Utilising GIS capabilities to study and analyse the spatial distribution of crimes in Kuwait

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Introduction

Generally, the level of security is considered to be one of the main indicators of development in any community. Thus, it is essential to maximise public safety and effectively tackle all of the serious types of harm that people face, particularly with regard to crime-related incidents. Naturally, criminal activities are a primary concern, and awareness of them results in a significant negative monetary and psychological impact on people and nations. In every society, crime is classified as a serious state of insecurity, fear and discomfort. Each country determines what constitutes a series of forbidden criminal activities and punishes a criminal for those activities by imposing fines or imprisonment or both. Therefore, there is no permanent or globally determined definition of crime (Henry and Lanier, 2001). One of the primary ways to better understand and recognise patterns of crime and how crime can be effectively handled is to determine the precise geographical location in which the crime is committed (Chainey and Ratcliffe, 2013) Several disciplines, such as sociology, psychology, criminology and geography, have traditionally contributed to fully exploring the study of crime (Georges, 1978).

Hence, decision makers and planners in most developed countries have recently formulated their strategic plans to effectively provide the highest standards of security. Thus, the use of various methods and visualisation tools, particularly the Geographic Information System (GIS) tool, has dramatically increased in modern policing and crime scene investigation. However, in Kuwait, as in most developing countries, police organisations have encountered fundamental problems when attempting to determine, investigate and prevent criminal activities. Surprisingly, modern technologies such as GIS, particularly in the crime investigation field, have not been widely used in these countries to date compared with developed countries, which are greatly concerned with using these visualizing tools.

A wide range of literature studies conducted in several countries, such as the United States, the United Kingdom, Italy, Germany and some countries in Latin America, have illustrated the relationship between crime and its determinants. They have noted that several socioeconomic, environmental and cultural determinants may positively or negatively impact the crime rate based on the spatial distribution of offences, offenders and victims, specifically age, gender, urbanization, poverty, wages, income inequality, social exclusion, educational level and cultural and family background (Buonanno and Leonida, 2005). Moreover, to profile catchment areas into customer segment types and locate facilities, a mixture of GIS and spatial location models have been increasingly applied throughout the arrival of geodemographic packages (Birkin and Clarke, 1998).

This study basically concentrates on utilising GIS capabilities to study and analyse the spatial distribution of four patterns of crime in the state of Kuwait with the purpose of developing crime reduction strategies and organising the police force. In order to achieve this purpose, two analytical methods have been specifically used: location-allocation modelling and spatial interaction modelling.

The project is carried out based on data provided by 80 police stations covering 89 districts in Kuwait. The crime mapping and crime analysis primarily focuses on determining the types of crimes, such as crimes against the public interest, crimes of defamation and insult, crimes against people (physical body) and property crimes.

Using GIS Techniques in policing and to prevent crime

A Geographic Information System (GIS) is the result of a combination of traditional types of science, such as geography, cartography and surveying, and modern types of science, such as remote sensing, Global Positioning Systems (GPS) and computer sciences (Gu et al., 2009). Typically, many definitions can be applied to the term Geographic Information System (GIS), and most of those definitions focus on the hardware, software, data and analysis components. However, depending on the nature of the purpose of the system's use and on the user's knowledge, GIS can be easily defined. One way that GIS can be defined is as a computer system that provides several powerful analytical functions, such as capturing, managing, integrating, manipulating, analysing and presenting spatial data and geographic information referenced to the Earth to support informed decision making (Heywood et al., 2002). At its simplest level, GIS is defined as

"A powerful set of tools for collecting, storing, retrieving, at will, transforming and displaying spatial data from the real world for a particular set of purposes" (Burrough and McDonnell, 1998)

Its rationale is centred on the belief that GIS has significant capabilities to positively help a local police force rapidly allocate, respond to, forecast and, thus, prevent emerging spatial patterns of crime in an informative and efficient way. In addition to its data query capabilities, GIS is a powerful tool that can be prevalently applied to provide a wide range of spatially integrated, comprehensive and referenced data for police organisations so they can have access to specialised crime mapping and conduct specific crime analysis. Moreover, law enforcement organisations can effectively apply the communication component of GIS to identify the detailed relationships between the pattern of offence, the victim and the offender (Neill and Gorr, 2007).

Using the powerful tools of GIS from the primary process of data collection through the investigation and assessment of any criminal activity can fundamentally support policing and crime prevention initiatives. Consequently, strategic decision-making can be supported by utilising the powerful analytical tool that is provided by using GIS (Chainey and Ratcliffe, 2013). It is also helpful in terms of identifying the spatial and social distribution of victims and the demographic characteristics of the offenders (Gaviria and Pagés, 2002).

In the 21st century, GIS is considered to be ubiquitous, covering a wide range of aspects of contemporary life, especially in policing and crime prevention. In general, computerized crime mapping can play a positive and vital role in relation to allocating resources, predicting staff needs and assessing crime prevention strategies (Yon, 2003).

Location-Allocation (LA) Models

In the current century, the most important strategic and operational considerations in metropolitan areas is to optimally determine the location for emergency services facilities such as police stations, fire stations and ambulance stations by maximising the coverage of events throughout the regions and by minimising the response time of dealing rapidly and effectively with emergency events (Li et al., 2011).

Consequently, location-allocation modelling is one of the most prevalent techniques used to determine the optimal location for service provision. These models, which are commonly applied within some GIS systems, particularly ArcGIS, are frequently used by service planners to identify the optimal location for service provision, depending upon a particular set of criteria or identified constraints, such as the number of possible facilities that need to be opened, the number of facility sites to be distributed, the demand points allocated for each single potential facility and the need to minimise the distance travelled, time response or cost of travel from each source (event) to the destination (facility) (Brunsdon and Singleton, 2015). An ideal location plays a critical role in emergency service systems, telecommunication networks, public services, etc. Minimising the costs and decreasing the travel distances are the principal objectives of locating emergency sites (Rahman and Smith, 2000).

Spatial Interaction Models

Spatial interactions, such as migration and airline travel, naturally form a location-to-location network (graph). In the network, a node represents a location (or an area) and a link represents an interaction (flow) between two locations. Locational measures, including both simple measures, such as in-flow, out-flow and net-flow and more complicated measures such as centrality, entropy and assortativity, are often derived to understand the structural characteristics of locations and the roles they play in generating interactions. However, due to the dramatic differences in size (such as population) among locations and the small-area problem, locational measures that are derived with the original flow data often exhibit spurious variations and they may not be able to reveal the true underlying spatial and network structures (Koylu and Guo, 2013).

Spatial interaction models can be grouped under the generic heading of gravity models (Roy and Thill, 2004). They have gained wide acceptance as a reasonable model of spatial interactions between locations (such as regions). Spatial interaction models incorporate a function characterising the origin, i, of the interaction, a function characterising the destination, j, of the interaction and a function characterising the separation between two regions, i and j. The model is characterised by a formal distinction that is implicit in the definitions of origins and destination functions on the one hand, and the separation functions on the other hand. Origin and destination functions are described using weighted origin and destination variables, respectively, while the separation functions are postulated to be explicit functions of numerical separation variables (LeSage et al., 2007).

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