demonstrated through an approach in a framework. SCRIVIS-DSS is divided into three modules; from pattern identification module to information visualization module followed by decision making module as shown in Figure 1.

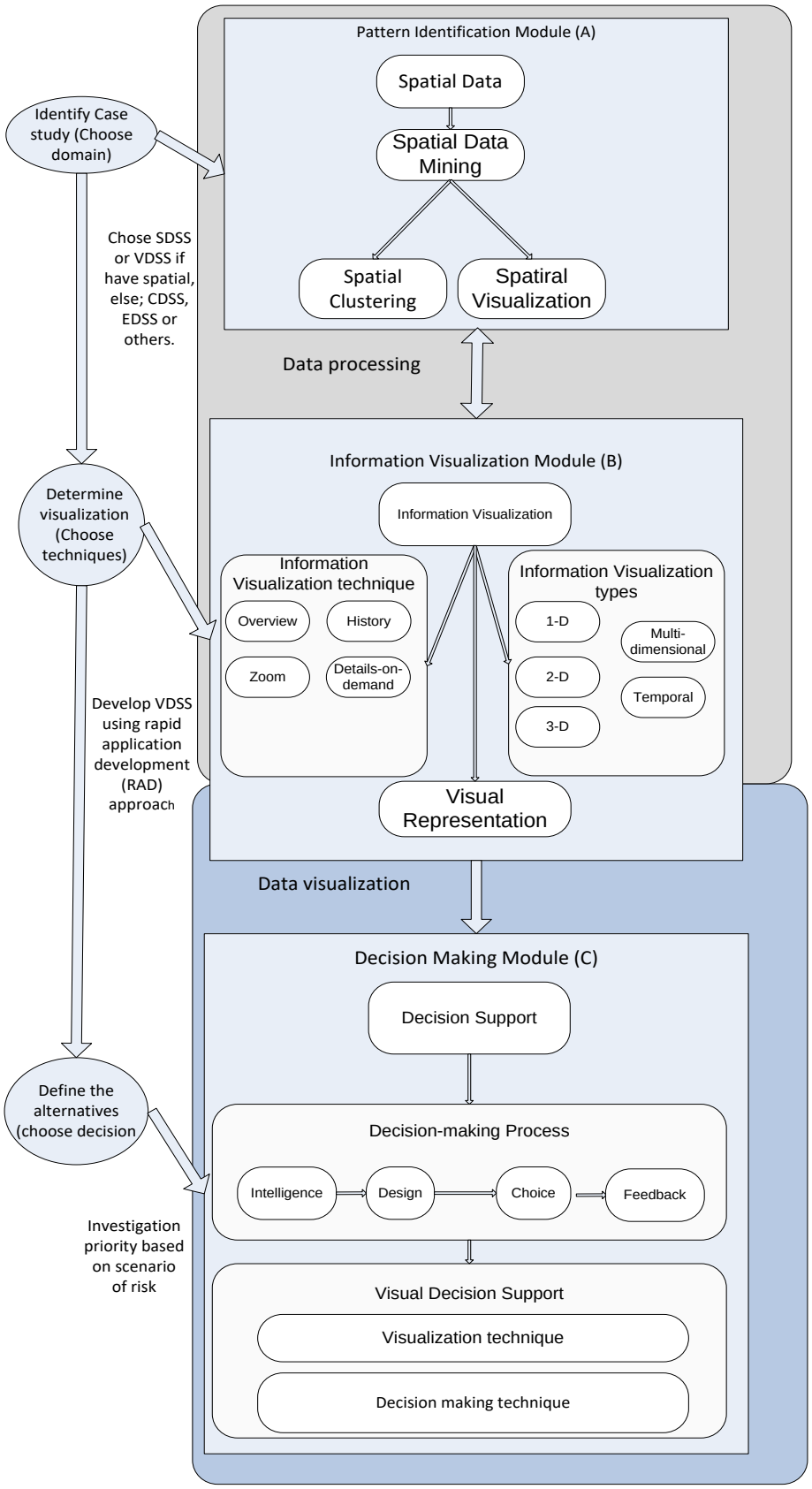

Figure 1: SCRIVIS-DSS Framework for Development of SDSS

4. Conclusion

This paradigm shift towards the involvement of academicians with police or any emergency or security officers are significance. SCRIVIS-DSS consist of three modules; from pattern identification module to information visualization module followed by decision making module. Spatial DSS could be serve as basis to help decision-makers with strategic crime investigation as well as resources planning. Utilizing GIS and other spatial analysis could add advantage as online monitoring tools and provide valuable location based information to current DSS.

References

Agostini, P., L. Pizzol, A. Critto, M. D'Alessandro, A. Zabeo and A. Marcomini (2012). "Regional risk assessment for contaminated sites Part 3: Spatial decision support system." Environment International 48: 121-132.

Ahmadisharaf, E., A. J. Kalyanapu and E.-S. Chung (2016). "Spatial probabilistic multi-criteria decision making for assessment of flood management alternatives " Journal of Hydrology 533: 365-378.

Arias-Hidalgo, M., G. Villa-Cox, A. van Griensven, G. Solórzano, R. Villa-Cox, A. E. Mynett and P. Debels (2013). "A decision framework for wetland management in a river basin context: The "Abras de Mantequilla" case study in the Guayas River Basin, Ecuador." Environmental Science and Policy.

Balogun, T., H. Okke and C. Chukwukere (2014). "Crime Mapping in Nigeria Using GIS." Journal of Geographic Information System 6: 453-466.

Chakhar, S. and V. Mousseau (2008). Multicriteria decision making, spatial. Encyclopedia of GIS. S. Shekhar, Xiong, H. (Eds.), Springer: 747-758.

Ester and Brantingham (2014) Ester, M. and P. Brantingham (2014). Spatially Embedded Co offence Prediction Using Supervised Learning. Proceedings of the 20th ACMSIGKDD International Conference on Knowledge Discovery and Data Mining

Ezzati et al. (2016) Ezzati, S., A. Najafi and P. Bettinger (2016). "Finding feasible harvest zones in mountainous areas using integrated spatial multi-criteria decision analysis." Land Use Policy 59: 478-491

Ferretti, V. and G. Montibeller (2016). "Key challenges and meta-choices in designing and applying multi-criteria spatial decision support systems." Decision Support Systems 84: 41-52

Fetzer, M. D. (2011). Carrying weapons for protection in the workplace: findings from the National Crime Victimization Survey, Workplace Risk Supplement. Albany, State University of New York: 100.

Jiang, J., P. Wang, W.-s. Lung, L. Guo and M. Li (2012). "A GIS-based generic real-time risk assessment framework and decision tools for chemical spills in the river basin." Journal of Hazardous Materials 227–228: 280-291.

Ghazali, A. F., Alias, S., and Amran, Z. A. (2020), Decision Support Systems in a Smart City: A Review, International Conference on Industry 4.0: A Global Revolution in Business, Technology, and Productivity, SEGi University, Kota Damansara, Malaysia.

Ghazali, A. F., Suhaimi, A. (2022), The Emerging Technology of Blockchain for Decision-Makers in Supply Chain Management, International Journal of Business and Technology Management, 4(3), 487-497.

Ghazali, A. F., Suhaimi, A. (2022), Modeling SCOPUS Trend of Decision Support Systems in Energy: A Bibliometric Analysis, International Journal of Advanced Research in

Engineering Innovation, 4(4), 44-57.
Ghazali, A. F., Suhaimi, A. (2020), Visual Decision Support System for Food Security, ASEAN Workshop on Information Science and Technology (AWIST2020).
Ghazali, A. F., Suhaimi, A., and Wahab, S. F (2022), Data Visualization of Decision Support Systems Research in Sustainability: A Bibliometric Analysis, International Journal of Advanced Research in Technology and Innovation, 4(3).
Ghazali, A. F., Noor, N. M. N., Mohemad, R., and Saman, M. Y. M. (2016), Development of a Decision Support System with Risk: Supporting Police and Government in Crime Prevention, Research Journal of Applied Sciences, 11(6), 340-344.
News24 (2014) News24, retrieved 2016, dated 4th December 2014. (2014). "Housebreaking most feared crime survey." Retrieved 13th February, 2016, from http://www.news24.com/SouthAfrica/News/Housebreaking-most-feared-crime-survey-20141204
Niekerk et al. (2016) Niekerk, A. v., D. d. Plessis and I. Boonzaaier (2016). "Development of a multi-criteria spatial planning support system for growth potential modelling in the Western Scape, Southern Africa." Land Use Policy 50: 179-193.
Oatley, G., B. Ewart and J. Zeleznikow (2006). "Decision support systems for police: Lessons from the application of data mining techniques to “soft” forensic evidence." Artificial Intelligence and Law 14(1-2): 35-100.
Palmisanoa et al. (2016) Palmisanoa, G. O., K. Govindanb, A. Boggiac, R. V. Loisi, A. D. B. a and R. Romaa (2016). "Local Action Groups and Rural Sustainable Development. A spatial multiple criteria approach for efficient territorial planning." Land Use Policy 59: 12-26.
Pollock, W., H.-J. Joo and B. Lawton (2010). "Juvenile arrest rates for burglary: A routine activities approach." Journal of Criminal Justice 38: 572-579.3.
Power (2008). Decision Support Systems: A Historical Overview. Burstein, Springer.
Power, D. J. (2005). Decision Support Systems Concept. Encyclopedia of Information Scienc and Technology. K.-P. Mehdi. Hersheys, PA, USA, IGI Global: 750-753.
Power, D. J. (2007). "A Brief History of Decision Support Systems." version 4.0. Retrieved 21st November 2016, from http://DSSResources.com/history/dsshistory.html
Power, D. J. and R. Sharda (2007). "Model-driven decision support systems: concepts and research directions." Decision Support Systems 43: 1044-1061.
Power, D. J. and R. Sharda (2009). Decision Support Systems, Springer Berlin Heidelberg.
Suhaimi, A., Othman, A. A., Sundram, V. P. K., and Ghazali, A. F. (2021), Consumers’ purchase decision based on intrinsic and extrinsic factors related to food safety issues: A review, IOP Conference Series: Earth and Environmental Science, 756(1) 012010.
Suhaimi, A., and Ghazali, A. F. (2022), Data-driven Insights from Visualization of Bibliometric Analysis on Consumer Purchase Decision, Asian Journal of Research in Business and Management, 4(3), 619-631.
Tabrizi, L. R. and A. Madanipour (2006). "Crime and the city: Domestic burglary and the built environment in Tehran " Habitat International 30: 932-944.
Weenen, T. C., A. Jentink, E. S. Pronker, H. R. Commandeur and E. Claassen (2013). "A decision framework to evaluate intellectual property strategies in the medical nutrition market." PharmaNutrition 1: 65-72.
Winkler, J. A., S. Thornsbury and M. A. e. al. (2010). "A conceptual framework for multi-regional climate change assessments for international market systems with long term investments." Climatic Change 103: 445-470.
Yao, R. T., D. R. Harrison, S. J. Velarde and L. E. Barry (2016). "Validation and enhancement of a spatial economic tool for assessing ecosystem services provided by planted forests." Forest Policy and Economics 72: 122-131.