Spatio-temporal analysis of theft-related crimes in inefficient urban textures: A case study of the central part of Tehran

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A B S T R A C T

Crimes are taken into account as the most common social problems observed in most cities across the world which can also bring about negative effects on mental, physical, and financial aspects of individuals’ lives. Thus, the aim of this study was to perform a spatio-temporal analysis of theft-related crimes in inefficient urban spaces and textures of the central part of Tehran (Districts 11 and 12), Iran. To this end, a comparative analysis research design was used and then the spatio-temporal patterns of theft-related crimes committed in the central part of Tehran were identified and investigated through statistical and graphic-based tests within the geographic information system (GIS). The information required in terms of the types and the number of crimes was also obtained via library method from the Law Enforcement Force of the Islamic Republic of Iran (Islamic Republic of Iran Police) in Tehran metropolitan area. The findings of the present study revealed that the crime hotspots had been distributed in a clustered pattern in the central part of Tehran. Moreover, temporal analysis of months, days of the week, and overnight hours of the opportunities for the occurrence of all theft-related crimes in the central part of Tehran demonstrated that the third ten days of the month, three final seasons of the year, and the first starting days of the week between 10 a.m. and 2 p.m. were the peak times of the crimes committed. The findings suggested that the large number of urban worn-out textures, high levels of intrusiveness in these areas, presence of abandoned lands, as well as lack or absence of some public urban services and facilities for citizens could affect the geographical distribution of types and number of crimes as well as the formation of their spatial patterns. It was assumed that renovation and reconstruction of worn-out textures, organization of buildings including the removal of corners, unfinished buildings, as well as ruined ones, modification of the physical structure of residential areas, widening streets under 6 meters, creating passages for blind alleys, encouraging residents to maintain beauty and security through holding sociocultural programs, locating police stations, and establishing healthy entertainment and recreational centers to increase official surveillance in the central part of Tehran could reduce the possibility of the damage caused by such textures and finally lower crime rates.

K e y w o r d s: Spatio-temporal analysis, theft-related crimes, inefficient texture, central part of Tehran
Introduction

Today, increased crime rate is considered as a disturbing issue observed in all cities especially megacities across the world, which has been also become one of the important concerns among citizens, organizations, as well as political, social, and economic leaders and authorities in communities. It seems that, in the present century, unfavorable urban textures have created numerous problems in terms of the security of their citizens and they have also affected growth of social harm (Kamal, 2011). In this regard, the rates of urban anomalies have also increased since cities have developed physically and socially and turned into heterogeneous centers in terms of their demographic, social, and cultural features. So; Individuals’ social and residential environment, inappropriate residential structures, as well as social failure and economic poverty can provide the grounds for urban damage as well as unrestrained and sprawling growth of such deviations (Pishgahifard et al., 2011). With the spread of this damage; security may also fade away, crime rates are likely to increase, people can also act cautiously in social activities, fears and worries may double following each incident, and finally citizens are likely to feel insecure (Kamali, 2011). Therefore, one of the barriers to the presence of people in urban spaces and textures is the lack of sense of security (Modiri, 2006). Like most countries in the world, Iran has witnessed big transformations in terms of urbanization during the past half-century. Moreover, migrations from urban areas to the cities, expansion of urbanization, and increase in urban population have led to high rates of social deviations (Bayat Rostami et al., 2010:3). In this respect, the results of a survey conducted in 8 major cities in Iran determining the sense of security among citizens demonstrated that 81% of the residents were feeling insecure and some of the causes of insecurity were rooted in environmental factors (Taherkhani, 2002). Among the cities wherein crime rates have been reported significant due to being the capital city and the feature of being a model is the city of Tehran which also needs more attention in this regard. Because of its physical and demographic development along with the demolition of the old areas, indefensible spaces have been highly increasing within this city. In the meantime, Districts 11 and 12 of the Municipality of Tehran metropolitan area located in the central part of the city have today turned into problematic and damaging areas despite their historical and even socioeconomic backgrounds. Moreover, these districts have been called as abandoned or dismantled areas which are deteriorating and facing serious problems in physical, socioeconomic, and security-related domains.

In the Universal Declaration of Human Rights, liberty has been assimilated to security and governments are in charge of meeting the given rights and providing security in cities. Within the model of human needs, Joh Lang places security as one of the basic needs in the second division. Urban crimes can also impose very huge costs at individual, social, and national levels (McCollister et al., 2010; Carmona et al. 2003:10), so attention to the issue of urban security is doubly important since the rise in crimes in metropolitan areas not only creates insecurity, chaos, and confusion in citizens’ lives, but also makes the public sector spend large budgets and expenditures, energy, and time on discovering crimes, arresting offenders, doing judicial investigations, as well as rehabilitating and punishing offenders. This issue can similarly have enormous financial and spiritual burdens on communities. Accordingly; investigating security, its underlying factors, as well as strategies to strengthen it are of utmost importance due to extensive urbanization and spread of social insecurity in cities (Rahimi, 2006; Kamran & Shoaie Barabadi, 2007; Abdali, 2016: 36-37). Given its structural complexities and functional conditions, as well as its governing and specific physical, socioeconomic, and cultural feature;
the central part of Tehran (Districts 11 and 12) is encountered with high rates of crime and social deviations. In other words, one of the most important problems in Districts 11 and 12 in the city of Tehran are currently high crime rates and social anomalies. So, the purpose of this study was to identify and shed light on the spatio-temporal patterns of theft-related crimes in the central part of Tehran (Districts 11 and 12) in Iran using statistical and graphic-based tests in the geographical information system (GIS).

**Research literature**

Scholars have long been debating the impacts of geographical environments on social deviations. Therefore, attention and interest towards spatio-temporal analysis and evaluation of the relationship between space and crime have increased in scientific circles across the world over the past few years (Anselin et al., 2000). Numerous research studies conducted in the domain of crime and environmental opportunities are essentially considered as a part of the instructions for environmental prevention of crimes (Clark & Ja’afarian, 2008:446). The history of investigations on the geography of crime can be also traced to the early work by Queteler and Guerry, French ecologists, in the first half of the 19th century. For the first time, studies based on statistical principles and methods on geographic environments and crime emerged in the work of these two ecologists (Shokoui, 1990: 45; Kalantari, 2001: 54; Abdali, 2017: 11-12).

The theories about increasing security in cities with respect to the environment were put forth from the 1960s onwards in the United States. In this domain, Jane Jacobs was the first one to address this issue in 1961 in her work entitled as “The death and life of great American cities”. She believed that citizens’ natural monitoring could contribute to city livelihoods and also appropriate urban design and planning could make it possible to have social control targeting crime prevention. According to Jeffery, Jacobs was the first one who triggered the issue of the relationship between environmental conditions and crime prevention (Jeffery & Zahm, 1993). In 1969, Jeffery was also the first person using the phrase “crime prevention through environmental design” (CPTED). She also put an emphasis on urban design and planning of structures and neighborhoods within a city in order to control and prevent crime. In her viewpoint, normal care by citizens and proper design of buildings and urban spaces could be important factors controlling urban crime. In addition, “Defensible Space”, the book written by Oscar Newman had a special influence on the formation of this attitude (Jason & Wilson, 2011:22). In 2011, Erdoghan et al., reviewed and analyzed five types of crimes in Turkey and concluded that the offences could non-randomly occur in time and in place except for ones relating to the use of firearms and cold weapons. All the crimes committed in Turkey were distributed on matrices in clustered patterns which were significant in western and southwestern Turkey in terms of crimes such as fraud and theft. Wang et al. (2013), in his study at one of the counties in the United States evaluated the spatial distribution of crimes using the spatial differentiation pattern (group divisible patterns: GD patterns). The results of this research study showed that the Hot Spot Analysis (HOT) had acted more successfully in terms of the identifying crimes than the Habitat Suitability Analysis (HSA). John and Kevin (2017), in their study entitled as “Changes in the levels of crime among small and large cities” concluded that increase in income inequality as well as racial and ethnic heterogeneity would augment levels of crime and this inequality could be more visible in big cities. March and Jenz (2017), in a study entitled as “Regional conditions of immigration and crime: Evidence from a special policy in Germany” also argued that crime rates depended heavily on regional conditions, i.e. increased crime rates were correlated with increased population density in areas that had attracted large numbers of foreign immigrants.

In addition to the translation of a part of the studies conducted in other counties in Iran, several investigations have been carried out in this domain
including the recent study by Bayat Rostami et al. (2010) in which the findings showed that cities using the CPTED had been more successful in fighting crimes and strengthening security and comfort among their citizens. Finally, they offered suggestions to empower streets and neighborhoods against crimes through the CPTED (Bayat Rostami et al., 2010). As well, findings of the study by Kalantari et al. (2011) revealed that the CPTED was among the significant approaches for analyzing and explaining the relationship between environment and crime. According to this approach, modifying the design of residential units and taking their adjacent neighborhoods into account, committing crimes against property could be prevented (Kalantari et al., 2011). In their article, Adibi Sa’adinejad and Azimi (2011) analyzed levels of security in the neighborhoods of the city of Babolsar in terms of physical indicators. The results of this research indicated that Districts 3, 4, 5, and 15 had the best conditions in relation to the physical form of crime prevention considering the indicators examined. Also, the neighborhoods with the lowest standards to reduce the incidence of crimes had been actually formed in the fourth wave of urban development in the city of Babolsar mainly in emergency conditions and as residential locations for low-income people (Adibi Sa’adinejad & Azimi, 2011). Kalantari and Jabbari (2013), in their article, investigated the relationship between the type and the extent of urban land use in the formation of spatial patterns of crimes in District 19 of Tehran metropolitan area and concluded that the type and the extent of the uses in this part of the city had significant impacts on crime patterns. It was revealed that the highest crime rates had been occurred in commercial and administrative uses representing about 1.9% of the total area of the given district (Kalantari & Jabbari (2013). Furthermore, Abdali (2017) in his study entitled as “Spatial analysis of quality of life and crime in inefficient urban textures in Districts 11 and 12 of Tehran using spatial regression” concluded that the quality of life of people residing in crime hotspots could be influenced by such offences and the residents were likely to have lower quality of life; however, distancing from these crime hotspots had much reduced the impact of crimes on their quality of life (Abdali, 2017:186).

Theoretical foundations

Today, studies of urban geography have stepped towards new boundaries and a new horizon can be seen in the domains of experiencing issues in cities including attention to quality of life, social welfare, equitable distribution of income, wealth, services, and facilities, attention to the effect of urban spaces and constructions on individual and social behaviors, examination of geographical characteristics of crimes and social deviations within cities, as well as designing urban environments to prevent crimes and to decrease the levels of urban offences. Geographical and spatial analysis of crimes in cities is also among new trends that are to examine this aspect of urban issues of today’s human and also present appropriate mechanisms and strategies to confront with social deviations and prevent crimes through geographic analysis tools and technologies (Abdali, 2017:21). It should be noted that people are living in a specific frame of time and place and they are engaged in specific contexts and interact with individuals in a social manner taking their individual and social actions into account. Therefore, basic functional roles played by individuals as well as mutual effects between individuals, community, and surrounding environment can be observed in these environments. The point of importance in the domain of geographic analysis of urban crimes is the relationship between urban spaces and environments, also between negative and abnormal social behaviors. Actually, this issue which has been added over the few recent decades to urban geography is a practical framework for the spatio-temporal analysis of crimes and the study of the relationship between deviations and space and time within cities.
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(Abdali, 2017: 50). Overall, these studies investigate the emergence, quality, and distribution of crimes within the geographical environment of a city and also predict probable crime locations as well as socioeconomic indicators of offenders and their place of residence, provide the possibility for the identification of crime hotspots, and forecast the probable locations of the occurrence of anomalies within cities through spatial displays of offences and integration of this information with spatial data. Eventually, this information can effectively decrease levels of crime within cities, prevent them, and consequently contribute to increased security (Kalantari, 2001:63-64). In the domain of geographical studies on urban crimes; four key factors of law, offender, target victim (object or person), and place (special time and place wherein offences happen) have been very much emphasized (Kalantari, 2001:64; Pourahmad et al., 2016; Abdali, 2017:77). Obviously, some places are endowed with more possibilities and opportunities for committing crimes due to their special physical structure as well as the socioeconomic status of their inhabitants; in contrast, some locations can be barriers and inhibitors of crime opportunities. This issue can also make offenders seek for the least dangerous and the most appropriate opportunities and spatial conditions in terms of the selection of hotspots to commit criminal acts. Therefore, identification of the spatial conditions creating and facilitating these opportunities as well as presenting strategies to change such conditions and to convert them into defensible spaces against social deviations are taken into account as the most important goals of geographical research on crimes committed in cities. Therefore, these studies not only investigate and analyze the spatial distribution of crimes but also specify the relationship between environmental factors and socioeconomic conditions of crime hotspots within geographical areas. Moreover, the relationship between life spaces and social areas of the city and abnormal behaviors are determined through mapping crimes; thereby, the prediction of locations for the occurrence of types of crime within urban areas is made possible (Kalantari, 2001:65; Abdali, 2017:2-5).

Spatio-temporal composition of crime hotspots

The so-called areas with high crime intensity or hotspots represent a place with high rates of crime. The area of this space is a part of a city, a small neighborhood, or several streets adjacent to each other, and even a house or residential complex. Another definition of the given term refers to small areas with a large number of predictable crimes, at least for a period of one year (Kalantari, 2001:85; Pourahmad et al., 2016; Farhadikhah, 2016:61; Abdali, 2017:72). The history of identification and analysis of urban crime hotspots as a scientific approach also dates back to the 1980s and it is one of the concepts that has become of utmost importance among urban crime analysts in the last 15 years. Today, it is also considered as a valid achievement in terms of coping with social deviations and preventing crimes (Kalantari & Tavakoli, 2007:80; Ziari et al., 2016; Abdali, 2017:72-74). It seems that the initial ideas for the study of crime hotspots came up as the result of urban crime pin mapping provided manually by police departments about 200 years ago. Since the distribution of crimes within a geographical area is a function of the spatial conditions of the location for the occurrence of crimes, as well as a factor of time, motive, and ability of the offenders, and the distribution manner of the targets; showing offences on the map of the cities with pins or colored signs implied that the distribution of crimes was tended to a focus and a density in a special area and sometimes small parts of a city, or this distribution was scattered and did not follow a particular pattern. Although the given assumption was not far from the fact and probably simple analyses of crime hotspots had been conducted by urban crime investigators or police officers over the past 100 years; individuals like Brantingham in 1975 and 1981, Crowe in 1975, Abeyie and Harris in 1980, and Parish in 1986 in their works and writings over the past 30 years discussed the analysis of urban crime hotspots in certain areas of the
city (Weisburd et al., 2004: 34). But, clearly, research in this field was started by Sherman, Gartin, and Buerger in 1989 and the term crime hotspot was raised by them for the first time. Sherman et al. (1989) in a study on Minneapolis found that 50% of the contacts with the police stations had been only made from 3.3% of crime hotspots (Sherman et al., 1989). Since then, the investigation by Sherman et al. and its noticeable results was considered by researchers and led to extensive studies on other cities in the world especially in developed countries. The findings of all these studies revealed similar results and confirmed the ones about crime hotspots by Sherman et al. These investigations showed that a significant number of crimes had been only focused in certain areas of cities.

Among the research pioneers in the domain of urban crime hotspots is New York City Police Department that has systematically applied the above-mentioned approach in crime analysis long with strategic planning to reduce offences (Bratton & Knobler, 2009:45). Also, a research collection has been fulfilled in this context with the support of the National Institute of Justice in the United States. Among the eminent research institutes for the identification and analysis of crime hotspots is the Center for Crime Reduction affiliated to the Home Office in the United Kingdom. It should be noted that the results of several case studies in this field can be retrieved from the website of this center. Among these investigations, a survey in 1990 was conducted in the southern corridor of East London suggesting that 18% of total thefts committed had been focused only on 6% of this area (Home Office, 2003:26).

**Spatio-temporal patterns of crimes**

In 2004, Jerry Ratcliffe made use of several techniques in his study in order to understand the spatio-temporal composition of crime hotspots and to conduct a spatio-temporal analysis of these areas. His research studies could help police officers deal with offences and also set proper crime prevention strategies. In his view, the most important spatio-temporal patterns of crime hotspots were as follows:

- **Dispersed Pattern:** In this pattern, the locations of the crimes are spread across an area and they are neither clustered nor focused such as the status of houses robbed within this area due to inadequate and incorrect design of these places. The events occurring in the center of the crime hotspot are not clustered; as a result, they can have the same features of vulnerability in the future.

- **Clustered Pattern:** This pattern creates a cluster-shaped focus in one or more special spaces within the crime hotspot; for example, terminals or stadiums that may be the focus of a number of auto-related crimes.

- **Dotted Pattern:** This particular pattern of the crime hotspot is matched with a specific location; for example, a parking lot in a shopping mall in a crowded city center is of such a kind wherein all crimes occur in a special place (Ratcliffe, 2004). Figure (1) illustrates three types of spatial distribution patterns of crimes.

![Figure 1: Three types of spatial distribution patterns of crime](Source: Ratcliffe)

Diffused Pattern: In this pattern wherein the crimes occur during 24 hours overnight, the temporal limits are extensive and it is not possible to detect any focus of criminal activities over time. These hotspots have no
ascending or descending trends and they are not very useful and important from the perspective of some crime prevention.

Focused Pattern: These types of crime hotspots can be seen during the day and also detecting their statistical significance, in terms of crime rates, can be beneficial to reduce them; especially when there are activities deserving more attention than other cases. Moreover, a police officer may find the peak time of offences over 3 hours in terms of testing a crime pattern in order to have enough time to deploy more police forces at that time.

Acute Pattern: These hotspots are rare wherein crimes have been limited to a period of time. Considering that offences in some time periods are special, this does not mean that events cannot happen at other times (Ratcliffe, 2004).

Figure 2: Three types of temporal crime hotspots (Source: Ratcliffe)

Study area
The central part of Tehran comprised of four main squares of Enghelab, Imam Khomeini (RA), Khorasan, and Rah Aahan with a population of about 529,604 people (according to the census released in 2011) constitutes 5.6% of the total population in Tehran metropolitan area. It should be noted that the census released in 2011 was cited in this study due to lack of access to statistical blocks in 2016. This part of the city covers an area of about 2790 hectares, equivalent to 3.94% of the total area of the city of Tehran. Examining the relative population density in the central part showed that this area included 190 people residing per hectare (Statistical Center of Iran, 2011). In terms of urban divisions provided by the Master Plan, the central part of Tehran includes Districts 11 and 12. District 12 has an older texture than District 11, wherein the core of the city of Tehran has been established and then expanded to its surroundings. After this area, the oldest district in the city of Tehran in terms of its spatio-physical features and historical texture is District 11 (Rouhi, 2002: 87-88). The location of the study area in District 12 was displayed in Figure 1.
Methodology

A comparative analysis research design was used in this study. To identify and to understand the patterns of crimes committed in Districts 11 and 12 in the city of Tehran, statistical and graphic-based tests in the GIS were used. The most important statistical test employed in this study was mean and standard deviational ellipse and the nearest neighbor distance index among the cluster tests to identify crime hotspots. In addition to the statistical tests in this study, some of the graphic-based statistics including Kernel density estimation were employed. In this respect, the data related to the crimes examined were considered as the focus of events in the central part of Tehran (Districts 11 and 12). It should be noted that the Microsoft Excel was used to establish a database in this study and the comparative analysis was performed via the graphical program of ArcView in the GIS. The population included all theft-related crimes committed in a one-year period (2010) in Districts 11 and 12 in the city of Tehran and then recorded in the police stations. Figure 4 shows the conceptual model of this study.
Findings

Types and number of theft-related crimes in Tehran and central Tehran

The total number of theft-related crimes committed within the city of Tehran was 1666 cases, of which 492 cases had taken place in the central part of Tehran (Districts 11 and 12). The given crimes had been divided into two general categories of larceny and felony/ransom. The type and rate of these crimes are presented in Table 2.

<table>
<thead>
<tr>
<th>Type of crime</th>
<th>Division of the type of crime</th>
<th>Frequency in the study area</th>
<th>Frequency in Tehran metropolitan area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larceny</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>purse/wallet theft</td>
<td>by pedestrians</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>by car occupants</td>
<td>7</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>by motorcyclists</td>
<td>296</td>
<td>918</td>
</tr>
<tr>
<td></td>
<td>other cases</td>
<td>75</td>
<td>230</td>
</tr>
<tr>
<td>car theft</td>
<td>personal car</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>livestock and poultry</td>
<td>livestock</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>theft</td>
<td>shoplifting</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>jewelry shop</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>audio/video</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>appliances and electronics store</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>other cases</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>motorcycle theft</td>
<td>personal motorcycle</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>objects inside a car</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>equipment, parts, components</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>auto equipment theft</td>
<td>engine license plate</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>cellphone</td>
<td>9</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>wires and power cables</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>other cases</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>breaking into a house</td>
<td></td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
Investigating crimes within the city of Tehran showed that, among the offences, purse/wallet theft by motorcyclists with a frequency of 918 cases equal to 55.10% had the highest rate and shoplifting with 12 cases equal to less than one percent (0.72) was placed in the final ranking. Moreover, evaluating the crimes in the central part of the city of Tehran (Districts 11 and 12) revealed that purse/wallet theft by motorcyclists with 296 cases (60.16%) was the most frequent crime among the theft-related offences committed in this area.

Dotted distribution of crimes
In order to have a spatial and geographic analysis of the crimes; firstly, the crime location was stored as a single dot in the spatial database; then, the spatial pattern of the given crimes committed in Districts 11 and 12 were extracted using analysis models (statistical and graphical) and then the formation of the crime hotspots was measured. The study of the spatial distribution of the crime locations demonstrated the large numbers of points on a map reflecting the focus of crimes within certain parts of the central area. The distribution of the crimes in the central part showed that the number of the crimes had an increasing trend from the southern central part towards the middle and northeastern central part. The dotted distribution of total theft-related crimes in the central part of Tehran was shown in Figure 5.

<table>
<thead>
<tr>
<th>Felony and ransom</th>
<th>disguised as a passenger</th>
<th>7</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>with car stop</td>
<td>3</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>disguised as an agent</td>
<td>0</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>other cases</td>
<td>83</td>
<td>346</td>
<td></td>
</tr>
</tbody>
</table>

Source: Law Enforcement Force of the Islamic Republic of Iran (Islamic Republic of Iran Police), 2010

Temporal analysis of crimes
Temporal analysis of crimes is performed based on changes in the types and levels of cooperation in the context of the time according to seasons of the year or different months in the year, as well as days and overnight hours. This analysis can help those involved in judicial systems and police departments better identify crime hotspots as well as patterns of crime and crime prevention. Temporal analysis of the year,
months, days of the week, and overnight hours of all
theft-related crimes committed in the central part of
Tehran showed that the third ten days of the month,
three seasons of the year, and the first starting days of
the week between the hours of 10 am and 2 pm were
the peak hours of committing crimes. Figure 3
illustrates theft-related crimes during the year, months,
and days of the week, as well as overnight hours.

Mean center and standard deviational ellipse of
total crimes
To measure the spatial distribution and the center of
the gravity of the crimes examined, graphic-based
statistical models including the mean center and
standard deviational ellipse were used. The mean
center showed the central part as the mean basis of all
crime locations. The standard deviational ellipse was
also employed to determine the standard deviation
distance of each crime location from the mean center,
dispersion, as well as its direction and position. Map 3
illustrated the mean center and standard deviational
ellipse of the crime locations in the central part of
Tehran (Districts 11 and 12). Considering the maps
obtained from the given statistical tests, spatial patterns
of crime in the central part of Tehran were as follows:

The mean focus of all the crimes committed in
the central part of Tehran was matched to a high extent
with the geographic center of this part of the city. This
center was located in Naser Khosro Avenue and near
Imam Khomeini (RA) Square. The standard
deviational ellipse of all the crimes examined was
largely focused indicating that most of the crimes
tended to be in the center of their ranges. This
suggested that the probability of the incidence of
crimes in these areas in the central part of Tehran was
higher.
Cluster test
Several methods were used for cluster analysis and identification of spatial patterns of crime. The nearest neighbor index is among the most important cluster tests. This index is a simple way to test the focus of crimes in a geographical area.

The amount of the nearest neighbor index in the distribution of all crimes including all theft-related crimes was equal to 0.75. Accordingly, the spatial distribution of all the crimes in the central part of Tehran was clustered. It is worth considering that the Z-score of these crimes was -11.919 to check the accuracy of the test and the nearest neighbor. If the Z-score was a large negative number, the results of the nearest neighbor index could be ensured (Table 2 and Figure 4).

<table>
<thead>
<tr>
<th>type of crime</th>
<th>nearest neighbor index</th>
<th>Z-score</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>total number of theft-related crimes</td>
<td>0.754856</td>
<td>-11.919790</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Source: Authors, 2017
Spatial analysis of crimes using Kernel density estimation

Kernel density estimation is considered as one of the most appropriate methods for visualizing crime-related data in a continuous manner. The given test can determine the level of evenness based on the variations in the density of the crime locations on the area created. Based on the given method and in order to determine the crime hotspots within the central part of Tehran, these calculations were performed using the Spatial Analyst Tools and Kernel Density in the ArcGIS program and the test results were shown on Figure 8.

After examining the spatial distribution of all the theft-related crimes (492 cases) committed within the central part of Tehran and based on the Kernel density estimation, the results of the previous test were confirmed otherwise and revealed that the distribution of crimes investigated in this area had been gathered in a clustered manner; in other words, high rates of crime were observed in some parts of this area (abnormal areas) and other parts had no signs of the crimes investigated in this study.
Conclusion

Today, increase in urban crime is one of the major challenges to city officials and managers that have also made them get involved in this issue. Growing rates of crimes and their rising wave due to scientific and industrial progress, growth in the phenomenon of urbanization, as well as developments in communications and transportation have all caused the inability of judicial organizations to curb the crime wave, so achieving preventive measures examining the roots of crime factors in an environment seems of utmost importance. Accordingly, this study was a spatio-temporal analysis of theft-related crimes in the central part of the city of Tehran. Based on the findings of this research study, the mean center of total crimes committed in the central part of Tehran matched largely with the geographical center of this part of the city located in Naser Khosro Avenue near Imam Khomeini (RA) Square. The standard deviational ellipse of all the crimes investigated also had a huge focus indicating that the collection of crimes committed in this area had occurred in limited parts at lower rates and most of crimes were oriented to the center of area. This suggested that the probable incidence of crimes in this area in the central part of Tehran was at higher levels. Using the nearest neighbor index, the results revealed that the distribution of all the theft-related crimes within the central part of Tehran had followed a clustered pattern indicating that specific areas of Districts 11 and 12 in the city of Tehran were the crime hotspots; in contrast, a movement towards northwestern, western and southeastern part of the central part of Tehran in terms of committing crimes was somewhat observed. Moreover, Kernel density estimation was used to
identify and to analyze the characteristics of the crime hotspots in the central part of Tehran. According to this method, the distribution of crimes investigated in this area was clustered; in other words, parts of the study area had high crime rates (abnormal areas) and other areas had no signs of offences. The most important crime hotspots investigated were associated to indefensible spaces, commercial areas in the central part of the city, uninhabited population, and crowded streets.

Suggestions

It seems that the following strategies would be effective to control crimes and to increase security in the central part of Tehran (Districts 11 and 12):

- Accompanying and encouraging residents of the central part of Tehran to participate in terms of prevention of crimes and provision of social security.
- Making changes in small indefensible spaces with no official surveillance due to their physical characteristics, lack of light, and no disclosure of the crimes due to darkness providing proper spaces for committing crimes.
- Eliminating physical irregularities and disorders as well as dirty and poor-quality neighborhoods, cracked walls, and ruined buildings that somehow attract offenders and stimulate them to do their illegal acts. These neighborhoods wherein signs of lack of attention and destruction can be observed show that the residents of these neighborhoods feel more vulnerable and withdraw from participation and social protection. Thus, social order and control are very low among them.
- Establishing police stations in large scales or even in small scales such as police boxes (kiosks) in the crime hotspots within the commercial-administrative areas.
- Separating efficient and inefficient uses from each other and increasing sociocultural roles, as well as tourism and hospitality based on historical and physical identity and stimulating blind and indefensible spaces.
- Providing proper lighting for streets and pavements, organizing and empowering physical constructions, and boosting social development in neighborhoods located within the central part of Tehran.
- Creating healthy spaces for recreation and leisure times, building outdoor playgrounds, constructing sport halls, making outdoor parks and pitches in the textures inside the neighborhoods to help the youth as residents spend their spare time, which can also have effects on preventing crimes and increasing surveillance.
- Providing favorable services and infrastructure, organizing facilities, equipment, and services needed by the residents of these areas per capita, and restoring balance in the types and composition of the uses.
- Adopting appropriate policies for urban development in order to empower and balance these areas and deal with structural problems and barriers of the crime hotspots considered as the most important priority which can be implemented in the form of short-term, mid-term, and long-term plans; in addition, adopting proper policies for empowering the physical spaces of hotspots against crimes as another basic step taken to reduce crime in these areas.
- Organizing buildings in the neighborhoods of Districts 11 and 12 in the city of Tehran (including the removal of the corners, unfinished buildings, and ruined ones).
- Reducing inactive uses in Districts 11 and 12 in the city of Tehran and increasing activities for dynamicity and presence of people at the neighborhood level.
- Locating fascinating and frequently visited uses as one of the most important factors in reducing indefensible spaces.
- Removing barriers blocking pedestrian sidewalks.
- Determining and deciding about unused lands and brown and abandoned ones in Districts 11 and 12 in the city of Tehran.
- Widening streets in neighborhoods wherein they are less than 6 meters.
- Encouraging residents in the central part of Tehran in order to preserve beauty and maintain security through sociocultural programs.
- Improving, modernizing, and reconstructing buildings in Districts 11 and 12 in the central part of Tehran (especially District 12 because of being older).
- Locating micro and active uses such as newsagents and so on at crime hotspots to increase official surveillance and reduce crime rates.
- Determining and deciding about ruined and worn-out buildings (clean-up or reconstruction) in Districts 11 and 12 in the city of Tehran whose numbers are not low.
- Improving the quality of housing by providing some facilities and loans and trying to match houses and neighborhoods with the principles and criteria of urban planning and also investing in these areas for freewill and without expectations and taking economic justifications into account and also making revenues for relevant organizations including municipalities.
- Constructing streets and passages in these areas which allow easy and immediate access to the police and security forces as well as rescue groups such as fire-fighting engines and emergency vehicles.
- Creating enough lighting in alleys and passages because experience has shown that committing a crime including theft in dark places is more likely than bright ones and the presence of adequate lighting in these areas is in itself a deterrent to committing theft-related crimes.
- Closing off commercial centers without business permits and licenses and obliging them to obtain the necessary business permits and licenses, and then providing full and accurate monitoring in the mentioned centers and finally dealing decisively with offenders by the Office for Public Places affiliated to Law Enforcement Force of the Islamic Republic of Iran (Islamic Republic of Iran Police).
- Beautifying the appearance of existing buildings and monuments in these areas because it has been proven that dirty and poor-quality housing can have an effect on committing crimes.
- Creating safe spaces for recreation and leisure time of residents in the old and inefficient textures of Districts 11 and 12 of the Municipality of Tehran.
- Suggesting strategies to prevent and reduce crimes in areas wherein crime hotspots have not yet become acute, but they are capable to become a massive hotspot.

According to the above-mentioned issues and due to numerous problems raised in the given areas in terms of physical, socioeconomic, and cultural aspects and in order to reduce crime rates and improve the quality of life in the hotspots, the city managers and other officials as well as those involved are required to put organization and empowerment policies in the domains of physical construction and socioeconomic and cultural development on their agenda.

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