Evaluation of urban resilience to crime:
A case study of theft crimes in Varamin[1]

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A B S T R A C T

The resilience of people to an adverse event in their city, community or environment reflects their flexibility in coping with or absorbing the incident. Achieving a resilient community requires attention to both physical and social aspects of resilience. In this quantitative survey, the spatial distribution of theft crimes in the districts of the city of Varamin were analyzed with the help of nearest neighbor index (NNI) and kernel density estimation (KDE) methods, and the social and physical aspects of resilience were evaluated by the use of questionnaires, official reports, and public records. The results showed a relationship, with a correlation coefficient of -0.344, between crime rate and resilience, which indicates that the communities that enjoy a higher resilience have a significantly lower crime rate. The rate of crimes varied with social, economic and physical characteristics of districts, and while the crime vulnerability indicators of peripheral districts were mostly physical-objective and were formed based on the concept of crime prevention through environmental design, the vulnerability indicators of the central districts were both objective and subjective and belonged to the social dimension of resilience.

K e y w o r d s: *Resilience, vulnerability, crime pattern, theft, Varamin city town*

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1. This article is based on the master's thesis of a collaborating student in the research entitled "Social, institutional and physical resilience to reduce crime: A case study of theft crimes in Varamin" at the Faculty of Geography of the University of Tehran.

Introduction

The word resilience is derived from the Latin word resilio, which means to rebound, return, or leap back. Although there is still a debate as to where the term resilience was first used in its modern scientific sense, it certainly became popular following the publication of Holling's (1973) seminal work titled "Resilience and stability of ecological systems" (Ramezanzadeh, Lasbui & Badri, 2014: 111). Scholars have diverging views about the field of science to which the term resilience belongs. While some scholars relate this term to the field of ecology, others consider it as a concept of physics (Leeuw et al., 2000: 229), and there are some who believe that it is taken from the field of psychology and psychiatry, and specifically from the works of Garmezy, Werner and Smith (Klein et al., 2003: 38). One can simply define resilience as the opposite of vulnerability which refers to the degree of exposure to a risk and the sensitivity to that risk (the extent of damage) (Cutter et al., 2008: 70). Vulnerability results from the conflict between human and artificial systems and natural environment and emerges when a system cannot absorb or handle a change or phenomenon (Saeedi & Darabi, 2014: 1052). In the context of sociology, vulnerability of a community is determined by the social and demographic characteristics of its members, such as age, ethnicity, language, socioeconomic status, population of people with special needs (e.g. people suffering from mental and physical disorders, homeless people, vagrants), non-natives, and seasonal tourists (Perry et al., 2001: 102). A review of articles on the resilience shows that the resilience of a community to disasters could be a function of religious affiliation, sense of belonging (Paton et al., 2008: 110), spirituality, ethics, culture (Varghese, 2010: 518), social trust (Graneheim & Lundman, 2004: 108), community education and empowerment, past experience of disasters, social networks, knowledge of deficiency in public services, social and economic security, social capital, information and communication systems, and meritocracy (Moore et

al., 2013: 294). To study the resilience of a community to threats, one should attempt to identify different dimensions of resilience in that community to understand how it's social, economic, institutional, political, and administrative capacities affect these dimensions. The researcher's view about the concept of resilience and how it should be analyzed plays a key role in the measurement of resilience and its causes and how risk mitigation policies and measures will be adopted to address vulnerabilities (Mitchell, 2012: 73). Despite the attention paid to the concept of resilience across the world and in Iran, only a few systematic formulations have been proposed for urban resilience. While there is a consensus on the factors that cause vulnerabilities and those that make a community resilient, there is still a debate as to how these factors should be measured. The fact that each of many studies conducted on the dimensions, components, and indicators of resilience has approached the issue from its own particular viewpoint indicate that urban resilience can also be investigated in many ways, and the angle of approach should be chosen according to the objective (Farzad Behtash et al., 2013: 34-35).

The present study is focused on the urban resilience to crime. Research has shown that social, economic, and cultural characteristics and structures of urban areas can make them susceptible to crime while proper deterrents can make them less prone to criminal activities. In other words, the conditions and qualities of an area can make it hard to commit a crime or at least increase the risk of arrest and due punishment. The incidence of crimes at city level has been the subject of many studies, where the factors affecting the rate of different crimes have been investigated from different viewpoints that attribute the criminal behavior to personal, environmental, economic, social and cultural variables. Most of these studies have investigated the incidence of crimes from one dimension. However, considering the past studies carried out in this field and the fact that social anomie is influenced by numerous factors, the present study

assumes the crime as the result of various causes and attempts to investigate a broader group of factors involving the resilience and vulnerability to crime by using a holistic approach that takes into account several views towards crime susceptibility. During the data collection phase, the researchers have attempted to gather any data that may have an impact on the level of resilience and vulnerability to crime. This study is on the city of Varamin (Tehran Province, Iran), which has experienced an increasing rate of theft crimes in the past decade (NAJA office of applied research, 2016). The paper presents the results of a spatial-locational analysis performed on the theft-susceptible areas of this city, followed by an investigation to determine the relationship between urban resilience and vulnerability to theft and identify the social and physical dimensions of this resilience. Overall, the study seeks to determine the level of correlation between the social or physical resilience of a location and its susceptibility to crime, and to discover the factors that make one environment vulnerable and the other resilient to crime, in order to facilitate the adoption of necessary crime prevention and control measures and policies.

Reserch Literature

In the past century, the Chicago school sociologists explored the relation of the physical structure of a city and its moral system as well as the relation between the rates of crime, suicide, divorce, prostitution, etc., with the natural environment of the city in order to understand the impact of social and ecological factors on social disorganization and deviant behavior. The Chicago school of sociology was the first school to study urban crime in urban environments with due attention to economic, social, and physical characteristics that are specific to cities, and believed that the behavior of urban residents must be studied in the urban environments (Kamrannia, 2006: 16). These studies showed that the distribution of offenders over the city had a systematic pattern, with higher rates among disfranchised people living in the old neighborhoods and lower rates in the affluent

neighborhoods. In addition, the crime rate was found to reduce with distance from old neighborhoods and showed a relationship with the ethnicity of residents (Kalantari, 2001: 60). In 2001, a doctoral dissertation by Kalantari on the geographic distribution of crime in Tehran reported that with Tehran's growth in both population and size, the consequent rise in the density and complexity of land use zones, decline in the community control, and disruption of social bonds have created several negative forces that facilitate crime in this city. He added that spatial mobility is another important factor that facilitates the increase in the crime rate in the migration destinations such as Tehran. Lastly, he argued that the low social, economic, and living conditions of criminals encourage them to further defy social norms. In a master's dissertation by Abbasi Varaki (2008), the spatial analysis of crime centers in Qazvin showed that the rate of drug-related offenses is proportional to the distance from the city center and reaches its highest level at the western parts and after that at the southern parts of this city.

In a master's dissertation by Rostami (2010), the spatial analysis of theft patterns in Zanjan's central districts revealed that the most important crime hot spots of this city are located in Sa'adi and Market districts, which are densely populated and very busy during the day but become sparsely populated and very quiet during the night. A study conducted by Pishgahi et al. (2011) on the spatial distribution of drug-related crime hot spots in the city of Kermanshah reported that Jafarabad squatter settlement and Rashidi crossroad were the most important drug-related crime hot spots in this city. The high proportion of residential and commercial zones in these areas was cited as a cause of high frequency of drug-related crime near these areas. In addition, a direct relationship was found between population density of these areas and the rate of criminal offenses. The spatial analysis performed by Saraee and Hosseini (2015) on the distribution of crime in Yazd showed that the type and style of crimes are strongly related to the economic and social condition of

the area. More specifically, poor neighborhoods of this city had a high rate of drug-related crimes, illegal immigration, and assault and battery. In contrast, affluent neighborhoods had a higher rate of traffic violations, financial crimes, fraud, forgery, theft, and indecent exposure. In this study, the police districts of 12 and 14 had the highest rate of recorded offenses, which highlighted the significant role of squatter settlements in the rate of crime.

Theoretical Foundations

According to Kafle, the resilience of a community can indeed be measured, but this requires due attention to the unique characteristics and risks of the place (Kafle, 2012: 317). This means that it is impossible to design a single model for measuring the resilience of all communities, and each community needs its own measurement tool developed based on its hazards, location, and contextual factors (Ayyub, 2013: 343). To evaluate the resilience of a community, one needs to examine all dimensions of resilience in that community. This is because each dimension involves one aspect of the community, and it is the aggregation of these aspects that makes a community resilient or vulnerable. To achieve a resilient community, the fundamental social and cultural aspects must be considered alongside the physical aspects. For example, a city with a decent physical structure and infrastructure but without significant socio-cultural capital will still have many problems in dealing with emergencies and crises. Thus, in order to have a city with a suitable degree of resilience, it is imperative to improve the aspects in which the city suffers from shortcomings (Farzad Behtash et al., 2012: 118). The social aspect of resilience, or the so-called social resilience, refers to the ability of a group or a community to cope with external stresses and disturbances resulting from social, political and environmental changes (Adger, 2008), Adger was one of the first to extend the definition of ecological resilience to human societies and to link social

resilience with social capital (Ghiasvand & Abdulshah, 2015: 82). In fact, social capital is one of the most important human measures associated with the degree of resilience of a social system. The high resilience of a social system can certainly be a sign of its rich social capital. In this regard, it can be argued that the greater the social capital of a human system, the greater the capacity of that community to adapt to external changes (Ghorbani et al, 2015: 627). Among the different types of capital that play a role in the effectiveness of local management in creating resilient settlements, social capital and its components such as mutual trust, social networks, and norms are perhaps the most important (Badri et al., 2013: 41). All social theories emphasize the importance of social institutions, including individuals, organizations and communities and their ability or capacity to tolerate, absorb, counter, or cope with different types of hazard (Keck & Sakdapolpak, 2013: 7). Another important factor in this regard is the components of the urban form as theorized by Katzen, Lynch, and Rudwin, which include land use, transport and access networks, open public spaces, as well as urban landscape and physical form. These components are closely related to the theories about the concept of resilience in the urban environments. A highly pervious city texture design can play a key role in the extent of the resilience of a city when a disaster strikes (Jalali, 2011: 29). In this study, the Chicago school was chosen as the theoretical basis for the study of crime susceptibility and the criteria and indicators that affect the level of vulnerability to crime and link it to environmental and spatial characteristics.

Chicago Approach

In the past century, a group of theoreticians such as Robert Park, William Thomas and Florian Znaniecki at the University of Chicago introduced and advocated an ecological and demographic approach to sociology, which became known as the Chicago School of sociology. When discussing the social deviances, this

approach is more focused on the variables that are associated with the urbanization phenomenon, including language, ethnicity, immigration, residential areas, and population density (Pour Mousavi et al., 2011: 64). This theory concentrates on the population density, population size, and ecological factors, and their individual and collective impact on the crime rate and even the type of crime (Bayanloo & Mansourian, 2006: 35). Throughout the twentieth century, sociologists of the Chicago school studied the behaviors such as suicide, divorce, and prostitution in cities to understand the relation of demographic factors such as age, household size, population density, and immigration, as well as ecological factors such as race, ethnicity, and place of residence on these behaviors. Recognizing the role of social disorganization, they then further studied the relation of the aforementioned factors with crime and delinquency (Ahmadi et al., 2013: 63). After studying the neighborhoods and the life stories of criminals, they found that the neighborhoods with the highest crime rates are located in industrial and commercial areas. Stark introduced five dimensions of urban structure as the predictors of criminal activity and reduced informal social control in neighborhoods, which included poverty, transience (when people continuously move in and out of the area), density, dilapidation (disrepair and collapse of buildings), and mixed-land use (having residential, industrial and commercial zones in one place). In this approach, a bold emphasis is placed on the spatial, physical and environmental features that affect crime (Rezaei Bahrabad, 2010: 80). Burgess argued that cities grow in concentric ring-shaped zones, each

concentrated on a certain activity or housing a certain social group. From the center to the periphery, these zones are (1) the central business zone, (2) the transition zone, which is a mixture of residential and commercial buildings, (3) the working class residential zone, (4) the middle class residential zone, and (5) the affluent residential zone. Burgess believed that because of high population density and mobility, high rate of transience, and disrepair of buildings, the highest rate of crime and delinquency occurs in the transition zone (ibid, 81) and, conversely, the outermost zone, which houses the affluent residents, has the lowest rate of crime. However, this pattern of crime rate (highest in the central transition zone and lowest in the peripheral zones) was later rejected by many studies conducted outside the US. In Argentina, for example, crime rates are higher in the peripheral zones than in other parts of the city, as these zones in fact house the poorer citizens (Ahmadi, 2005: 57-59).

The Study Area

The city of Varamin has an area of 2,635 hectares and is located at an altitude of 915 meters. The city is bounded on the west by the city of Ray, on the east by the city of Pishva, on the south by Javad Abad town and Kavir desert, and on the north by the cities of Pakdasht and Qarchak. According to the master plan of Varamin, this city consists of 11 districts and 35 urban neighborhoods (Varamin renovation and improvement program, 2010: 15). According to the 2016 national census, the city of Varamin houses a population of 225628 people (Iranian Statistics Center, 2016).
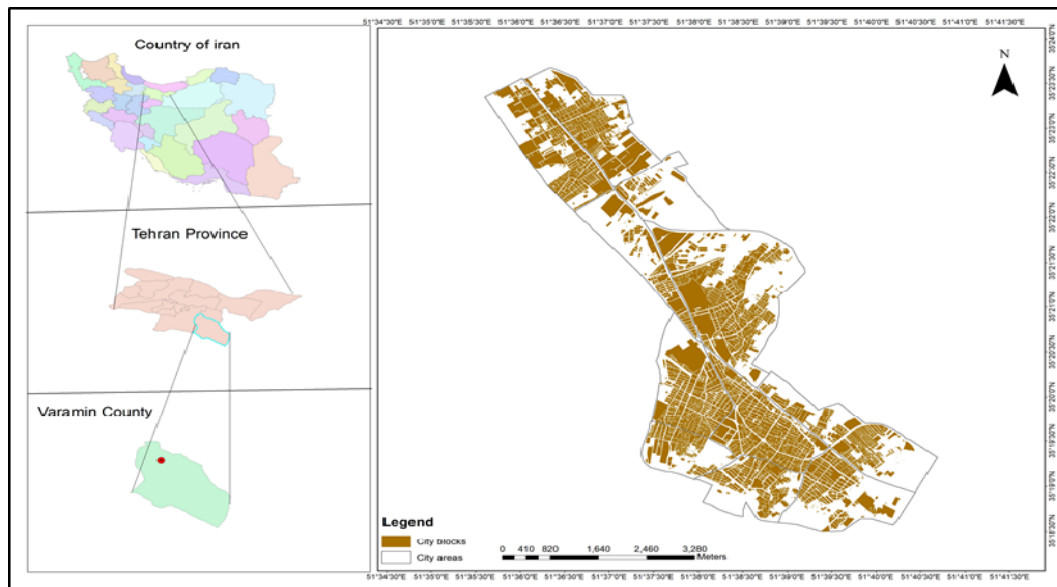
Figure 1: Geographical location of Varamin

Methodology

Given the nature of objectives and hypotheses, the research was carried out using a correlational quantitative survey method. Statistical data on reported thefts were acquired from the local branch of NAJA office of applied research in Varamin. The coordinates of theft sites were extracted from the addresses in the files and imported into the geographical information system (GIS). Using the GIS software, the spatial distribution of theft crimes were analyzed using the nearest neighbor index (NNI) and kernel density estimation (KDE) method. The social and physical resilience of city districts were measured with the help of a questionnaire as well as statistical reports. For this purpose, the studied indicators were divided into two groups of objective and subjective based on the nature of resilience. The subjective social resilience was measured using the social capital questionnaire, and the objective social resilience was estimated based on the statistical reports available in public records. The subjective physical resilience was measured using a researcher-made questionnaire based on crime prevention through environmental design (CPTED)

approach, and the objective physical resilience was approximated using the statistical reports based on different indicators. Using the Cochran formula, the size of simple random sample needed for measuring the social resilience (social capital index) of the citizens living in 11 districts of Varamin was calculated to 385 people, but considering the low population of some districts, the sample size was increased to 415 to improve the validity of the results. The physical resilience (compliance with CPTED criteria) was measured using a researcher-made expert-oriented questionnaire in collaboration with the local population. Indicators were non-dimensionalized using the Fuzzy method and then weighted using the Principal Component Analysis (PCA). The obtained weights were multiplied by a scale bias elimination index and then summed to obtain the combined index or the total resilience of each district. Finally, the Pearson correlation test was used for comparative study of resilience and crime susceptibility of the studied districts.
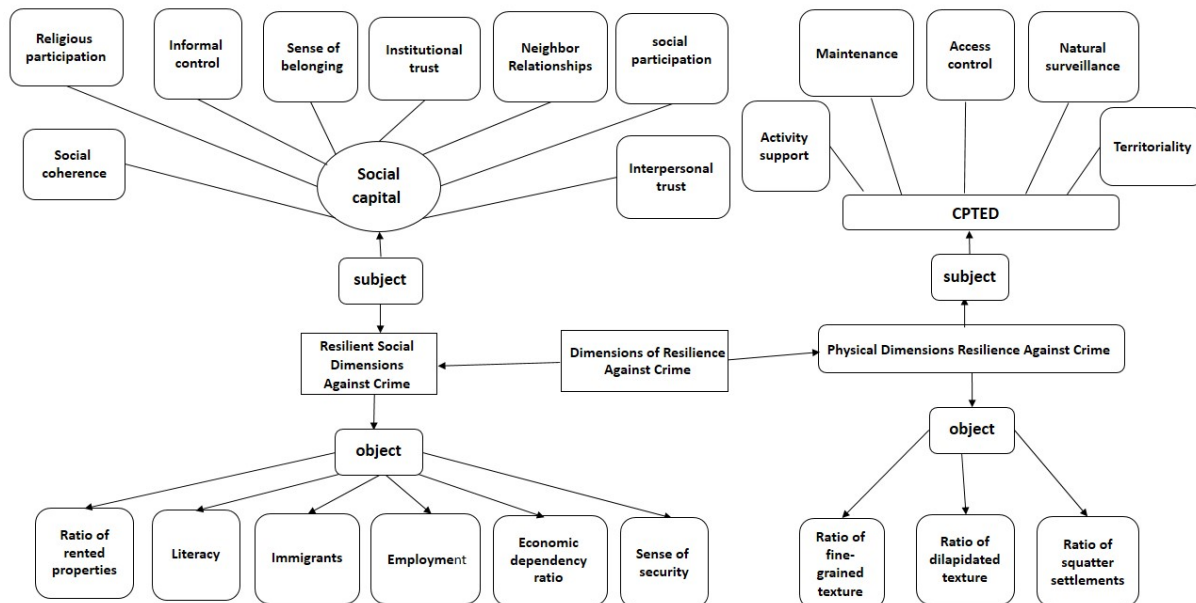
Figure 2: Conceptual model of research (Source: Authors)

Research Findings

Data about theft crimes in Varamin were obtained from the statistical reports made available by the Varamin branch of NAJA office of applied research. The theft crimes reported to the police authorities stationed in the legal domain of the city of Varamin between April 5 and March 17 of the years 2013, 2016, 2015 and 2016 were included in the research database. The theft crimes were classified into 14 groups including the robbery in private and public places, burglary in houses and shops, theft of automobiles and auto parts, theft of electrical and telecommunication equipment, purse

snatching, shoplifting, pick-pocketing, theft of motorcycles, theft of livestock, and other types of theft. During the study period, the total number of thefts reported in the greater Varamin area was more than 1,250 cases of which more than 760 cases had occurred in the legal domain of the city of Varamin. The most frequent theft crimes were the theft of auto parts and then the robbery from the houses.

Table 1: Frequency and percentage of theft crimes committed in the city of Varamin

Category of theft crime	Frequency	Frequency Percentage
Automobiles	96	12.5
Auto parts	251	32.8
Houses	129	16.9
Shops	31	4.1
Motorcycles	65	8.5
Private places	59	7.7
Public places	36	4.7
Shoplifting	15	2
Purse snatching	24	3.1
Pickpocketing	4	0.5
Electrical equipment	19	2.5

Livestock	5	0.7
Other thefts	31	4.1
Total	765	100

Source: Varamin branch of NAJA office of applied research (authors' calculations)

Nearest Neighbor Index (NNI)

A nearest neighbor index (NNI) of one indicates that the tested data is distributed randomly, an NNI of less than one means that the data is clustered, and a NNI of greater than one indicates that the data has a uniform distribution. The higher Z scores reflect the greater accuracy of the NNI test. As shown in Table (4-3), the total NNI score of all theft crimes in Varamin is 0.541, indicating the clustered nature of the theft data of this city. The obtained Z score, i.e. *-24.21,* also supports the accuracy of this claim. As can be seen, all theft crimes except livestock robbery have an NNI score of less than one which means they are of clustered type, and they all have a negative Z score, which again confirms the accuracy.

Table 2: NNI and Z scores of theft crime categories in Varamin

Spatial distribution of crime	*Nearest Neighbor Index*	*Z score*	*Crime*
Fully clustered	0.541	-24.21	All theft crimes

Spatial Distribution

The investigation of theft crimes in each district (Table 3) showed that district 1 with 200 reported cases of theft, or about 26% of all theft cases, has the highest rate of theft among all districts. The second highest rate of theft was observed in district 10, where only about 11% of all thefts (less than half of district 1) were committed. This indicates that the main theft hot spot of Varamin is district 1 which is located in the center of the city.

Table 3: Frequency of theft crimes in Varamin (by district)

district	Total Theft crimes	Percent
1	200	26
2	70	9
3	44	6
4	63	8
5	61	8
6	26	3
7	69	9
8	75	10
9	3	0
10	87	11
11	63	8
Total	761	100

Figure 3 shows the distribution of all theft crimes in different districts of Varamin. The rate of different types of theft should also be analyzed by district in order to reach a model for explaining the nature and place of the thefts committed, then identify the reasons behind the thefts, and finally reach a strategy to prevent or mitigate the occurrence of these crimes. The spatial distribution of theft crimes in Varamin indicates that the frequency of theft in the central, northern, and southern parts of the city has a clustered form. Specifically, most theft crimes have been committed either in the central neighborhood

along the main streets of the city, or in the outskirt neighborhoods such as Kheirabad, Gultapeh, Amroabad, Sakinebanu. This indicates that theft crimes are mostly concentrated in certain areas of the city which have transformed into theft hot spots.
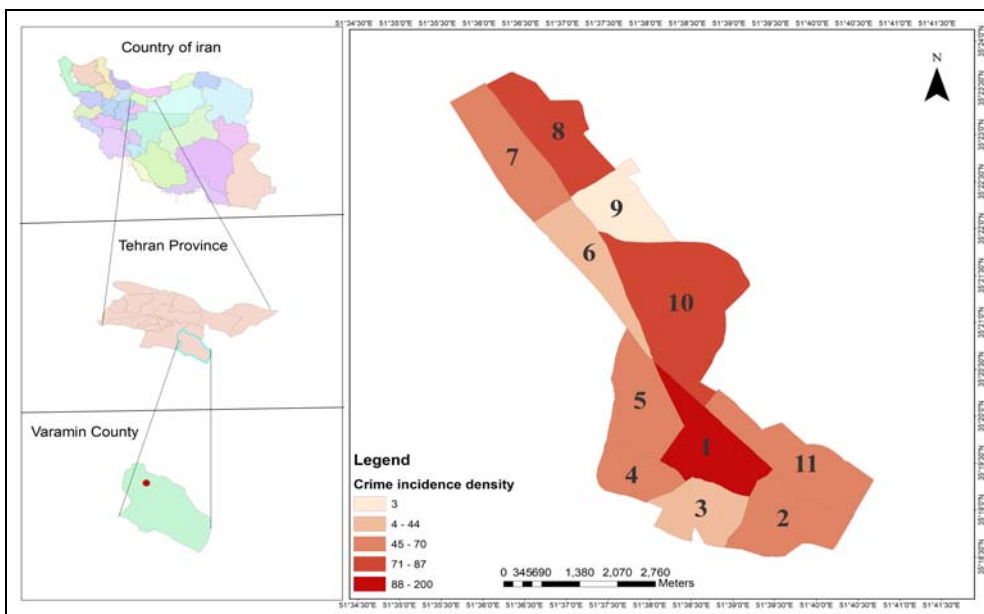

Figure 3: Theft crimes in Varamin (by district)

Our investigations into the spatial distribution of theft crimes in Varamin showed these crimes frequently occur in certain hot spots. Preliminary investigations showed that the physical and social features of crime hot spots play a key role in the formation and distribution of crime patterns. To understand the effect of study variables on the rate of theft crimes, various indicators were used to determine the relationship of resilience and vulnerability of districts and analyze the impact of individual indicators in this regard. Given the involvement of different social and physical dimensions with the resilience of communities, various indicators were used to reach a holistic result with regard to the subject of research.

Considering the past studies on the social impact of resilience on the incidence of crime, most of the scientific resources consider social capital as a very influential factor in crime control and prevention, through mechanisms such as unofficial control with minimal police presence, institutional trust and social participation of citizens, citizens' sense of belonging and caring for the environment, etc. To determine the spatial distribution of the social capital and thus the social resilience, the components of social capital in 11 districts were measured. The results of this measurement are provided in Table (5). Overall, districts 2 and 9 were found to have, respectively, the best and worst total mean scores in this respect.

Table 5: Social capital indicators in Varamin

Indicator	District 1	District 2	District 3	District 4	District 5	District 6	District 7	District 8	District 9	District 10	District 11
Neighbor Relationships	2.42	2.54	2.54	2.45	2.15	2.38	2.54	2.51	2.54	2.49	2.35
Sense of belonging	3.29	3.34	3.36	3.02	2.89	2.89	2.56	2.65	2.50	3.22	3.29
Interpersonal trust	2.82	2.82	2.87	2.90	2.60	2.76	2.79	2.54	2.50	2.95	2.51

Informal control	3.41	3.56	3.49	3.41	3.24	3.42	3.37	3.34	3.46	3.53	3.49
Institutional trust	2.87	3.10	2.56	2.76	2.76	2.92	2.62	2.62	2.53	3.02	2.62
Religious participation	2.97	3.03	3.11	2.76	2.88	3.09	2.56	2.95	2.93	3.07	3.09
Social coherence	2.86	2.91	2.75	2.76	2.58	2.82	2.46	2.51	2.22	2.87	2.67
social participation	1.75	2.02	1.71	2.16	1.75	2.53	2.26	2.12	1.20	2.02	2.20
Sense of security	3.65	3.64	3.65	3.23	3.63	3.53	2.99	3.16	3.35	3.37	3.19

The objective study of social characteristics by district was carried out by conducting simple calculations based on the statistical reports gathered from official sources. For this purpose, the gender ratio, household size, employment rate, unemployment, ratio of rented properties, literacy, and ratio of immigrants in each district were obtained and the share of each district in the total sum in each category was calculated.

Table 6: Social status of districts of Varamin

district	Facilities	Tenants	immigrants	Gender ratio	People born elsewhere	Literacy	Ratio of rented properties	Household size	Economic dependency.	Employment	density per hectare	Unemployment	Housing density	Active population
District 1	32.2	15.7	16.1	95.5	4.4	5.0	39.1	3.5	2.2	87.8	231	7.2	3.6	43.6
District 2	0.3	7.9	4.5	98.2	2.9	4.1	41.3	4.0	2.4	89.4	222	6.1	4.1	33.5
District 3	3.6	6.5	5.9	108	2.3	4.4	37.0	3.8	2.5	84.9	244	9.8	3.8	30.1
District 4	0.3	6.7	7.3	103	7.4	1.6	45.3	4.1	2.8	80.2	346	14.3	4.3	43.7
District 5	10.5	15.9	168	97.7	6.9	7.7	40.7	3.7	2.2	88.5	299	6.5	3.8	63.2
District 6	45.6	2.9	3.4	98.9	4.2	4.3	35.7	3.9	2.2	94.4	83	2.8	9.5	17.1
District 7	4.0	10.4	12.0	107	1.6	1.8	47.0	4.3	2.3	85.1	193	8.2	4.6	29.8
District 8	0	10.8	10.8	115	4.6	5.5	47.3	4.2	2.4	85.5	182	9.1	4.2	31.9
District 9	0.7	0.29	0.3	323	0.6	8.4	37.8	5.2	1.4	66.9	24	11.4	5.6	1.3
District 10	1.8	16.2	١٧.٤٤	17.4	5.4	8.1	39.5	3.9	2.6	88.2	199	8.2	4.1	26.5
District 11	0	7.5	٦.٤٣	101	8.3	4.6	42.5	3.9	2.5	79.9	255	14.0	3.9	20.6

The studies on the effects of physical features of cities on the incidence of crime and the resilience of urban environments to crime have mostly supported the crime prevention through environmental design (CPTED) approach. This approach examines the relationship between location and incidence of crime by the use of indicators such as maintenance, accessibility and permeability, and natural surveillance by citizens through environmental design. In this part of the study, a standard form was prepared based on the research literature for assessing the physical design condition of the city. This form, which is a combination of three standard forms, was validated with the collaboration of local residents to examine neighborhoods and passages and was ultimately completed based on the researchers' expertise after the deep observation of neighborhoods and areas of interest. The results of the environmental design questionnaire are provided in Table 7. Overall, the mean total environmental design score indicates that district 1, or the central part of the city, has the best condition in terms of CPTED indicators, while district 4 located in the southern part of the Amroabad neighborhood has the worst situation in this regard.

Table 7: mean score of CPTED indicators in the study districts

Indicator	Access control	Maintenance	Natural surveillance
District 1	30	4.3	3.5
District 2	2.1	2.8	2.4
District 3	2.6	4.3	3.1
District 4	2.5	2.3	2.3
District 5	2.5	4.3	3.5
District 6	30	4.1	3.5
District 7	20	30	2.2
District 8	2.3	30	2.7
District 9	20	4.5	2.2
District 10	2.3	2.8	2.8
District 11	2.1	30	2.2

The objective quality of physical characteristics in each district was measured based on official statistics. For this purpose, the ratio of dilapidated texture, the ratio of squatter settlements, and the ratio of fine-grained texture were studied to determine the physical resilience of the districts.

Table 8: Physical characteristics of districts of Varamin

District	Ratio of fine-grained texture	Ratio of squatter settlements	Ratio of dilapidated texture
1	9.0	0	2.1
2	20.4	14.1	0
3	269	0	7.3
4	35.6	311	0
5	13.1	0	0
6	6.6	0	2.8
7	37.3	9.6	22.3
8	34.9	3.8	24.9
9	7.4	0	0
10	26.9	0	40.4
11	47.4	26.1	0

Non-dimensionalization

The fact that each quantitative indicator has its own measurement scale makes it impossible to compare their values with each other. Therefore, to make a comparison, one should somehow make these indicators unit-independent. In this study, this goal was achieved through fuzzy non-dimensionalization.

Fuzzy non-dimensionalization

In this method, the non-dimensionalized values of positive and negative indicators are obtained using:

Equation (1)

For positive indicators

$$\pi_{ij} \frac{a_{ij} - \min a_j}{\max a_j - \min a_j}$$

Equation (2)

For negative indicators

$$\pi_{ij} \frac{\max a_j - a_{ij}}{\max a_j - \min a_j}$$

In this method, the weights of indicators were calculated by using the principal components analysis technique to maximize the sum of squares of correlations. This approach is the preferred method for the cases where there is a high correlation between indicators. The weight assigned to the indicators by the first factor depends on the correlation between the indicators. In other words, the greater the correlation between an indicator and other indicators, the higher the weight it will be assigned with. This method allows the researcher to obtain a vector as the first principal component, which is linearly related to the principal components and has the highest sum of squared correlations with the indicators. The eigenvector (F1) associated with the highest eigenvalue yields the correlation matrix (R) of the weights.

Table 9: Weights calculated by principal component analysis

Indicator	7	6	5	4	3	2	1
Neighbor Relationships	.32	.36	.19	-.37	.50	-.33	-.37
Sense of belonging	.04	-.01	-.44	-.01	.54	.03	.68
Interpersonal trust	.20	.52	.19	-.35	.34	-.12	.57
Informal control	-.01	-.01	-.18	-.40	.87	-.02	-.06
Institutional trust	-.56	.14	.16	-.40	.27	.13	.60
Religious participation	.03	-.50	-.35	-.17	.48	.49	.24
Social coherence	-.09	.04	.02	-.12	.47	.02	.85
social participation	-.12	-.38	.64	.09	.17	-.41	.44
Interpersonal trust	-.10	.23	-.30	.02	.17	.74	.46
Informal control	.00	-.14	.17	.10	.00	-.32	.89
Institutional trust	-.13	.31	-.19	.25	-.49	-.17	.69
Religious participation	.12	-.18	-.11	.16	.03	.02	.94
Social coherence	-.24	-.00	.50	-.26	-.15	.58	.38
social participation	-.00	-.20	.37	-.32	.10	.53	-.63
Sense of security	-.12	.06	.05	-.00	-.24	.66	-.67
Household size	.11	-.13	-.05	.12	-.02	.02	.96
Ratio of rented properties	.07	-.02	-.15	-.09	.34	.86	.08
Literacy	.17	.24	.48	.46	.33	-.53	.19
immigrants	-.07	-.04	.11	.34	.63	.18	-.59
Tenants	.03	-.06	.21	.33	.55	.16	-.66
Facilities	.03	-.07	.54	.19	.00	.66	.38
Natural surveillance	.15	-.04	.08	.05	-.29	.67	.63
Maintenance	.25	.03	-.10	.18	-.22	.89	-.11
Access control	.29	.02	.21	.22	.06	.52	.654
Ratio of squatter settlements	-.25	.19	-.18	.81	.25	.35	-.08
Ratio of dilapidated texture	.23	-.01	.08	-.45	-.38	.73	.00
Ratio of fine-grained texture	-.18	.31	.11	-.07	-.09	.90	-.00
Residential unit less than 50 meters	04	.04	.07	.37	.41	.73	-.26

The calculated weights are provided in Table 9. In the cases that there are two, three or even more vectors, the weight must be derived from the first vector, as it can explain the most variance. After calculating the weight of every indicator, the weights were multiplied by the scale bias elimination indices and then summed to obtain the total resilience index of each district. Then, the physical and social resilience indices were summed independently to determine the resilience of districts in social and physical dimensions (for negative weights, the absolute value was used in calculations).

Table 11: Final weight obtained for various dimensions of resilience

Indicator	District 11	District 10	District 9	District 8	District 7	District 6	District 5	District 4	District 3	District 2	District 1
Community resilience	6.87	7.46	4.46	5.87	5.43	10.17	7.66	6.90	9.22	8.69	9.51
Physical resilience	0.39	0.54	0.47	0.56	0.16	1.73	1.25	0.52	1.25	0.49	1.70
Social resilience	6.49	6.91	3.99	5.31	5.27	8.44	5.81	6.40	7.97	8.20	7.81
Weights of crime in districts (inversed)	0.68	0.56	0.98	0.62	0.65	0.87	0.69	0.68	0.78	0.65	0.00

The Pearson correlation was used to measure the correlation between crime rate and physical and social resilience. The results show that the correlation coefficient between crime rate and community resilience is -0.344, meaning that the more resilience the community has, the lower is its crime rate and vice versa. This correlation was at an average level and had a P value of 0.022 (p<0.05), which proves the reliability of this correlation at 95% confidence level. Almost the same results were obtained for other aspects of resilience. The correlation coefficient between social resilience and crime rate was found to be -0.319 and showed an inverse correlation between them with a P value of 0.035 (p<0.05), which indicates reliability at 95% confidence level. The correlation between physical resilience and crime rate was also calculated to -0.300 which clearly showed the inverse relationship between the physical aspect of the resilient community and the rate of crime.

Table 12: Pearson coefficient of correlation between research variables

Correlation coefficient of resilience dimensions		Physical Resilience	Social resilience	Community resilience	Weights of crime in districts
Crime rate	Pearson Correlation	-.300*	-.319*	-.344*	1
	Sig. (2-tailed)	.048	.035	.022	-
Community resilience	Pearson Correlation	.768**	.969**	1	-.344*
	Sig. (2-tailed)	.000	.000	-	.022
	Sig. (2-tailed)	.000	.000	-	.022
social	Pearson Correlation	.585**	1	.969**	-.319*
	Sig. (2-tailed)	.000	-	.000	.035
phisical	Pearson Correlation	1	.585**	.768**	-.300*
	Sig. (2-tailed)	-	.000	.000	.048

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

As mentioned, an inverse relationship was found between the level of resilience and the susceptibility to crime. However, according to Table 12, this is an incomplete correlation because districts 1, 2, and 10 have both a high resilience and a high crime rate, which contradict the hypothesis of a complete correlation between these variables. Therefore, the resilience indicators of these districts were studied separately to determine the impact of each indicator on the resilience of that district. According to the results, district 1 had the second highest resilience in the city, but ranked first in terms of crime rate. This district ranked 9 in terms of social participation, percentage of immigrants, and ratio of rented properties, ranked 8 in terms of informal control, institutional trust, neighbor relationship, ranked 7 in terms of illiteracy, and

population density. In fact, the high ratio of rented properties and migrants can reflect an increased level of inattention to or unfamiliarity with the environment. This undermines the effect of informal control of citizens on crime prevention, which has resulted in poor condition of district 1 in terms of crime rate. On the other hand, the central district is in better shape than another district in terms of indicators such as maintenance, natural surveillance through design, level of facilities, sense of belonging, and ratio of fine-grained textures. In general, all of the weak indicators of district 1 are of social type and physical indicators of this district are in generally good shape. This proves that the central part of the city is suffering from a deficiency in social resilience. District 2 also has a high crime susceptibility. In this district, the indicators for the level of facilities, maintenance, and the ratio of squatter settlements are worse than other parts of the city. Unlike district 1 where vulnerabilities had social origins, the main residence problems of district 2 have a physical nature, and this has led to a high rate of crime, despite the acceptable ranking of the district in terms of resilience. The results also show that the districts with a high ratio of squatter settlement were in poor condition in terms of physical vulnerability. More specifically, districts 2, 4, and 8, i.e. Sakineh Banu, Amroabad and Kheirabad neighborhoods which had the highest ratio of squatter settlement, had the lowest level of urban facilities, and a poor level of maintenance from the environmental design perspective. Therefore, the districts with squatter settlements had the lowest physical resilience and this has had an impact on their crime rate. It is indeed notable that four of the five squatter settlements were found to be crime hot spots.

Conclusion

Various studies have investigated the decreasing or increasing impact of individual, environmental, economic, social and cultural factors on crime rates. Given that social anomie is affected by numerous

parameters, the present study sought to investigate a broader group of factors influencing the resilience and vulnerability to crime with the crime considered as the result of various factors. The results showed a correlation between the crime rate and the resilience of the city with the correlation coefficient of -0.344, which means the higher the resilience of the community, the lower is the crime rate, and vice versa. This correlation had a P value of 0.022 (p<0.05) which indicated significance at 95% confidence level. Similarly, the coefficient of correlation between social resilience and crime rate was calculated to be -0.319, which showed an inverse relationship between crime and social resilience with a P value of 0.035 (p<0.05), indicating significance at 95% confidence level. The coefficient of correlation between physical resilience and crime rate was also found to be -0.300 which showed the inverse relationship between these variables. The importance of the identification of vulnerability and resilience indicators lies in their involvement with the spatial pattern of crime incidence. In other words, the rate of crime varies with the social and physical characteristics of the places. The vulnerability indicators that affect the crime rate in the peripheral areas of the city are mostly physical-objective and have been formed based on the concept of crime prevention through environmental design, but the vulnerability indicators involving the crime rate in the central parts of the city are both objective and subjective and belong to the social dimension of resilience. In fact, the spatial and holistic approach to social issues, and particularly crime, shows that the analysis aimed at controlling the crime rate should consider all social, physical, and environmental dimensions in a single process, which culminates in the social issue of crime susceptibility.

References

Adger, W. N. (2000). Social and ecological resilience: are they related? Progress in human geography, 24(3), 347-364.

Ahmadi, S., Sayfoddini, F. & Kalantari, M. (2013), Spatial analysis of crime patterns in district 17 of Tehran municipality, Journal of Applied Geosciences Research, 13(31), 47-72.

Aitsi-Selmi, A., Egawa, S., Sasaki, H., Wannous, C. & Murray, V. (2015). The Sendai framework for disaster risk reduction: Renewing the global commitment to people's resilience, health, and well-being. International Journal of Disaster Risk Science, 6(2), 164-176.

Ayyub, B. M. (2014). Systems resilience for multihazard environments: Definition, metrics, and valuation for decision making. Risk Analysis, 34(2), 340-355.

Badri, A., Ramezanzadeh Lasbui, M., Asgari, A., Ghadiri Masoom, M. & Salmani, M. (2013), The role of local management in promoting resilience to natural disasters with an emphasis on flood, Case study: Cheshmeh Kileh basin of Tonekabon and Sardarabad basin of Kelardasht, Quarterly Journal of Crisis Management, No. 3, pp. 39-50.

Bayanloo, Y. & Mansourian M. K. (2006), The relationship between population density and the rate and type of crime, Journal of Social Welfare, 6 (22), 29-56.

Cutter, S. L., Ahearn, J. A., Amadei, B., Crawford, P., Eide, E. A., Galloway, G. E. & Scrimshaw, S. C. (2013). Disaster resilience: A national imperative. Environment: Science and Policy for Sustainable Development, 55(2), 25-29.

Cutter, S. L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E. & Webb, J. (2008). Community and regional resilience: Perspectives from hazards, disasters, and emergency management. Community and Regional Resilience Initiative (CARRI) Research Report, 1.

Farid Taherani, S. (2011). Fear in urban space, Tehran, Armaneshahr Publishing.

Farzad Behtash, M.R, Keynejad, M.A., Pir Babaei, M.T. & Asgari, A. (1392). Evaluation and analysis of dimensions and components of the resilience of Tabriz metropolis, Journal of Fine Arts Architecture and Urban Development, 18 (3), 33-42.

Farzad Behtash, M.R, Pir Babaei, M.T., Keynejad, M.A. & Agha Babaei, M.T. (2012). Dimensions and components of resilience in Islamic cities, Quarterly Journal of Iranian-Islamic city, 9, 113-121.

Ghiasvand, A. & Abdolshah, F. (2015), Economic resilience indicators, Ravand Quarterly Journal, 23(71), 77-106.

Ghorbani, M., Avazpour, L. & Yousefi, M. (2015). Analysis and evaluation of social capital for the promotion of sustainable land management and resilience in local communities, case study: South-Khorasan Province, RFLDL international project, Range and Watershed Management, Journal of Iranian Natural Resources, 68(2), 625-645.

Graneheim, U. H. & Lundman, B. (2004). Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. Nurse education today, 24(2), 105-112.

Kafle, S. K. (2012). Measuring disaster-resilient communities: A case study of coastal communities in Indonesia. Journal of business continuity & emergency planning, 5(4), 316-326.

Kalantari, M. (2001). Geographical survey of crime in the districts of Tehran, Dissertation for Ph.D. in Geography and Urban Planning, supervised by M.T Rahnamayi, Faculty of Geography, University of Tehran.

Kamrannia, J. (2006). Spatial and prospective analysis of crime pattern in the central districts of Shiraz, Master's thesis, Beheshti University of Tehran.

Keck, M. & Sakdapolrak, P. (2013). What is social resilience? Lessons learned and ways forward. Erdkunde, 5-19.

Klein, R. J., Nicholls, R. J. & Thomalla, F. (2003). Resilience to natural hazards: How useful is this concept? Global Environmental Change Part B: Environmental Hazards, 5(1-2), 35-45.

Mitchell, T. & Harris, K. (2012). Resilience: A risk management approach. ODI Background Note. Overseas Development Institute: London.

Moore, M., Chandra, A. & Feeney, K. C. (2013). Building community resilience: what can the United States learn from experiences in other countries? Disaster medicine and public health preparedness, 7(3), 292-301.

Paton, D., Gregg, C. E., Houghton, B. F., Lachman, R., Lachman, J., Johnston, D. M. & Wongbusarakum, S. (2008). The impact of the 2004 tsunami on coastal Thai communities: assessing adaptive capacity. Disasters, 32(1), 106-119.

Perry, R. W., Lindell, M. K. & Tierney, K. J. (Eds.). (2001). facing the unexpected: Disaster preparedness and response in the United States. Joseph Henry Press.

Pfefferbaum, R. L., Pfefferbaum, B., Van Horn, R. L., Klomp, R. W., Norris, F. H. & Reissman, D. B. (2013). The communities advancing resilience toolkit (CART): An intervention to build community resilience to disasters. Journal of public health management and practice, 19(3), 250-258.

Pourmousavi, M., Zanganeh Shahraki, S., Ahmadifard, N. & Abdi, N. (2011), Effect of high rise buildings on the rate of urban crime (case study, districts of Tehran), Human Geography Research, 77, 61-74.

Ramezanzadeh Lasbui, M. & Badri, A. (2014). Socio-economic structures of the resilience of local communities against natural disasters with an emphasis on floods, case study: Cheshmeh Kileh and Sardarabad tourism hubs, Journal of Geographic Society of Iran, New edition, 12(40), 109-131.

Rezaei, B. (2010). Dilapidated urban textures, crime hotspots: effect of dilapidated textures around Razavi shrine on the crime rate, Tehran, Iranian Social Studies, 4(4).

Sadiqlou, T. & Sajasy Qidari, H. (2014). Prioritization of factors affecting the resilience of farmers to natural hazards (with emphasis on drought). Case study: Farmers in Ejrud villages, Geography and Environmental Hazards, 10, 129-153.

Saeedi, I. & Darabi, H. (2014), University landscape design with resilience to water crisis (case study: Malayer University), Ecology, 40(4), 1051-1066.

Van der Leeuw, S. E. & Aschan-Leygonie, C. (2005). A long-term perspective on resilience in socio-natural systems. In Micro Meso Macro: Addressing Complex Systems Couplings (227-264).

Varamin Improvement and Renovation Project. (2010). Iranian Civil Construction and Housing Company.

Varghese, S. B. (2010). Cultural, ethical, and spiritual implications of natural disasters from the survivors' perspective. Critical Care Nursing Clinics, 22(4), 515-522.