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Feasibility Study of GIS and AHP Techniques in Site Selection for Pedestranization towards Urban Regeneration[1]

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ABSTRACT: Pay attention to the public transportation, cycling and Pedestrian oriented development (POD) and car-free streets can increase the quality of urban spaces and create more secure pedestrians with Psychological comfort for human. Old urban fabric with hidden physical, historical, and cultural values has been the best evidence of urban identity and meanwhile, the life and growth of this fabric has prevented the internal erosion of the city and has limited its unlimited expansion. This paper gives an introduction to the role, importance, issues, and limitations of urban fabrics of cities like Zanjan in relation with traffic and the necessity of public transportation development, policies, and alternatives from the urban planning point of view. The methodology used was based on 7 parts including causes and factors affecting development of the pedestrianism movement, The status of pedestranization in the methods of intervention in the old urban fabric, public success in improving and renovating the old city fabrics, obvious records of implementation in old cities and today's missing ring, feasibility study of implementing urban walking paths in the old fabric of Zanjan City (legal, and spatial-physical background), indicator-making, paths potential survey, and implementation of the model in GIS environment, and finally, selecting paths capable of pedestrian sidewalk. Our findings revealed that Middle Sadi path ranked first place, followed by the West Imam Khomeini path as a secondary option.

Keywords: public transportation, urban old fabric, pedestrian, GIS, site selection, AHP, modelling.

INTRODUCTION

The city communication network plays its lifeline role and it is considered as one of the important fundamental and determinant lines in urban development plans. The importance of networks in urban design is such that they cannot be considered separated from each other, because all of the activities of the inhabitants of a city including commercial, cultural and administrative activities depend on communication networks (Gharib, 2003). On the other hand, the formation of a city fabric is directly related to the city's street network so that each of these fabric types is affected by the formation of the streets within the city. Star (radial), annular (circular), raster, and linear fabrics are of this type. What are important from the perspective of transportation and traffic in various fabrics, are the characteristics of movement, access and efficiency of various transportation systems, safety, and costs associated with these systems (Amoud rah, 1997). Among the recent developments in the new trends of world unbanning, attention to pedestrian evacuation and its requirements is considered as an important forgotten theme of the city. Neglecting the social, economic, and architectural role of streets and paying sole attention to the roadway and its various problems, and neglecting the organization and planning of pedestrian movement,

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is considered as one of the failings of contemporary urbanism. In fact, pedestrian walks are created through eliminating the roadway traffic on a part of the city that has become historical or commercial for architectural reasons. These passages can take the form of streets, markets, marketplaces, squares, parks or a complex space. In this context, recovery and development of pedestrian areas has become one of the paths of urban planning and design, referred to as "the pedestrianism movement". The historic fabric of Zanjan City is based on downtown and historic cores and the presence of historic and valuable elements such as the traditional market, the main mosque, the mausoleum of Seyed Ebrahim Mausoleum, Bala Cemetery, and others, which are the most important historical and cultural factors of identity. However, today, this fabric is faced with numerous problems and it is going towards decay and destruction. The communication structure within the old fabric of a city, such as Zanjan, is according to the historical formation, past performances, consideration of human scale and is organically formed. Short and pedestrian-scale access with a social prominent role, passage complexity, hence, climatic conditions and urban security, lack of access to spaces and car stops, non-standard slopes, inadequate and uneven surfaces (especially in eastern and central sections of urban fabric) are among the main features in the neighbourhood network.

The connection network of valuable historical fabrics have two major differences with streets and alleys of contemporary city fabric:

a. Low width, which is not constant across the passage and changes because of spatial (four sides, intersection, etc.) or functional (forecourt of mosque, school ...) events and adds physical attractiveness to the passage.

b. Many labyrinthine spaces resulted from the urban twists and its organic character and movement along the passage is associated with a variety of views and landscapes.

The above differences are considered as the structural characteristics of the old fabric and should be considered as one of the planning principles (improvement and modernization) of new urban fabrics. Whereas, the action criteria in detailed plans is not such, and passage widening (from one side or from the axis) as well as other projects of the fabric (raster and lineat) have been popular. The last approach must be changed. Rehabilitation and conservation of old fabrics is necessary but we must also consider the accessibility factor to be able to respond to today's needs (Bavand, 2005). Pedestrian movement within the city has been experienced for many years in cities and the city's main structure has been formed based on this type of movement. This has existed since the ancient period and has been one of the important features of cities of that time. Man was considered standard for everything during the antiquity, the Middle Ages, and even in the urban design of the Industrial Revolution. The length, width, and height of urban openings, the proportions and intervals were considered in compliance with the measurements of humans. Man was the base and the natural reference for our cities design (Knoflacher, 2002). Walkability has been very important and critical in pre-industrialization cities. In this type of cities, residential commuting was conducted by walking or slow movement of wagons and carriages. This resulted in a well-granulated city fabric, relatively high density housing and also the connections between all locations being through a continuous network of pedestrian routes. The first step toward, separating the roadway from the sidewalk in the world was taken by the American architect and urban designer called "Frederick Low Olmsted" in 1858 where he proposed pa resence in the pristine nature and seeing landscapes to reduce the stress of daily life of citizens. Habibi (2001) counts the tourist pedestrian routes as a bilateral step or even a multilateral step towards the revival of cities' ancient fabric. Aminzadeh and Dayinejad (2002) consider the ever increasing of environmental deterioration of Iran's large cities to be caused by the lack of employers', designers' and planners' attention to the present deteriorating environmental situation, the lack of a comprehensive environmental policy, and the lack of clear concepts and principles of sustainable design. Therefore, they emphasize on environmental consideration towards achieving 'sustainability' and 'urban life and vitality' through principal presentation in city layout. This principle is based on three theories: ordering the environment in an ecological context, paying attention to the constraints related to energy consumption, and, ultimately, recovery and recycling instead of widening and construction of roads.

METHODOLOGY

This is an applied research work, which is based on descriptive analysis. The documents and library resources were used for data collection for theories, and field observations were used for the collection of statistics related to the theoretical studies. The process consisted of seven sections including factors influencing the 'pedestrianism movement' development, the position selection of the human movements and pedestrian-oriented in intervention methods in the ancient fabric, universal success in upgrading and renovating the old

urban fabric, clear run history in the ancient cities, and today's missing link, (i.e. the feasibility of creating urban pedestrian paths in the old city of Zanjan, legal and spatial-physical background), index-making, potential assessment of paths and model implementation in GIS environment and finally, selecting walkable paths. The most selective technique is based on the Analysis Hierarchical Process (AHP), which provided the possibility of zoning the susceptible paths by integrating exclusive capabilities of GIS.

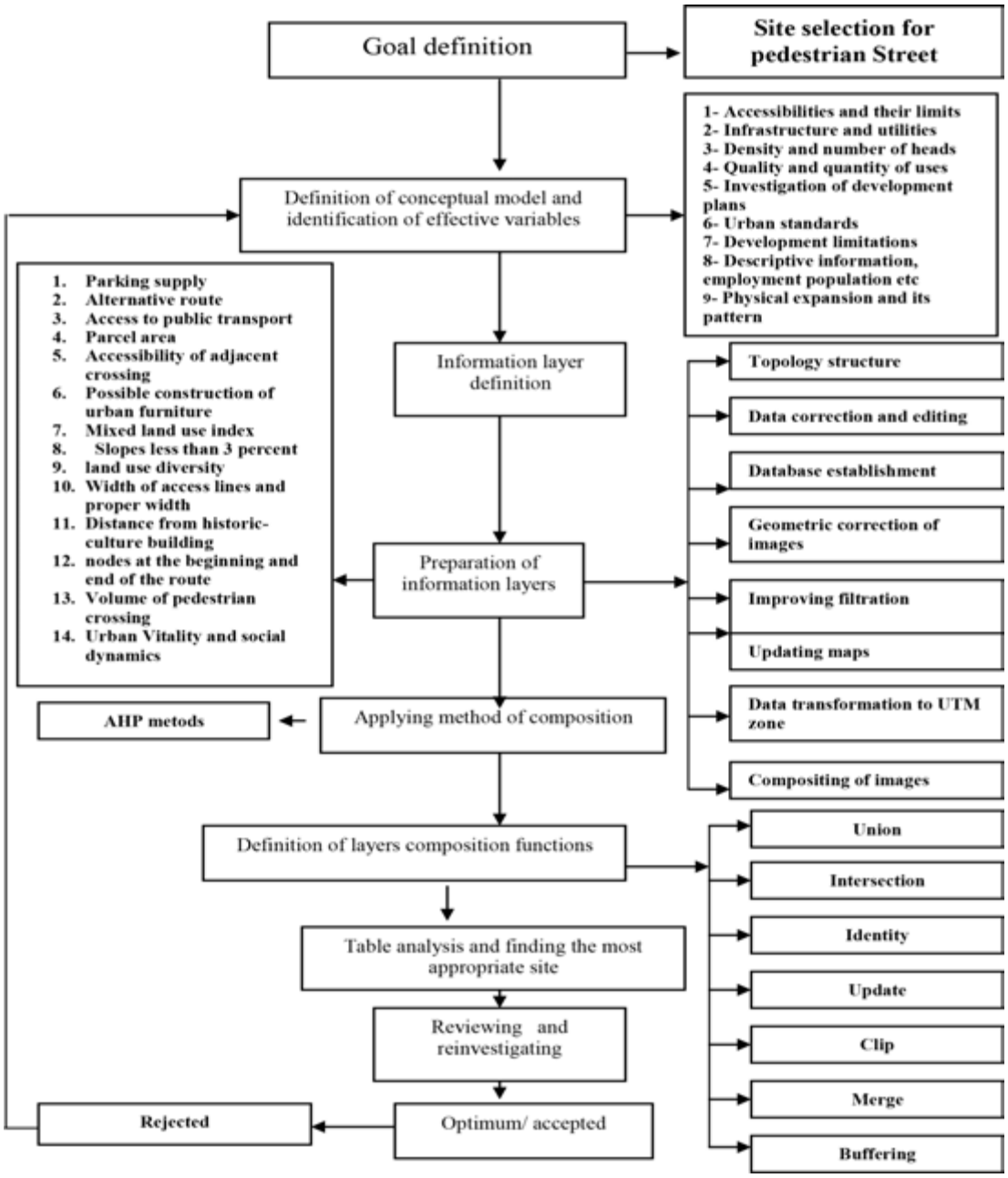

Fig. 1. Methodology of research

DATA ANALYSIS

Collective life is a chance to get away from everyday stresses of life, leisure, social interaction and gatherings of various groups and individuals and a platform for participation, freedom of speech and expressing them in space (Daneshpour and Charkhchian, 2007). The most important facilitator of such opportunities can be squares or plazas, neighbourhoods and city entrances, waterscapes (beach and river), walking paths and so on. The reflection of pedestrian movement has more significance as one of the novel thoughts in pedestrian routes.

Factors Influencing Development of The 'Pedestrian Movement'

In brief, the main causes of the spread and importance of the pedestrian movement in the past three decades can be stated as follows: Modern changes in urban life quality, social behaviour, and public culture; deepening organizing ideas within urban areas; having the highest social role; overcoming the limitations of space usage for the movement of the physically incapable; achieving urban sustainable development; strengthening the urban identity-making elements; increasing the environmental perception; upgrading the image of city; ability to understand the space using visual and non-visual senses; possibility to design integrated and coordinated paths; civic renewal of life and citizen participation in collective life; increasing recreational and tourism spaces; dealing with the population explosion and population drain in historical fabrics; accumulation resulting from large scale and the economic boom; possibility to promote public health of the citizens; improving urbanization culture; having more freedom; overcoming inter-city trips; increasing presence time in the urban public spaces; protection and maintenance of the city's historical and valuable remains; and increasing vitality, flexibility, and safety.

Position Locating The Human Motions And Pedestrianism in The Intervention Methods in The Old Fabric

Intervention in the urban old fabrics can be done by different methods such as protective-healthy, decorative-protective, renovated, topical-subjective, and comprehensive restoration (Habibi and Maghsoudi, 2007). In each of these methods, certain policies have been considered regarding transportation. For example, establishing walking and vehicular access networks in healthy-protective intervention method, walking prioritization in the city along with reducing internal transportation traffic of the old fabric (reducing vehicular traffic as much as possible), and allocating some of the main paths for walking in the decorative-protective intervention method. In intervention methods, there has been a particular look at facilitating walking in cities and it is attempted to enhance the citizens' pedestrian presence in cities' public issues. In fact, walking is the common point of all of the above mentioned methods in transportation policies in order to intervene in old fabrics.

Overall Success in Improving And Renovating The Old City Fabrics

Experiences of different countries in the restoration (improvement, renovation, and remodelling) of old urban fabrics suggests that these policies and strategies in most leading cities have been specifically planned and implemented for renovating old fabrics. For example, the expansion of public transport, walking paths development, expansion of bike lanes, construction of traffic tunnels, regulation and spatial distribution of land uses and levels of public services in compliance with the communication networks, using a green gasoline to reduce emissions, setting speed limits to 30 km, construction of parking towers, traffic bans in some parts of the city, street direction changes, and the use of intelligent traffic systems have all been successfully implemented with positive results in most successful European and American cities such as Oslo, Paris, Amsterdam, Stockholm, Malaga, Helsinki, and others.

In such cities, under influence of the daily issues and conditions, urban planning has experienced many developments, and new approaches and trends have emerged in different periods of time, including sustainable development, smart growth, new urbanism, social justice, environmental planning and development based on public transport have social justice, environmental planning and public transportation-based development (Abbas Zadegan, Rezazadeh & Mohammadi, 2011), and finally the walkability is of key goals of the public transport-based development. Portland City (Oregon State, U.S.A.) is one of the leading and successful examples of creating attractive pedestrian areas in the city. Various ethnic festivals and markets in this city are held to different occasions, attracting many people form the surrounding areas. In early 1980s, a huge square was constructed the participation of people. Its pavement bricks, engraved with the names of the purchasers, were sold to the public for high prices (Mahdizadeh, 2000).

Obvious Records of Implementation in Old Cities And Today's Missing Ring

In the old cities of Iran, the formation of urban spaces and roads was based on the distances and the requirements of walking. The cities expansiveness and the distances between its various centres was such that citizens could commute from one point to another by walking. If animals were used to displace individuals or goods, the speed and movement was such that there was no need to differentiate between the roadway and walkways. This pattern of movement in the city not only created a sensational and chimerical link between the city and the citizens, but it also gave the cities' roads and passages a social and cultural character. In the contemporary urban design of Iran, the paths and the natural rights of the pedestrian has received very little attention by urban planners and designers and walking lanes have not been considered as an independent part of urban spaces, but rather as a function of the vehicular roadways.

In fact, in the common urbanism tradition, planning for the car has always been ahead of planning for Man. In Iran, the gradual dominance of vehicular access over urban passages and spaces has caused urban planning and design to be far removed from the daily scale and needs of pedestrians, resulting in reduction of value and social and cultural attraction of urban spaces. In this process, the concept and function of consistent and suitable urban elements such as the neighbourhood, street, square, cross, and alley have undergone substantial and qualitative change losing their human-rich content in the process.

A large part of the problem in Iranian cities originates from neglecting walking paths, while walking remains as the most important method of commuting. But one of the most important valuable steps conducted in recent years to improve the quality of walking was the pedestrian project that took place in Tabriz, Mashhad, Bushehr, Tehran, and Uromia. It should be noted that the construction of sidewalks solely does not guarantee success and efficiency in the city. Also, constructing a special walking path in a city cannot be considered as a model for implementation in other cities. Differences in climate, culture, and the different characteristics of urban spaces in each area demands a special approach to the issue of walking paths.

Feasibility Study of Implementing Urban Walking Paths in The Old Fabric of Zanjan City (Legal, And Spatial-Physical Background)

The old fabric of historic Zanjan City is the primary focus of city's formation and expansion. Hence, it has been located in the centre of the urban radius and in the innermost of the urban development ring. The city streets are linked to the old fabric limits by the east-west radial rings. In other words, Zanjan's old fabric is located in city centre. Surrounding this fabric, there are arterial streets. Additionally, the downtown is sometimes the most important core of social interactions. From the walking point of view, the commercial centre of the city fabric owes to the market and surrounding areas, and walking attractions (shopping and visiting the shops along the Sadi Avenue and across the Imam Ave.) are the leading centres for social interaction in Zanjan City. But, this has reduced the importance of vehicle and lack of required spaces for pedestrian traffic has decreased the walking quality within the concerned area. Assessing the urban network in the old fabric indicates the dominance of different conditions - the followings are a few examples: ‹roadway and walkway integration›, ‹increasing commercial land use without parking lot provision›, ‹environmental and landscape pollution in the southern part›, ‹non-geometric and organic fabric›, ‹incompatible and traffic-attractive land uses›, ‹breaking citizenship rights and urban public spaces›, ‹traffic jump formation›, ‹correlation between physical exhaustion and width of passageway›, and finally ‹lack of urban walk paths›. Whereas, based on the structure of the communication network, administrative instruction for modifying the structure of the public transportation systems, and Iran's and world experiences on developing this urban space as an important intervention strategy, walk paths in Zanjan City can be site-located and designed.

Indicator-Making, Paths Potential Survey, and Implementation of the Model in GIS Environment

Step I: Defining and Determining the Site Location Indices

Walking zones have physical and cultural qualities that must be considered. The physical aspects of walkway construction, such as renovation and relocation of the infrastructures are not seen, though they have high costs. The first step in implementing the walking path is the approval of local traders and shopkeepers. On the other hand, choosing the right time to convert the path to the sidewalk is essential for continued success and failure prevention. The success and public use of sidewalks depends up on both the design and the operation, maintenance and management. In addition to the governmental support and funding from organizations

such as traffic, municipality, urban planning and other relevant organizations and also cooperative investment companies, the non-governmental grants can be utilized to improve sidewalks. In this regard, the legal aspects should be considered while designing the sidewalk, including:

1. Available accesses to private sector entities.
2. Problem of raising goodwill.
3. Housing improvements due to the landlord and tenant disputes.
4. Probable resistance of trade's people.

Most of the discussion about the construction of the sidewalk is the increasing traffic the streets next to the sidewalk. Feasibility study of the sidewalk regions should be done through studying traffic patterns of surrounding areas and the required parking lots of that area, which has to be provided. There are some criteria and sub criteria, which must be considered in order to have a successful sidewalk traffic plan. For example, providing parking outside the roadway, access to public transportation, establishing taxi stops, compliance with the traffic in other commercial centre, etc.

Therefore, it is necessary to determine the quantitative and qualitative indicators for site location and the design of walk paths because it is considering the absolute positioning and location of the site in relation to the spatial relationship and neighbourhood units that will ensure its success. Thus, the qualitative and quantitative criteria affecting site location were clarified according to this principle and the review of the literature associated with the problem. For these criteria, certain sub-criteria have been defined according to the area's local conditions, for example, access, replacement, gradient, aesthetics, diversity and vitality.

Step II: Paths Selection and Spatial Data Collection

In this step, the characteristics of communication networks were identified in the form of 15 main themes in the old city fabric, and their information was entered in the database. The quantitative characteristics included axis length and width, physical characteristics and the qualitative characteristics including vitality, land uses around the site, and surrounding roadway and pedestrian accesses. Later, the elimination of inappropriate passages was performed using the Boolean logic and vital indices for sidewalks. Therefore, the eligible six paths were diagnosed as South Sadi, North Sadi, West and East Imam Boulevard, Middle Besat (between Rasht Darvazeh and Arg Darvazeh), and Firdausi Ave. having most of the criteria.

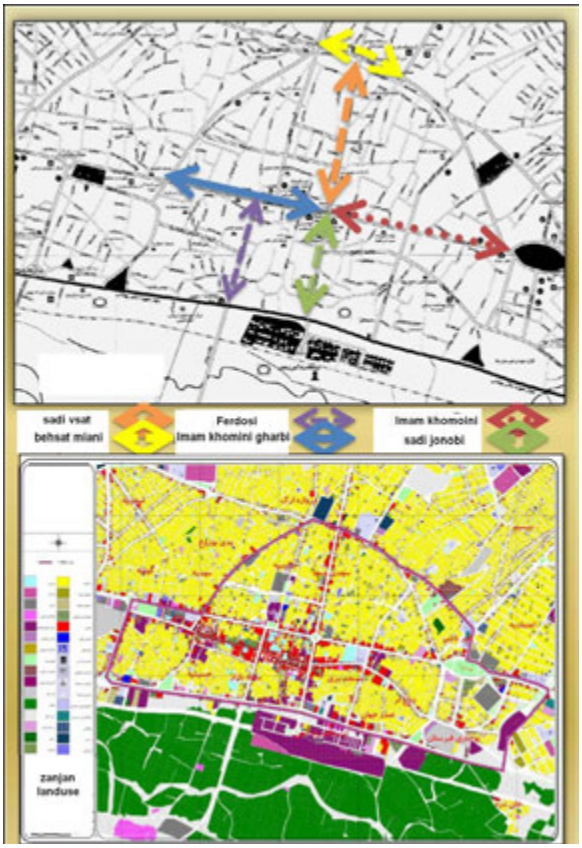

Fig. 2. Final selected paths and positions related to urban monument, Network Street and landuse.

Step III: Preparing Questionnaire for Residents Mental Development and the Paths Traffic Taken

In this step, the statistical (closed and open) questionnaires were filled up. The sample size was approximately 400 persons based on the Cochran›s sampling method. This step was conducted with the help of the students of Zanjan University. Then, surveying the number of the daily walking trips within the abovementioned paths were done at 4 different time intervals (10-11, 11-12, 16-17, and 17-18) in order to determine the vitality and attractiveness of the walking path.

Step IV: Selecting the Appropriate Integrated Model

Among the multi-criteria decision making and map-integrated models, Analytical Hierarchy Process (AHP) is one of the most comprehensive systems designed with multiple criteria. AHP is a flexible, robust, and simple method used when having opposite choice options that make decisions difficult (Zebardast, 2001). This multi-parameter assessment method was first proposed by Thomas L. Saaty in 1980 and it has had several applications in various disciplines.

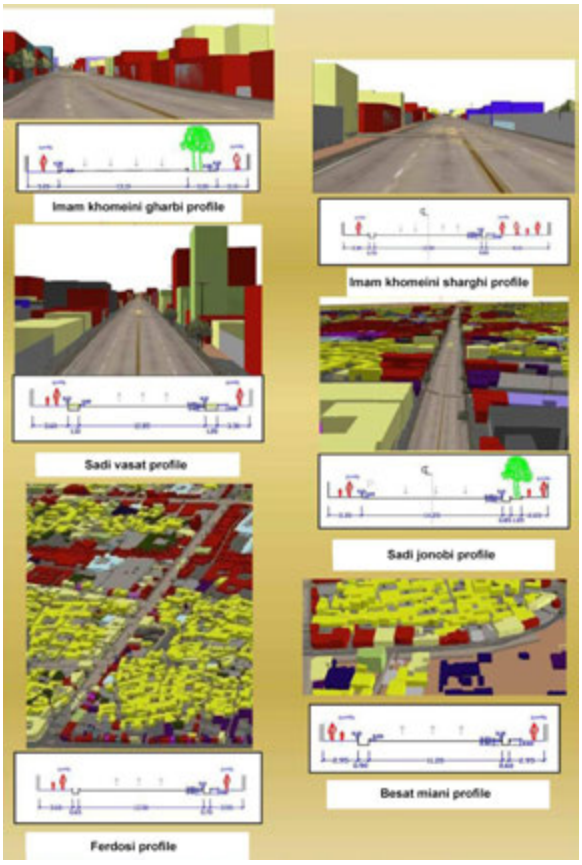

Fig. 3. Cross section and 3D views of selected paths.

Step V: Weighting Indices and Determining the Optimal Location

At this step, the paired comparisons for the criteria and then its repetition for the sub-criteria were conducted using the Delphi model. The next step was to determine the importance coefficient of options and finally the following results were obtained by adding the final score for each of the six paths:

1. The Middle Sadi path having the maximum score was identified as the most important path for creating a sidewalk, followed by the West Imam Khomeini path.
2. Besat and Firdausi achieved the least possible score and were not recognized eligible for converting into sidewalk path.

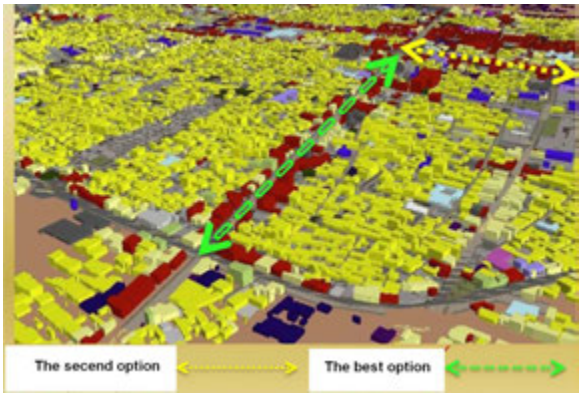

Fig. 4. Location, 3D view, and landuse around selected paths.

CONCLUSION (MAIN FINDINGS)

Today GIS is considered as one of the top 10 technologies, and its integration and analysis capabilities in relation to spatial-temporal data has doubled its importance. Moreover, the implementation of urban and regional planning models such as fuzzy systems, multi-criteria analysis, neural networks, etc., in the related software environment has made GIS one of the most important decision-making tools. In this regard, the feasibility study using GIS and its AHP modelling in selecting optimal walkable paths, is one of the network analysis-based new projects, which are used to identify projects capable of development in the renovation of the old fabrics of Zanjan City. The results showed that despite the success of the selection of optimal paths and their grading, the use of AHP requires caution and realism because of the "order reverse" and "lack of indicators connection" (access, alteration, slope, attraction, diversity and vitality). Moreover, all factors have not necessarily a hierarchical structure and may have cross-feedback features. Under such circumstances, it is recommended to use alternative models such as ANP and fuzzy.

As one of the main urban public spaces, urban

walkways are of the missing rings of renovation in the Zanjan City's old fabric. Therefore, the use of efficient systems and appropriate site location models can be useful in completing the loop.

In this study, according to the criteria and weighting the options through paired comparisons and grading six walkable paths, the Middle Sadi path ranked first place, followed by the West Imam Khomeini path as a secondary option. It should be mentioned that fabric renovation and spatial-physical development aimed at renewal, increasing vitality requires a systematical approach, proper site location and site selection of landuses, implementation of the subjective-local plans, and finally pioneer development projects and 'designing Middle Sadi sidewalk path' can play such role. This does not mean creating restrictions and avoiding vehicular transportation, particularly in crisis management. The importance of this factor is crucial when the Zanjan Urban Management emphasizes on the second project, i.e. West Imam Khomeini path. Finally, it was found that despite the traffic data, stakeholder polls, lack of inhibiting urban transportation systems, there are many other important factors, which must be considered while locating a sidewalk for the concerned study area.

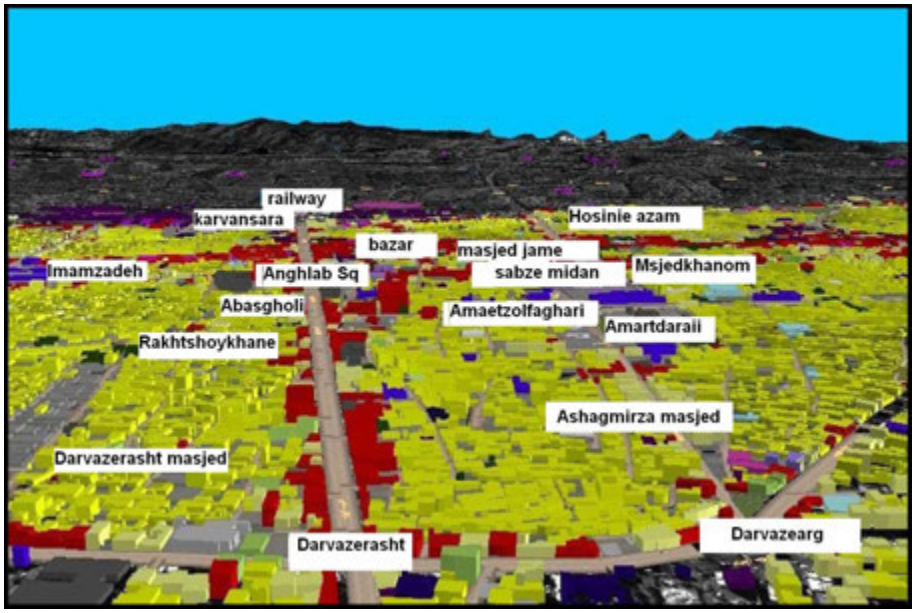

Fig. 5. 3d image of landuse presented and important element in Sadi Vasat.

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