Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 165 (2016) 315 – 325

Procedia Engineering

www.elsevier.com/locate/procedia

15th International scientific conference "Underground Urbanisation as a Prerequisite for Sustainable Development"

Providing the needed green spaces together with splendid architecture through development of public underground spaces for city of Tehran

Mohammad Mahdi Safaee [a,*], Marjan Ghafoori [a]

[a]*Islamic Azad University (IAU), South Tehran Branch, Iran*

Abstract

City of Tehran which was once small city surrounded by gardens and farms; now a days has changed into a huge mass of high rise and unsuitable structures in comparison with other buildings and has almost lost its green identity. More than 200 years have passed since city of Tehran has been the capital city of Iran with the rapid growth of population and irregular growth of automobiles, and construction projects which have changed the feature of city. This made Tehran face a lot of shortages Such as green spaces, quiet and splendid atmosphere which might have established social relationship among people. This city is now seriously facing with shortages of green spaces which results in lack of enough oxygen, air pollution and decrease in quality of living and lack of city livelihood which the unfavorable result of them can be seen on the soul, mind and also the body of its citizen. In this article emphasizes are made on the social factors, technical and structural condition for development of underground spaces. This case suggest development of green spaces in one of the old and densely populated region of Tehran. Therefore not only do we maintain many public spaces needed for the district such as commercial spaces, service spaces like halls, cinemas, parking, sidewalks; we can also have free on the ground spaces for children playground, sidewalks, aerobic exercises, and many landscape also are formed. Following this, many residential spaces can be formed around these open spaces with eye pleasing views and landscape. Consequently this will cause more social relation, dynamic, sustainable city life and together with splendid architecture. Development of these centers in different distances of the city can decrease negative aspects which we have already referred.

Peer-review under responsibility of the scientific committee of the 15th International scientific conference "Underground Urbanisation as a Prerequisite for Sustainable Development

* Corresponding author. Tel.: +0098 21 88679365-7.
E-mail address: safaee@cectd.com

Peer-review under responsibility of the scientific committee of the 15th International scientific conference "Underground Urbanisation as a Prerequisite for Sustainable Development
doi:10.1016/j.proeng.2016.11.706

Keywords: underground space, delicate architecture, splendid architecture, green spaces, air pollution, Freeland, city of Tehran.

1. Introduction

Tehran's comprehensive plan lacks a number of very important components and details in its design and regulations. According to Tehran Municipality's construction rules and regulations the Floor Area Ratio (FAR) of residential buildings is required to be about 60 percent-70 percent and any extension to north is permitted only in case neighbors' rights are recognized and reserved. This regulation has led to the emergence of linear parallel eastern-western building masses in neighboring blocks which neither have created a beautiful landscape nor are capable of addressing the psychological needs of the citizens or safeguarding their privacy. Houses built on the southern edge of street or, otherwise stated, northern edge of a neighboring block, face the street and the yard of the neighboring block northward and southward, respectively.

In addition, due to unrestrained growth in migration to Tehran, increased demand for housing units and high price of land in the city, buildings' FAR has increased uncontrolledly and the city is faced with a lack of neighborhood centers in coadunate blocks. Only a limited number of blocks have neighborhood centers, squares or open spaces, which are required to address people's needs for having social interactions. This is while, urban squares are places that bring people mental relaxation, by providing them with spaces for communication and interaction, recreation and relaxation, taking a stroll, eating and enjoying the environment as well as creating a delectable and desired space and atmosphere. Although, in Iran, great attention and emphasis have been paid and put, respectively, to and on increasing the number of open spaces and parks for years, little effective effort has been made to this end. Such spaces are hardly found across Iranian cities. Despite all efforts, squares in Iranian cities have mostly turned into places for cars to ply back and forth. Among the main obstacles to creating such spaces are the high price of land in Tehran as well as the willingness to avoid changes in the fabric of the neighborhoods to prevent from displacement of their residents. Using underground public spaces will provide ample and favorable opportunities for restructuring urban fabrics and finding sufficient room on the ground to create open spaces. This will help create secure and climatic spaces for business and trade under the ground and open, serene, green and pedestrian-friendly places in neighborhood centers for the residents.

2. Tehran's History

Although two centuries have elapsed since the designation of Tehran as the capital of Iran, the history of the city's immediate development does not exceed 80 years. On the whole, the growth of the city began in the third decade of the 19th century, which was accompanied by unrestrained development, destruction of farmlands and pieces of land surrounding the city and suburban areas as well as rapid growth of villages and townships and their speedy amalgamation with the urban fabric. During the past few decades, the city experienced a speedy growth and underwent rapid changes. The table below features information provided by the Statistical Center of Iran about changes of Tehran city during the past few decades:

Table 1. Changes of Tehran city.

Tehran's population	In 1986 = 8,108,000	In 2011 = 12,183,400
Buildings constructed by private sector	In 1986=10,215	In 2012 = 46,918
Number of parks	In 2006 = 1,476	In 2011 = 1,989
The area of forests	In 1991 = 959 hectares	In 2012 = 900 hectares

3. Consequences of Tehran's rapid growth

To turn Tehran into a modern capital, the city's urban officials initiated a large number of changes and reforms in its structures. These restructuration and alterations were initially seemed contextually strange to many of the citizens, who lacked deep insight about it. Due to this conflict as well as the opposition between tradition and modernity, many of the city's structures either ran into problem or were not established properly. The fundamental changes implemented during the past years, to alter Tehran's appearance, have had diverse positive and negative consequences. Among the positive outcomes are the increased number of recreational and cultural places in the city, construction of modern facilities as well as highways and tunnels, development of universities and educational environments, expansion of industries and plants and generation of job opportunities. Accumulation of modern facilities in Tehran has led to the unrestrained migration of people from villages and other provinces to the city, which, per se, has resulted in a remarkable growth in its population and caused the valuable architecture used in the city's old buildings as well as the construction values to slide into oblivion. Among the negative consequences of this have been the increased number of visually unappealing buildings in Tehran with no strong and unique identity, destruction of the landscape, increased environmental pollution, disturbance of the ecologic balance, destruction of the trees and green spaces, increased number of deserted inefficient fabrics, growth in the number of people living in the city's marginal zones and suburban areas accompanied by an increase in urbanization, disturbance of people's privacy due to the high density of buildings in each neighborhood, reduction of the citizens' quality of life as well as their increased callousness towards where they live.

Despite all the facilities that Tehran's development has provided the people with, their uneven and unbalanced dispersion among the districts and unavailability in some areas as well as the metropolis' heavy traffic and high production costs, have left the citizens unable to use them sufficiently and properly. People have not established a deep connection with these facilities. In addition, in some districts, the facilities fail to cater to all clienteles' needs.

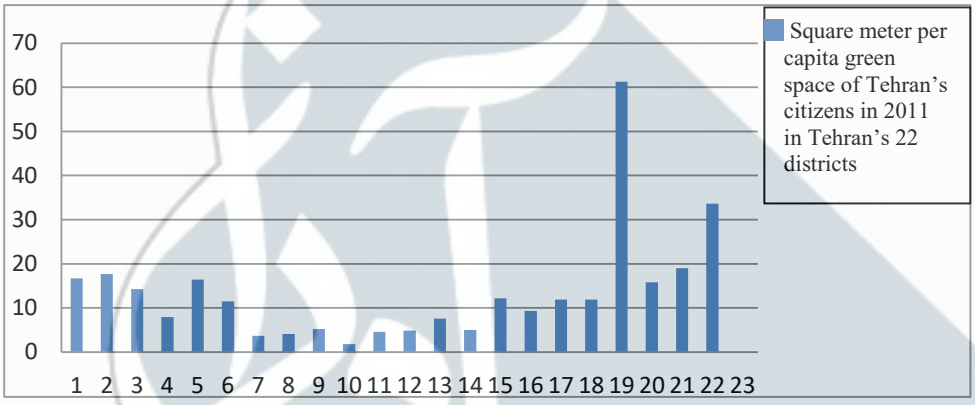
Among the other major problems Tehran city is currently faced with, is the anatomy and structure of its present buildings. The breaching of the regulations or failure of the laws to comprehensively address the requirements of urban life have presented the citizens with a host of psychological and social problems. The residents of the buildings in neighboring blocks, which according to the city's comprehensive plan, either face the street or the yards of the neighboring houses, have minimum joint space to establish connection with each other or often fail to see a desired landscape. In addition, open areas have been designed and constructed with minimum green spaces. In most of Tehran's districts, pedestrians have to walk along narrow pavements, with a width of one-two meters and irregularly recessed or protruded buildings along its route, which has created unsafe alcoves and blind spots. Even when they are safe, the inappropriate materials used in their construction make them practically unusable on rainy days. Unrestrained constructions have also caused Tehran city, which once used to be known as 'The City of Green trees', to suffer from a lack of green spaces.

Fig. 1. Tehran during 1785 to 1925.

Fig. 2. A pattern of the linear parallel building masses in Tehran.

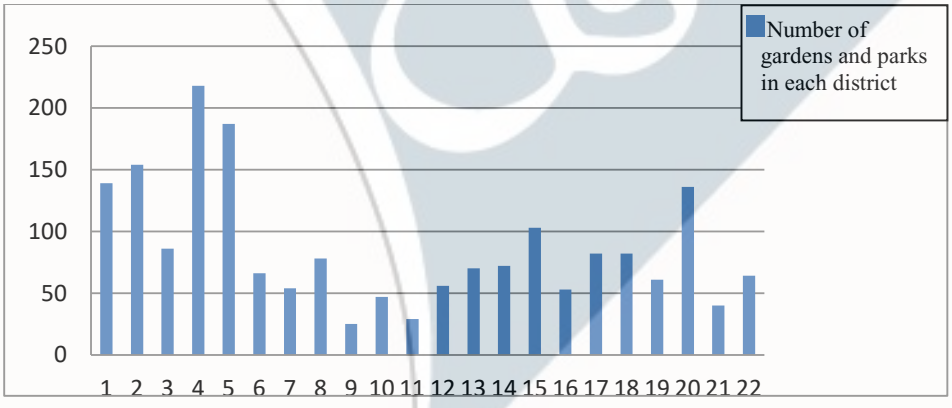
Tehran's 22 districts each has a different per capita green space. A study of the available statistics and information indicates a glaring difference between per capita green space in Tehran and the number of the parks in the districts of the city. Most of the districts suffer a lack of green spaces. A glance at Tehran's per capita green space in 2006 indicates that districts number 10 and seven with 2 meters and 3 meters, respectively, had the lowest per capita green space among the areas of the city. Nevertheless, a few years later, statistics pertaining to district No. 10, which is the main subject of the present study, showed that this area has faced a regression in this regard and, with 1.8 meter, has the lowest per capita green space in the city.

According to the statistical annals of Tehran, per capita green space of the districts of the city are as follows:



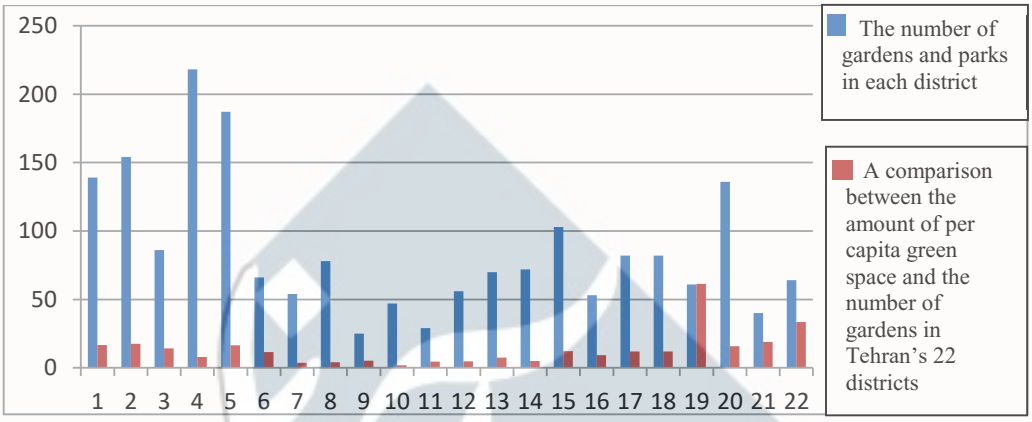
Graph. 1. Square meter per capita green space of Tehran's citizens in 2011 in Tehran's 22 districts.

A glance at the statistics pertaining to per capita green space of the districts in Tehran shows considerable difference between the dispersion of the mosaic network of green spaces in the city and urban standards. Tehran Municipality has done its best to turn the city's useless and deserted pieces of land into green spaces to increase gardens and parks. According to Tehran Municipality's figures and information, the number of gardens and parks in the districts of the city in 2011 were as follows:



Graph. 2. Number of gardens and parks in each district.

A comparison between the amount of per capita green space and the number of gardens in Tehran's 22 districts



Graph. 3. The joint graph for comparing the amount of each district's per capita green space with the number of gardens in that district.

A glance at the comparison between the amount of Tehran's per capita green space and the number of gardens in the city's 22 districts shows that not only has the 'proposed strategy' failed to be effective, but it has also caused numerous problems for the citizens living in areas adjacent to these dispersed parks and gardens.

4. Rapid growth problems

At present, Tehran has taken on a different appearance compared to the past. Tehran's public spaces are full of and severely impacted by automobiles due to the changes in citizens' lifestyle and unrestrainedly increased use of cars. The overly large number of vehicles and means of transportation in the city has led to traffic congestion, noise pollution, air pollution, obstructed view and lack of green landscape. The new design of Tehran's urban spaces has failed to lead to the creation of favorable open spaces and urban nodes. In most of the spaces, due to the disproportion between the created urban spaces and transportation system, disobedience to laws and rules, insufficient number of routes, heavy traffic and inadequate parking spaces, Tehran is faced with a situation in which spaces are used for functions and purposes which are not exclusive to them. The spaces allocated to pedestrians have turned into places for cars to ply back and forth and parking lots. This is while, any city requires spaces for social interactions among people and to create a sense of attachment and delectability, to increase its citizens' satisfaction and improve their quality of life. In fact, neighborhood centers, which are contexts and places for manifesting citizenship and civil life and providing people with the opportunity to rest, communicate with each other and relax, are seldom found across Tehran. Despite this, the overwhelming number of cars, the city's poor traffic culture which has led to a reduction in cars' speed as well as a number of problems arising from these, have caused Tehran to practically turn into a parking. The ascendancy of cars over humans as well as different types of pollutions caused due to their excessive use have made it more essential to separate the places in which cars ply from residential spaces as much as possible. At present, addressing people's needs to improve their quality of life is among the most important responsibilities of urban management. This is while, modern life, the increase in urbanization, large-scale migration and population growth have turned cities into centers for diverse activities. Accumulation and concentration of facilities and services in metropolises have led to an increase in migrations to these places and the high density of the buildings constructed in them. Due to Tehran's congestion, density and pressure, the city's green spaces are increasingly being destroyed on a daily basis. The situation has exacerbated due to brokers' greed, the city's urban bottlenecks and a failure to fully enact laws and regulations guaranteeing protection from and expansion of green spaces. This is while, high-density neighborhoods need to have open green spaces inside them to turn into suitable places for social interaction, provide their residents with green landscape and, in general, as a green, fresh and natural lung, be able to save people from diverse psychological problems stemming from environmental pollutions. But, the population growth and, thus, the need to provide shelter for the increased number of people in Tehran, have greatly pushed up the price of land and houses in the city and heightened the need for green spaces. High prices and cumbersome ownership rules have posed various problems for those who seek to own a land to

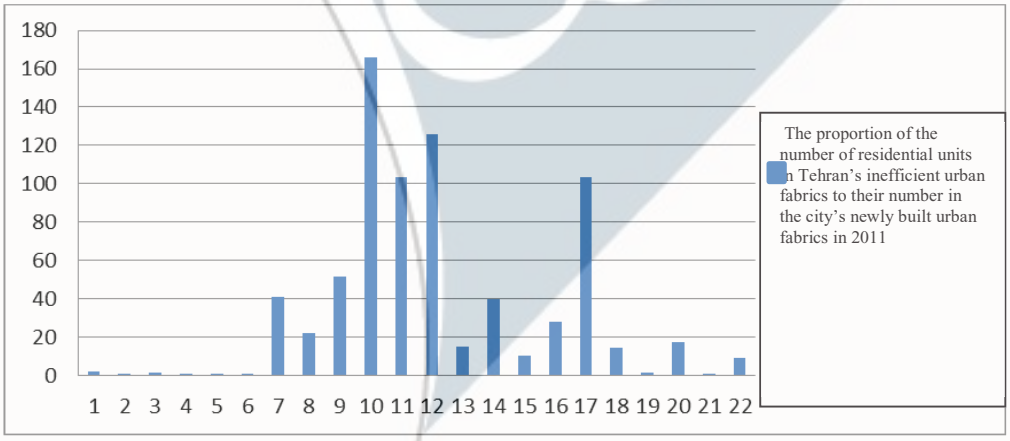
carry out renovation operations or implement development projects. The question is how to deal with these problems?

5. Tehran's inefficient fabric

Most of Tehran's districts have undergone numerous changes due to the problems brought by unorganized efforts to develop the city as well as disobedience to urban development laws and regulations. Failure to address human nature and needs and the culture of the context in which development projects are implemented, as well as paying little attention to building a sustainable city have also played a role in causing the alterations in Tehran. Using low-quality construction materials in some districts has caused the fabric and anatomy of those areas to become inefficient, brought their economic value down and damaged their function. In some districts buildings have been deserted due to their inefficiency. This is because these buildings fail to include sustainability elements. The present architecture of Tehran and its houses fails to address problems such as air pollution, mandatory migration of the buildings' residents, deformation of the buildings and increased congestion of the streets and neighborhoods. At present, the buildings of the city do not fulfil certain needs of their residents. People are faced with a shortage of spaces for living; because most of the buildings do not provide them with the level of life and living standards they deserve. They need to have sufficient and comfortable places for sleeping as well as receiving and serving their guests and would like to have private and mysterious spaces as well as more public ones, privacy, satisfaction, a sense of delectability and self-esteem in their houses.

In addition to, making the city's landscape look unorganized, imbalanced, inharmonious and disfigured, the increase in the number of Tehran's inefficient fabrics has caused collective memories to fade away and reduced the quality of social interactions and urban life. Buildings constructed in Tehran in the past few decades, particularly at the time of the Islamic revolution of 1979 and during the eight years of Iraqi imposed war (1980-88), often have failed to have a high value and considerable significance. In some districts, they have damaged the appearance of the neighborhood, due to the gradual deterioration of their fabric, and reduced the efficiency and favorability of the area. Inefficient fabrics are a kind of disease that have been developed due to the failure to pursue and implement a comprehensive plan and negative impacts of certain unfavorable anatomical, functional, environmental, social, economic and cultural factors. According to Tehran Municipality's statistics and information, districts 10, 11 and 12 has the highest proportion of inefficient residential fabrics to newly built fabrics among the other areas of the city. The graph presented below features this proportion in each district separately.

The proportion of the number of residential units in Tehran's inefficient urban fabrics to their number in the city's newly built fabrics in 2011



Graph. 4. The proportion of the number of residential units in Tehran's inefficient urban fabrics to their number in the city's newly built urban fabrics in 2011.

Tehran's inefficient fabrics possess hidden capacities and potentials which can be used to accelerate the development of the city. This is while, they have often failed to receive sufficient attention. Nevertheless, by developing suitable plans for exploiting the potentials of each fabric, the impact of renovation or reconstruction in reviving, restructuring or improving the quality of public and collective spaces can be witnessed.

Table 2. This is the caption for this Table in font 9pt. The caption must be centered.

Year	Height of Dam (m)	Width at Base (m)
1200	10	50
1350	15	70
1625	17	90
1865	25	119
2006	39	115

The table captions must be in 9pt Times New Roman. If tables need to extend over to a second page or column, the continuation of the table should be preceded by a caption, e.g. "Table 1 (Continued)". The text inside tables should be in 9pt. Whereas every effort should be made to place tables within a single column, larger sized tables may span across both columns by inserting suitable section breaks. In all events, tables must be anchored to move with the text.

6. Needs of Jeihoon

For questions on writing the paper and submitting papers, please consult this guideline first. If your question is not answered, kindly contact the Secretariat at A brief study of Jeihoon, a neighborhood in Tehran, and comparing it to its adjacent vicinities, indicate that economic problems have led to a reduction in the number and quality of green spaces in this area. The number of buildings in this area has witnessed a rapid increase due to its population density and low-priced lands. In some areas of the neighborhood, buildings and houses have been constructed even in smallest pieces of lands. This has ruined the city's old fabric and left no public spaces for the citizens. This neighborhood is faced with a lack of open, green and public spaces due to the unrestrained construction of buildings in it. Even efforts by Tehran's municipality to turn the small pieces of land it has purchased from the residents of the neighborhood as well as the area's inefficient fabrics into green spaces and parks have proved futile and failed to solve any problem. The small parks built by Tehran Municipality in this area have turned into a habitation for addicts and criminals and, thus, caused greater insecurity.

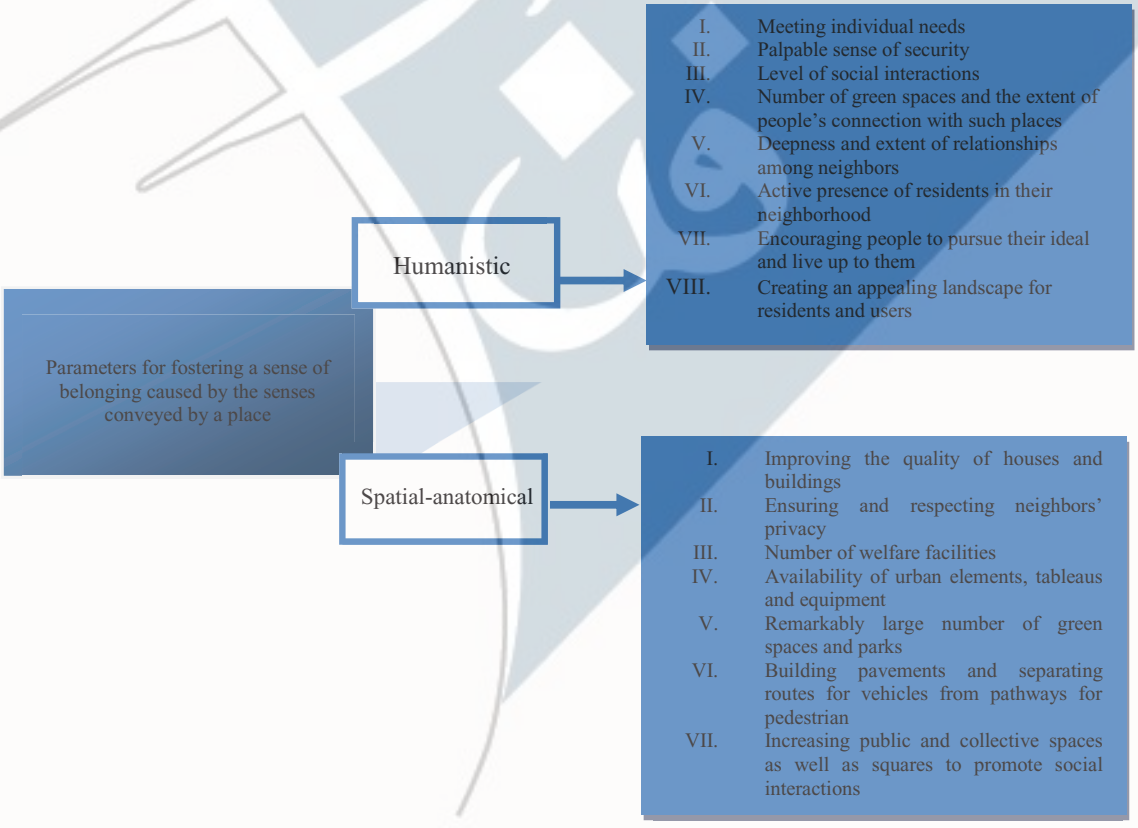
Among other problems the neighborhood is currently faced with are its inefficient fabric, small number of places with urban uses for its residents (such as gardens and open green spaces, network of pathways providing easier access to different places for residents and cultural spaces), low per capita residential use (11 square meters on average), lack of service spaces in residential areas, inequitable distribution of certain urban services (such as health and treatment services) across the district, lack of pools, fountains and Howzes (a centrally positioned symmetrical axis pool) and failure to equip pathways and main transportation and traffic networks with urban furniture and necessities. This is while, the problems and difficulties existing in the neighborhoods of this district are quite evident and palpable. To improve the quality of the anatomical and spatial aspects of the district, it is of utmost importance to pay attention to issues such as changing the cultural structure of the households, tackling environmental problems, increasing the number of open spaces, preventing the destruction of green spaces, controlling the high level of pollutions, improving the indices of the quality of life, upgrading the services and equipment and raising the quality of the houses as well as transportation and communication networks — such as pathways.

Currently, demand for building parks and creating green spaces has increased following the recognition of the citizenship rights, identification of the citizens' needs and renewed demand for greater and improved welfare. The larger number of green spaces and parks will help people raise the level of their social interactions and experience a greater sense of belonging to where they live. Given the abovementioned facts, Jeihoon is faced with a shortage of green spaces. This is while, the number of green spaces is among the main criteria for evaluating the quality of an

urban environment. These spaces provide citizens with the opportunity to interact with each other and experience nature. To identify Jeihoon's problems and assess their severity, copies of a questionnaire were randomly distributed among 100 residents of the neighborhood, the answers to which were measured on Likert Scale. The results of the study suggested that the level of social interaction between the residents of the neighborhood is quite low, the area suffers from a lack separate routes for pedestrians and vehicles as well as pavements and security facilities — such as traffic signs and tableaus, sufficient lighting in the streets and pathways for pedestrians and paralyzed people — which is quite dangerous for children, the level of the district's public security is relatively low and the residents have lost their trust in one another, are reluctant to cooperate with each other and show indifference towards their neighborhood. The outcomes also indicated that Jeihoon citizens highly demand a greater number of green spaces in their area as well as the improvement of their environment and facilities and vote for stricter separation between spaces used by pedestrians and vehicles and the transfer of certain urban spaces with non-residential uses to underground places. The study revealed that most of the subjects were quite willing to continue living in the area in case its appearance improves.

In view of the abovementioned facts and information, Jeihoon is encountered with a lack of green spaces. This is while one of the main gauges for assessing the quality of an urban area is the number of its green spaces. These places provide citizens with the opportunity to interact with one another and enjoy the nature. These two outcomes of the functions of green spaces cause an increase in the social activities and willingness of the residents to improve their living condition. Having a greater sense of belonging is among the main factors in increasing social interactions and helping citizens better define and perceive their living environment and assume a larger number of civil and social responsibilities towards where they live. The parameters for fostering a sense of belonging are categorized as follows:

Table 3. Categorizing parameters for fostering a sense of belonging.



Increasing the number of open places will lead to the greater vivacity of the society by encouraging citizens to walk and live a collective life. To foster friendly relations among citizens in modern societies, they can be encouraged to go to such places by adopting effective strategies. That is when, a neighborhood will witness the increased presence of its people in public places and their greater vivacity and will be able to convey a sense of delectability. That is when, people will begin to see their neighborhood and be seen more often in its open and public spaces.

Since civil and urban life is formed and defined in urban spaces, these places are required to be built on the basis of people's participation, rational thinking, collective behaviors and human values. Only when created with the participation of all of its residents, a neighborhood will be a suitable place for social interactions and will have positive impacts on the human and interpersonal relations developing inside its territory.

At present, great attention is being paid to urban development, sustainability, multifunctionality and beauty. Using underground spaces is a possible solution to improve Tehran's present distorted appearance. In the past, such places were creatively used for acclimatization or other purposes in architecture and urban development. However, at present, they are hardly used for other purposes in metropolises. Currently, they are merely used as subway and networks for urban transportation. This is while, designing and constructing underground places will lead to the revival of a large number of neighborhoods. For instance by constructing underground places near the subway station in Marunouchi district in Tokyo, urban officials have made ample room on the ground for communications and constructing urban facilities; in addition to highlighting and emphasizing the district's urban landscape and helping it become symbolic. Another example of such places is Manzanares River's M-30 project in Madrid which has helped clean the river, build parks, create green spaces and provide people with a calm and favorable environment by separating pedestrians' pathways from routes for vehicles and transferring urban services to underground spaces. Nevertheless, the participation of people and private sector in the implementation of such projects plays a fundamental and instrumental role. To guarantee people's maximum participation in a project, urban officials are required to develop a suitable plan and prepare the ground for public involvement and cooperation in the undertakings. This will guarantee the delectability of a place.

7. Conclusion

The author of the present study intends to, in the framework of a proposed plan, deconstruct and, then, reconstruct an urban block, with an area of about 5,000 square meters, in part 3 of Tehran's district No. 10 which has the lowest per capita green space among other areas of the city. The reconstruction project incorporates building units and facilities with temporary uses, such as parking spaces, commercial units, conference halls, movie theaters and warehouses, on underground floors as well as housing units on the floors above the ground. The first few above-the-ground floors of the residential buildings encircling the block and facing the street, will be the same height as nearby buildings to maintain the harmony of the landscape. The units on higher floors will maintain a distance from the edge of the unit on the floor below them, which will serve as their terrace. In fact the area used as the terrace of the units on higher floors will be a part of the roof the unit built on the floor below them. Green spaces will be created on these terraces. Therefore, higher floors will not be visible from the street. A green landscape will be created inside the block which will not only serve as a place for neighbors' gatherings and social interactions, but will also compensate for the neighborhood's lack of green spaces. In this project, green spaces will also be created on -1 floors, the lighting for which will be provided by creating voids on ground floors. These green spaces will be extended to the buildings' terraces, facades and roofs as well. The whole architecture of the block seeks to convey a sense of delectability to its residents as well as those of the nearby houses.

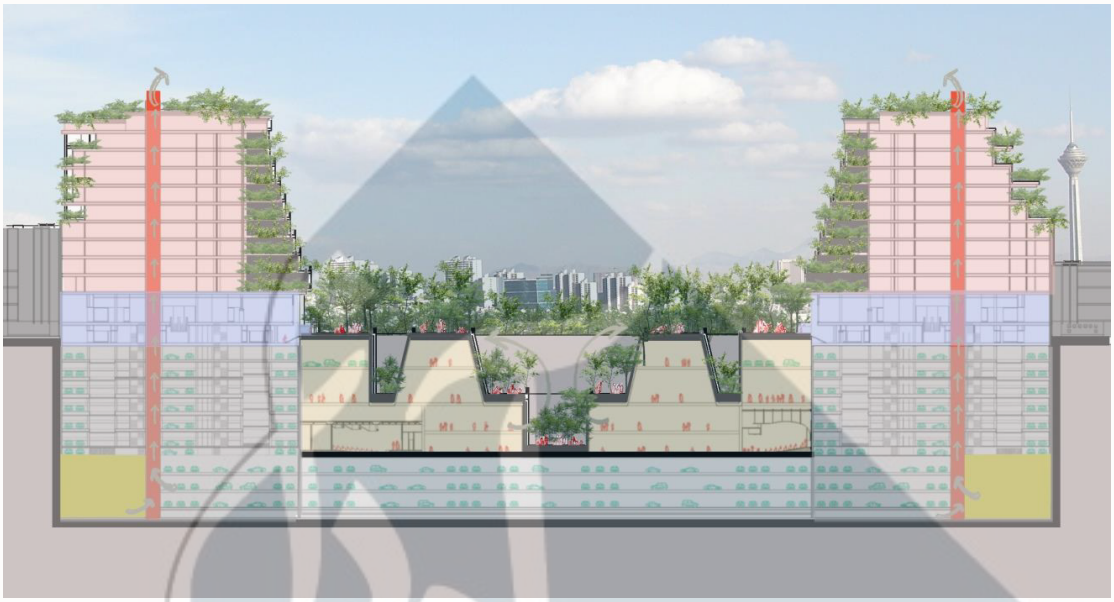


Fig. 3. A schematic section of the proposed project. (Drawn and designed by the authors of the present study).

References

[1] M.M. Safaee, Shavadan, the Sustainable Architecture in the City of Dezful in Iran, Proceedings of 12TH International Conference of The Associated Research Centers For Urban Underground Space(ACUUS2009), Shenzen, 2009, pp. 96-102

[2] K. Zayyari, L. Vahedian Beiky, Z. Parnoon, The Study of Environmental Crisis and Local Distribution of Green Space in Tehran City, Urban - Regional Studies and Research Journal. 14 (2012) 25-28.

[3] M. Okuni, The Sustainable Urban Design and Underground Networks in Tokyo, Madrid and Bilbao, Proceedings of 12TH International Conference of The Associated Research Centers For Urban Underground Space(ACUUS2009), Shenzen, 2009, 83-89.