



UNIVERSITI PUTRA MALAYSIA

**DEVELOPMENT OF GEOGRAPHICAL WEIGHTAGE REGRESSION
MODEL FOR URBAN CRIME IN SUNGAI PETANI, KEDAH, MALAYSIA**

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FK 2020 37



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By

NUR SUHAILI BINTI MANSOR

**Thesis Submitted to the School of Graduate Studies, Universiti Putra
Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of
Philosophy**

December 2019

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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December 2019

Chair : Associate Professor Helmi Zulhaidi Mohd Shafri, PhD
Faculty : Engineering

Development and urbanization may bring prosperity to some urban dwellers, but most often, socio-economic imbalances do take place that condemned the low-income group to poverty. It is noted that the changes in land use do bring about changes in the urban formation that leads to changes in the daily life activities of the people, but social imbalances do create new opportunities or change the existing opportunities for them to commit crimes. This research discussed the subject matter of land use and its relation to the neighbourhood perception of safety on criminal activity located in Sungai Petani, Kedah. The study firstly used SPOT-5 satellite images to measure urban growth for thirteen years from 2000 to 2013 processed by ERDAS IMAGINE software. The first objective is on urban changes from the year 2000 to 2013 is recorded at 24.2% growth. Then, secondly, the crime data that combined three types of crime, including violent crime, property crime, and drug offenses were collected from the Police Department in Sungai Petani. The crime distribution hotspot in the town of Sungai Petani was identified, and the direction of urbanization taking place was observed to be taking place towards the industrial sites of Kulim, Kedah and Pulau Pinang. Thirdly, in addition to these data, neighbourhood perception of safety data was obtained from 444 respondents through a questionnaire that measured several variables, viz., urban security, individual safety, social problems, crimes, development, and governance of the locality studied were interviewed and analyzed. Analytical Hierarchy Process (AHP) analysis was used to examine the suitable variable to be included in the model developed. The result revealed that land use is perceived to influence crime relative to the neighbourhood perception of safety whereby the weight for land use is 88.7 percent while the weight for perception is only 16.7 percent that includes the issues of governance, social problem, criminal problem, urban security, and individual safety. The aim of this study is also to investigate and to establish an urban crime model. The factors from AHP that produce consistent and realistic weight values of influent factors on criminal activity are residential, commercial and road. Besides the latter, neighbourhood perception of safety is influenced by the factors of gangs, burglary, fear of crime and fear of neighbourhood

crime. In order to identify the relationship between land use and neighbourhood perception of safety on criminal activity, a geographically weighted regression (GWR) model by ArcGIS software is used that could be used to manage crime prevention in the future development of the township of Sungai Petani. The results $R^2 = 0.82$ revealed that there are strong correlations between urban growth and crime incidents such as violent crime and drug crime. The result confirmed the theory that the strength of the relationship increases whenever any variable used is compared with the increase in urban development and growth. Thus, this research is able to distinguish the spatial trait of criminal activities and drug abuse occurred, and the findings will benefit the local authorities, planners, and crime control specialists in recognizing the criminal incident zones effectively and to act proactively as opposed to a reactive response. The crime pattern identified will contribute to further understanding the high-risk area of the crime and thereby to prevent future potential crime from taking place. The study does make suggestions that by improving the security measures, governance, and development of the said urban area will strengthen societal wellbeing of the urban area as well as ultimately to ensure sustainable development goals for the country be reachable.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PEMBANGUNAN MODEL REGRESI PEMBERAT GEOGRAFI BAGI JENAYAH BANDAR DI SUNGAI PETANI, KEDAH, MALAYSIA

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Pembangunan dan perbandaran boleh membawa kepada kemakmuran bagi sesetengah penduduk bandar, tetapi kerap berlaku adalah ketidakseimbangan sosio-ekonomi yang menyebabkan kumpulan berpendapatan rendah menjurus ke kancah kemiskinan. Diperhatikan perubahan dalam penggunaan tanah telah membawa kepada pembentukan bandar yang dapat mencorak aktiviti kehidupan harian rakyat, tetapi ketidakseimbangan sosial mendorong kepada peluang baru atau mengubah peluang sedia untuk mereka melakukan jenayah. Kajian ini membincangkan isu guna tanah dan kaitannya dengan persepsi kejiranan terhadap keselamatan tentang kegiatan jenayah di Sungai Petani, Kedah. Langkah pertama dalam kajian ini dengan menggunakan SPOT-5 imej satelit untuk mengukur pertumbuhan bandar selama tiga belas tahun dari tahun 2000 hingga 2013 yang diproses oleh perisian ERDAS IMAGINE. Objektif pertama tentang perubahan bandar dari tahun 2000 hingga 2013 direkodkan pada pertumbuhan sebanyak 24.2%. Kedua, data jenayah yang menggabungkan tiga jenis jenayah, iaitu jenayah ganas, jenayah harta benda, dan kesalahan dadah telah diperolehi dari Jabatan Polis di Sungai Petani. Taburan jenayah di kawasan tumpuan bandar Sungai Petani telah dikenalpasti, dan hala tuju pergerakan perbandaran diperhatikan menuju ke arah kawasan tapak perindustrian seperti Kulim, Kedah dan Pulau Pinang. Ketiga, sebagai tambahan kepada data ini, data persepsi keselamatan kejiranan telah diperolehi daripada 444 responden melalui soal selidik yang mengukur beberapa pemboleh ubah, iaitu, keselamatan bandar, keselamatan individu, masalah sosial, jenayah, pembangunan, dan tadbir urus kawasan yang dikaji telah ditemuduga dan dianalisis. Analisis proses analitikal hierarki (AHP) telah digunakan untuk memeriksa pemboleh ubah yang sesuai untuk dimasukkan ke dalam model yang dicipta. Keputusan itu menunjukkan bahawa penggunaan tanah lebih berpotensi untuk mempengaruhi jenayah berbanding dengan persepsi keselamatan kejiranan di mana nilai peratusan bagi kegunaan tanah sebanyak 88.7 peratus manakala untuk persepsi hanya 16.7 peratus termasuk aspek-aspek masalah tadbir urus, masalah sosial, masalah jenayah, keselamatan bandar, dan keselamatan individu. Tujuan kajian ini juga adalah untuk menyiasat dan membina satu model jenayah bandar. Faktor-faktor dari AHP yang menghasilkan nilai berat yang konsisten

dan realistik dari faktor yang mempengaruhi aktiviti jenayah adalah kediaman, komersial dan jalan raya. Selain itu, persepsi persekitaran terhadap keselamatan juga dipengaruhi oleh faktor-faktor seperti adalah gengster, pencurian, ketakutan terhadap jenayah dan ketakutan terhadap jenayah di kejiranan. Dalam usaha untuk mengenal pasti hubungan antara penggunaan tanah dan persepsi keselamatan persekitaran berkaitan aktiviti jenayah, model regresi berwajaran secara geografi (GWR) melalui perisian ArcGIS telah digunakan untuk mengurus pencegahan jenayah dalam pembangunan perbandaran Sungai Petani pada masa hadapan. Keputusan $R^2 = 0.82$ menjelaskan bahawa terdapat hubungan yang kukuh antara pertumbuhan bandar dan kejadian jenayah seperti jenayah ganas dan dadah. Keputusan ini telah mengesahkan teori bahawa kekuatan hubungan ini akan bertambah sekiranya sebarang pemboleh ubah tersebut dibandingkan dengan peningkatan pembangunan dan pertumbuhan bandar. Oleh itu, kajian ini dapat membezakan ciri ruang aktiviti jenayah dan penyalahgunaan dadah yang berlaku dan dapatan kajian akan memberi manfaat kepada pihak berkuasa tempatan, perancang dan pakar kawalan jenayah dalam mengenal pasti beberapa zon kejadian jenayah dengan berkesan dan bertindak secara proaktif dan bukan reaktif. Corak jenayah yang dikenal pasti akan menyumbang kepada pemahaman lanjut tentang kawasan jenayah yang berisiko tinggi dan seterusnya mengelakkan jenayah yang berpotensi daripada berlaku. Kajian ini juga ada memberi cadangan dengan meningkatkan langkah-langkah keselamatan, tadbir urus, dan pembangunan kawasan bandar akan meningkatkan kesejahteraan hidup warga bandar dan, akhir sekali untuk memastikan tujuan pembangunan bandar akan dicapai selaras dengan pembangunan yang mampan.

ACKNOWLEDGEMENTS

With the name of Allah the Most Compassionate and Most Merciful

All praise and thanks to Almighty Allah, with His blessing giving me the strength and passion, could manage to finish the research until this manuscript completed be compiled. I am thankful and Syukur to Allah for making things possible, Alhamdulillah. I want to acknowledge the support and assistance that I have received from my supervisor, Assoc. Prof. Dr. Helmi Zulhaidi Mohd Shafri and to thank him for his untiring guidance, advice, help, and encouragement throughout my study in the Faculty of Engineering, UPM. Sincere thanks also to the guidance and encouragement by my co-supervisor, Prof. Dr. Shattri Mansor, and Assoc. Prof. Dr. Biswajeet Pradhan that gave some idea and consultation in urban crime analysis. Many thanks to Polis Diraja Malaysia (PDRM) and the Malaysian Remote Sensing Agency (ARMS), which provided me with valuable data and information. The authors gratefully acknowledge the help and expertise of many other people, especially Professor Dr. Engku Muhammad Nazri Engku Abu Bakar, Professor Dr. Mohd Hasmadi Bin Ismail, and Dr. Aimrun Wayayok, for outstanding contribution and support to this work. The author is thankful for the scholarship and the financial support from the Higher Education Ministry and Universiti Utara Malaysia, Malaysia. Sincere thanks to Dr. Mohd Zuli Jaafar and MZJ team for guide in formatting thesis. Thanks to my friends Sarah Hanim, Maizatul Akma, Habshi, Rashidi Mugula, and Amirulikhsan who have given any information and help me during the years of study and make my study in UPM a valuable one.

Finally, this thesis is wholeheartedly dedicated to my parents abi- Mansor, umi-Ninaliza, umu-Hapsah, umu-Hanim, my husband Mohd Adhar, my daughter Nur Yasmin Dalili, my son Ahmad Yazid who have been our source of inspiration and gave me strength when I thought of giving up, who continually provide their doa's, moral, emotional, and financial support. Thanks to my children, siblings, relatives, mentor, and friends, who always shared positive words of advice and encouragement to finish the study.

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

3D	Three Dimensional
AHP	Analytical Hierarchy Process
ECER	East Coast Economic Region
EPU	Economic Planning Unit
ESRI	Environmental Systems Research Institute
GCP	Ground Control Point
GIS	Geographic Information System
GR	Geographically Regression
GUI	Graphics User Interface
GUI	Graphical User Interface
GWR	Geographically Weighted Regression
IDR	Iskandar Development Region
MCSD	Mean Centre and Standard Distance
MQLI	The Malaysian Quality of Life
MRSO	Malayan Rectified Skew Orthomorphic
NCER	Northern Corridor Economic Region
NNI	Nearest Neighbour Index
OLS	Ordinary Least Square
SDGs	Sustainable Development Goals
SPSS	IBM SPSS Statistics

CHAPTER 1

INTRODUCTION

Crime is one of the significant problems faced in most contemporary society. Criminal activities that occur unabatedly and continue to be a significant concern in the society as it influences perception of safety in the neighborhood. Therefore, study should be encouraged and monitored continuously as precautions should be taken to reduce and monitor potential criminal occurrences in the urban crime areas.

1.1 Background of Study

In recent years, there has been increasing interest in the emerging challenges brought about by the expansion of urbanization to social life. Over the previous decade, issues emerging in the urban area have been developed rapidly in many fields of study. Urban development has been studied by many researchers that focus on the changing population as the main effect to industrialization and urbanization taking place. According to Taubenböck et al. (2012), urbanization defined as the development of the population and cities. To clarify, cities today play strategic roles in the modernization process as well as in the organization and operation of the global economy (Szirmai, 2014). By the middle of the 20th century, scholars and planners have realized that urbanization should be planned and managed carefully before it gets out of hand. Some experts have been analyzing that the evolution of the modern urbanization cycle is much determined by the long-term economic cycle (Enyedi, 2011). However, contemporary urban development is somewhat clouded by controversy as a variety of social problems and crimes are the norms where poverty, environmental crisis, the traditional and new structures of local social inequalities, and others are the main social portraits observed.

Changes in the structure of progress in the development process in Malaysia, which is tied to globalization, digital revolution and migration have led to changes in the crime rates and patterns. Sociology and criminology can provide the conceptual and theoretical thoughts on how this interplay works, and those interested in the geography of crime will often use empirical analyses of perpetrators, crimes, and the impacts of crime to evaluate the various theoretical positions (Fyfe, 2000). Bradley (2015) said that the geography of crime as a sub-discipline is comparatively the latest development that took shape in the academic world, and it is comparable to environmental criminology, which recently emerged as a criminology sub-discipline.

Thus, scholars that are concern with the distribution of crime would include a few primary subjects as the key questions, viz., how and why crime are distributed geographically across society, how and why the crime is spread in the society over time? And how and why crime is socially spread across society? While those from the perspective of law enforcement, the insight into the geographical, temporal, and social

distributions of crime, victimization, and criminals are essential for understanding the roots of crime. Those coming from the social perspective would see the differences in the distribution of crime represent causal processes that are taking place in the society that create a crime by people in distinct social locations and situations because, as concluded by Brantingham and Brantingham (1999) that...“Time and space levels of crime are not random, but represent people, their choices, their evaluation of locations, and their behavior”.

Many studies have examined the sources of opportunities and incidents for neighborhood crime, but have yet to disentangle the distinct roles of participation and information of the locals on producing or mitigating opportunities for crime and incidents (Lochner, 2004; Kitchen, T., & Schneider 2007; Taylor et al., 2010; Kang, 2016). Studies have shown the levels of the physical and social disorder trust among neighbors that is an element of the social cohesion and shared expectations that will impact crime rates in neighborhoods (Oh & Kim, 2009; Steenbeek, & Hipp 2011; Stein et al. 2016). Thus, the perceived lack of involvement by residents sometimes reflects the reality of a socially disorganized neighborhood as a consequence of the prevalence of the physical and social disorder trust among neighbors. Within this framework of discussion, the theory of collective efficacy highlights the ability of residents to draw together to work toward the common goal of safety (Renauer, 2007; Wickes, 2010 and Stein et al., 2016). Thus, the involvement of the neighborhood becomes a highly relevant subject due to prevent and to limit criminal activity.

Within this perspective, the Analytical Hierarchy Approach (AHP) is one of the available tools frequently used in the decision-making processes with various factors such as land suitability that was found to be a useful method to evaluate the weights. Arquero et al. (2009), when applying AHP, found that constraints of criteria and sub-criteria are compared to each other in determining the relative relevance of each variable in achieving the goal of the research undertaken. The AHP method is practical and thus is suitable in giving the evaluated weightage for each criterion. Eldin et al. (2013) also suggest that using AHP would reduce the risk of making wrong decisions by using indices and consistency ratios to validate a comparison matrix consistently. Thus, the AHP usually could provide a clear and realistic set of decision making (Chakraborty et al., 2017). Therefore, the weightage value of all the criteria that is strongly influenced by being identified through employing AHP methods can be integrated with GIS analysis can be used as spatial decision-making approaches.

In linking AHP and GIS, the spatial data obtained can be displayed and analyzed in the form of maps. In this regard, the integration of AHP and GIS is one of the discoveries that demonstrate the capabilities of GIS not only in a specific field but in the various scientific fields, including social research of the society. The changing nature of research tasks from being just a science-based or social-based research has allowed the application of AHP to be developed outside of the GIS environment using a variety of analytical software from various disciplinary of study.

The capabilities of spatial operations in GIS help many to analyze spatial relationships that involve different layers of data, predict crime incidents and take appropriate steps

for future events. Spatial analysis techniques provide a measure beyond the aggregate level to assess land use and neighborhood perceptions of safety that may vary across certain geographical spaces and identify the criminal activity. This has allowed the researcher to study the relationship between neighborhood elements and crime that is relevant to the spatial proximity (Gorman et al. 2013 and Yang, 2010).

In crime analysis, regression analysis has played a role in attempts to identify critical aspects of crime (Anselin et al. 2010). Radil (2016) provides a review of the exploratory regression techniques related to criminology. The Geographical Weighted Regression (GWR) techniques also have been incorporated in crime research focusing on local relationships. Cahill & Mulligan, (2007) and Jopp, (2016) concluded that GWR techniques explained more variance about the relationship between elements of opportunity and crime. GWR is superior to global techniques in determining the effects of neighborhood characteristics and contributes to “spatially informed criminology by exploring the geographic dimensions of immigration and by modeling the heterogeneous spatial patterns underlying the risk” of crime rather than Ordinary Least Square (OLS) (Graif and Sampson 2009).

However, there is no direct study and thus, a knowledge gap, investigating land use and neighborhood perception of safety on crime incidents. Though there is a study on the correlation between crime and neighborhood perception has been reported by several investigators but not linking to land use. St. Jean (2007), Wyant (2008), Yang (2010), and Armstrong et al. (2015) found out that the GWR could discover which effects are more strongly correlated with crime land use or perception of safety. GWR allows us to account for the spatial variation of relationships between the theoretical frameworks and criminal behavior (Zhang and Song 2014). In GWR, the model creates a continuous surface of parameter estimates that vary over space (Harris et al. 2010).

In this introductory chapter of the thesis is to share with the reader with the systematic line of work being pursued by the researcher. In the present work, the nature of the research problem, objectives of the study, methodology, the database, and the spatial-statistical techniques have been dealing with in carrying out this research. This chapter serves the purpose of a prism through which subsequent work can be viewed and assessed.

1.2 Statement of Problem

The past decade has seen the rapid expansion of urban area in many countries. In recent years, there has been an increasing pattern in interest related to the challenges of urbanization on social life. Experts were constantly analyzing the evolution of the modern urbanization cycle as greatly determined by the long-term economic cycle (Andrusz et al., 2011). Modern urban development is rather complex and problematic as it faced a variety of social problems, the widening gap of social inequalities, poverty, crime, environmental, and other societal constraints in the urban locality.

It is well-known that much criminal activity facing us in the world today related to the prevalence of social and criminal problems in society. Every day we are bombarded with news of violent crime, and the less fortunate among us are the witnesses or victims of these crimes. Natural disasters worldwide add to the worsening of the socio-economic circumstances and the devastation taking place in society. However, it is not a simple act to find alternatives in managing and alleviating these issues. To begin with, it needs a thorough knowledge of the causes, dynamics, and implications of these criminal issues.

This rise in crime will endanger life, property, and social life in the neighborhood. The definition of crime is related to the demolition and damage of property or exhibiting violent behavior on people and disrespecting people and organizations. Criminal behavior is affected by individuals, society, and the activity of the state that governs the country. Under such social crises and problems in the community, the government and societal organizations play the main role in making continuous efforts to educate the people regarding the understanding of crime and its effects on their life and community (Crawford & Evans 2016).

Several alternative technologies that studied the changing society and the environment have developed in the last few years. Under such societal challenges, the development planner and the implementor have to monitor and control the criminal activity in order to maximize the positive impacts for the neighborhood perception of safety in their area. Geographic Information System (GIS) is one of the alternative technologies that its use is significant for planning, assessment, and monitoring, among others, of urban crime.

Furthermore, the task of the researcher is to identify what kind of spatial patterns of criminal activities that correlate with land use and neighborhood perception of safety do prevail and identify in Sungai Petani. These are the main issues that are being identified as the research problem that need to be resolved and the choices of the methods to be employed. It is difficult to measure these parameters due to many parameters are reliably noticed to be involved and to model them.

1.3 Research Questions

A number of research questions regarding this research remain to be addressed. The research question posed is:

Can an urban crime model approach predict criminal activities in the study area? What parameters are involved in studying land use and perception of safety? How are they measured? And how to model them?

1.4 Research Objective

The intended aim of this investigation is to establish an urban crime model using geospatial analysis that can promote crime prevention for future development in Sungai Petani, Kedah. The research objectives of this report are as follows:-

- I. to identify and evaluate the rate of urban growth in Sungai Petani using Remote Sensing,
- II. to generate geospatial data for crime records based on each criminal types/crime analysis,
- III. to determine the relationship between land use and perception of safety on crime incidents in Sungai Petani,
- IV. to develop a geospatial model in predicting the urban crime trend in the future.

1.5 The Scope of the Study

The strength of the spatial planning lies in its addressing the urban problems or the issues of land use/land cover based on the functional locations of different urban components and resultant cost, friction, suitability from economic gains, social benefits, and comprehensive sustainability. Thus, spatial planning is an elementary level necessary strategic planning tool to achieve the goals of urban development in the study area of Sungai Petani specifically and generally as it is also possible for any other urban areas. Sungai Petani town occupies a strategic location in terms of location of other city areas of regional importance, which is located 35 km north of Georgetown, Penang Metropolitan City. The transition in cities and their region's urban spatial structure is a significant theme in urban studies and has long been the topic of scholarly research (Sýkora & Bouzarovski, 2012). An urban spatial structure is a city's spatial arrangement resulting from the interaction over time between topography, land markets, infrastructure, taxation, laws, and urban policy. Urban spatial buildings can be described by using indicators such as normal land use and spatial population distribution.

Therefore, to test the effectiveness of the model, the study applies spatial analytical tools to understand the phenomena studied with a socio-spatial perspective. The reason for choosing an urban area is that urbanization does add social pressure on the state and the importance of managing urban crime with neighborhood perception of safety in the community. To see the relationships, a model is developed to discuss the linkage. The rationale for producing an urban crime model is to establish the relationship between land use and perception of safety, including governance, social problem, criminal problem, urban security, and individual safety. It will ascertain the effectiveness of spatial planning along with social dimensions as a strategic urban planning tool in addressing urban development in the study area.

1.6 Significance of the Study

Economic development has transformed Malaysia in the last three decades from an agriculture-based to an industrial-based economy and from idyllic rural life to an urbanized country. With these social changes spurred by development as showed by migration and social mobility among Malaysians with multi-ethnic and religious origins have brought social transformations in society with diverse social composition and influence the direction of social integration in the urban setting and the larger society.

According to Andrews and Withey (2012) argue that it is possible to look to a consensus on the indicators independent of consensus on a model of society and those specific parameters can be agreed upon as "important" even if this judgment cannot be made concerning a general model. The study of the spatial pattern of urban crime with neighborhood perception on safety at the city level would reveal the signature of this unstoppable forces of globalization, economic development, migration, and culture on the urban habitat.

Therefore, this study used by the GIS application is to analyze an urban setting, and it identifies the modeling of criminal and drug activities related. Modelling GIS can predict those spatial qualities of significance, guide the researcher to control the potential violations in the urban areas, and to make constructive responses that will strengthen societal wellbeing among the urban dwellers.

The longitudinal information of urban growth from GIS shows that the improvements in urban living are expected as the urbanization expansion and intensification take place. The criminal and drug abuse activities information gathered were superimposed on the longitudinal GIS information of Sungai Petani obtained. The patterns observed show that drug abuse activities are related to the crimes committed to having an association with the development of modern industrial and housing plans. Thus, this study is set out to explore the relationship between urban growth and neighborhood perception of safety on criminal activity in Sungai Petani, Kedah.

1.7 Summary

In chapter 1, this chapter generally briefs out the background study, problem statement, research questions, scope, and significance of the research. It also includes a brief explanation of a transdisciplinary study employed in this research that combines social sciences and sciences, hardware, and software.

In chapter 2, this chapter reviews the issues related to transdisciplinary knowledge. These include the history of measuring urban growth and crime using geospatial technologies and applications currently used to manage the problems. In addition to that, the review includes previous studies of urban development and crime related to the social problem using GIS, Remote Sensing, and expert choice. Besides that, this chapter reviews the

criteria for selection parameters using Analytical Hierarchy Process (AHP) crime analysis studies in the implementation of urban crime model, especially for the neighborhood to help the surrounding residents to feel safe and secure. To strengthen further the understanding of the relationship between crime and perception of neighbourhood safety, Geographical Weighted Regression (GWR) is used to measure the correlation between land use and the perception of safety. This chapter also contains information on past researches or articles that have been published which are related to this study.

Chapter 3 presents and explains the detailed workflow of the general methodology used as a guideline in this research. The selection of the study area is discussed in this chapter. Then, the data acquisition, converting data into spatial, correlation analysis, satellite image processing, and model crime using suitable hardware and software such as ArcGIS, Erdas Imagine, expert Choice, and IBM SPSS 21 are presented and explained.

While in chapter 4, data will provide the result of the methodology done in the previous chapter included the analysis. Crime incident was map using geostatistical methods which are valuable from the police department and local authority to define the hotspot area of criminal activities. Each criminal types/crime analysis is based on criminal records of the Police Department in Sungai Petani, Kedah. The results and analysis will assess the capability of the Analytical Hierarchy Process (AHP) for weighted each parameter for land use and perception of safety. Correlation of the land use and perception of safety can be seen based on the regression analysis. The urban crime model shows the critical crime area and allows the researcher to identify and suggest intervention programs with the intention to prevent crime in the future.

Lastly, chapter 5 is a conclusion, and the suggestion was made based on the overall study, which consists of the summary of research findings, limitations, recommendations and policy implications to improve the future study in a new research area.

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Nur Suhaili Mansor is a Ph.D. student in GIS and Geomatic Engineering at Faculty of Engineering, Universiti Putra Malaysia, and a tutor in the School of Government, Universiti Utara Malaysia. Her doctoral research investigates an urban crime model using geospatial analysis that can promote crime prevention for future development in Sungai Petani, Kedah. She takes a multidisciplinary approach that encompasses the fields of science and technology, social studies, crime, drug, Analytical Hierarchy Process (AHP), Geography Information System (GIS), and Geographical Weighted Regression (GWR) model. She is a member (M721) of the Institution of Geospatial and Remote Sensing Malaysia (IGRSM) since 2019.

She holds a master's degree (2010) in Geography Information Science from the Universiti Teknologi Mara (UiTM) Shah Alam, Malaysia. The thesis has investigated the influences of the environment towards human behaviors, particularly in committing a crime by using GIS open-source of ecological crime analysis, evaluate/investigate the relationship between surface temperature and crime convicted, and using Q-GIS open-source software. Her Degree (2009) from Universiti Teknologi Mara (UiTM) Shah Alam, Malaysia on Science Geomatics (Hons.). She studied cartography, engineering survey, cadastral survey, hydrography survey, photogrammetry survey, and applied remote sensing and geographic information system (GIS), such as ArcGIS, Erdas, Envi, etc. Parallel to her academic career, she has been working as a researcher for crime analyst, eco-tourism, and sustainable agriculture using GIS.

LIST OF PUBLICATIONS

- Mansor, N. S., Shafri, H. Z. M., & Mansor, S., (2019). 'A GIS Based Method for Assessing the Association Between Urban Development and Crime Pattern in Sungai Petani, Kedah Malaysia'. 'International Journal of Recent Technology and Engineering (IJRTE)', ISSN: 2277-3878 (Online), Volume-8 Issue-2, July 2019. Page No.: 4374-4380.
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