Analysis of Spatial Structure of City According to the Shape Pattern of City the Case Study: Behshahr

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Abstract: Nowadays urbanism is the most significant prospect of human society's development in the developed countries and developing states. The human societies confront so many difficulties with development of cities that lack of facilities and environmental capacities and pollutions that are related to it is one of its more significant ones. With changes during the current decades, the towns of our country confronted so many problems and irregularities that its most important is the discordant spatial structure of the cities. Behshahr is a city that was not immune of these changes and confronts so many problems and difficulties this study is performed with the aim of knowing the spatial structure of the Behshahr city and the role of different factors on it. In this study the models of entropy and Williamson, factorial analysis, TOPSIS and Pearson and spearman coefficients are used to consider the spatial structure of the Behshahr,the results of this study indicate that: The central part of the city has a stronger (accumulated) spatial structure and the surrounding parts have the weaker (dispersed) spatial structures.The local and hierarchical usages were unbalanced in the urban areas and sections of Behshahr (concentration of the usages in the central part and lack of usage diversity in the urban sections) and caused disorder in the spatial structure of the town through disturbance in the central part and lack of urban motion in the urban districts and sections.

Key words: Construction · Spatial structure · Entropy and Williamson · Factorial analysis

INTRODUCTION

The cities became the centre of industrial activities after industrial revolution. Therefore the villagers come to the towns seeking for a job and its result is the new spatial relations. In spite of successes in so many countries particularly the third world countries, some irregularities were generated. The increasing growth of population in the cities of our country after performing the land reformations and its intensity after the Islamic revolution caused the cities encounter the structural libertinage and disorder because of the urban substructures which are proportionate with the population acceptance. The urbanism and urbanity process encountered different difficulties during the critical and passing situations of the society that the unsuitable spatial structure of the city is one of them [1].

Behshahr city with a population about one hundred persons is not except from this rule. If the current and rapid development of the city in two sides of the west and east is not controlled and conducted, it can be lead to so many problems and difficulties in a short time. The local government particularly the municipality of Behshahr can influence the method of urban development not only through the direct designing but also through performing a logical and steady system of norms and provisions of the lands, investment in substructures and In long term the form of city depends on the method of reaction among these forces and can act as a factor to strengthen or prevention. Due to the continuous changes of the spatial structure of the cities and non-existence of a clear viewpoint about the spatial development of the city, the norms and provisions which are related to the lands, investments in substructures and are often incompatible

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and may be their effects and reflexes were not in the same side and were opposite each other that these effects creates an insufficient spatial structure that has other difficulties too this insufficient spatial structure causes to increase the life of the urban substructures nets and therefore increase the expense of capital and current which is related to them and even has significant influence on urban environmental quality and efficiency.

Definitions and Meanings

Construction: Construction has different meanings. On one side it is used in meaning of construction and on the other side in meaning of method, style and manner [2]. Also this word means compose and form and sometimes it means the method of combining the structure of something, the act, or process of constructing and combining the parts and components of one thing [3].

Area: From geography viewpoint, the area is a place that events have mutual interaction with each other and the human's activities are formed in it. In fact the space is a set of bodies and contents, when a quality or suffix is attributed to the space that body and content determines the extent and identity of the space [4]. The geographical space includes the nature and all the resources that can directly and indirectly face the human being's needs and creates a new face of the ground area, in this way the geographical space is a habitat area that is formed from the natural conditions and social structure of the society [5].

The Spatial Structure: The spatial structure of the city is the result of historical procedures and changing economical- social and political conditions. The spatial structure of the city is more popular than the skeletal structure and proportionally includes the urban elements and factors that settle the method of establishment and relation between them with determined degree of order and operational capacity.

The Research Method: Regarding the types of researches on the basis of nature and method, in this research the descriptive- analytical method is used. In the current research the required information in this research is prepared using the books, articles, internet data bases and local resources and then changes of spatial structures of the city are evaluated and analyzed using the Shannon entropy model, Williamson model, the factorial analysis, TOPSIS and Pearson and Spearman correlation coefficients. In this research some variables such as the

area of regions and urban and population are used to analyze the spatial structure of the city in the form of entropy model to determine the pattern of the city and its effective factors in the form of the above mentioned model and also in the following we evaluate the effect of the pattern of city on the distribution of applications and urban services using the Williamson model, the factorial analysis, TOPSIS and Pearson and Spearman correlation coefficients and analyze the spatial structure of the city on its form.

Introducing the Studied Area: Behshahr is placed in the north of the first pillar of the Alborz mountain chain (Jahan Mora Mountain) in the crossing of plain with mountain on the sedimentary soils outside of forest between 53 degree and 34 minutes of eastern longitude and 36 degree and 43 minutes of northern latitude. This town limits to the Mazandaran Sea from the north, to the Ridge of Jahan Mora Mountains from the south and the neighbor villages from the east and west. This town is placed in the 9 kilometers distance of the Gorgan Gulf, 18 kilometers distance of the Mazandaran Sea, 94 kilometers distance of Gorgan, 45 kilometers distance of Sari and 300 kilometers distance of Tehran. The area of this town is about 1400 Hectare and its level from the Mazandaran Sea is changed at least 24 and at the most 61 meters and also from the open water is -3 to 30 meters [6].

The Development Stages of Behshahr City Based Onthe Histology: The recent changes that have occurred in the social level significantly influenced the development pattern of the cities. With developmentof services part and also centralization of industries in the towns so many populations of villages attracted to the cities.And this migration of rural peoples to the cities plays an important role in creating the accumulation and crowd in the cities and leads to their non-planned development [7]. By adding the new districts to the city limit, needs for services and civic facilities are increased.

It must be said that formation of urban textures was because of different reasons and has appeared in the form of some characteristics in the urban textures and in the following table the development steps of the city are presented briefly.

Considering the Spatial Structure of the City According to the Models: In discussion about considering the spatial structure of the city two subjects are focused one is the main part that is related to the structure of the city and is considerable through determining the pattern of the town

Table 1: THE development stages of Behshahr city Based onThe Histology

Historical texture	This texture is the primary core of the Behshahr.Behshahr was a small village before the year 1012 and construction of Shah Abbas palaces in the southern slope of the Jahan Mora Mountain causes to attract population and form a city that is named Behshahr [9].
Old texture	This texture spins around the primary core of the city or the historical texture. The end of the period of formation of this texture reaches to the end of Qajar period. The old texture of Behshahr is about 174 Hectares that includes 6 sectors and placed in the centre of the city the families who live in these sectors are 4621 families that include 19405 people, this texture, with the density of 115.161 people per hectare has the most population in comparison with other areas [9].
Middle texture	The time step of constituting this texture can be from the year 1300 until the beginning of 40 decades [10].
New texture	This texture forms after the 40th decade because of migrations increase. It includes two texture: 1-The border texture: this texture is placed in the east of Behshahr and is formed because of migration and includes some districts such as Ghaem. 2-The semi-rural texture: this texture is formed because of connection of Zirvan village to Behshahr in 1991 in the west of the city and develops so much from that time to now [11].
Discontinuous texture	This texture is formed because of discontinuous expansion and development of the town, around the city. The discontinuous texture of Behshahr is formed in the northern part of the city since 1951; the main reason of its formation was because of constructing the railway. After 1951 the personnel of railroad constructed the organizational houses that later the slaughterhouse area was formed and developed by increase of construction around these facilities, this area was separated from the main structure of the city and forms the discontinuous texture [12].

Table 2: The area, population amount and accumulation in areas of Behshahr

District	The area of the regions in Hectare	Population	Accumulation
1	185.86	15467	83.21855
2	291.61	22013	75.48781
3	310.59	23761	76.50279
4	141.87	6348	44.74519
5	173.84	4989	28.6988
6	112.82	5120	62.35386

Table 3: The spatial distribution of population in the urban areas during 2006 in Behshahr

District	The area in Hectare	pi	Ln(pi)	pi×ln(pi)	the population of the area	pi	Ln(pi)	pi×ln (pi)
1	185.86	0.15	-1.87881	-0.28703	15467	0.19	-1.61412	-0.32132
2	291.61	0.23	-1.42839	-0.34238	22013	0.28	-1.2612	-0.35732
3	310.59	0.25	-1.36533	-0.34856	23761	0.30	-1.18478	-0.36232
4	141.87	0.11	-2.1489	-0.25059	6348	0.08	-2.50469	-0.20464
5	173.84	0.14	-1.94567	-0.27802	4989	0.06	-2.74559	-0.17629
6	112.82	0.09	-2.37801	-0.22052	5120	0.06	-2.71968	-0.17922
sum	1216.59	1		-1.7271				-1.6011

Reference: The calculations of writers

H=-(-1.79)=1.72   H=-(-1.60)=1.60

G=0.96   G= 0.89

and the second one is the non-main part of the city or suburbs that is evaluable through distribution of usage in the suburb areas on the basis of the above mentioned points, in this part of the research the Entropy and Williamson models are used to consider the form of city and the pattern of usage in the suburb areas of the city.

Considering the Form of City and Population Distribution in the Civic Areas According to the Shannon Entropy Model: This model uses to analysis and determine the form of city and population distribution. The general structure of this model is as the following:

$$H=-\Sigma Pi \times ln(pi)$$

$$G=H/LNK$$

In the above equation:

H : The amount of Shannon entropy

Pi : The ratio of area of the built regions of i (the total residential accumulation) to the total area of the built areas in whole of areas

N : Whole of areas

The value of Shannon entropy amount is from 0 to In(n). The amount of 0 displays the accumulated form of the town. While the In(n) amount displays the scattered form of the city [13]. This model is used in determining the form of town and population distribution in Behshahr.

The tables above show that mounts of entropy for the area of the districts and population are 0.96 and 0.89 respectively, the nearness of entropy amounts to

Table 4: The area of the usages according to the districts of Behshahr 2005

District	The area of the district in Hectare	Population	Residential	Commercial	Educational	Religious and cultural	Therapeutic	Health and welfare	Sport	Official and disciplinary	Green space
1	185.86	15467	804664	7392	20560	15472	0	3938	5203	0	2266
2	291.61	22013	923203	13351	15732	13172	0	2158	779	0	0
3	310.59	23761	1205063	16950	19094	6962	0	1014	3457	1424	5505
4	141.87	6348	277799	2331	8914	2686	0	742	147	0	228
5	173.84	4989	237474	2853	5563	4117	0	530	4214	0	0
6	112.82	5120	242184	2061	3992	921	0	0	773	0	237

Table 5: Per capita of usages in the Behshahr districts and calculation of coefficient of variance

District	Residential	Commercial	Educational	Religious and cultural	Therapeutic	Health and welfare	Sport	Official and disciplinary	Green space
1	52.02	0.477	1.329	1.0003	0	0.25460	0.33639	0	0.14650
2	41.938	0.6065	0.7146	0.59837	0	0.098033	0.035388	0	0
3	50.716	0.7133	0.8035	0.29300	0	0.042675	0.145491	0.05993	0.231682
4	43.761	0.3672	1.4042	0.42312	0	0.117045	0.023157	0	0.035917
5	47.599	0.5718	1.1150	0.82521	0	0.106234	0.844658	0	0
6	47.301	0.4025	0.7796	0.17988	0	0	0.150977	0	0.046289
Coefficient of variance	0.074	0.22	0.26	0.52	0	0.76	1.116	0.82	1.105

the number one indicate the scattered form of the city and imbalanced distribution of population in the urban districts.

Distribution of Usages on the Basis of Williamson Indexes or Coefficient of Variance: Considering the usage of lands and comparing the types of usages in the urban districts, is the structural and civic reflex of spatial order of the city. According to one of the main basis in urbanism, the method of using the land and construction in the urban areas forms on the basis of the current condition of the city and confirmed and important cases such as accumulation, the method of establishing the official, commercial buildings and the method of allocating the land for the urban services.

To evaluate that how imbalanced an index distributed among the urban areas the method of coefficient of variance (CV), that is sometimes named Williamson factor, is used [14]. This method is used to consider the procedure of inequalities that existed in distribution of usages among the districts of Behshahr and the high amount of (CV) indicates more inequality in distribution of above mentioned index. The coefficient of variance is calculated using the following formula.

$$CV = \frac{\sqrt{\dfrac{\sum_{i=1}(X_i - \bar{X}_i)^2}{N}}}{\dfrac{\sum_{I=1}^{N} XI}{N}}$$

In this equation:

X_i = Is the amount of an index in a particular area

$\bar{x}$ = The average of I index

N = The amount of areas (4).

The results of the model above indicate that distribution of usages in different districts of Behshahr is unequal and these usages are scattered illogically in Behshahr and these inequalities are evident more in the green space, sport, health- therapeutic and official – disciplinary, of course it must be said that this unsuitable local distribution and the order of civic usages causes to decrease the quality of the urban life in the districts and regions of the city.

Factorial Analysis: To know the effective factors in preparing the urban services the factorial analysis method has been used in this manner that at first the sum of the indexes which are used in this research are operated using the SPSS software, in this manner that indexes which have an internal relation tend to aggregate around an axis. So the indexes which have the correlation more than 0.5 percent constitute a factor and conversely the indexes which have the negative correlation and don't have the possibility of aggregation with these indexes constitute another factor. So the factors obtained through the correlation matrix [15]. The results of this method was reduction of 8 initial indexes to 2 major factors by the

Table 6: The factorial score of each district in Behshahr

| Grade | The combined indexes | The factorial score of each factor | | District |
		Second factor	First factor	
1	2.323	1.2851	1.03875	1
5	-1.0288	-0.8756	- 0.1532	2
4	-0.68	1.007	- 1.6871	3
3	- 0.1914	-0.7588	0.5673	4
2	1.0031	0.2936	0.7094	5
6	- 1.426	- 0.9514	- 0.4751	6

Table 7: Determining the amount of enjoyment on the basis of combined indexes

District	The factorial score	Grade	Amount of enjoyment
1	2.323	1	Enjoyed
2	-1.0288	5	Deprived
3	-0.68	4	Deprived
4	-0.1914	3	Deprived
5	1.0031	2	Enjoyed
6	-1.426	6	Deprived

Reference: the calculations of writers

Table 8: Giving weight to the indexes using the Shannon entropy method

	Green space	Official and disciplinary	Sport	Health and welfare	Religious and cultural	Educational	Commercial	Residential
E	0.636754	0	0.7054	0.815204	0.922293	0.981092	0.986158	0.999352
D	0.363246	1	0.2946	0.184796	0.077707	0.018908	0.013842	0.000648
W	0.185923	0.511837	0.150787	0.094585	0.039773	0.009678	0.007085	0.000332

Varimax rotation method in the factorial analysis and then on the basis of the data compares the level of civic services in the districts with each other and the degree of enjoyment of districts was calculated in the combined factor.

Distribution of Civic Services in the Districts of Behshahr Using the TOPSIS Method: The most important criterion to analyze the condition of spatial equality in the city is the manner of distribution of public utilities. The TOPSIS model is one of the methods in explaining the manner of distribution of public utilities. This method shows the amount of inequality in distribution of civic services in the urban districts. In this method, at first 6 districts constitute a matrix using 8 indexes. Then using the Shannon entropy model, these indexes are weighted and at last are ranked through performing the six steps of TOPSIS model. As the following table indicates, to explain the distribution of civic services 8 indexes are used for 6 urban districts. The statistics and normalized weight of each of the indexes of civic services for the selected areas of Behshahr is showed in the following table, that the sport, official and disciplinary and the green space indexes have the most weights. Also, inequality of each of the civic

services indexes in the six districts of the city is determined using the distribution of scattering coefficient. On the basis of the obtained results, the most inequality in the spatial distribution is related to the official and green space indexes and the less one is related to the commercial and residential services. The commercial services that are used more to supply the daily needs, are distributed equally in most of the urban areas and indexes such as the health and welfare, sport, official and disciplinary and green space which have the regional operations, are often placed in the regions that are the centre of that area and in this reason, most of inequality in spatial distribution of these services exist in the six districts of the town.

Considering and recognizing the condition of the urban districts in the case of the manner of distributing the services in the urban area is the point that recently is propounded in the programming culture and its position is not determined properly and completely yet. One of the suitable criteria to know the facilities and shortages of the civic districts is their classification on the basis of service indexes and finding the quality of services in the city. On this basis, the standardized scores are divided to three levels of balanced, semi-balanced and unequal. According to the performed considerations the district

Table 9: Ranking of the urban districts in Behshahr on the basis of the civic services using the TOPSIS method

Grade	TOPSIS	Negative distances	Positive distances	Urban districts
2	0.205492	0.13486656	0.52144423	1
6	0.053476	0.03119887	0.55221723	2
1	0.803781	0.53493471	0.13058837	3
4	0.072537	0.0427179	0.54619417	4
3	0.203936	0.13737552	0.53624588	5
5	0.063685	0.03699478	0.54390429	6

Table 10: Dividing the urban areas of Behshahr in the case of spatial distribution of civic services

Names of districts	Amount of districts	TOPSIS score
District No. 3	1	Between 0.7 to 1 is balanced
-	0	Between 0.4 to 0.7 is semi-balanced
Districts 1-2-4-5-6	5	Between 0 to 0.4 is imbalanced and unequal

Table 11: Calculation the Spearman correlation coefficient between the population and services ranks among the urban areas of Behshahr

D2	D	TOPSIS rank (service index)	Population rank	Urban areas
1	1	2	3	1
16	-4	6	2	2
0	0	1	1	3
1	1	4	5	4
1	1	3	4	5
1	1	5	6	6

$$\Sigma d\,2 = 20$$

$$r = 1 - \frac{6\sum d^2}{N^3 - N}$$

R=1-0.57=0.43

Table 12: The method of distribution of indexes in relation with the population

Method of distribution	The basis of division
Weak	0 – 0.5
Middle	0 – 0.75
Good	0.75 - 1

number 3 is known as the most balanced area and other districts are known as the imbalanced urban area in the optimal distribution of services and quality of accessibility of civic services for the citizens.

Generally, on the basis of the structural divisions, among the six urban districts one district was balanced and five districts were imbalanced and also considering the Pearson Correlation relationship among the population accumulation and obtained scores through the TOPSIS method, indicates that the Correlation coefficient was (P-Value =0.573). This mean that there isn't a significant relationship among the population accumulation and distribution of services; it means that whatever the districts obtain high ranks in the case of equality in distribution of civic services, it is not related to the population accumulation.

The Relationship of Population Distribution and Services Distribution: Since the services distribution is performed in the urban areas due to facilitating the servicing and suitable and optimal accessibility for the citizens, if distribution of services and urban facilities was not according to the correct and systematic standards, the servicing is not performed easily and the required services of citizens were not distributed equally and in the balanced form among the town. In this case, maybe there will be some imbalances and inequalities between the population distribution and required service area [16]. In this survey the relationship between the population distribution and services distribution is evaluated using the Spearman coefficients. The obtained results indicate that there is a very little relationship between the population distribution and services distribution among

the six districts of Behshahr, the obtained Spearman coefficient was 0.43 that is indicative of the little and weak relationship between the population distribution and services distribution among the urban areas in Behshahr.

Considering the aspects of the spatial structure of town is seems necessary from the different service indexes and the method of population distribution, because the spatial structure of the city has a coherent and stable structure and consists of different components and elements that instability of each of these elements influenced whole of this collection and urban structure. In the current survey the spatial distribution of population and services among six districts of Behshahr is considered and indicates that there isn't any logical and coordinated relationship between two variables. Since the districts which have a low level of population accumulation, are placed in an equal and balanced level of service distribution. Behshahr that has about 1400 Hectare area and 84177 people population, is so imbalanced and scattered in the case of physical development, because the gross density of the town is 60 person per hectare. The scattering and imbalance of physical development of Behshahr has a negative influence on the distribution of population and services. On the basis of the performed evaluation using the 8 service indexes, just the district No.3 is placed in a balanced level. The Pearson correlation coefficient between the population accumulation and TOPSIS score indicates there isn't any relationship between these two variables. In other words, the services distribution had not conformed to the population needs, but the social and economical characteristics of the residents of those districts influenced the services distribution. Therefore, the Spearman model has been used to establish a relationship between two variables of population and services and reaching a programming pattern in this case. In spite of this, the result of model indicates a very little, weak and reverse relationship between the population and services.

At Last According to the above Mentioned Cases and Subjects We Can Explain the Spatial Structure of Behshahr as the Following:

- Development of city in term of directions: on a eastern- western plain, the heights (mountains) are as the natural elements that form the connectional axis along a linear and manmade axis in a perpendicular direction on it and creating the main structure of town

- Development of town from historic viewpoint in two different period: A) pre-modern and pre-capitalism, B) Modern era.

The procedure of urban changes in the first era was slow, endogenous and had the operational solidarity and suitable and proportionate structure. In the second era, under the influence of policies, change of the operation in town, population increase and …, the spatial structure of city has accomplished in term of development toward the west and east, decrease of green spaces and agriculture, combining the villages into the town, appearance of living in the suburbs and … at last lack of structural proportional solidarity.

- From the structural viewpoint: the spatial structure of city is affected by the social, cultural, economical factors and … in addition to the form of natural bed or land and take some particular characteristics to it and these characteristics are as the following:
- The proportionally heterogeneous, less-accumulated and scattered residential areas in the city
- The most residential accumulations in the central parts of the town near the most concentration of establishing the economical and service parts in the urban and ultra-city scale.
- Adjoining the gardens and open areas together with the low population accumulation.
- The residential areas such as the changed elements and components in the past and present time.
- The linear and longitudinal development of the city as the most important aspect of development during the past decades.
- In spite of the relatively suitable conditions there is deficiency of the current network and replication to the needs of the service exhibitors and persons who referred to it in the central part.
- Lack of an organic relation of new urban development with the formed part of the town, lack of service and welfare facilities, the weakness of relational hierarchy and loss of the spatial disciplinary in these urban developments, the horizontal development in the suburbs specially in the west and east of the city, lack of cultural and social identity, the form of these developments and suitable reduction of residence.
- Lack of control on the urban management in the case of some unsuitable applications, lack of the active and free urban areas that were suitable for the social interactions in the city.
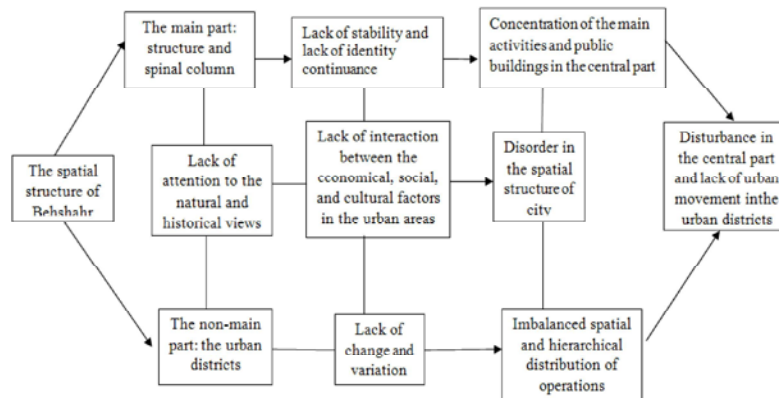
- Lack of relation or connection between the numerous civic systems (transportation system, activities and applications system) with each level of operational hierarchy in the city (urban, regional, district, local).
- Presence of unsuitable applications near each other particularly in the residential textures.

CONCLUSION

The condition of structure and spatial form of the city is resultant of natural conditions, the system of population accumulation and its historical activities and changes, the social and economical procedures and at last the movement system.

Several factors are effective in considering the spatial structure of the city and the most important ones are: the economical structure, operation and activity structure and distribution of activities.

Considering the economical structure of the city make it possible to find its operation in the changes of the social structure of city (occupation – population) and also it's possible to observe the appearance of these social and economical changes in the structural area of the cities.

The economic power of the city, which includes the major economical activities (agriculture, industry and services), is one factor that influences the formation and of urban development and motivates it. The natural and regional condition and also the national policies are some factors that play an important role in the economic power of the city and its place in the urban hierarchy. Creating the occupational opportunities or jobs in the case of industry and services causes immigration and attraction of population to cities and changes its social structures. Besides with continuation of immigration, its spatial effects on the form of city and its development become apparent.

According to the table above, the results of considering the changes of spatial structure in the city indicate that by changing the occupational structure of the city from industry to service, the pattern of city changed from the accumulated form to the scattered form (with the change of 86 meter per each person per capita in year1973 to 167 meters per each person in year 2005) and from checkered pattern to the linear pattern, in this respect the Entropy and Williamson, the factorial analysis, TOPSIS and Pearson and Spearman coefficients methods are used to determine the effects of these economical (occupation), social (population and immigration) and structural (the form of city and operational patterns) changes in the spatial structure of the city that indicate the scattered growth and development of the city and imbalanced distribution of operations among the urban districts and this case indicates the disorder in the urban structure through disturbance in the central part and lack of movement and mobility in the districts of city.

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