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Article

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Determining the Optimal Use of Urban Underground Space (Selected Streets of Isfahan City)

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Abstract: The use of underground spaces can lead to increased land productivity in cities. This paper addresses the issue of which of the four commercial, warehouse, public parking and passageways (two-floor streets) are optimal if we want to use the spaces below the streets of the city. Therefore, the selected 21 main street of districts 5 and 6 of Isfahan were selected as problem options. Using 2013 data and linear programming method, the objective function was designed for optimal user allocation. In the following, based on the two-stage hierarchical analysis method in the GIS software environment, the optimization problem was investigated. In order to investigate in the first stage, the type of use was selected as the main criteria of the problem including parking, warehouse, business center and passage use, and then, for the second step, the sub-criteria of landing price, traffic flow, area of green space and surface were selected. The results from the first phase survey showed which street is more important for which user. In addition, the results from the second phase survey showed which sub-criteria are more relevant in choosing a type of land use. Based on this, it is possible to decide which street is needed and what the priority of which street is to use for underground space. For the use of parking and passage, Shahid Hemmat Highway has the highest score and HezarJarib Street account for the commercial use and warehouse with the highest score.

Keywords: optimal use, urban space, underground, two-stage hierarchy, city of Isfahan
JEL Classification: C61, N55, R12, E29

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1- Introduction

The growth of the population of large cities is inevitable. Today, more than 50 percent of the world's population is concentrated in large cities and metropolitan areas (O'Sullivan & Sheffrin, 2008). Hence, it is important to provide adequate living conditions for the urban population, because the growth of cities depends on the survival of the inhabitants of the city and the economic activities related to them. Land is the main input for urban development. Land characteristics such as supply constraints, non-portability, durability and limited succession differentiate it from other inputs. Today, most governments have concluded that if the urban land market is to be abandoned, it cannot lead to an effective allocation of land use. In the meantime, the need for more space in metropolitan areas is a global phenomenon (Pourmohammadi & Khalilnejad, 2002).

Today, growth of urbanization has created four main problems for cities: 1. The rise in land prices: the development of property, real estate, is creating large cash flows in the city and causing less exploitation of land available for public use. 2: Lack of value chain for economic growth due to inadequate policy or inadequate capacity building and inadequate coordination of institutions involved in urban management. 3. Land use pressure: unbalanced allocation of building land and ground facilities. 4: Environmental impacts: Increasing environmental and water pollution of the city. Isfahan has been set above the standard levels (KhoshAkhlagh, 1999), which causes disturbance to the urban ecosystem and, consequently, decreases citizens' quality of life (Lovett et al., 2009).

If we can increase the productivity of land use in the cities, there can be little improvement in the scarcity of land. Accordingly, the use of land by the public sector to provide local public services has a large contribution to land use in cities; for example, a large proportion of the urban area is covered by main streets and suburbs. If it can use the space below the streets, there is a relative improvement in the scarcity of land in large cities.

Underground space enhances the city's livability, public health promotion, multiple and coherent use of underground and terrestrial development, rehabilitation or re-injection of energy into older cities, transportation and efficient services. Considering the remarkable separation capacity at the underground level, the underground city complex reduces noise compared with urban land surface (bus, car), time saving, road traffic shortening and increased transport speed, which directly reduces energy consumption (as a direct benefit) and reduction of air pollution (indirectly). Underground structures are naturally protected from unbalanced weather such as storms, whirlwinds, thunderstorms and other natural phenomena and flood risks (Bobylev, 2006). The temperature of the underground space is approximately 28 ° C, and the moisture content does not exceed 60% to 70%. If we can create more commercial and service spaces in the basement, it can increase the productivity of land in the cities. In general, the output benefits of this kind of urban space are significant (Lin & Lo, 2008). On the other hand, one of the main parts of municipal expenditures in providing services to citizens is the construction of streets to improve the traffic flow in cities. Considering the issues expressed in this

study, this issue in Isfahan was examined that if the urban planners want to use the spaces below the selected streets, what the right one is and which streets will be prioritized. The absolute rate of urbanization in Isfahan has always been accompanied by an uptrend, and it is expected it will continue with this trend by 1405 (Nowrouzi, 2009).

Statistics show that the number of clean and healthy days in Isfahan has not been sustained and accompanied by frequent ups and downs (Statistics of Isfahan City, 2011); therefore, with considering the limited urban land, can we use the below space of streets? This article studies that if we want to take advantage of the underground spaces of some streets to improve land use efficiency, we need to answer two basic questions:

1- What street has the higher priority in Isfahan to use underground urban space?

2- Which use (warehouse, parking, business, passage) is in the top priority?

To answer the above questions, a few sub-criteria (land price, green area, traffic flow, employment) were first defined, and then based on the use of two-step Analytical Hierarchy process, street priority and proper use for underground space was obtained.

2- Literature Review

a) Foreign Researches

Wang et al., (2013) examined the factors affecting the potential development of underground urban space in seven sections in Nanning, China. Several factors such as geology, land prices, spatial conditions, the level of economic development, the benefits of underground urban development and urban planning compatibility were selected. The results indicated that the higher the average prices of the regions, has the positive and significant relationship with the potential development of underground urban space, therefore, areas with higher land prices and favorable spatial conditions, have priority development.

Li (2012) explored the economic and social potential of economic and social demand in the suburban metropolitan area of Suzhou City in China. Regions with different potentials were weighed and mapped by Analytical Hierarchy Process (AHP) and GIS.

In a paper, Babylov (2011) reviewed the underground urban infrastructure problems in Moscow. He urged the reform of state administration to be implemented primarily at the federal level, in spatial planning, along with underground space planning and economic sectors.

Joneydi et al., (2011) investigated the use of underground space in metro stations and the establishment of commercial centers related to it in the central region of Montreal. It has provided walking from the city center to escape the harsh weather. They concluded that, despite the high cost of building in the basement above the ground level, a large part of land investment would be offset by the choice of competitive alternatives (Case Study of Hart City in the Netherlands) and it creates a more commercial and serviceable space. On the other hand, it will save on the cost of occupying the land, helping to attract more investment in the long run.

Qihu (2016) in an article, explores the problems and development of the underground space of China. He referred to five problems in the use of underground space, including non-aligned solutions,

integrated management system, incomplete regulations, incomplete program and unspecified policy.

Hunt et al., (2016) in a study consider the use of urban underground space in line with the policy of reducing the problems for better living in cities, such as: reducing carbon in international law. This article explores how these spaces will be used in the future. They concluded that accepting more of these spaces could bring many benefits.

Kian et al., (2015) examined the expansion of underground commerce in China. Some of these spaces have become entertainment for the residents of the city. Rental of commercial underground spaces has increased, but in assessing the value of underground commercial land, the theory and the different methods have been investigated. They also tried to examine the relationship between land prices and underground land prices. They provided a method for calculating the price of underground commercial land, which applies to the theory of valuing to use underground commercial land as well as actual assessment.

Le et al., (2016), arguing that traffic congestion and the shortage of ground space are increasing, the needs to find more space in the city underground is undeniable; they explore the possibility of planning for the use of this potential in urban planning. They concluded that for sustainable development of the city, it is necessary to realize the different underground resources of the city and to evaluate them scientifically, then, in general, we plan and manage these developments. The urban underground geological structure and characteristics determine the UUS engineering conditions and the characteristics of urban underground resources.

b) Iranian Researches

Molaie (2012) in a paper to study subsurface spaces studied the aspects and benefits of using these spaces from the perspective of sustainable urban development through descriptive-analytic research method. After designing the problem and its importance, the concept of sustainable development and features of underground spaces were discussed. In this research, the area of Tajrish Square in Tehran was studied with natural, historical, cultural and social elements, as well as numerous issues in traffic, environmental and spatial dimensions. In this research, subsurface development in the area of Tajrish Square is proposed as a combination of point and linear developments. The results of the study indicated that the development of underground spaces with respect to the principles of sustainability can be effective in solving urban problems, especially in large cities and their densely populated centers.

Mozafari et al., (2014) investigated the importance, necessity, and legal considerations, ownership, and feasibility of subsurface spaces in metropolitan areas. In this paper, after an overview of the necessity of using subsurface spaces, the planning process and the various aspects that should be considered in the design of these spaces are mentioned. In the following, the laws and considerations of the legal and property rights of some countries for the construction and development of subterranean spaces were examined and compared, and in particular, the situation of the laws and regulations of Iran was dealt with. The results indicated that there was no comprehensive model that could solve all issues related

to the construction and exploitation of these spaces, and each country had regulations in accordance with its economic and social viewpoints. In Iran, given the urgent need to use subterranean land in metropolises and the legal burden and property problems that the construction of these spaces, in particular the lack of observance of their privacy can create for urban management and private owners, as well as different attitudes which is at the level of decision-makers regarding the scope of ownership, it is necessary to look at these plans by the legislative bodies, to clarify and to lay down the rules for their implementation, operation and maintenance.

Afradi (2012) did a research entitled "underground urban structures and passive defense approaches in line with their efficiency" based on a research-prescriptive approach. In this study, by providing passive defense solutions for the protection and efficiency of urban subterranean structures, the results showed that passive defense not only has the potential to be used in the design and planning of underground structures, but also can play an important role to continue the activities and services of these structures in crisis situations.

Zainli & Jalali (2015) investigated the social consequences of the construction of Hakim highway tunnel in Tehran metropolis using a fast matrix method. The results of this study showed that the most negative result of the project construction phase activities on the social and cultural environment is related to the low traffic intensity parameter. The impact score of the project in the exploitation phase on the social and cultural environment was +74, with the highest positive impact on reducing the high intensity traffic.

3- Theoretical Background

Underground urban space is a desirable urbanization area below the city level due to reasons such as high land prices, migration phenomena, air pollution, population congestion and traffic. Important factors influencing the selection of the type of underground space use are traffic, land prices and air pollution. For example, in the city of Beijing, green spaces were replaced by the transfer of commercial space to the underground.

The nature of the evolution of urban space is a reflection of the need for land in the economic and social system, and urban economy simultaneously dominates the production and interaction of urban space. The land use pattern has always changed the spatial structure of the city. This is an important part of space sharing in the distribution of economic benefits and land use structure. Uses of these spaces are considered as follows. The area includes a business and office environment where underground space development has been developed, such as land-based development. Underground space is dedicated to the construction of parking (200,000 square meters), commercial centers (200,000 square meters) and a multipurpose tunnel (100,000 square meters) (Linxu, 2007). The sub criteria of the passage, parking, and commercial sector are based on the study. Because the underground space is related to the surface (structurally and functionally) (Chow et al., 2002); therefore, any manipulation in the basement creates side effects for the owner, and therefore depends on the owner's permission. Hence, land prices are an important factor in the allocation of these spaces, and the relationship between land economics and underground economics is understood

(Pasqual & Riera, 2005), and finally, land use planning can lead to allocate underground urban space. Air pollution is another important factor in decision making for such spaces. The sub-criterion of green space as a proxy for air pollution is presented in the research model. Population density and buildings are directly related to the demand for underground urban space and the using of underground parking is one of the most important uses of such spaces. According to the subject and purpose of the research, the employment level criterion was used instead of the construction density and population. Storage and facilities use are one of the other uses for underground urban space. The optimal use means optimal allocation of underground space related to the research road to the warehouses, passageways, parking lots and commercial sectors, taking into account the sub-criterion of land prices, green area, traffic flow and employment level associated with each of the passages.

In general, it can be said that these spaces, as an important part of urban spatial resources, are of great importance for improving the productivity of land use and reducing traffic congestion in the central parts of the city. Developing the use of these spaces will help improve the urban environment. With accelerating urbanization, the extent and depth of the use of underground space has reached unprecedented levels and many problems in the development of underground development such as lack of planning, irrational design and unplanned use has been making. Underground space is a non-renewable resource of value, and many of the caverns created in the basement have irreversible consequences. Therefore, the development of underground space must be done carefully and professionally. In order to ensure sustainable operation of underground space, before excavation and construction, factors affecting the potential of underground city development should be considered. In exploring literature in urban underground, five key factors that have a direct impact on the development of these spaces are as follows: a) Geological features: These characteristics are more important than the cost of construction and exploitation. For example, soil type, proximity or distances to geological faults or the presence of groundwater currents can have a direct impact on the cost of drilling, retrofitting, and the use of these spaces during construction and operation (Sterling et al., 2012). b) Land prices: Underground space development is often done in the central cities of major cities. The relative price of land in these areas is higher than other parts of the city. These areas are known as centers of economic, administrative, historical or cultural activity of cities (Song, 2012). In previous studies, the relationship between land prices and local conditions and the development of the underground space use has been evaluated positive. It can be said that the use of underground spaces in some way increases the supply of land in these areas, also increases the productivity of land use in these areas (Sterling & Godard, 2000). c) Location conditions: These conditions are a serious restriction on the use of these spaces. Since underground structures are expensive to build, underground space is often developed in cities and countries with good financial conditions. It can be said that economic growth plays an important role in the formation of urban underground space. Tung (2006) suggested in his studies

economic growth as the main factor for underground space development. Chen and Wang (2005) presented a positive relationship between the use of urban underground space and the annual per capita income of citizens. Hey et al., (2012) also confirmed that per capita gross domestic product had a positive relationship with the density of urban underground utilization.

d) The advantages of using underground space: Despite the high costs, the development of underground space in recent years due to its numerous benefits, it is expected to increase the use of these spaces dramatically. These benefits can be divided into two categories: direct benefits that are mostly economic, technical, functional and social (Godard, 2004), and indirect benefits including external benefits such as environmental protection and knowledge development. e) Adaptation to urban planning: Regardless of the economic and technical aspects, for the use of these spaces, obtaining legal and administrative licenses is also required for urban underground construction (Admiraal, 2010). Studies have shown that these licenses do not exist in many countries within the framework of macro-urban development plans; therefore, urban planners should propose the creation of a legal framework for planning appropriate use of underground space. (Sterling et al., 2012). It is necessary to formulate regulations regarding the volume, structure and function of the use of underground space in urban planning. It is also necessary to consider the use of these spaces in metropolitan programs as an ideal solution for the best use of urban resources. Based on the above analysis, we can conclude whether the development of the use of these spaces is consistent with urban planning. This has a significant impact on the potential use of underground space (Bobylev, 2010).

4- Research Method

In this research, the two-step hierarchical analysis method was used to select the best sub-criteria of user and weight of sub-criteria and the linear programming model by Akbari & ZahediKeyvan (2008) for allocating underground space. In the first step, among the sub-criteria of land prices, traffic flow, area of green space and employment, the best option was chosen according to the defined criteria such as warehouse, business sector, parking lot and bus. Subsequently, based on the best sub criteria, and with the help of the Hierarchical Model II, with a few selected streets, the best way to exploit the uses of underground urban space in the first-order hierarchical model is to be selected.

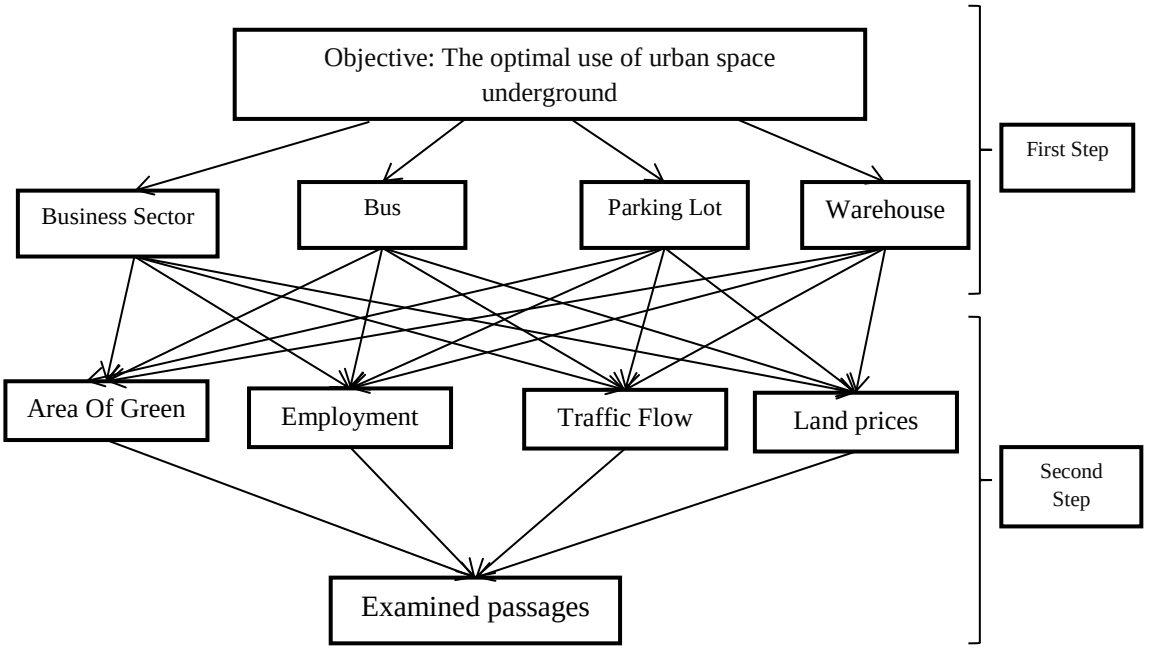

Fig1. A Two-Step Hierarchical Chart of Research

To optimize the values of sub-criteria influence on the use of underground space (Z), the Multi-Purpose Math Model (Equation 1) was used.

$$Z = W_p(P) + W_E(E) + W_t(T) - W_g.(G) \quad (1)$$

St:

$$500 \leq P \leq 630000$$

The following restrictions benchmark land prices

$$928 \leq G \leq 480048$$

The following restrictions benchmark Area of Green

$$4400 \leq T \leq 21966$$

The following restrictions benchmark Traffic Flow

$$0 \leq E \leq 2506$$

The following restrictions benchmark Employment

$$\forall: P, G, T, E > 0$$

$$\frac{\Delta Z}{\Delta P} \geq 0, \quad \frac{\Delta Z}{\Delta E} \geq 0, \quad \frac{\Delta Z}{\Delta T} \geq 0, \quad \frac{\Delta Z}{\Delta G} \leq 0$$

In addition, to optimize the values of sub-criteria influence on the use of underground space (Z), the multi-objective math program model (Equation 1) was used. In this equation, W is the weights of each sub-criterion obtained from the second-order hierarchical analysis. P is the Land prices, which increases with its desire to use underground. Land zoning prices have been used for land prices because, according to research, there is a strong statistical relationship between zoning prices and real estate prices. In this research, price changes are important; therefore, these data were used. G is the area of the green space of the streets, and if used from underground space, it eliminates the priority of passageways for the use of underground urban space. T is the traffic volume criterion, which has a positive interface using the underground space. E is the criterion of employment, which means that how many jobs are around the range. The relation of this criterion is considered positive by using the basement space. To estimate the range of variations of each variable, the data were collected field by 2013.

To investigate the data with different domains, Z_i standardization is used as follows:

$$Z_i = \frac{X_i - X_{min}}{X_{max} - X_{min}}$$

Firstly, the field related to the sub-criteria for zoning prices, green space area, employment level, traffic flow, was compiled for each of the selected streets in the GIS environment. Subsequently, the information about the questionnaire was completed by 16 experts in the research subject. The second hierarchical analysis was recorded in Expert Choice software. Since the importance of each of the sub-criteria varies according to the type of criteria, so the weight of each individual is calculated. The weight of the criteria was completed by 16 selected experts including managers and experts with the experience of Isfahan municipality in Isfahan municipality headquarters. A related university degree and having at least 10 years of practical work experience in the subject field were considered as the benchmark of choice. By calculating and obtaining consistency of expert opinions, the weights were multiplied by the numerical value of each of the following criteria and the passages were prioritized based on the type of using.

Selecting Sample for Study

Given the available data of Isfahan city, this city was selected as the sample of the study. In addition, due to the need for field study and precision for a more accurate study, the 5th and 6th areas were selected according to the new structure and the lesser historical sites. In the survey of the entire streets in these two regions, the streets that were more accessible to use the basement space were selected.

5- Results

According to the statistical data of the municipality of Isfahan in 2014, the streets of North Sheikh Saduq, South Sheikh Saduq, Mosalla, Hezar Jarib, Sajjad, Hemmat Highway, Azadegan Highway, Shahid Keshvari, Mirfrendeski, Abshar, Aeine khane in six district and Boulevard of Keshavarzi, Artesh, Mohtasham Kashani, Shariati, Khaghani, West Nazar, Tohid, Hakim Nezami, Shahid Aghbarparast and the Shohadaye Soffe in the 5th district of Isfahan were selected as main Streets. The selection criterion is a combination of major metropolitan areas of the 5th and 6th areas, so that relatively high land prices, heavy traffic volumes, high employment and low green space, and they have the following subcategories at least a minimal structural difference.

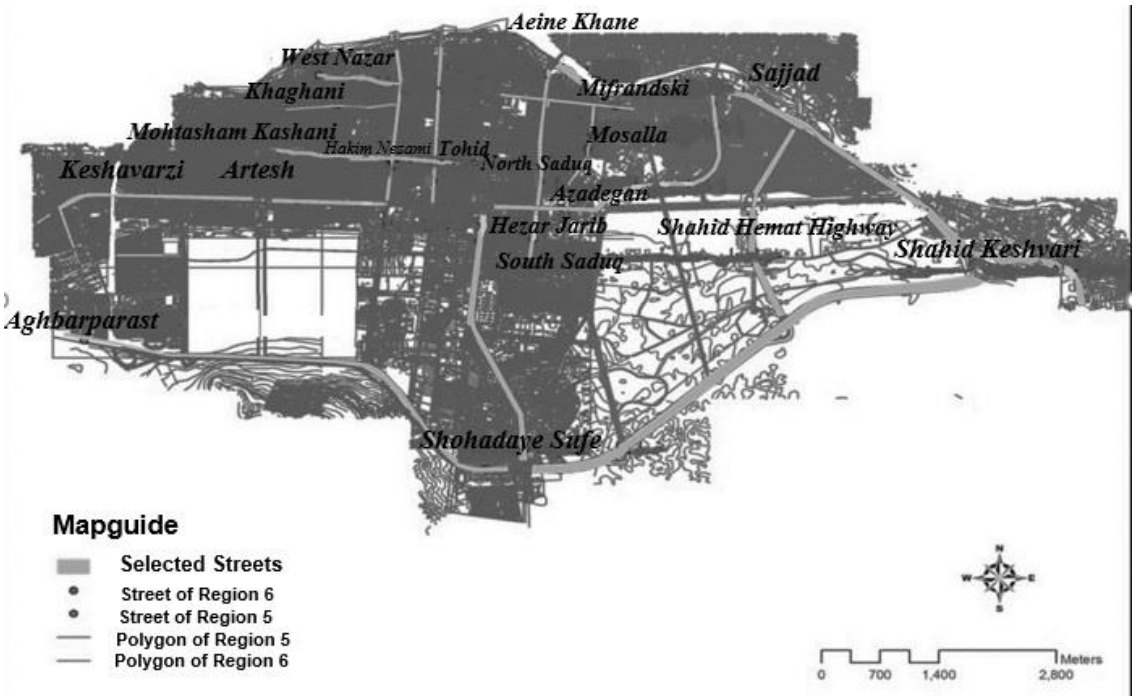

Fig2. Passages of 5th and 6th district of Isfahan due to traffic volume

Source: (Department of Urban Planning and Architecture of Isfahan Municipality)

Examining the Research Questions

1) What is the priority of the criteria (storage, parking, business and passageways)?

According to the results of Table 1, parking has the highest priority.

Table1. The final weight of the main criteria

Rank	Main Criteria	Ultimate weight
1	Parking Lot	0.305
2	Business Sector	0.297
3	Pathway	0.202
4	warehouse	0.196
Inconsistency rate: 0.1>0.02, judgments are consistent		

2) Reviewing the second question: What is the priority for the various sub-criterion (land price, green space, traffic volumes, and employment)?

The results in Table 2 show that the employment sub-criteria for storage use is the most important criterion, in Table 3 sub-criteria traffic for parking use has the highest score, in Table 4 the traffic sub-criteria for passageway use is the most important one, in Table 5 sub-criteria employment for Business Sector use has the highest score. According to the compatibility test, all results are consistent enough so it can be said of credit are sufficient for review.

Table2.The Initial Weight of Sub-Criteria According to Warehouse Criterion

Rank	Initial Weight	Sub-Criteria
1	0.427	Employment
2	0. 305	Traffic pedestrians
3	0. 163	Land prices
4	0. 105	Area of green space
Inconsistency rate: 0.1>0.02, judgments are consistent		

Table3. The Initial Weight of Sub-Criteria According to Parking Criterion

Rank	Initial Weight	Sub-Criteria
1	0. 379	Traffic Pedestrians
2	0. 305	Area Of Green Space
3	0. 223	Employment
4	0. 134	The price of land
Inconsistency rate: 0.1>0.04, judgments are consistent		

Table4. The Initial Weight of Sub-Criteria According to Passageway Criterion

Rank	Initial Weight	Sub-Criteria
1	0. 607	Traffic
2	0. 182	Area of green space
3	0. 137	Employment
4	0. 74 4	Land prices
Inconsistency rate: 0.1>0.03, judgments are consistent		

Table5. The Initial Weight of Sub-Criteria According to Commercial Use Criterion

Rank	Initial Weight	Sub-Criteria
1	0. 388	Employment
2	0. 256 2	Traffic pedestrians
3	0. 181 3	Land prices
4	0. 174 4	Area of green space
Inconsistency rate: 0.1>0.03, judgments are consistent		

3) What is the priority of the streets to use underground urban space?

According to the results obtained from the prioritization of the sub-criteria in the first stage, the analysis of the weights obtained from tables 1 through 5 in the road layer was created and, according to the planning model (Equation 1), optimal use for each street was obtained.

-Warehouse and Commercial use: Warehouse usage is a kind of supplement to commercial use; therefore, warehouse and commercial use can work better together. In Figs 3 and 4, use review results are presented. The results show that the streets: Hezar Jarib, Tohid, Hakim Nezami and Artesh are the main priorities for this combination use.

- Parking Use: For the Parking Use, Artesh streets, Hemmat and, Aeine Khane are the top priorities.

- Passageway Use: For the passageway use, which is a kind of two-story street, the streets of Hemmat, Aghbarparast and Artesh are the most important.

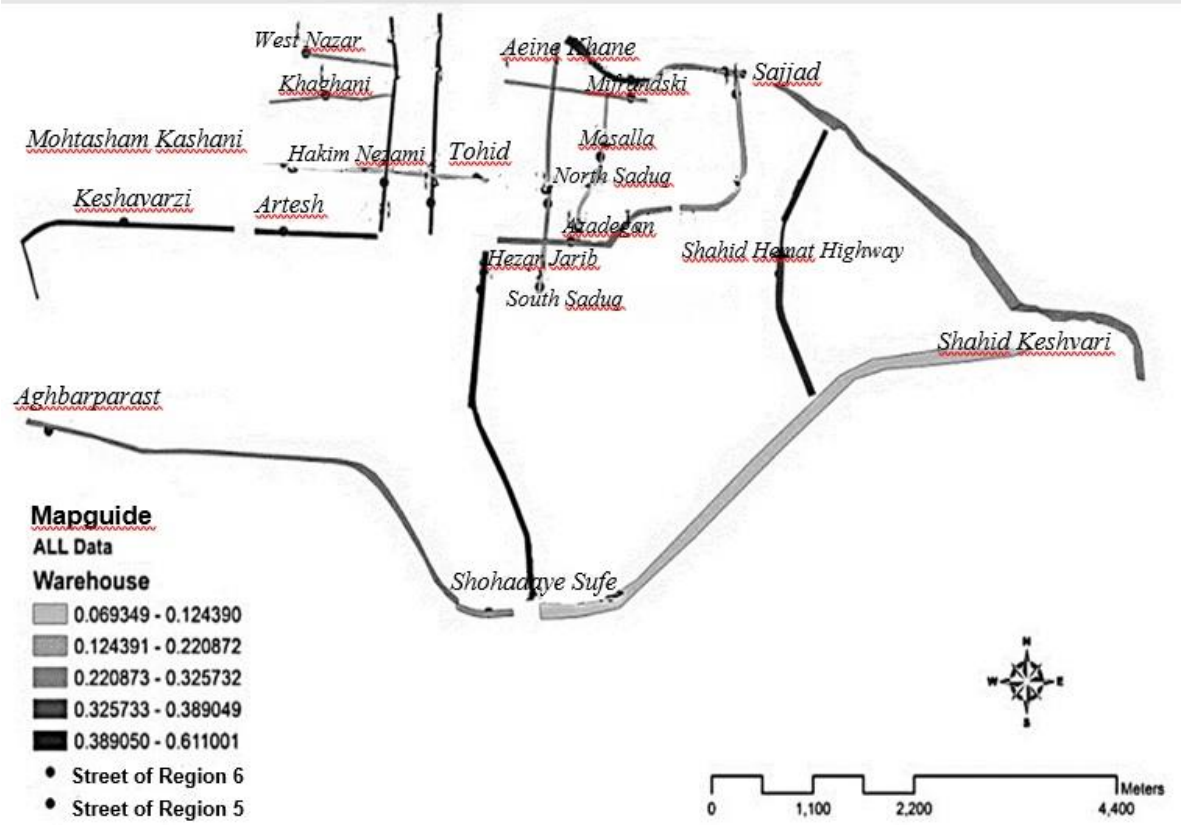

Fig3. Ranking Passages, the Warehouse Use Mode

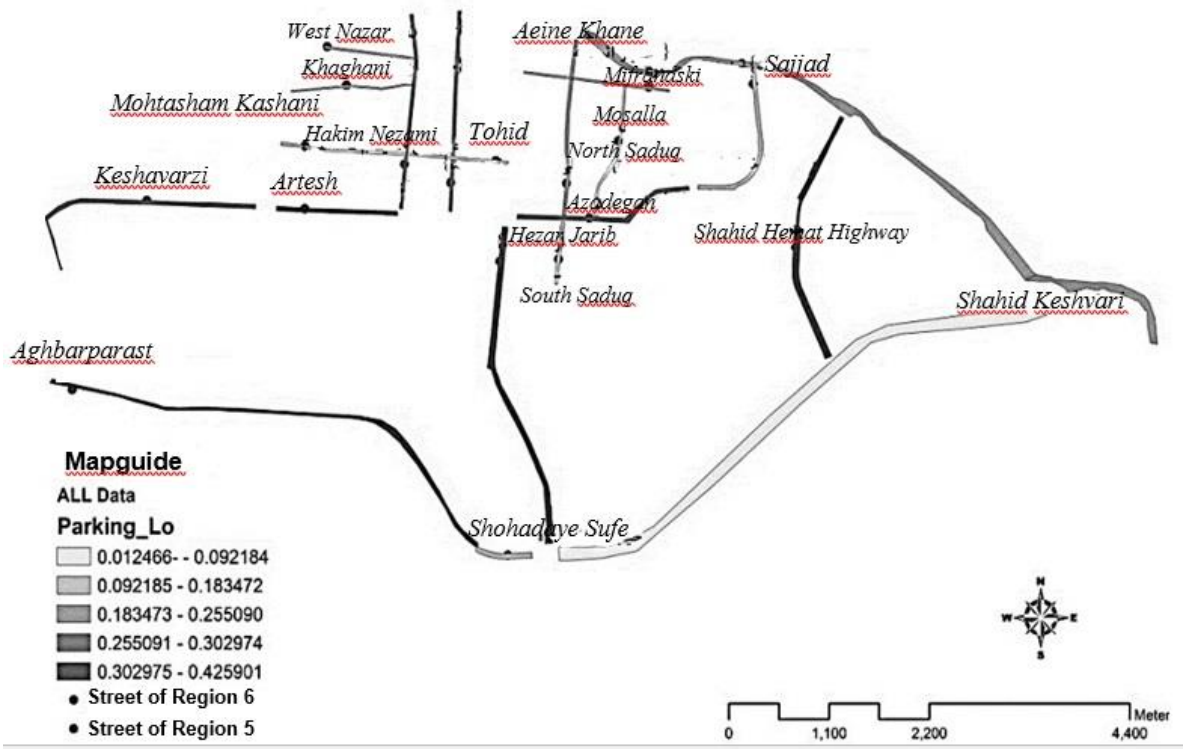

Fig4. Ranking Passages, the Parking Use Mode

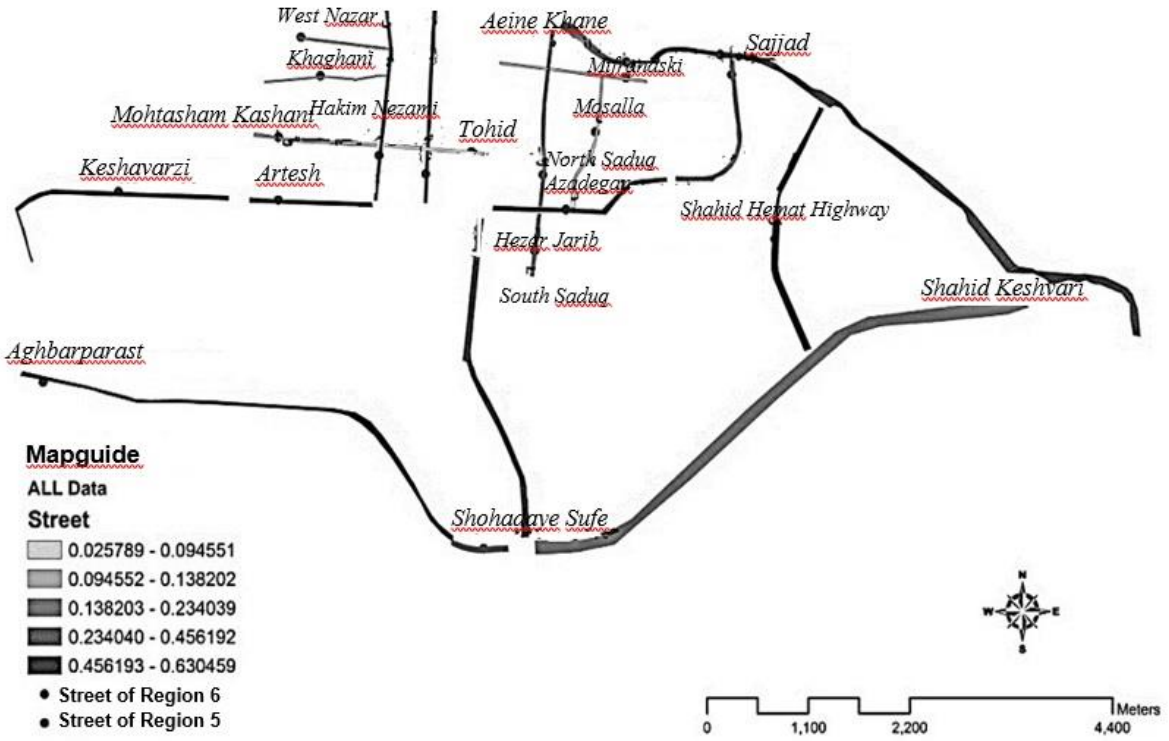

Fig5. Ranking Passages, the Passage Use Mode

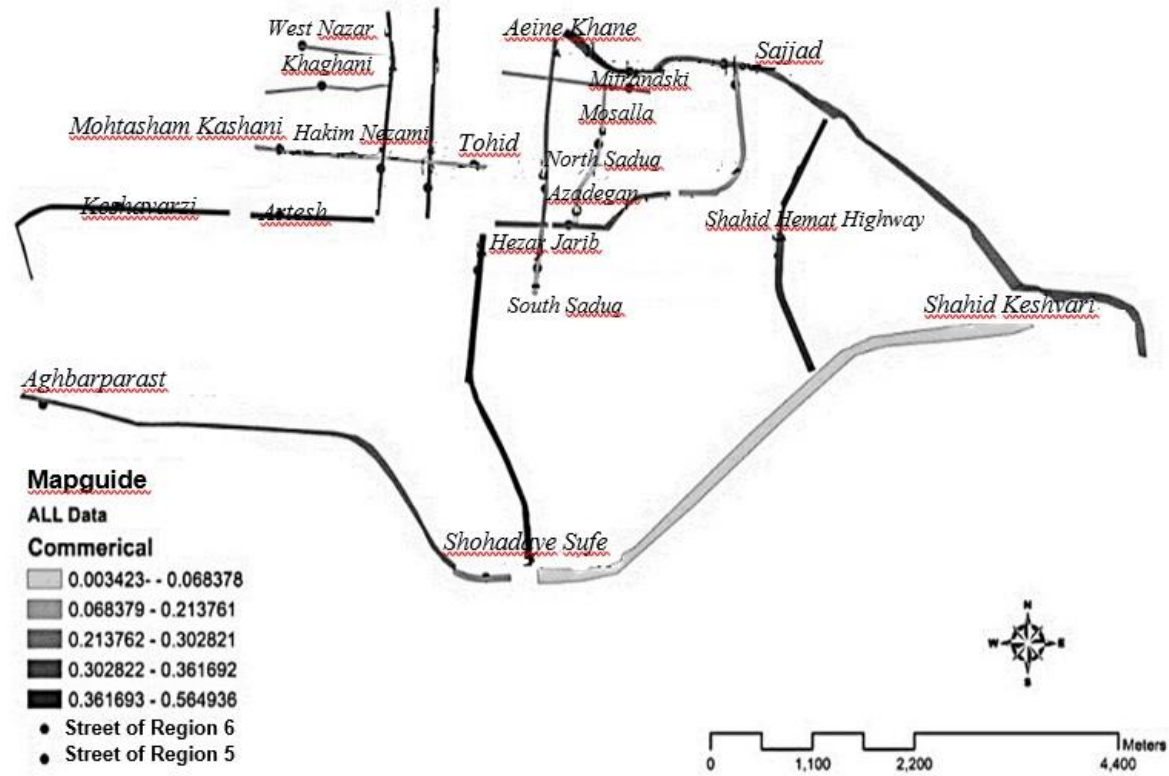

Fig6.Ranking Passages, the Commercial Sector Use Mode

Table6. Comparison of the Score Types of Recommended Uses for Underground Spaces in the Main Streets

Street Name	Parking Use		Warehouse Use		Commercial Use		Passage Use	
	Total score	Rating	Total score	Rating	Total score	Rating	Total score	Rating
Shahid Hemat Highway	0.426	2	0.632	6	0.318	7	0.630	1
Artesh	0.355	1	0.374	4	0.337	4	0.456	3
Abshar	0.255	4	0.317	10	0.293	10	0.282	9
Azadegan	0.291	9	0.326	8	0.301	9	0.338	6
Aghbarparast	0.363	8	0.311	11	0.256	11	0.591	2
Aeine Khane	0.233	3	0.352	7	0.033	6	0.194	13
Tohid	0.229	11	0.389	2	0.362	2	0.298	8
Hakim Nezami	0.303	7	0.380	3	0.349	3	0.326	7
Khaghani	0.092	5	0.124	19	0.123	19	0.067	20
Sajjad	0.183	19	0.219	13	0.205	13	0.194	14
Shariati	0.139	12	0.197	16	0.193	15	0.095	19
Shohadaye Sufe	0.168	18	0.173	17	0.162	18	0.202	12
Shahid keshvari	-0.012466	13	0.098	20	0.003	21	0.222	11
South Saduq	0.167	21	0.167	18	0.163	17	0.184	15
North Saduq	0.245	14	0.324	9	0.303	8	0.234	10
Keshavarzi	0.303	10	0.364	5	0.331	5	0.348	5
Mohtasham Kashani	0.155	6	0.213	14	0.203	14	0.13	17
Mosalla	0.046	16	0.069	21	0.069	20	0.026	21
Mifrandski	0.154	20	0.221	12	0.214	12	0.095	18
West Nazar	0.156	17	0.198	15	0.191	16	0.138	16
Hezar Jarib	0.420	15	0.611	1	0.565	1	0.374	4

The results obtained from the design of the first hierarchical model indicate that the Parking Lot as the best use and the commercial sector, the passage and the warehouse are in the next priorities. The results of prioritizing the second model criteria (traffic flow, employment, green space and land prices), based on the factors required in practice, show that the correct decision cannot be made between different uses; therefore, it is necessary to conduct a comparative comparison using a two-stage hierarchical analysis method. The results in Table 7 show that on the basis of a pair comparison, which use is suitable for which street. In this table, the use is defined as the first use sample for each street.

Table7. Summary of research results

Use Type	Passage With Minimum Score	Passage With Maximum Score
Parking Lot	Shahid Keshvari	Shahid Hemmat
Warehouse	Khaghani	Hezar Jarib
Passage	Mosalla	Shahid Hemmat
Business Sector	Shahid Keshvari	Hezar Jarib
Public	Shahid Keshvari	Hezar Jarib

6- Conclusion and Discussion

The urban underground space can be considered as a supplementary input, considering the overall costs and benefits as well as the time and money of travel. In the comprehensive and detailed designs, which are always in three dimensions of height, length and width, the nature of underground urban space is ignored. Perhaps the dimension of depth could be measured against the altitude dimension on the ground level, and it is

considered as the fourth dimension and the complementary dimension of height.

Developing the use of these spaces will help improve the urban environment. As urbanization has increased, the breadth and depth of the use of underground space have reached unprecedented levels, and many of the problems in the development of underground development are due to factors such as lack of planning, irrational design, and unnecessary use. Underground space is a non-renewable resource, and many of the holes created in the basement have irreversible consequences; therefore, the development of underground space must be done carefully and professionally. In order to ensure sustainable operation of underground space before excavation and construction, factors affecting the potential of underground city development should be considered. In sum, the use of underground spaces can increase the productivity of land in cities. Therefore, it is necessary to choose among four commercial utilities, a warehouse, public parking and a passageway (two-floor Street). In this research, 21 main streets in 5th and 6th district of Isfahan were selected as problem options. Using the 2014 data and linear programming method, the objective function was designed for optimal use allocation. The results of the first stage survey showed which street is more important, to which use is chosen. Then, for every street, the optimal use was chosen. Moreover, the results of the second stage survey showed which sub-criteria in choosing a type of use is more important. On this basis, it is possible to decide which street is needed for which use and what the priority of which street is to use the underground space. For example, for the parking and passageway, Shahid Hemmat highway has the highest priority, for commercial and street warehouse use, Hezar Jarib has the highest score.

At the first glance, increasing the use of underground space leads to a reduction in green space, but it can be achieved by providing underground constructions (building of business units and assigning it to owners of lands dedicated to green space use (or, using the concept of transferable developmental rights), it suffered losses in this shift and eventually led to an increase in urban green space and a reduction in carbon emissions.

In total, it can be said that in planning, it is necessary to include these spaces in planning models. To use these spaces, you need to take three basic steps:

- Step 1: identify the urban requirements for underground urban use
- Step 2: specify the appropriate type of underground space according to the location of the spaces
- Step 3: create the right legal framework for using these spaces

It is also suggested that all urban development methods be reviewed with the possibility of using urban underground space. For this purpose, it is necessary to prepare a specific instruction by the municipal department's architectural and urban planning department and inform the city planning consultant engineers. It is also imperative that planners and designers of buildings and facilities in their designs make it possible to use these spaces, and how to use it first in feasibility studies and then, with a clear picture of the current situation and consideration the former and future positions to make use of these spaces make plans.

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