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SHOPLIFTING CRIME HOTSPOTS ARE INFLUENCED BY POPULATION DENSITY AND PROXIMITY OF SHOPS TO POLICE STATION LOCATIONS IN JEDDAH CITY, SAUDI ARABIA

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Abstract:
Saudi Arabia's criminal policies are hampered by a paucity of research findings, which generally guide decision-makers on the best course of action. Despite the availability of GIS datasets and modelling tools, crime analysis is an issue that receives little attention. This study used GIS data to map out hotspots in Jeddah, Saudi Arabia, in order to analyze shoplifting crime. The study also looked into whether population density and the proximity of stores to police stations have an impact on shoplifting crimes. These methods involve the use of proximity analyses and the Kernel Density Estimator (KDE). The results suggest that police stations are not evenly distributed throughout the city. Furthermore, in relation to the density and size of the people in Jeddah, especially in comparison to Western cities, the number of police stations is small. The KDE analysis shows the crime hotspots surrounding the city centre, which are higher in crime than the areas to the north and south. The results of this study can be used to improve decision-making in crime prevention and control in Saudi Arabia and elsewhere since they provide an understanding of the spatial patterns of crime with a special focus on shoplifting crime.

Keywords: GIS, shoplifting crime hotspots, population density, police, proximity

1. Introduction

Crime mapping is of great value to policy design, implementation and evaluation. Crime mapping is a communication tool as it provides information on, for example, areas with high crime frequency for the deployment of security personnel (e.g., hot spot detection with respect to patterns of shoplifting and response to the threat). It also provides information on how the various crime patterns are related to socioeconomic indicators (e.g., gender, educational attainment) for an effective policy design. Since crime mapping is useful to policymakers, in order to understand and potentially prevent shoplifting, it

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is equally important to advance the science. Understanding progress requires detailed knowledge not only of the qualities and motivations of criminals, but also of the environmental elements that may assist or hinder their criminal activities. Shoplifting is essentially a spatial crime since by definition it occurs in specific types of premises whether small independent retail outlets, supermarkets of shopping malls, located predominantly in urban settings. Recent development in geographical information science (GIS) is providing an interesting opportunity for an effective approach to crime mapping.

In criminology, more attention is being paid to ascertaining the relations between crimes and disadvantaged socioeconomic groups which is necessary for addressing social dislocation issues as earlier explained (Shaw and McKay, 1969). However, a proper understanding of the crime pattern is enormous to decision making as one of the most notable tools mainly used in crime research to inform policy design, is the GIS. Presently, the application of this technology using disaggregated data has led to a number of studies that have concerned with mapping, cluster analysis and spatial patterns of crimes generally. The application of GIS in crime mapping is basically to evaluate the spatial patterning of the crime incidence and to associate factors responsible for the pattern (Hirschfield, Bowers and Brown, 1995).

The works of Hirschfield, Bowers and Todd (1995) and Hirschfield, Bowers and Brown (1995) were some of the pioneering steps in spatial analysis of crimes in Europe. Hirschfield, Bowers and Todd (1995) reported on the progress that has been made towards developing a GIS-based crime analysis and mapping system for use in the analysis of crime incident data recorded by the Merseyside Police force in north-west England. The research was supported by the British Urban Crime Fund; a spatially targeted anti-crime initiative aimed at reducing vehicle crime, domestic burglaries, drug-related crime and public disorder in inner-city areas. The analyses were done in a GIS environment (Arc View) because of its functionalities which can highlight the patterns in crime statistics and the socio-demographic characteristics of areas with high levels of criminal activity.

In another study by Hirschfield, Bowers and Brown (1995), the relations between the crimes and the disadvantaged in Merseyside, North-western England were explored to find out the links between deprivation and certain types of crimes. The study focuses on this area as it was the most deprived urban region in Europe and has a significant number of crimes and related violent activities. Another reason was the availability of spatially referenced data. The ultimate aim of the study was to test the hypothesis that the crimes are high where deprived areas directly border or are close to them. The results show that the affluent areas are highly surrounded by the disadvantaged, consequently, leading to relatively high crime in the affluent areas.

This paper presented and analysed the data obtained from a survey of Jeddah shops (but spatially referenced data), regarding the targets/victims of shoplifting. Although there have been few studies in this field in Saudi Arabia, mostly reported in newspapers that highlight this phenomenon. For example, it has been observed that

shoplifting is a very common crime and the police or responsible authorities are not doing enough to curtail this problem. The total loss to small and medium shops is between SR 5000 to 15000 and losses can be expected to increase as the population increasing brings on increasing in the number of shops. Moreover, according to Ministry of Interior data, Riyadh and Jeddah have the highest rates of shoplifting crime. Al-Maghluth argued that shoplifting is a sociological problem that needs to be studied. For this reason, this study seeks to shed light on this crime and study the factors that contribute to it.

In the first part of the present study, data were collected from 301 stores in Jeddah. In order to build a wider knowledge about the managers' and employees' experience of shoplifting. This was necessary because there are no commercial victimisation surveys in Saudi so the researcher could use comparable to the national commercial victimisation survey in the UK. The data were collected via a questionnaires survey distributed to 16 areas of Jeddah selected on a stratified cluster basis to reflect all Jeddah neighbourhoods in aspects such as density, nationality, the standard of living and geographical location (north, south, east-west and the centre of Jeddah). The questionnaire survey in this study asked about the total number of shoplifting crimes reported inside the shops, either by employees or customers, to the managers or local police, for the period 2016-2017. It focused on one type of crime category (shoplifting).

Some questions were adopted from the Commercial Victimization Survey for England and Wales in 2014 (Williams, 2016) in order to address a specific question, such as, why was the shoplifting not reported to the police? The answers to questions were coded using a wording manual. Two different models were built in order to analyse the crime trend. The first model focused on the shop characteristics and was analysed by various techniques statistical. The second model (which is of interest to this paper) focused on the area characteristics and was analysed by creating. The main objectives of this study are; 1) to assess whether the higher number of people (population density) in an area is influencing shoplifting crime, 2) to assess whether the proximity of shops to police stations' locations can result in an increased or decreased crime rate, 3) to identify the shoplifting crime hotspots areas in Jeddah city.

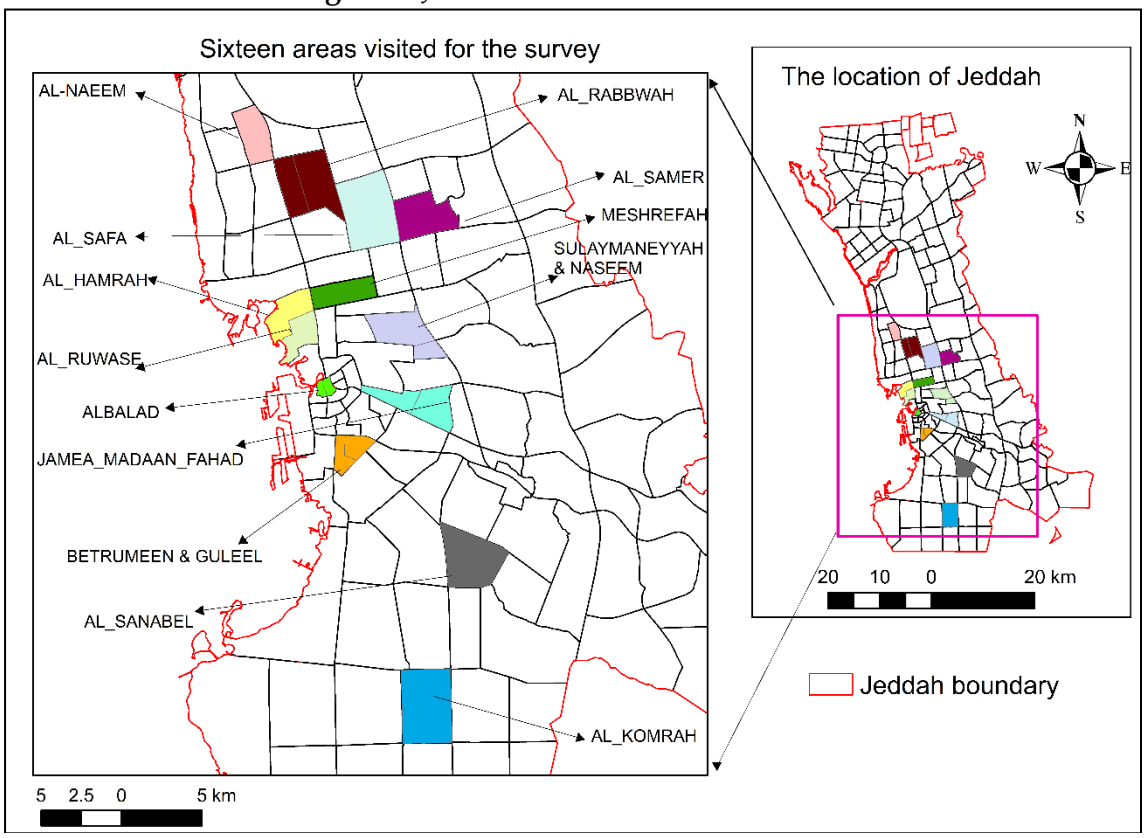
2. Study Area

Figure 1 displays the geographical location of the study area (Jeddah), the figure also will show Jeddah's neighbourhoods more than 120 areas which can be divided into map Sub-municipalities (shown later). The researcher also created a different map from the main map describing the location of the 16 areas selected for the survey using the Arc toolbox in the Arc Map. The map was then clipped down to more precisely focus on the 16 studied areas. This constructed smaller map was the foundation for the data collected from the questionnaire.

In essence, Figure 1 demonstrates the distribution of the sixteen neighbourhoods visited for survey data collection in Jeddah. The south areas were Alkomrah and the north neighbourhood was Alnaeem. Al-Balad area was observed to be divided in the

ArcMap into many polygons and it is called Al-Balad area because the area is very old and historical with many shops.

Figure 1: Jeddah Location in Saudi Arabia



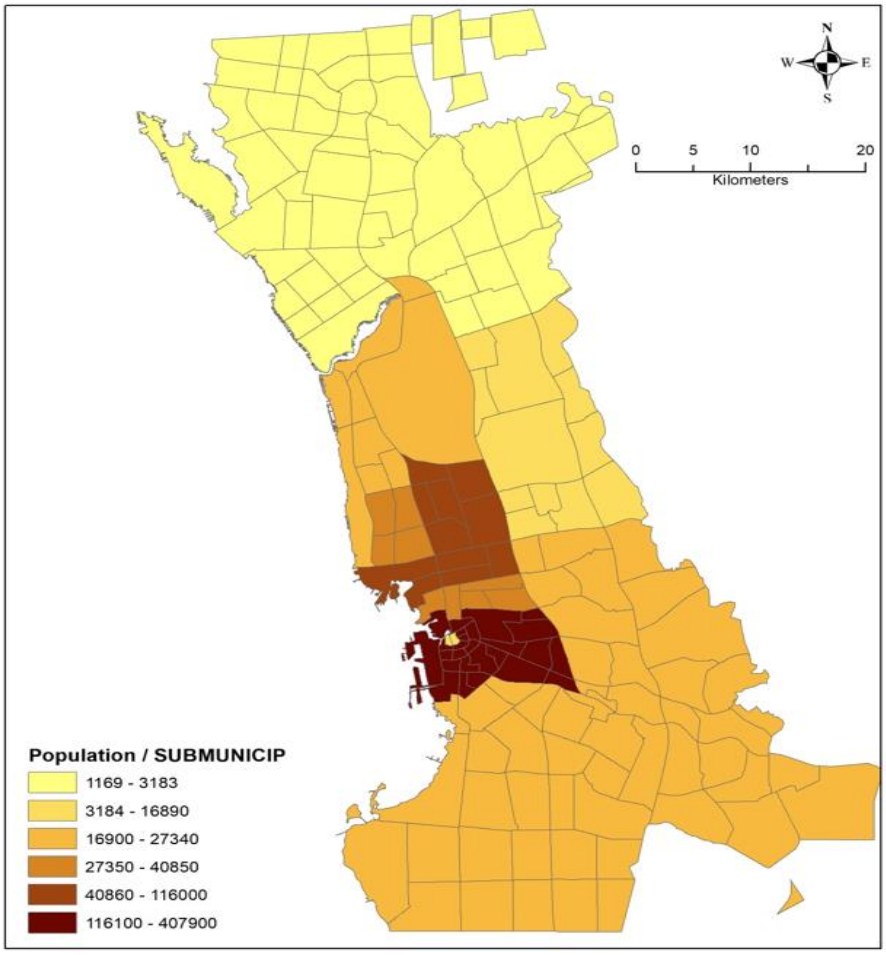
Sources: Jeddah Municipality.

The number of sub-municipalities depends on the size of the cities and population density as well as the history of settlements in the area. Some sub-municipalities have a large population in a small area of neighbourhoods such as the centre of Jeddah, while the less populated area, for instance, north and south have numerous neighbourhoods and smaller populations. The sub-municipalities in the north and the south contain larger neighbourhoods because of the low population in these two areas, which eases control in these areas. They are also new areas, which require less maintenance, compared to the central sub-municipality.

An exception to these principles, however, is the centre of Jeddah, where there are only two neighbourhoods in the sub-municipality, due to the historical importance of this area. The larger municipalities could be further sub-divided if the population changes. Jeddah and each of those sub-municipalities have a number of neighbourhoods. The purpose of dividing the municipality of Jeddah into 13 areas is to allow more control over such a big city. Municipalities assume multiple administrative, financial and technical functions, such as granting building permits and maintaining roads, within a specific geographic framework. The reason for the inception of this system was to relieve

the pressure on the central government (Al-Thunayan, 2001). Table 1 shows the sub-municipalities, their number of neighbourhood and the population

Figure 2: Total Population per Sub-municipality



Sources: Jeddah Municipality and Statistical Authority.

Table 1: Number of Neighbourhoods in Each Sub-municipality

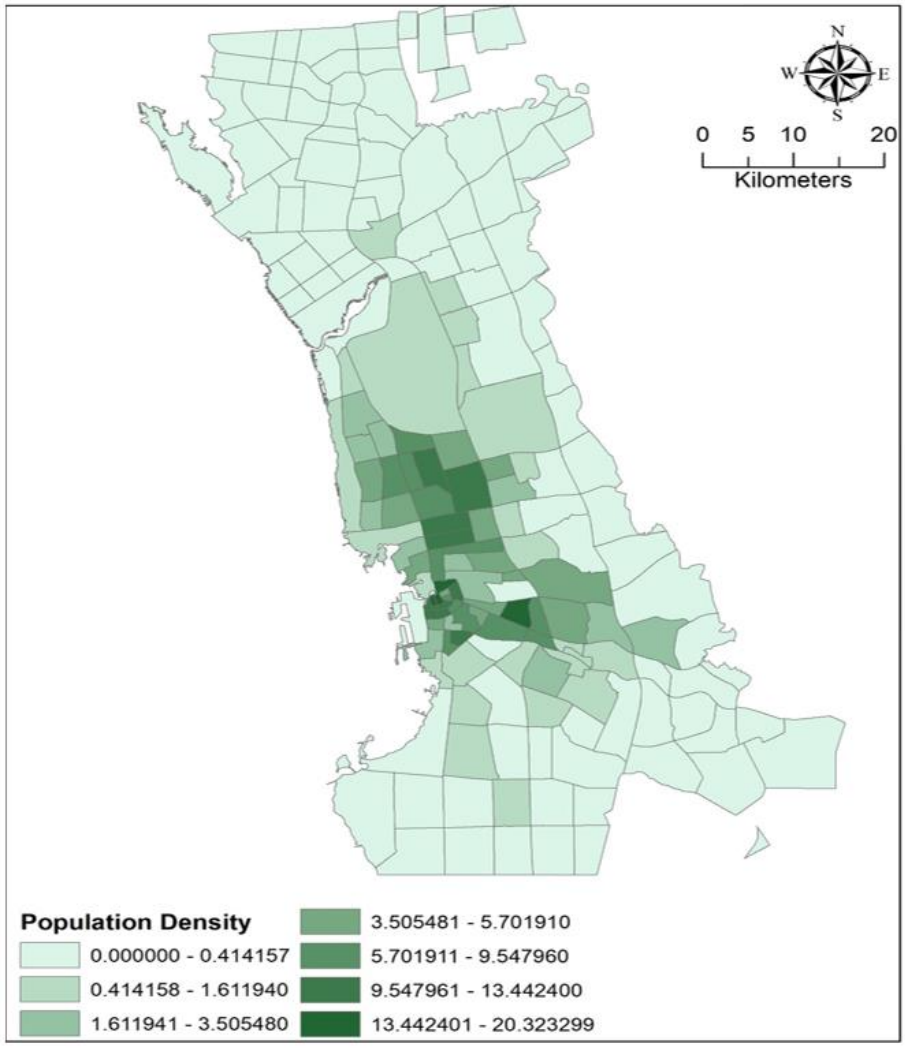
The Sub-Municipality Number	Sub-Municipality Name	Number of Neighbourhoods	Population
1	Al Balad	11	338407
2	Al Jamea ا Ah	15	815713
3	Historical Municipality of Jeddah	2	50683
4	Al Azizeyyah	5	342993
5	Al Sharafeyyah	5	204226
6	Al Safa	6	695917
7	New Jeddah	4	215719
8	Jeddah Airport	9	218721
9	Obhur	38	28646
10	Municipality of the South	41	203097
11	Um Asalam	14	276194
12	Buraiman	12	135683
14	Taibah	21	16364

Sources: Jeddah Municipality and Statistical Authority, 2016.

2.1 Jeddah Population Density

Population density data were obtained from the survey data collected from the General Authority of Statistics (2016) (https://www.stats.gov.sa/en/4522). Figure 3 illustrates the total population during 2016 when the census data were gathered. The map shows the overall total population density in Saudi Arabia. In explaining the map, an important point to be mentioned is that the non-coloured areas on the map are as yet uninhabited, as these are currently under construction. People only live in the areas shaded in the colours on the map. Jeddah's high density explains why the centre of Jeddah has many sub-municipalities, but only a small number of neighbourhoods. The centre of Jeddah has a high population and also contains a historical town, which requires more work and focuses to rebuild and renovate to avoid problems. Thus, it is an area of high density and low infrastructure. The map also shows that the largest population are located in four areas, Al Rabbwah, Al Azizeyyah, Al Safa and Al Jamea|Ah which have a population between 11,000 and 205,000 people. The most populated area coloured in blue, has a total population of almost 14,000, per km^2 while the lowest density is 70 people per km^2.

Figure 3: Jeddah Population Density

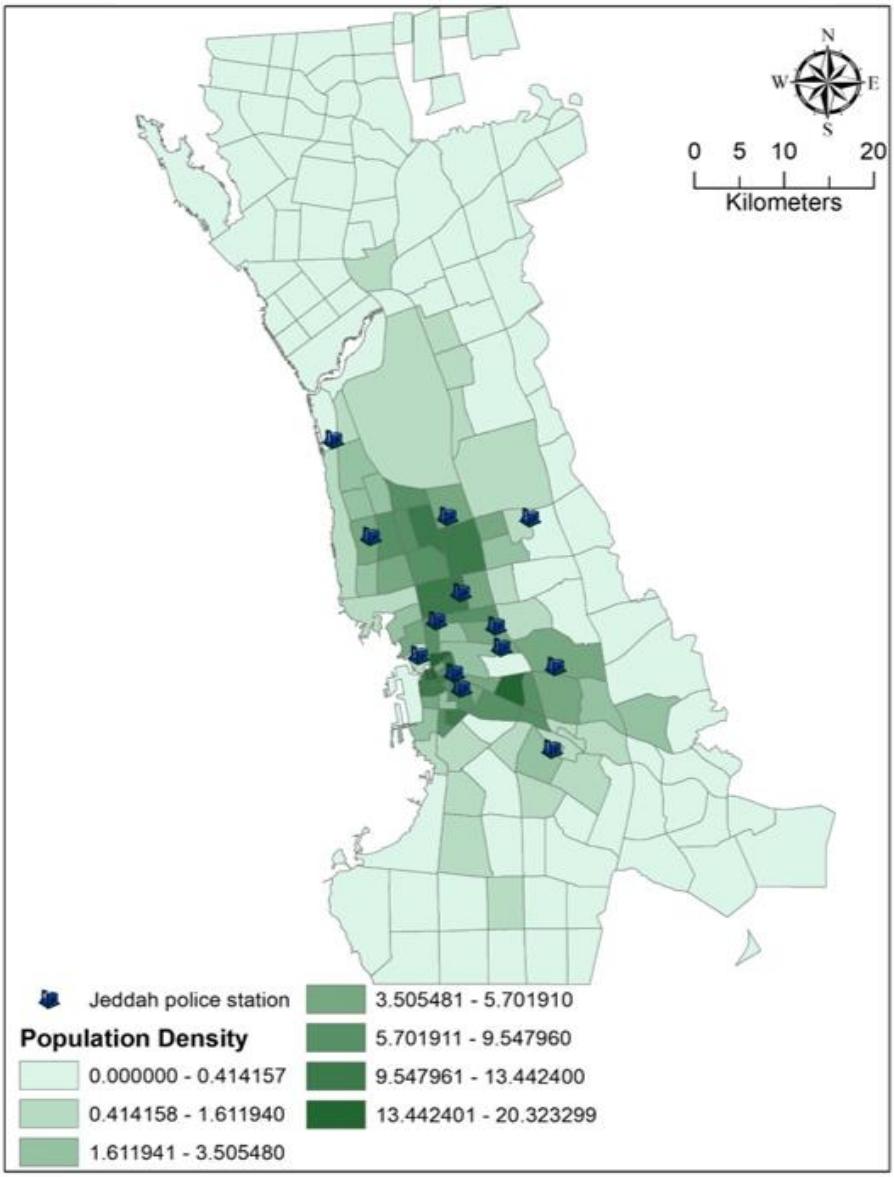


Sources: Jeddah Municipality and Statistical Authority, 2016.

2.2 Police Station Locations

According to the Jeddah municipality, the number of police stations located in Jeddah is 13 stations. The above map shows the locations of police and traffic stations distributed around the city. The information on the location of police stations is relevant in the analysis of locations of shops involved in the survey, which asked about the distance from a police station. It will also be used in analysing the crime data collected from Jeddah's prison to provide more information on the role of police stations in affecting crime rates. The map was created by the researcher, the data was collected from Jeddah municipality, November 2017, and the UTM data 1984, https://www.jeddah.gov.sa.

Figure 4: Map for the Distributions of Police Station Points and Population



Sources: Jeddah Municipality and Statistical authority. UTM: World 1984.

Table 2: Police Stations Compared to Population in the Areas where Stations Were Located

Police station name	Neighbourhood location	Population
Al Kandarah	Al Kandarah	55663
Aljameaiah	Al Sulaymaneyyah	30603
Al Balad	Al Balad	50683
Al Naseem	Al Naseem	44436
Al Sharafeyyah	Al Sharafeyyah	70891
Al Nuzha	Al Marwah	68708
Al Samer	Al Ajwad	8799
Ubhuer	Almarjan	13473
Northen	Al Azizeyyah	135167
Al Mountazahat	Alrughamah	114488
Al Nazlatean	Al Nazlah	27995
Al Janubyeah	Alameerabdulmajed	41698

The last point in the south is the farthest by an estimated 24 km, using the measurement in the ArcMap, Al Ameer Abdoulmajjed is the last area, which contains police stations south and this area is around 24 km from Alsahil area for example. In the north, the last area that contains a police station point is Al Marjan. in the northwest, and the farthest area from this is Al Frosyah, in the northeast by 21 Km. The centre, which has most of the police stations, and the neighbourhoods farthest north and south, contain few or no protective government institutions, for reasons, such as population density. The third and final was a method developed based on models built for shop characteristics, the other for area characteristics in order to give a clear and accurate understanding of the shoplifting crime trend in Jeddah.

3. Material and Methods

3.1 Location of Surveyed Shops

The questionnaire covered the following 16 areas; Al Naseem, Al Balad, Madaan Alfahad, Al Jamea|Ah, Al Sanabel, Al Sulaymaneyyah, Al Ruwase, Al Hamrah, Betrumeen, Al Samer, Al Khomrah, Guleel, Al Rabwah, Al Safa, Al Naeem, Meshrefah. According to the state agency (https://www.stats.gov.sa/) (https://www.ejar.sa/), the sixteen areas are reflective of the Jeddah neighbourhoods as these sixteen areas encompass all types of neighbourhoods.

The classification of these neighbourhoods depends on:

- density;
- size;
- social class.

The affluent neighbourhoods, for instance, are in the North West and east-central (Al Naeem) whereas the more deprived areas are in the centre (Albalad, Madaan Alfahad) and the middle-class area is in the south and north east (Al Safa, Al Khomrah). In addition, in terms of demographics, the sixteen areas reflect the density of population differently, so it is possible to identify the highest density of population (above 40,860),

the lowest density (1169 to 16890), and the moderate population density (16,900 to 40,850).

Figure 4-9 illustrates the number of shops, covered by the questionnaire survey in each neighbourhood. The total number of shops was 400, including some shops that refused to answer some of the questions and others that refused to answer any of the questions. The number of questionnaires distributed in each area depended on the number of shops in the area location; some areas have many more shops than others do, so the number of questionnaires distributed was larger. For example, in the Al-Balad area, 30 shops were surveyed in order to reflect the whole area. In contrast, Al Sanabel had 17 participants, because the areas were established only recently and so had fewer shops. Moreover, some shops were located on the main road of the neighbourhood, opposite other neighbourhoods, which also contained shops. The reasons for not covering the area after Jeddah airport are because the population density is very low and some areas have no people and the buildings were meant for the future. Table 3 shows the number of shops visited by the researcher and the total that responds and the percentages.

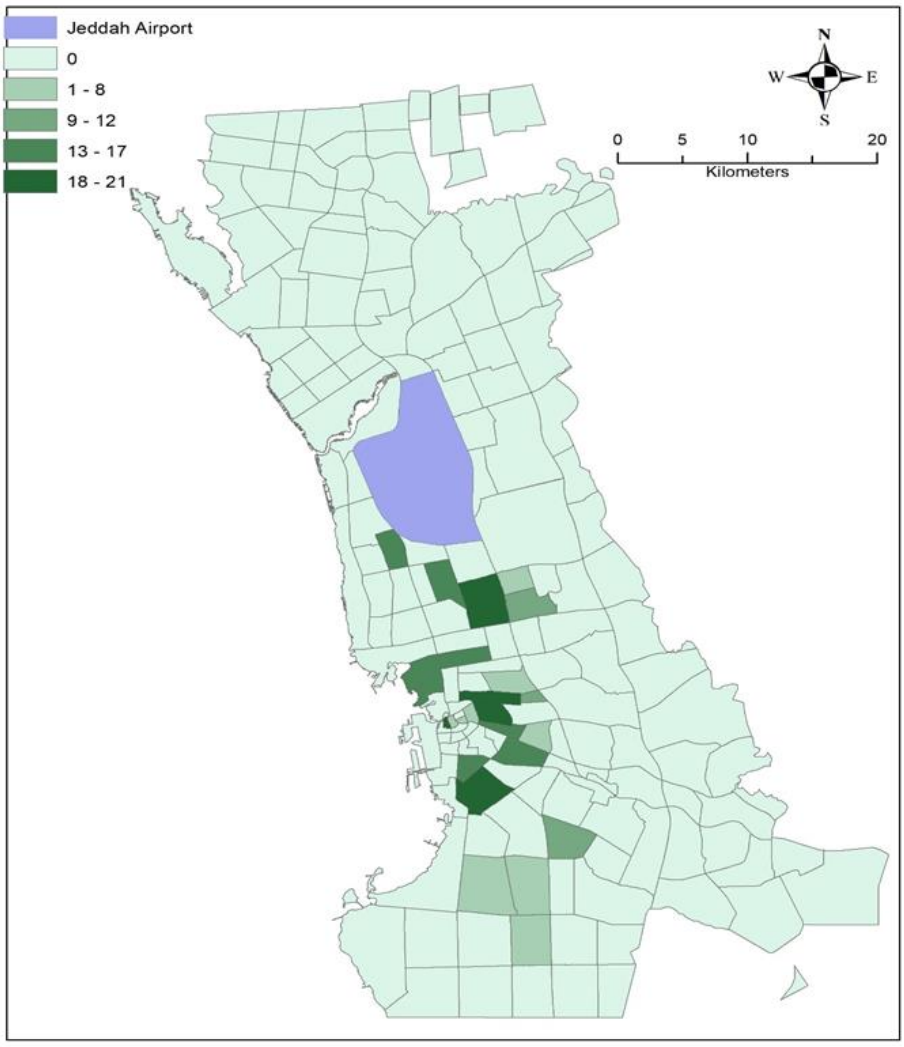
About 99 shops refused to respond to the survey for a number of reasons. Most of these were shops inside the mall, where the regulation does not allow any form of a survey, for security reasons permission took too long to enable gathering data, especially in the Al Jameaiah neighbourhood, but others were more flexible.

The area covered by the survey was over 39 km^2. The most southerly points covered were a hypermarket in the Al Khomrah area and the furthest north was a cosmetics shop in Al Naeem. The Euclidean distance between these two points was 39 km.

Table 3: Total Shops Visited by Researcher

No.	Neighbourhood	Number of Shops visited	Number of Shops that responded	Percentage (%)
1	Al Balad	45	38	12.62
2	Al Naseem	28	22	7.31
3	Madaan Al Fahad	22	16	5.32
4	Al Jameaiah	33	23	7.64
5	Al Sanabel	17	12	3.99
6	Al Sleymaniah	16	11	3.65
7	Al Ruwase	21	13	4.32
8	Al Khomrah	36	34	11.30
9	Quleel	26	17	5.65
10	Al Rabwah	24	15	4.98
11	Al Safa	30	21	6.98
12	Al Naeem	22	16	5.32
13	Meshrafa	23	17	5.65
14	Betromeen	16	15	4.98
15	Al Samer	20	16	5.32
16	Al Hamrah	21	15	4.98
17	Total	400	301	100

Figure 5: Shops Number per Neighbourhood



Sources: Jeddah Municipality and Victimization Survey.

3.2 Assessing Proximity of Shops to Police Station

In this study, the proximity of shops across the sampled areas was assessed in relation to the locations of police stations. The study built the distance-based model in ArcMap and Arc toolbox in order to measure the distance between the shops and police station, to find the nearest police station to the shops. Using the analysis tool in the Arc toolbox to create the model to measure how many meters are the shops far from the police station.

3.3 Kernel Density Estimates (KDE)

The ultimate purpose here is to identify and rank the crime hotspots based on Kernel Density Estimation (KDE) method. KDE helps to provide a visual representation of the hotspots. Kalinic and Krisp (2018) explained that the KDE algorithm fits a smoothly curved surface over each point. They further explained that the surface value is highest at the point location and diminishes as the distance from the point increases. It becomes zero at the search radius (bandwidth) distance from the point. If not set otherwise, the tool calculates the bandwidth specifically to the input dataset. The search radius units are

based on the linear unit of the projection of the output spatial reference. Therefore, bandwidth selection is one critical area that requires attention. KDE is advantageous as it takes into account the incremental values of the mean in the statistical and spatial distribution of crime incidence (Barrantes and Sandoval, 2009). KDE algorithm usually produces a continuous surface based on the population values, in this study, the total number of crimes for each polygon across the study area. The kernel density for polygon features will calculate the density of features around each output raster cell.

4. Results

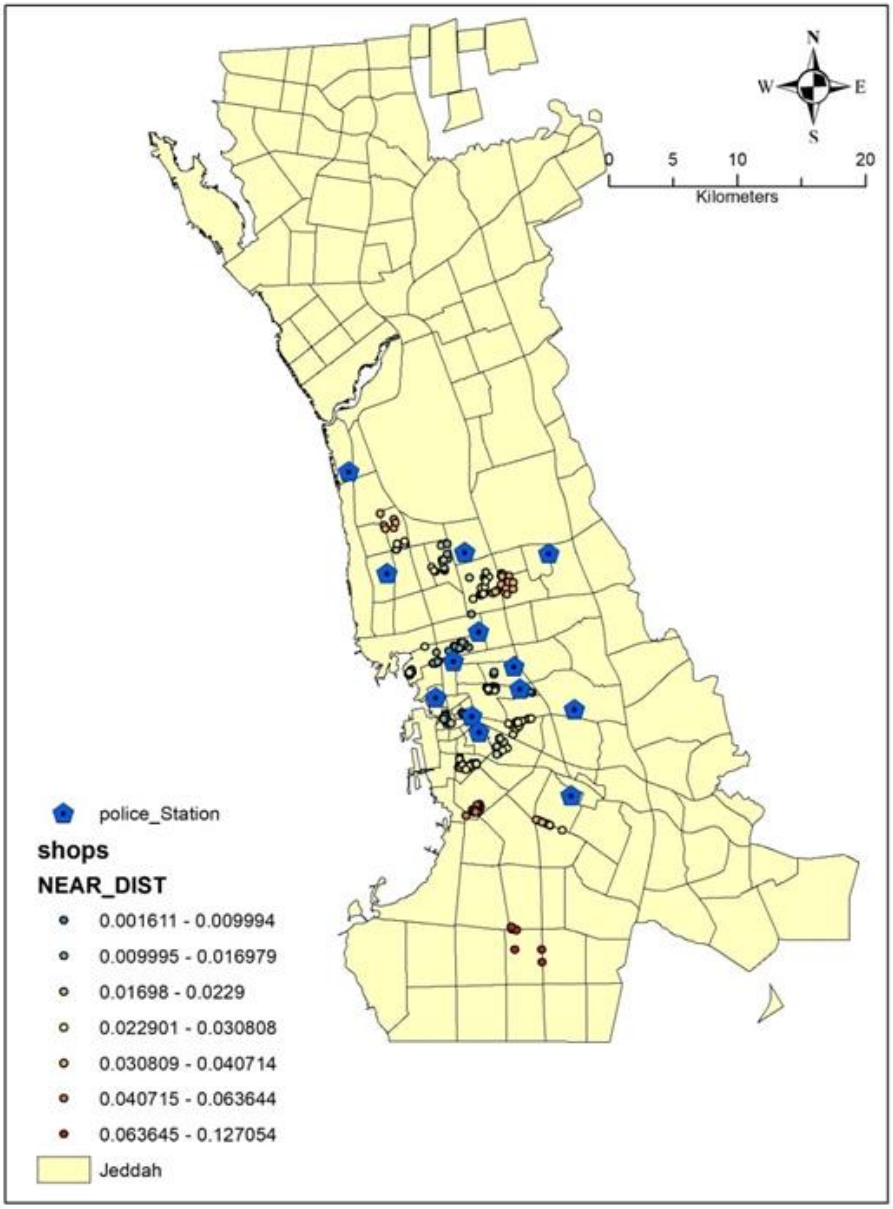
5.1 Analysing the Distance of Population from the Police Stations

The map of police station location earlier in this paper (Figure 6), shows the distribution of police stations are not evenly spread across the city. In addition, the number of police stations is small in comparison to the density and size of the population in Jeddah, especially in comparison to Western cities with a similar population density and multicultural population like London, where police stations are located everywhere across the city (https://www.met.police.uk).

The map above shows the closest police stations to the shops. It shows that the nearest shop to the police station is less than 100 meters and the farthest is in the south Alkohmrah area within 12 km. The next table will give more details about the number of shops closest to police stations and the reasons for unbalanced distribution. This map was produced by building a spatial model in ArcMap using shops and police station data. The map results were extracted through the Arc Toolbox, using proximity in the analysis tools.

Table 4, the analysis is done in the ArcMap, shows the number of the shops closest to each police station. The results show that some police stations have a large number of shops nearby. For instance, Al Nazlatean has 73 shops close to a police station. These 73 shops are distributed within different neighbourhoods. The second-highest number of shops surrounding a police station is 42, around Al Jameaiah. These shops are also distributed in the area and around it. One police station, however, has no shops in close proximity, so the researcher did not cover this area, which has the Al Mountazahat police station. Ubhuer police station has only one shop nearby. Al Samer police station has only four shops nearby. This area was covered by the researcher, but the police station was built towards the outskirts of the neighbourhood, meaning it is far away from the central shops. This geographical arrangement is similar to that of the Al Naseem police station, which is in close proximity to only two shops. The remaining police stations are well-positioned within their neighbourhood. The analysis of the shop to the closest police station was done by straight-line distance.

Figure 6: The Nearest Police Stations to the Shops



Sources: Jeddah Municipality and Survey Data

Table 4: Shops Close to Police Stations

Police Station	The number of shops in close proximity
AL Kandarah Station	27
Al Jamea l Ah Station	42
Al Balad	30
Al Naseem Station	2
Al Sharafeyyah	30
Al Salaam	15
Al Nuzha	33
Al Samer	4
Ubhuer	1
North Station	18
Al Mountazahat Station	0

Al Nazlatean	73
Al Janubyeah Station	26
Total	301

5.2 Shoplifting Hotspots Assessed through KDE

Figure 7 shows the hotspot maps of all areas covered by the researcher's survey of shoplifting crime. The map shows a hotspot area around the centre where the crime is highest compared to the area in the north and south. Kernel density was used from the Arc toolbox within square meters. High values in dark blue/green to light green indicate hot spot locations and vice versa for the lower values.

Figure 7: Hotspots Crime Area for Shops Visited for the Survey
(high values indicate hot spot location and vice versa for the lower values)

Sources: Jeddah Municipality and Survey Data.

5. Discussion

Our analysis of the models built provides an understanding of the spatial patterns of crime. The key objective here is to answer the research questions in research using the survey data. Thus, the paper found some findings, which have not been reported before as research in this area is still rare. In terms of the proximity and distance of stores to police stations, we can say that there is a clear relationship between the proximity of police stations and the crime rate. The closer the shop to the police station, the less theft could occur. For example, offenders target areas with no police station and density of population and close to the main road, which enables them to hide quickly. This is evident in the spatial pattern (e.g., hot spot) of shoplifting as revealed by this study, the crime rates were found higher in certain areas with no police station or regardless of their

proximity to police stations. From this angle, the deployment of more police officers to these stations is also important. The study recommends that more police officers should be deployed to these areas. When the size of police forces increases, the chances of victimization will be greatly reduced. Therefore, the relationship between the size of the police and crime rates is one area that this study would recommend for future studies.

An area is more susceptible to crime especially if there are associations between favourable factors and the type of crime, shoplifting in this context. For example, the distance from the police station, the farther away an area is to police, the more favourable it becomes for the offenders to perpetuate their activities. Secondly, is the high density, especially in unplanned areas where the offender takes advantage to hide easily after committing a crime, moreover, the unplanned area in Jeddah has a very narrow complex road which helps the offender disappear quickly even if the owner or the employee see him. The densely populated areas are more prone to this kind of situation. Also, the type of season affects the area to be vulnerable, especially during Ramadan time when the transaction is at its peak.

This study relies on a victimization survey and is upon which the geo-referenced data were derived. A victimization survey is advantageous as it allows one to track the extent of crime as well as the progress being made in crime prevention and control. This study, therefore, recommends an intensive data survey to be conducted by the Saudi Authority at least every 2 years. For example, the findings from the 2014 Commercial Victimisation Survey (CVS) in the UK have reflected substantial improvements in crime prevention and control, particularly in the area of shoplifting. Crime in the wholesale and retail sectors fell significantly between 2012 and 2014. For example, the number of incidents experienced by this sector fell from 7.7 million in 2012 to 4.1 million in 2014. This fall was statistically significant and was largely driven by falls in shoplifting. Compared with 2012, the 2014 CVS shows that the number of thefts in the wholesale and retail sector has fallen by around a third, from 15,836 to 10,319 incidents per 1,000 premises. Within this, theft by customers (shoplifting) has fallen by 3,749 incidents per 1,000 premises, from 10,445 to 6,695 incidents per 1,000 premises. Both falls are statistically significant. Because of the usefulness of the CVS approach, this study integrates this approach with spatial analysis to detect shoplifting crimes Williams & Pearson, 2016).

6. Conclusion

This paper explores the data collected from the study area, by means of a survey, about peoples' experience of shoplifting crime and the action taken by the police in response to this type of crime. The description of this paper shows that population density is mostly distributed from the centre and the neighbourhood around it approximately 20km north, south, west and east, with only 13 police stations to cover the city. The data reveal some areas of high crime in shoplifting with low population density. This study provides an

understanding of the spatial patterns of crime with a particular reference to shoplifting crime in Jeddah city.

Conflict of Interest Statement

The authors declares no conflicts of interest.

About the Author

Dr. Muneera Mogaemsh Alharbi is an Assistant Professor in the department of geography, Taibahu University, Saudi Arabia. She is interested in GIS and spatial analysis of crime research.

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