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IDENTIFYING ACCESSIBILITY PROBLEMS IN DETERIORATED URBAN AREAS, A CASE STUDY OF TEHRAN, IRAN

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THEME: Urban Structure and Spatial Distribution

Abstract

Tehran is the capital city of Iran, occupying some 700 square kilometres in area and with a population of almost 12 million in the city and province. Throughout the urban development process over the last seven decades many self-generated neighbourhoods have developed in which the majority of the residents are low-income families. Since these neighbourhoods have many problems and incur considerable maintenance costs, the authorities refer to them as 'deteriorated urban areas'. The main characteristics of these low-income neighbourhoods are: vulnerability to earthquakes; low quality of access and thoroughfares; insufficient open space; lack of green spaces; high levels of corruption and crime; high density of residents; inadequate urban infrastructure and high levels of poverty, which are barriers to private sector participation because they offer a low economic interest. This research explores the concept of 'lack of accessibility' caused by the narrow (less than six meters wide) streets obstructing traffic flows. In this regard, the Tehran City Revitalization Organization has chosen the policy of widening the streets as well as developing more highways to facilitate vehicular movement, at the expense of pavements, street trees and pedestrian spaces. This paper discusses the theory that in order to enhance the accessibility and integration of deteriorated neighbourhoods into the wider urban fabric and life of Tehran, a more pedestrian-friendly street network should be developed as the core element of regeneration plans which consider the spatial configuration of these areas. In addition, the ranges of socio-economic benefits that could be delivered by this approach were also evaluated. The theory of 'Natural Movement' forms the basis of the research with the exploration of the spatial pattern being analyzed through the use of Space Syntax using Depthmap software and GIS. The outcome of the research shows that although the studied neighbourhood is close to the most integrated street of the city and it is easy to reach, it is not well connected to the surrounding areas making it difficult to move through the area and causing spatial isolation.

1. INTRODUCTION

Tehran, the capital of Iran, is located on the southern slopes of the Alborz Mountains. It had a population of 7.6 million people in 2002, which is still increasing. The area of Tehran municipality is some 700 square kilometres (Bertaud[1] 2003). Bertaud classified Tehran as a dense polycentric city with an average of 146 people per hectare in the built-up area, a high density by world standards (Bertaud 2003). The urban development of Tehran dramatically increased from the 1920s at the beginning of the modernization of Iran with a focus on street network development which cut across the original urban fabric and in many cases demolished traditional buildings and urban monuments in order to establish new highways through the city. This approach dramatically changed the spatial structure of the city (Ghafari & Coulabadi, 2006). Madanipour (1998) has shown the current spatial structure of the city to be based around several main axes, in which Engelab Street expanded from the west to the east and divides the city into two main parts, [Figure 1].

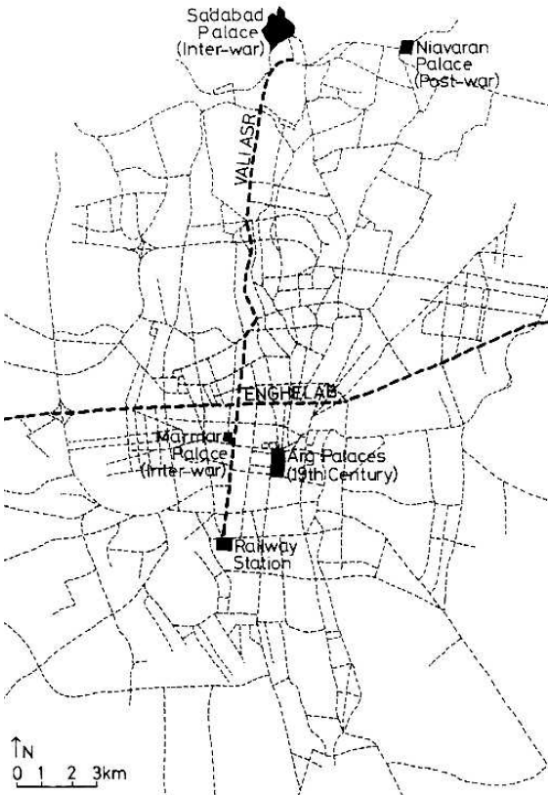

Figure 1: Two main axes in the spatial structure of the city; (Madanipour 1998)

Over the past three decades immigration to urban areas in Iran in general but especially to Tehran has increased considerably and led to accelerated urban development and the creation of large areas of spontaneous or squatter settlements around the urban fringe, mostly with no coherent layout, a dense building fabric, narrow streets and inadequate access into the adjoining neighbourhoods; most of these areas are officially referred to as 'deteriorated urban areas' (Azimi, 2004). These areas include neighbourhoods in which citizenship and human values have decreased and its residents do not feel safe,

[1] Alain Bertaud is an urban planner whose interest is in translating the theories and equations of urban economists into approaches and methods and spent some time at Tehran to make a report for the Ministry of Housing and Urban Development.

secure and are not satisfied in their living environment, and their basic civic needs are not fulfilled. These areas have a variety of problems such as social, environmental, spatial and economic issues that have been present in more than 40% of Tehran's population (Andalib, 2007d).

One of the basic problems of these deprived urban areas is their isolation as a result of poor street connectivity so that they do not function properly within the urban system, either economically or socially (Andalib, 2007c). In order to regenerate these areas the Tehran municipality relies on street network development not only to change the inner-structure of the deteriorated areas and integrate them to the surrounding urban fabric but also to create socio-economic stimulant zones and trigger socio-economic regeneration as well as easing the transport movement. However, none of their 'regeneration plans' was as effective as it was supposed to be due to lack of methodological and evidence-based approaches and relying merely on superficial traffic-orientated plans in street network development; an example of which is brought as followed.

1.1. The Traffic-Orientated Regeneration Approach: A Failed Method

There has been always a conflict between the modern urban development movement and the spontaneous traditional urban development in the cities in Iran since early modernization of the country. The first signs of modern urban planning could already be seen in the early 1920s when streets were first developed for vehicles (Andalib & Haji Ali Akbari, 2008). Since then the historical parts of the city as well as the old and in many cases the deprived neighbourhoods were obstacles for the 'modern urban planning'. In this regard, the first master plan for Tehran which was produced between 1967 and 1979 was the first official document to give priority to deprived areas. Since then many urban highways have been developed and many streets have been widened. However, the accompanying social or economic regeneration actions were few, dispersed, or focused on reconstructing poor quality housing along the main streets with large commercial blocks fronting the streets while poor housing remained behind them (Andalib, 2007a). In the first master plan, 2000 hectares were designated to be regenerated over the following 25 years, up to 1994, and 60000 people were encouraged to relocate to other parts of the city. However, the plan was not completed because of changes such as the Islamic Revolution of 1979 and the 8-year war between Iran and Iraq. Only one significant project has been set up since, based on developing Navvab Highway, rather than regenerating the urban areas themselves. Although this project is more about transport development and cannot be considered 'urban regeneration', it is the only important project of its kind. It was developed between 1999 and 2003, a highway being pushed through the middle of a deprived neighbourhood. However, since the project was car-orientated, just areas immediately along both sides of the highway were renewed and the rest of the area remained in a seriously deteriorating state (Andalib, 2007a). Figure 2 shows how the highway passes through the neighbourhood and leads to urban fragmentation, leaving the majority of the area in a deprived condition. This paper tries to contribute to the urban regeneration regime in Tehran by studying the spatial structure of the deprived areas and highlighting the accessibility problem of these areas which encourages socio-economic isolation in turn.

Figure 2: Navvab Highway, which passes through a deprived zone, was the focus of the TCRO[2] 1999-2003. Note the reconstructed high-rise blocks lining the road and the poorer areas behind them

1.2. The Research Objectives

The Tehran City Revitalization Organization (TCRO) aims to change the current traffic-orientated approach and to consider integrating the deprived areas into the urban fabric. However, one of the main obstacles in addressing this new idea is the narrative approach of the TCRO towards 'spatial isolation' and 'accessibility problem' and there is no rigorous evidence in the literature of the TCRO in regard to these issues. The aim of this research is to address the new approach and deliver rigorous evidences to the literature of the TCRO. In order to do so, theories and methods of applied research which are capable of achieving this are needed. One of the most effective set of theories and associated tools currently used for the purpose in a number of locations is Natural Movement Theory and Space Syntax which are applicable to investigate the relation between spatial configuration and movement (Hillier, Penn, Hanson, Grajews ki, & Xu, 1993).

2. NATURAL MOVEMENT THEORY AND ITS APPLICATION

Since the focus of this research is movement, accessibility, street network and urban form, the theory of natural movement is applied in this research. This theory believes that movement is fundamentally a morphological issue in urbanism. It is a functional product of the intrinsic nature of the grid, and not a specialised aspect of it. In fact, spatial configuration is potentially a predictor of both pedestrian and vehicular traffic flow in urban environments (Toker, Baran & Mull, 2005). Thus, in order to investigate movement and space use in general, the question of urban form itself needs to be considered (Hillier et al., 1993). According to natural movement theory therefore, in order to have sufficient and well-used urban spaces, the local properties of the space such as their form, size, and physical components are not as important as its configuration in relation to the wider urban system (Hillier et al., 1993). It suggests that the configuration of the urban spaces, e.g. streets, itself is the main generator of the movement patterns and not the local properties and attractions such as shops and offices. These attractions are then located to take advantage of the opportunities offered by the spatial configuration and the subsequent passing trade and such movement may then act as further multipliers. However, while it does not mean that the greater

[2] The Tehran City Revitalization Organization

proportion of movement is generated in all situations by the configuration it remains important to consider the spatial configuration as the primary generator without which we cannot understand the pattern of pedestrian movement or the distribution of attractors (Hillier et al., 1993). In terms of the probable effects of the three factors of attraction, configuration and movement on each other, this theory proposes that while configuration can affect both movement and attractions it cannot itself be affected by the other two [Figure 3].

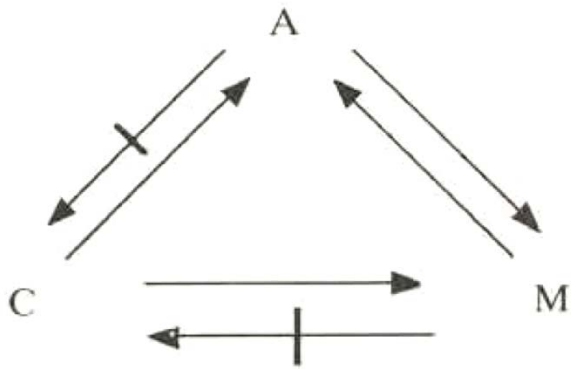

Figure 3: 'A' is attraction, 'C' is configuration, and 'M' is movement (Hillier et al., 1993).

2.1. Syntactic Measures[3] and Spatial Attributes

The result of applying space syntax for a city is several 'syntactic measures' some of which are the interest of this research. The most known measure in space syntax is 'integration'. It is related to the depth and mean depth in the graph for each node. It can be computed by calculating the mean depth of each node from all other nodes in the graph (Hillier et al., 1993). "Integration of a node is by definition expressed by a value that indicates the degree to which a node is integrated or segregated from a system as a whole (global integration), or from a partial system consisting of nodes a few steps away (local integration)" (Jiang, Claramunt & Klarqvist, 2000, p164). The most integrated lines are those from which all others are shallowest on average and the most segregated are those from which they are deepest (Hillier et al., 1993). In most cities, integration core maps will pick out the main streets and shopping areas, whereas the least integrated will tend to pick out areas with primarily residential functions (Hillier et al., 1993).

Intelligibility is another space syntax measure which is analysed in this paper. A city is intelligible if an unfamiliar person wandering randomly around the streets is more likely to be directed to or pass through the most integrated streets with a high measure of choice (Bafna, 2003); the measure which shows how often each street is visited on random journey simulations through topologically shortest paths in the system (Hillier et al., 1993). The integration and intelligibility of urban layouts are two significant factors which have implications for pedestrian movement (Ye & Josefsson, 1997). There is also a positive correlation between intelligibility and movement and as areas become less intelligible the relationship between spatial integration and movement weakens (Penn, 2001).

Syntactic measures highlight different spatial attributes which, as a result of numerous applications, work for most cities around the world. For example, the axial line map reveals that urban street networks usually consist of a very small number of long lines and a very large number of small lines (Hillier & Vaughan, 2007). similar research in different cities has also concluded that there is a positive correlation between pedestrian

[3] The measures produced in Depthmap

movement and global (city-wide) and local integration (Abubakar & Aina, 2006; Bafna, 2003; Hillier et al., 1993; Hillier & Vaughan, 2007; Penn & Turner, 2002; Toker, Baran, & Mull, 2005).

3. RESEARCH QUESTION

In order to address the aims of the research the spatial and functional characteristics of deprived neighbourhoods in Tehran was undertaken. This research assumes that the deprived urban areas in Tehran suffer from spatial isolation which in turn contributes to socio-economic isolation. In order to contribute to the literature of the TCRO this assumption needs to be supported through an evidence-based study and deliver rigorous evidences in regard to spatial isolation and accessibility problem of the Tehran deprived areas. The research question is therefore:

- *How is it possible to study the spatial structure of the city and identify the problems which encourage spatial isolation and discourage accessibility in the deprived areas in order to optimize the regeneration plan?*

4. MATERIALS AND THE METHODOLOGY

This research uses a case study from Tehran in order to investigate the notion of 'spatial isolation' in the deprived area and study its condition in the whole urban structure and develop a route filtering system for increasing its integration to the surrounding urban fabric using specific space syntax tools.

4.1. Selecting the Case Study Area

In order to select the case study area, the most recent Master Plan for the city of Tehran was used, provided by the Tehran GIS Centre, in which the locations of the deprived urban areas were identified (Figure 4). Among these candidate areas the study area, shown with black boundaries, was selected which was the only deprived area in the northern part of the city and so separated from other deprived areas and with a more identifiable character and boundary for study and comparison. All the deprived areas located at the southern part of the city are mostly surrounded by other deprived areas. Being surrounded by non-deprived areas creates an opportunity for urban regeneration which can make the best test of a morphological study in order to highlight its potential for regeneration. Moreover, the Tehran Grand Bazaar is located in the southern part of the city and this, because of its extent and because it forms a traffic-free island, has a great influence on the surrounding deprived areas and any research on the spatial character of such areas requires complex socio-economic and historical studies which are not relevant to this particular research. Additionally a non-deprived area nearby was also chosen for comparison. In this regard, the Tehran district 06, shown with a blue boundary in Figure 4, is chosen as the control area and the reason for this choice is that there is no specific border such as highway between district 07 and 06 and the whole area from the west part of district 06 to the east part of district 08 can be seen as one big urban area for further investigation.

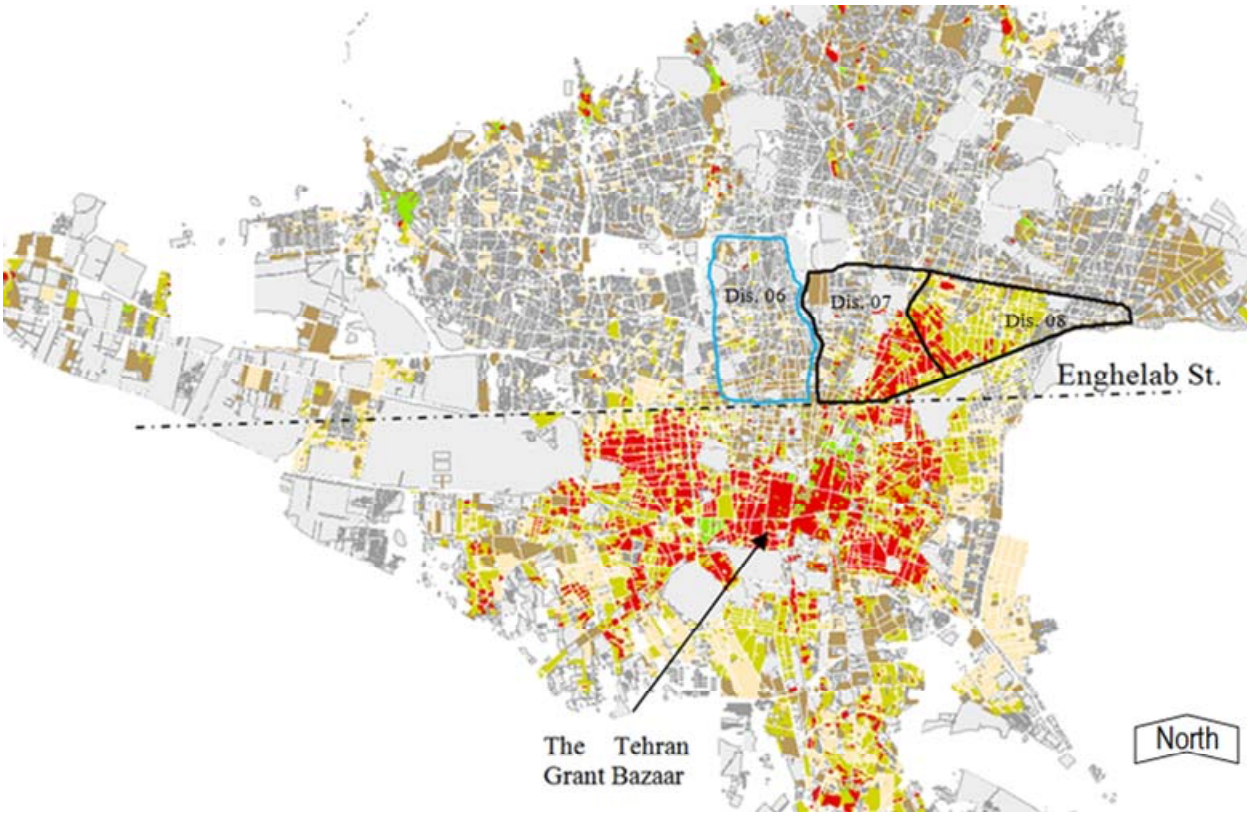

Figure 4: Tehran Deprived urban areas in the Tehran Master Plan, Tehran GIS Centre

4.2. Applying Space Syntax

In order to understand the Tehran urban structure an axial line map for the city was produced using Depthmap software (Turner, 2004). Since the map of the city is quite large and complex, the software was incapable of generating the axial map automatically; thus, the axial map was first produced manually in AutoCAD and then exported to the Depthmap software for further analysis. In the Depthmap several measures such as global and local integration were investigated. At the next stage, in order to have an in-depth statistical analysis, the Tehran commercial land use layer was extracted from the Tehran Master Plan using GIS and the distribution pattern of commercial blocks across the city were correlated with the distribution pattern of syntactic measures including local and global integration.

5. RESULTS

The distributions of global and local integration (R3) in the Tehran axial map are shown in Figure 5 to Figure 8. The location of the deprived areas is shown with a black continuous line; while, the location of the two case studies is shown with a blue dashed line. Figure 5 and Figure 7 show the axial line for the entire city; whereas, Figure 6 and Figure 8 show the axial lines in the two cases alone to enlarge the area and ease the understanding of its spatial structure. The most integrated street of the deprived area is shown with an arrow. Figure 5 shows the distribution of the global integration in the entire city with the most integrated street, Engelab Street, in the middle of the city. It shows that the city expands from the east to the west and then permeable into the neighbourhoods towards the north and the south of the city. It also shows that the residential areas in both the north and the south of the city are the most segregated areas. The maps also

show that in both local and global scale there is a tension in the pattern of distribution of integration. Figure 5 and Figure 6 show that the deteriorated areas in Tehran are located just at the edge of the most integrated streets and in many cases the main streets of the deteriorated areas are highly integrated. In this regard, Figure 7 and Figure 8 show that although the main streets in the deteriorated areas are highly integrated locally and globally, the level of integration decreases dramatically at the streets next to the most integrated ones and in some cases creates a mass of segregated streets.

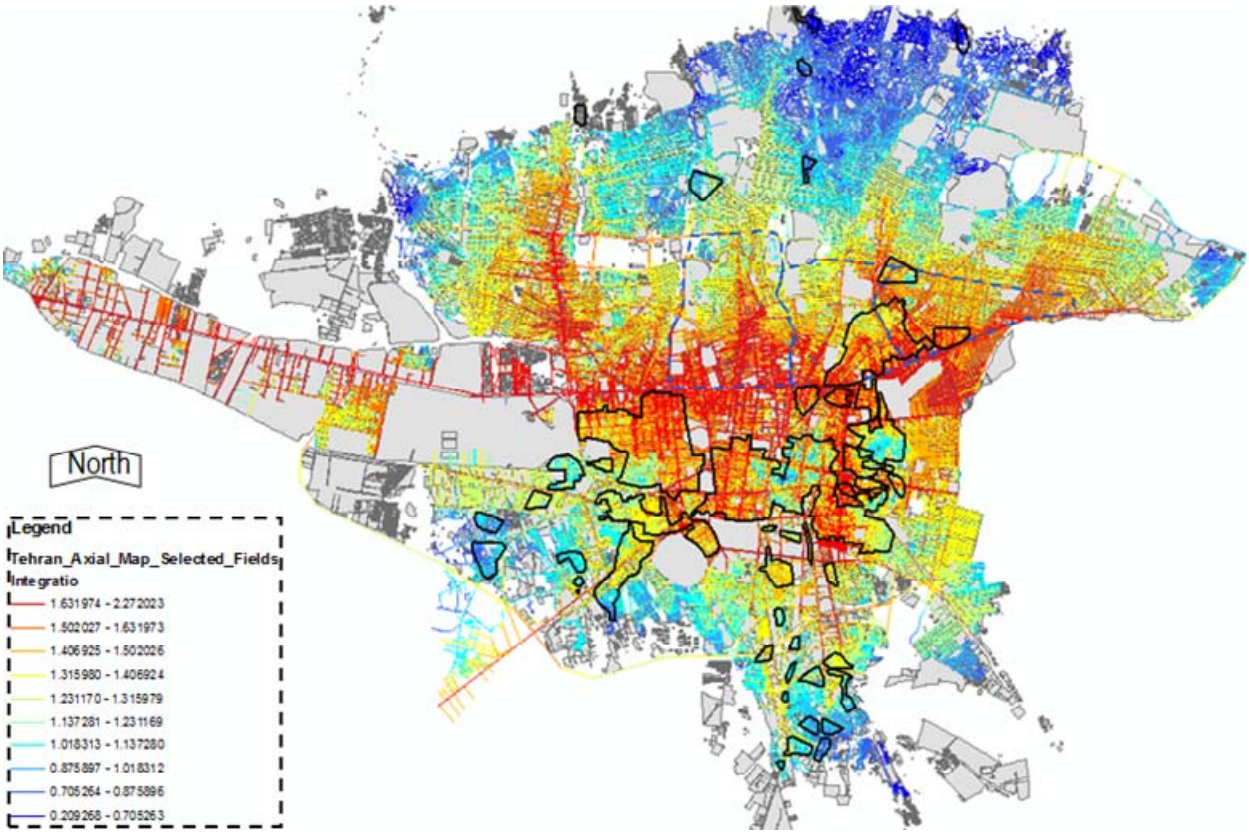

Figure 5: The distribution pattern of global integration in the Tehran axial-line map

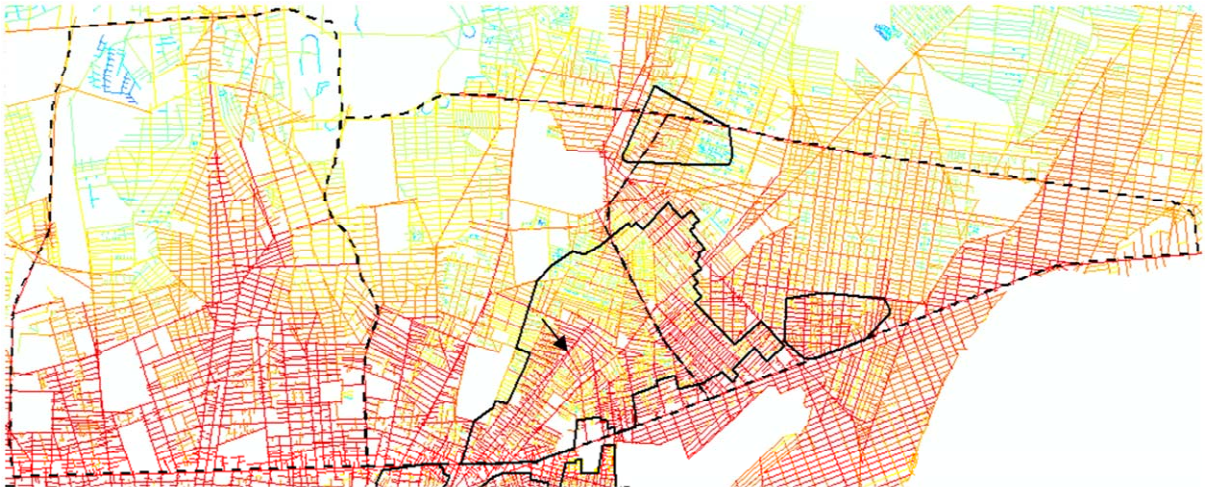

Figure 6: A bigger scale axial line map for the two case studies, global integration

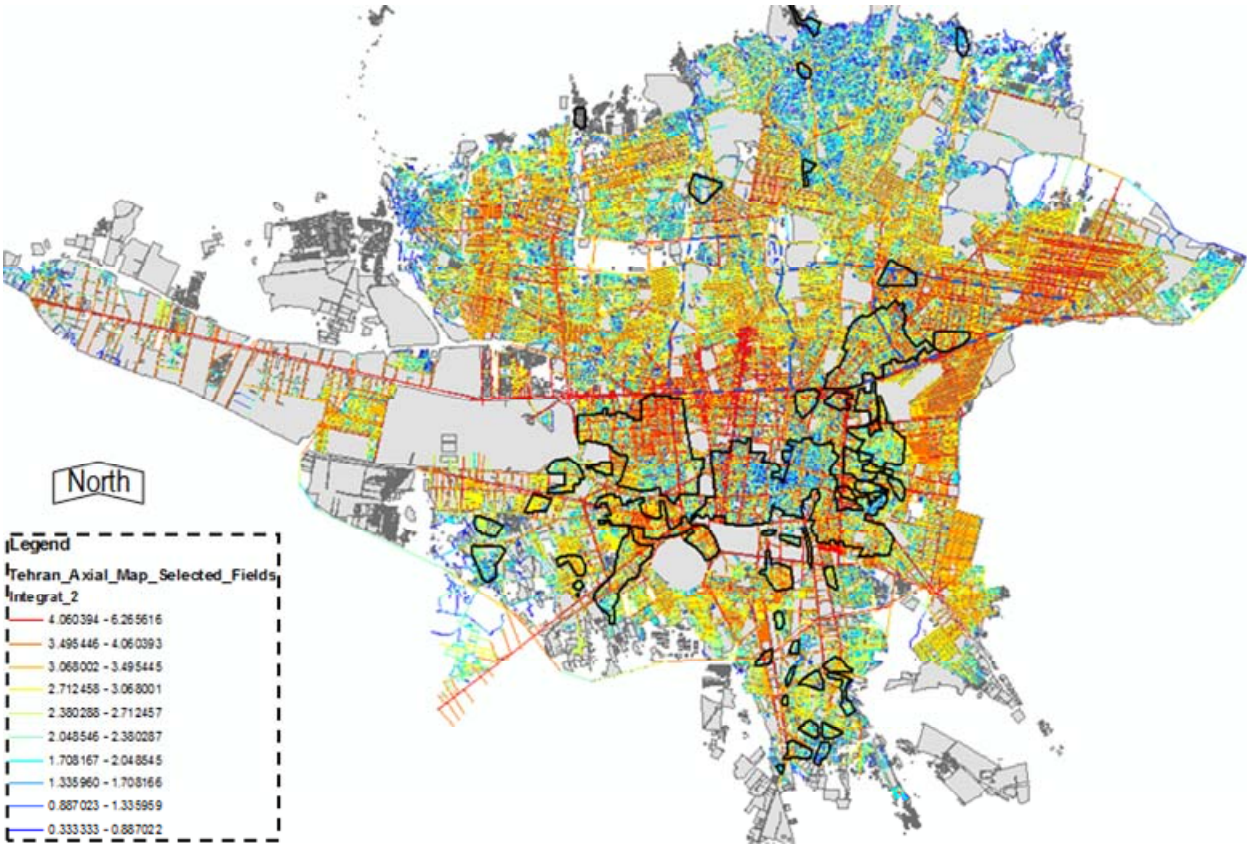

Figure 7: The distribution pattern of local integration in the Tehran axial-line map

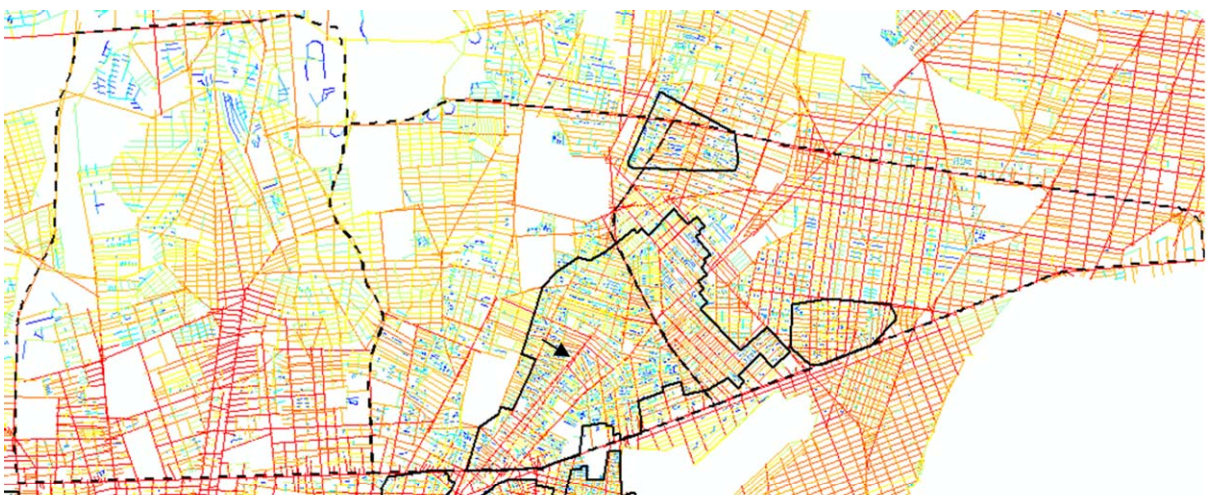

Figure 8: A bigger scale axial line map for the two case studies, local integration

The results of the correlation between integration and the amount of commercial land use[4] show that there is a significant positive correlation between local integration R3 and the amount of commercial land use (rs=0.498, N=1519, p<0.0005, two-tailed). It also shows that integration R7 is also significantly correlated with the amount of commercial land use; however, its correlation is lower than for local integration

[4] The amount of commercial land use is calculated based on the area of the retails adjacent to each line

(*rs*=0.393, *N*=1519, *p*<0.0005, two-tailed). Finally, it demonstrates that among different radii of integration, global integration is less correlated with the amount of commercial land use, although this correlation is still significant (*rs*=0.322, *N*=1519, *p*<0.0005, two-tailed) [Table 1].

Table 1: Correlations between integration and the amount of commercial land use

			Integration R3	Integration Rn	Integration R7
Spearman's rho	Sum Agreed	Correlation Coefficient	.498**	.322**	.393**
		Sig. (2-tailed)	.000	.000	.000
		N	1519	1519	1519

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

The results also show that there is a significant positive correlation between choice R3 and the amount of commercial land use (*rs*=0.376, *N*=1519, *p*<0.0005, two-tailed). It also shows that choice R7 is also significantly correlated with the amount of commercial land use; however, this is lower than choice R3 (*rs*=0.344, *N*=1519, *p*<0.0005, two-tailed). Finally, it demonstrates that choice Rn is also significantly correlated with the amount of commercial land use; however, this is the least in comparison to choice R3 and R7 (*rs*=0.181, *N*=1519, *p*<0.0005, two-tailed) [Table 2].

Table 2: Correlations between choice and the amount of commercial land use

			Choice Rn	Choice R3	Choice R7
Spearman's rho	Sum Agreed	Correlation Coefficient	.181**	.376**	.344**
		Sig. (2-tailed)	.000	.000	.000
		N	1519	1519	1519

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

The statistical results show that there is a positive correlation between integration and the amount of commercial land use (attractions) which based on the natural movement theory [Figure 3], could direct more pedestrian movement in return. It simply means that the more integrated a street is, the more commercial opportunities it can create and as a consequence the more pedestrian movement it can attract to the area. Thus, it is can be said that in the case of Tehran also integration can be considered as a predictor of movement and effective criteria in studying the notion of ‘accessibility’ and ‘spatial isolation’.

6. DISCUSSIONS

The first question raised by the results is whether the syntactic analysis is reliable for Tehran or not. In order to answer this question the result of the axial map and the syntactic measures will be compared with the literature to confirm the reliability of this approach.

6.1.1. Confirming the Results with the Literature

The first evidence in this regard is Hillier’s claim regarding the street networks consisting of small number of long lines and large number of small lines shown in the axial map (Hillier & Vaughan, 2007). As can be seen

in Figure 5, the Tehran axial map also consists of very small number of long lines and very large number of small lines. In fact, the length of almost 72% of the lines is below the average line length. Moreover the pattern of the spatial structure expansion of the city with Engelab Street in the middle of the city as the most integrated street is also mentioned by Madanipour (1998).

In terms of studying the urban structure in the context of this research, Hillier's idea regarding the city centre as including the most integrated routes located in or near the geographical centre of the city can also be seen in the Tehran axial map. However, the whole system does not look like a '*wheel'*, as he suggests, but is more homogeneous. The reason for this is the fact that the cities which Hillier examined are cities with a strong and dense CBD while; Tehran is a polycentric city with a low density CBD as Bertaud (2003) clarified in his report on Tehran spatial structure. In this regard some streets become '*movement-rich*' and some other become '*movement-poor*' and the activities and the land-uses which benefit from the movement are attracted to the 'movement-rich' streets and this in turn causes more movement, while the land-uses such as residential which do not benefit from the movement tend to be attracted to the 'movement-poor' streets. This process creates several centres across the city locally and globally and the whole city becomes a network of several linked centres at different scales, with residential areas forming the background or matrix (Hillier & Vaughan, 2007). For investigating this matter in Tehran the choice map (Rn) was extracted from the axial line, which shows the routes in different regions which may be used or visited more often in reaching the most integrated streets (Hillier & Vaughan, 2007), was overlapped with the Tehran Zoning Map extracted from the Tehran Master Plan. In this map the city centres are highlighted in red in addition to the activity axis (Figure 9). Also the streets which have a high choice value (Rn) are highlighted in gray lines. Figure 9 shows the overlap of the two maps and confirms that in the case of Tehran the activity axis, linking the city centres, follows the movement-rich streets with a high value of choice measure. In the case of Tehran, this verifies the result of the literature about the positive correlation between the choice measure and the pedestrian movement.

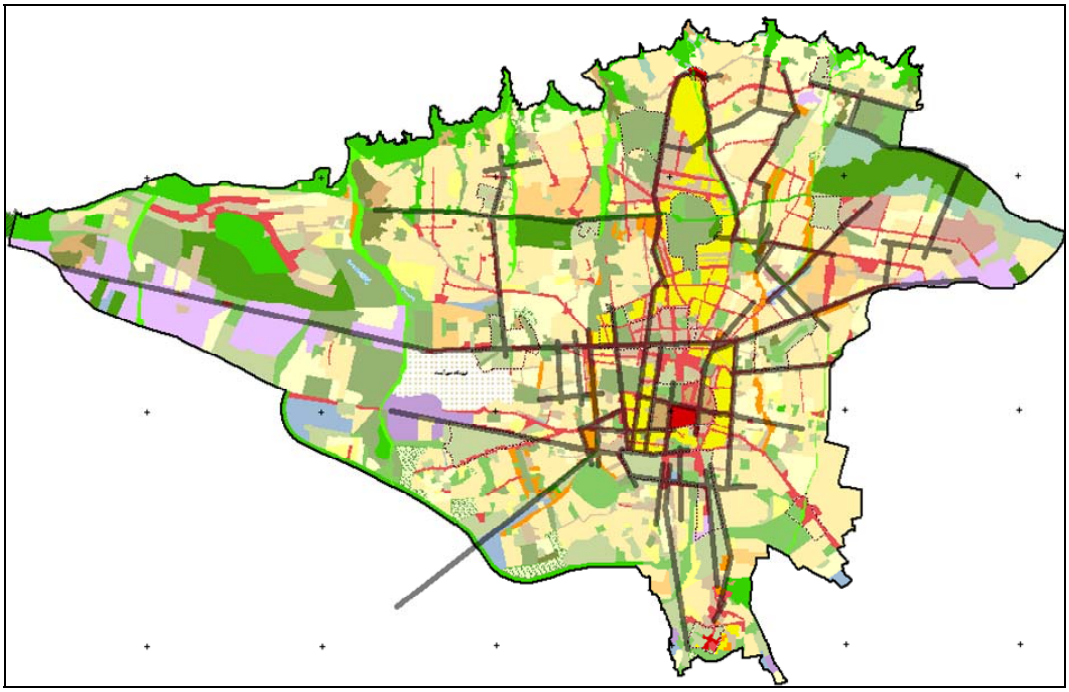

Figure 9: Overlaying the choice map Rn with Tehran City Centres in the Tehran Master Plan, zoning map

Regarding the location of the deteriorated urban areas in Tehran most of the areas are in or near the city centre and close to the most integrated streets of the city [Figure 4 and Figure 5]. In the case of this study it is interesting that the deteriorated area is just at the edge of the most integrated streets of the city and just north of Engelab Street. Figure 6 and Figure 8 show that while the most integrated street of the deteriorated area is connected to the most integrated street of the city, Engelab Street, the neighbourhood remain segregated (or not integrated as much as it could be) which causes social isolation. This creates the opportunity for the creation of a self-supporting immigration community which can survive economically due to its vicinity to the most integrated street of the city (Vaughan 2005).

6.1.2. Comparing the accessibility in the two cases of study

In the previous section the spatial structure of the neighbourhoods within the entire city was illustrated to show the importance of a holistic approach towards the regeneration plan. It also shows that although the literature highlighted 'accessibility' as one of the problems of the deteriorated neighbourhoods, the syntactic analysis of the spatial structure of the city shows that it is easy to reach the neighbourhoods, in terms of their proximity to the most integrated streets in the city. Here the spatial attribute of the deteriorated area will be compared with the control neighbourhood to investigate the accessibility within the areas and to study the permeability to the neighbourhood. In order to do that the axial line map of each case is extracted from the Tehran axial map and enlarged to be understood easier and will be analyzed separately [Figure 12, Figure 13 and Figure 14].

In terms of the spatial segregation or integration, the Tehran axial map shows that many neighbourhoods that are not classified as deteriorated in the Tehran Master Plan are also segregated however, as Vaughan (2005) mentioned, there is a difference between involuntary segregation, which happens in the deprived areas, and voluntary segregation, which usually happens in the wealthy neighbourhoods. In this regard the deteriorated neighbourhood and the control neighbourhood are compared to see whether Hillier's idea in terms of the spatial attributes of the deteriorated areas is applicable here or not. In this regard, a comparison between the axial line map of a deteriorated area and the axial line map of the non-deteriorated area shows the reduction of the axial line length in the deteriorated area and is accompanied by small size of urban blocks and more complex and disordered structure, a result which is supported by Hillier et al (2007) too. A numeric comparison between the axial line lengths in the two maps also shows that the average line length in the control neighbourhood is 339.823m while it is 230.849m in the deteriorated area which shows almost %33 reduction in average of the axial line length.

The degree of complexity of the inner structure of the neighbourhood is another factor mentioned by Hillier et al (2007) as applying to the deteriorated areas. Since there is usually an inverse correlation between the complexity of the structure and intelligibility, meaning the more complex the structure is the less intelligible the area is, the intelligibility measure is also investigated here. The results of this studying intelligibility of the areas show that the correlation between the local integration and the global integration in the control neighbourhood is R^2=0.672489, while the same result for the deteriorated area is R^2=0.607523, which shows a considerable reduction [Figure 10]. Also the correlation between the degree of connectivity and the global integration in the control neighbourhood is R^2=0.212339, while the same correlation for the deteriorated area is R^2=0.1863, which also shows a considerable reduction [Figure 11]. These results confirm that the control area of the research is more intelligible and the structure of the deprived area is more complex.

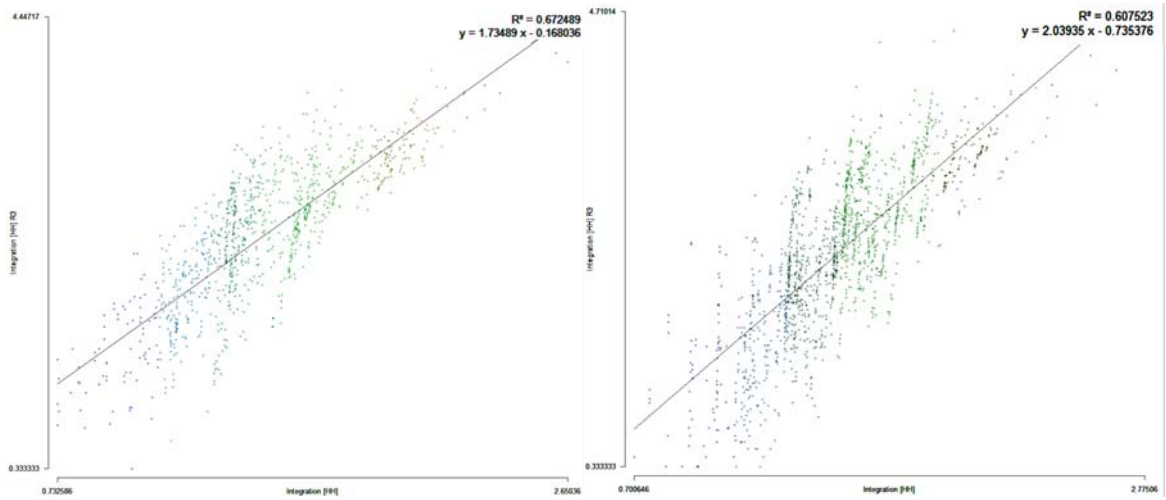

Figure 10: The correlation between the local integration and the global integration in the control (left) and deprived area (right)

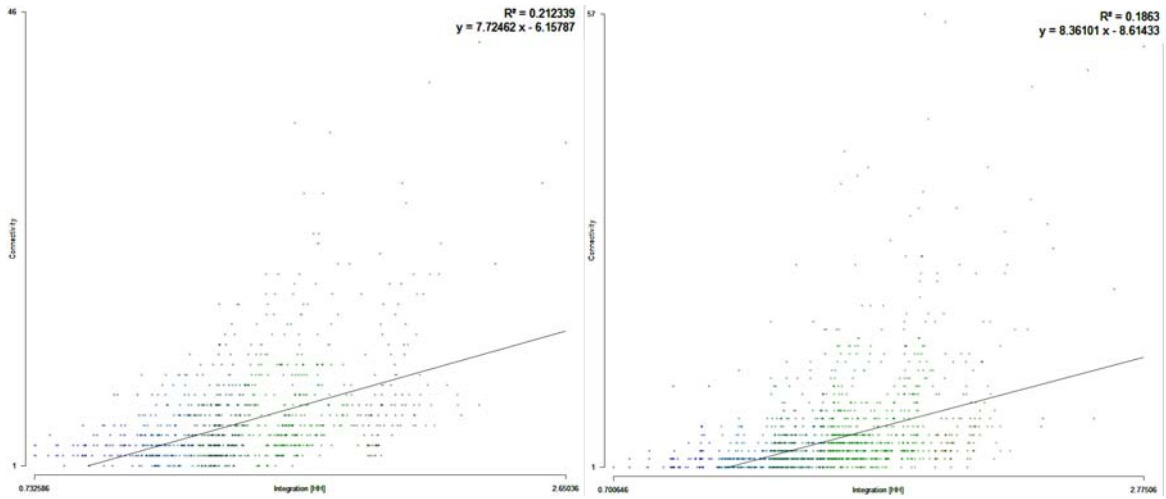

Figure 11: The correlation between connectivity and the global integration in the control (left) and deprived area (right)

Figure 12 shows the most accessible streets, both globally and locally, forming the framework and the main structure of the control neighbourhood. It shows that the three most integrated streets globally are also the most integrated locally covering the whole district from the north to the south. It also shows that there is a reasonable degree of connectivity between locally integrated streets, allowing the integration to be distributed homogeneously across the entire district and linking different neighbourhoods within the district. This condition provides opportunities for people to move from one neighbourhood to another easily and could also increase social interaction (Rismanchian, 2010).

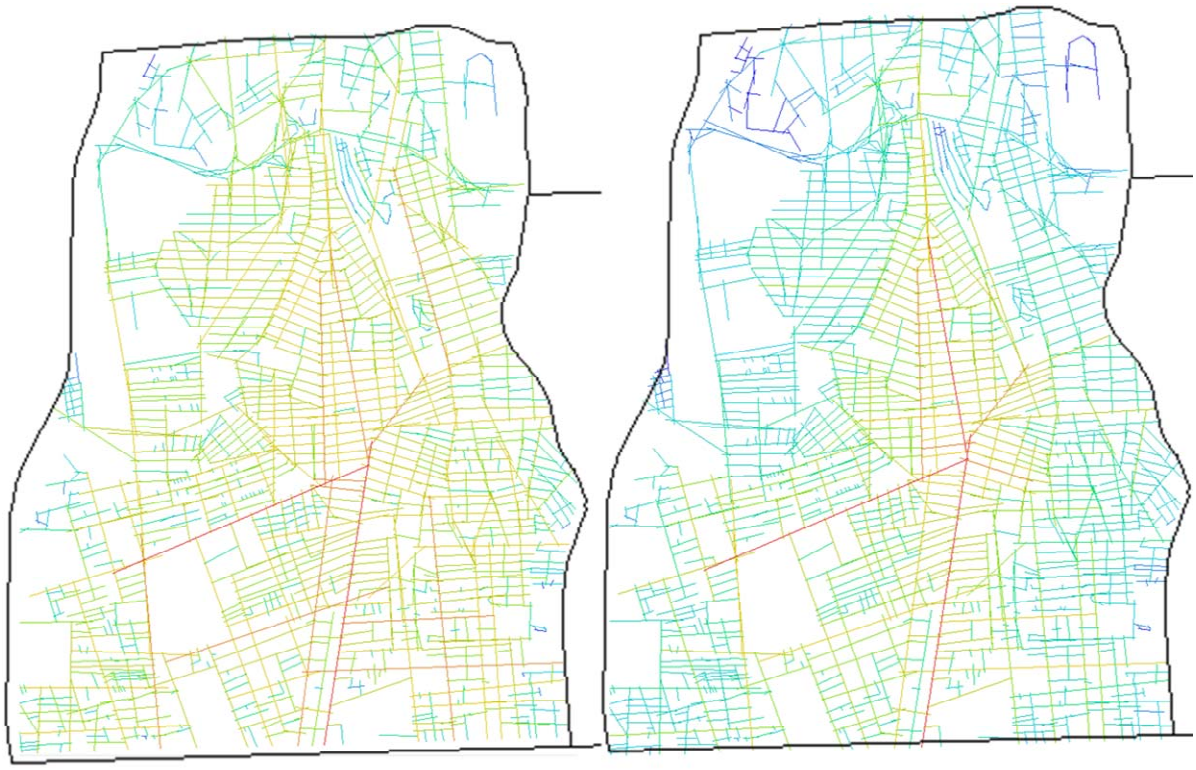

Figure 12: Left, Local Integration (R3) and Right, Global Integration for the control district 06

Figure 13 and Figure 14 show the global and local integration of the deteriorated neighbourhood as well as the most integrated street of the area with an arrow (the same street shown in Figure 6 and Figure 8). It shows that the streets which are most integrated locally do not necessarily also integrate globally. In fact the main street of the deteriorated area has a high value of integration not because it is well integrated with the surrounding street, but because of its connection to the most integrated street of the city.

It also shows that the most globally integrated streets do not cover the entire district. In fact there is no reasonable degree of connectivity between the locally integrated streets. Figure 14 shows that the most integrated street in the deteriorated neighbourhood is not connected to the rest of the integrated streets in the other neighbourhoods, thus causing fragmentation in the main spatial structure. Obviously, when the most integrated street of a neighbourhood becomes isolated, the whole neighbourhood suffers from spatial isolation and lack of accessibility. The interesting part is that as shown in Figure 6 and Figure 8 , the most integrated street of the deteriorated neighbourhood is directly connected to the most integrated street of the city but, because it is not well developed spatially, acts like a dead-end street which does not permit the integration to be distributed in the whole district properly [Figure 15].

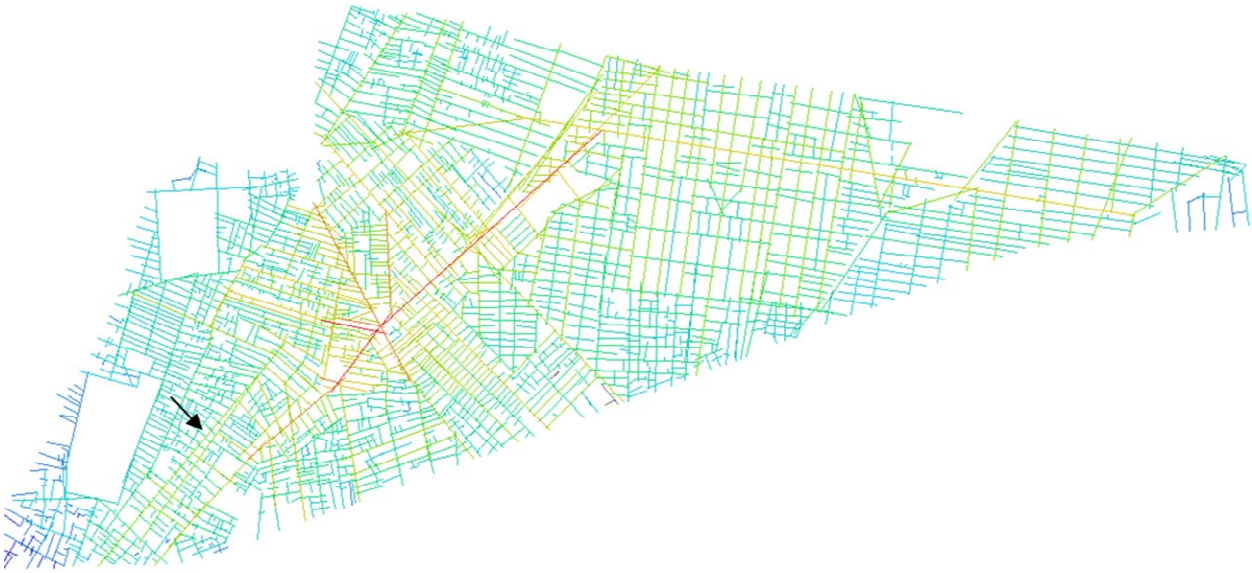

Figure 13: Global integration of the deteriorated neighbourhood in district 07, 08

Figure 14: Local integration (R3) of the deteriorated neighbourhood in district 07, 08

Additionally a comparative study on the distribution pattern of the choice measure at Figure 15 and Figure 16 show that while the most integrated streets in the control neighbourhood facilitate the permeability to the neighbourhood and almost cover the whole district, the most integrated street in the deteriorated area is not contributing in this regard effectiveley and causes a fragmentation in the main structure of the district. Considering that having a continuous framework of streets is one of the key points in encouraging pedestrian movement across an area, (Mansouri, 2008; Rogers, 2005), the fragmentation of the most accessible streets in the deprived area can be highlighted as the main spatial problem which discourages accessibility in the area.

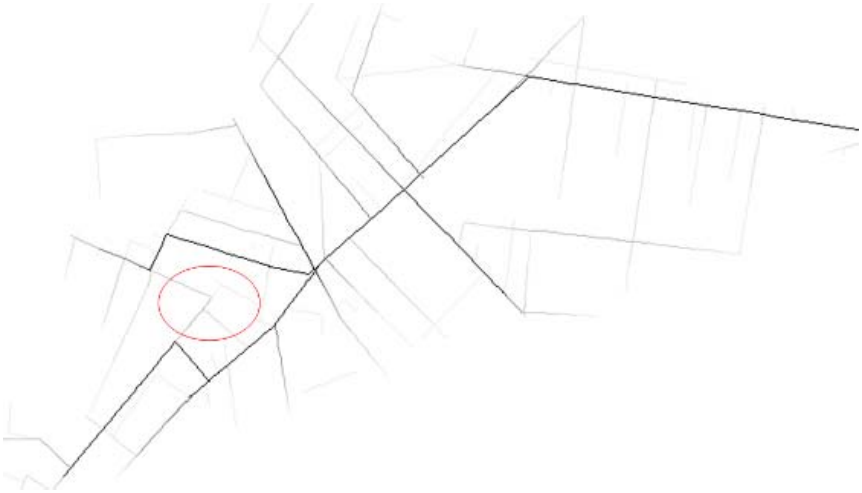

Figure 15: Topological choice measure (Rn) for the deteriorated area

Figure 16: Topological choice measure (Rn) for the control neighbourhood

The analysis highlight that the deprived areas in Tehran have accessibility problem which is the result of their inner structure and the spatial configuration of the street network in the neighbourhoods. It shows that in the case of this research any regeneration plan should focus on the most integrated street of the

neighbourhood and develop it in a way that could distribute the integration and accessibility over the whole area and make a connection with other integrated streets. Considering the literature and the results of the correlation between integration and the amount of commercial land use, the analysis suggests that the locally integrated streets in the neighbourhood have the potential to play the role of the neighbourhood centre and the socio-economic stimulant zones for regeneration plans. It also recommends that by making a reasonable connectivity between the most integrated streets and the potential neighbourhood centres, it would be possible to facilitate greater opportunities for people to move from one neighbourhood to another and so increase the social interaction possibilities.

7. CONCLUSION

This research hypothesized that the deteriorated urban areas in Tehran suffer from spatial isolation which contributes to socio-economic isolation. It also assumed that in order to release these areas from isolation, accessibility into the neighbourhoods should be enhanced while considering the current spatial structure. Additionally the street widening and highway development policy should be replaced with street network development considering the underlying spatial structure of the deprived areas.

In order to support the research hypothesis, natural movement theory and space syntax were applied to the selected area of Tehran. The main aim of producing these maps was to deliver rigorous evidences in regard to spatial structure of the city of Tehran and the condition of the deprived area in it. Afterwards, the produced maps were compared with the literature to verify that syntactic analysis is valid for studying and interpreting the spatial structure of Tehran. This research showed that by considering the deteriorated urban areas as a part of the entire city and studying them within the whole spatial structure, it would be possible to understand the pathology of the area more clearly. In this regard the outcome of the research confirmed that the deteriorated urban area, the case of this research, suffer from spatial segregation while surrounded with the most integrated streets of the city. It also confirmed that this area have a complex spatial structure and low intelligibility.

This research also investigated the accessibility to the deteriorated urban areas and showed that accessibility is more complex than could be solved merely by highway development or arterial road widening. In this regard, the research highlighted the inner structure of the deprived areas as the main spatial problem which should be the focus of the regeneration plans. It is also evidenced that while it is easy to reach the deteriorated area in Tehran, it is not easy to have access into it; and any regeneration plan should consider the permeability as the main problem. It is also shown that since the most integrated street of the deteriorated area is not well connected to the whole district, it makes the neighbourhood segregated and encourages social isolation. However, by connecting the integrated streets of the deprived area into the surrounding urban fabric it would be possible to increase the pedestrian movement and create more opportunities for socio-economic enhancement. By modifying government's approach towards street network development using such methods, it would be possible to create socio-economic stimulating zones and avoid urban gentrification in regeneration plans. It is also highlighted that any regeneration plan which does not consider the underlying spatial structure of the area in relation to the bigger urban fabric could cause more problem and urban fragmentation.

This research suggests that for enhancing the accessibility into the deteriorated area in Tehran, the neighbourhood centres and the most integrated streets of each neighbourhood should be developed based on the underlying spatial structure of the area, to form a well-connected structure and the main skeleton of

the district. Applying such an approach would allow the integration to be distributed homogenously in the whole area which could release the deteriorated area from spatial and socio-economic isolation. Considering the outcome of this research regarding the positive correlation between integration with pedestrian movement and commercial land uses (attractions) it can be assumed that a well-connected street network in the deprived areas can create more pedestrian movement and attract more commercial opportunities and trigger the socio-economic regeneration as a consequence.

This research showed that by having such a methodological approach not only it could be possible to manage street network development to facilitate accessibility and permeability to the neighbourhoods, but could also be possible to highlight the socio-economic potentials in the neighbourhood. Through this approach it is possible to identify the streets which have the potential to be developed as the neighbourhood centre and the main street of the neighbourhood, e.g. the most locally integrated street of the deteriorated area in this research. Having such an approach can help to optimize the regeneration plans.

REFERENCES

Abubakar, I., & Aina, Y. A. (2006). GIS and space syntax: An analysis of accessibility to urban green areas in doha district of dammam metropolitan area, saudi arabia. Paper presented at the *Conference Proceeding Map Middle East 2006,* http://www.gisdevelopment.net/proceedings/mapmiddleeast/2006/. 2009.

Andalib, A. (2007) Renovation notes for deteriorated urban areas volume 1. Renovation notes for deteriorated urban areas. First ed. Tehran, Tehran City Revitalization Organization.

Andalib, A. (2007) Renovation notes for deteriorated urban areas volume 2. Renovation notes for deteriorated urban areas. First ed. Tehran, Tehran City Revitalization Organization.

Andalib, A. (2007) Renovation notes for deteriorated urban areas volume 3. Renovation notes for deteriorated urban areas. First ed. Tehran, Tehran City Revitalization Organization.

Andalib, A. (2007) Renovation notes for deteriorated urban areas volume 4. Renovation notes for deteriorated urban areas. First ed. Tehran, Tehran City Revitalization Organization.

Andalib, A., & Haji Ali Akbari, K. (2008). *Nosazi-E bafthay-E farsoode ba mosharekat-E mardom [the renovation of deteriorated urban areas with the participation of the residents]*. Tehran: Tehran City Revitalization Organization.

Azimi, N. (2004). *Restructuring urban morphology in the context of globalising economy, a case study of rasht, iran.* Retrieved 1/17, 2009, from http://research.guilan.ac.ir/research/doc/c1208.pdf

Bafna, S. (2003). Space syntax: A brief introduction to its logic and analytical techniques. *Environment and Behavior, 35*, 17-29.

Bertaud, A. (2003). *Tehran spatial structure: Constraints and opportunities for future development* Ministry of Housing and Urban Development Islamic Republic of Iran.

Ghafari, A. M., & Coulabadi, F. (2006). Tehran-kalan shahr-E-bedoon-E arman [tehran, metropolitan without ideal]. *2nd Seminar of Construction in Capital,* Tehran.

Hillier, B., Penn, A., Hanson, J., Grajews ki, T., & Xu, J. (1993). Natural movement: Or, configuration and attraction in urban pedestrian movement. *Environment and Planning B: Planning and Design, 20*, 29-66.

Hillier, B., & Vaughan, L. (2007). The city as one thing. *Progress in Planning, 67*(3), 205-230.

Jiang, B., Claramunt, C. & Klarqvist, B. (2000) An Integration of space syntax into GIS for modelling urban spaces. International Journal of Applied Earth Observation and Geoinformation, vol. 2, no. 3-4, pp. 161-171.

Karimi, K., Amir, A., Shafiei, K., Raford, N., Abdul, E., Zhang, J., et al. (2007). Evidence-based spatial intervention for regeneration of informal settlements: The case of jeddah central unplanned areas. *Proceedings of the 6th International Space Syntax Symposium,* Istanbul. 1-14.

Madanipour, A. (1998). *Tehran: The making of a metropolis* (First ed.). England: Wiley.

Mansouri, A. (2008). *Spatial organization attributes.* Unpublished manuscript.

Penn, A. (2001). Space syntax and spatial cognition or, why the axial line? *3rd International Space Syntax Symposium Proceedings,* Atlanta. 11.1-11.17.

Penn, A., & Turner, A. (2002). Space syntax based agent simulation. *Proceedings of the 1st International Conference on Pedestrian and Evacuation Dynamics,* Duisburg.

Rismanchian, O. (2010). Barkhordi raveshmand dar modiriate harkate abere piade [A methodological approach towards the management of pedestrian movement]. *Manzar Monthly Periodical, 8*, 36-39.

Rogers, R. (2005). *Towards an urban renaissance: Final report of the urban task force chaired by lord rogers of riverside*. London: Office of the Deputy Prime Minister.

Toker, U., Baran, P. K., & Mull, M. (2005). Sub-urban evolution: A cross-temporal analysis of spatial configuraion in an american town (1989-2002). *5th International Space Syntax Symposium,* Delft. 1-7.

Turner, A. (2004). *Depthmap 4 A researcher's handbook*. London: Bartlett School of Graduate Studies, UCL.

Vaughan, L. (2005). The relationship between physical segregation and social marginalization in the urban environment. *World Architecture, 185*, 88-96.

Ye, M., & Josefsson, H. (1997). Urban redevelopment and city centre growth. *1st International Space Syntax Symposium,* London. *, 1* 07.1-07.14.