RA'EGA

O ESPAÇO GEOGRÁFICO EM ANÁLISE

AN APPLICATION OF AHP FOR PHYSICAL SUSTAINABILITY ASSESSMENT ON NEW TOWN OF ANDISHEH, TEHRAN - IRAN

APLICAÇÃO DA AHP PARA AVALIAÇÃO FÍSICA DA SUSTENTABILIDADE NA NOVA CIDADE OF ANDISHEH, TEERÃ - IRÃ

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Abstract

Recently, urban planning is attending to make cities more sustainable. This goal can be achieved easier in new towns, because the base of creating a sustainable city is prepared. Sustainability is important for creating immanent and viable urban areas for their residents. New towns have a specific place in Iranian urbanism because the methods of urban planning could realize through these settlements. New town of Andisheh is one of these settlements. It has been built at 20 km of southwest of Tehran in order to absorbing extra population of Tehran and Karaj. In this research, in order to study the sustainability of Andishe, the resources of sustainability are

studied and factors and indicators are extracted. Then according to theses indicators, this city is introduced and its physical sustainability has been studied. This research is an analytical-descriptive research and its analytical part is based on AHP method. In this research, this method has been run by using the software of Expert Choice. AHP uses dual approaches -quantitative and qualitative-in analyzing data. In this project, physical sustainability consists of factors such as housing, transportation, infrastructure, land use, form and morphology, density, vision and urban landscape. The results show that although Andishe is a planed city, based on planning thoughts and principles but physical sustainability of this city is low.

Keywords: AHP, Andisheh, Physical sustainability, New Towns, Urban Planning

Resumo

Recentemente o planejamento urbano está auxiliando a tornar as cidades mais sustentáveis. Este objetivo pode ser alcançado mais facilmente em novas cidades, porque a base da criação de uma cidade sustentável é preparada. Sustentabilidade é importante para a criação de áreas urbanas imanentes e viáveis para seus residentes. As novas cidades têm um lugar específico no urbanismo iraniano porque os métodos de planejamento urbano podem ser realizados através dessas instalações. A nova cidade Andisheh, situada na província de Teerã no Irã, é uma destas instalações. Ela está sendo construída a 20km, à sudoeste de Teerã, com a finalidade de absorver a população extra de Teerã e Karaj. Nesta pesquisa, com o objetivo de estudar a sustentabilidade de Andisheh foram analizados os recursos de sustentabilidade, extraindo fatores e indicadores. De acordo com os indicadores é apresentada a sustentabilidade física da cidade estudada. Esta pesquisa é analítico-descritiva, e a parte analítica é baseada no método AHP. Este método foi aplicado com a utilização do *software Expert Choice*. O AHP usa duas abordagens, quantitativa e qualitativa, nos dados analizados. Neste projeto, a sustentabilidade física consiste em fatores como moradia, transporte, infraestrutura, uso do solo, forma e morfologia, densidade, visão e paisagem urbana. Os resultados demonstraram que apesar de Andishe ser uma cidade planejada, com base em reflexões e princípios de planejamento, a sustentabilidade física desta cidade é baixa.

Palavras-chave: AHP, Andisheh, Sustentabilidade física, Novas cidades, Planejamento urbano.

INTRODUCTION

Resulted problems of World wars and industrial revolution were the cause of thinking about creating new towns. Planning the new towns has been scientifically discussed from 17th century in England. Patrick Geddes and Ebenezer Howard were pioneer of debating this idea. Although its founder is Leonardo da Vinci for dissolving

the problems of Milan and increasing its population (EBRAHIMZADEH and MARVI, 2006).

Actually, this idea is suggested after world war in order to decreasing the population of cities and Decentralization from Metropolises. In Iran, new towns have been built during present century. At First, the new town's planning was based on political and military issues. Before the Islamic revolution in Iran, these had being built to provide housing for industrial workers. But after the revolution, they have been built in order to decentralization of metropolises, absorbing their extra population, moving some industries from metropolises and providing housing for low-income workers (POURAHMAD et al, 2010).

Recently, urban planning tries to create sustainable settlements. This aim might easily achieve in new towns. This sustainability is regarded in dimensions as environment, economy, sociality, physical, urban management that it's solution for creating immanent and viable urban areas for their residents.

New towns have specific settlements. Because these places are the only towns that urban planning's methods can be completely realized in. Andisheh is one of these cities that built at 20 km of southwest Tehran for absorbing extra population of Tehran and Karaj. This research is to analyzing the physical sustainability of this new town.

LITERATURE REVIEW

In this way, one of the same researches is «European common indicators: toward local sustainable development» that it's produced by the European Council in 2003. Its indicators consist of resident's consent in local communities, share of local communities in weather changes, local moving and transportation of passengers, accessibility of public open spaces and facilities, quality of air, children's daily travels to school, sustainable management of local authority, vocal pollution, sustainable land use and the results of improving sustainability. Such indicators: accessibility of public open spaces and facilities and sustainable land use are related factors to this research.

Another related research <indicators of sustainable development>is published in the European Council website. This Councilproposed8indicators as socioeconomic development of sustainable production and consumption, Social inclusion, Demographic changes, Public health, Climate change and energy, Sustainable transport and Natural resources for assess sustainability of cities (http://ec.europa.eu/eurostat).

From such researches, the collection of sustainable development indicators in Sweden (2001) is the other one. It introduces factors as efficiency and profitableness, equity and cooperation, adjustment and compatibility, surplus resource for future generations (STATISTICS SWEDEN, 2001). For example, transport of goods and passenger is considered as a physical indicator of cooperation.

It is supposed that environmental, economic and social dimensions of sustainability are more noteworthy than physical ones.

METHODOLOGY

In this research, the resources of sustainability are studied. Then in order to analyzing physical sustainability of Andisheh, factors and indicators are extracted. Next, this city is introduced and its physical sustainability is analyzed based on extracted indicators. Following questions are tried to be answered through this research:

1- What are the sustainability dimensions of cities?

2- What factors and indicators have physical sustainability?

3- Is Andisheh physically formed based on the principles of sustainability?

4- Is Andisheh a sustainable city?

This is an analytical-descriptive research. It is used«Hierarchical analysis» and the software of Expert Choice in its analytical part.

CONCEPTUAL FRAMEWORK

SUSTAINABILITY: DIMENSIONS AND THE RELATED MOVEMENTS

Sustainability was originated from Howard's «Three Magnet», Mumford's «cities and crisis of culture», Aldo Leopold's «globe's behavior», Jane Jacobs's «common planning and Northland». It was proposed in urban management and governance, environmental, physical, economical and social dimensions. Whether Vilar and Bitly proposed this idea in land use and urban design, transport, urban ecology, use of energy and its efficiency, environmental equity, social equity and economical development (VILAR and BITLY, 2005). The irregular growth of population and its unreasonable distributing in natural and human environment have been caused increasing extension of cities, the reduction of natural resources, crowding traffic and etc. Therefore, strategies such as urban intelligent management, urban green belt, land-use planning and urban inner development have been solution for solving urban distributing and enhancing sustainability (QORBANI and NOOSHAD, 2008).

Actually, Sustainable development was originated from environmental movements. Shumakher used this concept in economical structures, renewal resources, productions and services. Of course, concept should be related to Barbara in 1970's (NASTARAN, 2010).Then, it's discussed in many conferences. In fact, «sustainable development is improving economical, social, cultural and technological conditions to achieve social equity so that pollution of environment and destruction of natural resources will be reduced. It's environmentally nondestructive; technically efficient; economically durable; socially acceptable» (ibid). In this way, Ahmadi (2009) says: «sustainable development is compilation of economical, social, environmental goals that increase human's welfare without harm for future generation's potential to meet their needs». In the manifesto of Stockholm e Rio, the goal of sustainability is quality improvement of life (AHMADI, 2009; VOSUQI, 2010). Therefore, the factors of sustainable development are consist of human (children and women), environment, culture, education, science, morality, security, cooperation (NASTARAN, 2010).

As a result of increasing extension of cities especially in developing countries, sustainability has became one of the basic subject in developments. Inattention to this problem cause secondary problems such as inequity and poverty, reduction of quality of life, housing condition and urban physical development, workless, false employment , crime and corruption (ibid). Therefore a Sustainable city is built for and with nature, and it provides security, calmness and beauty for its resident. This city has geometric and compact form, easy accessibility, efficient and sustainable transport, use of clean energy, dynamic economy and the realization of social equity (FADAYI, 1388; AHMADI, 2009).

In favor of sustainable development«New urbanism» and «smart growth»as new urban movements have been invented. In 1970's, urban and civil planners proposed some ideas such as compact city, urban-village, changing design regulations to progressing social concept and decreasing use of automobile. Whereas providing lands in difficult, buildings construction and roads widening have been expensive, organizations tried to encourage using public transportation. American Environment Protection Association (EPA) suggested smart growth to decease air pollution (GHORBANI and NUSHAD, 2008).

In conflict with diffuse and sprawl growth of cities, concepts as «the limitation of urban growth», «growth management» and «smart growth»were proposed. The limitation of urban growth tries to prevent environmental disaster by creating city's boundary (TURNER, 2007). The policy of growth management tries to soothe growth for achieving economical development, protection of quality of life and environmental conditions. Smart growth is concentrated on development density, land use spatial distribution and decreasing the use of automobile. This approach aims to organize the relationship between developments and quality of life (BLOUSTEIN, 2007). Smart growth attends to basic principles like prevent from out-urban growth, encourage to decrease growth speed and to grow central places, build land use and house's different types so that created places, meaningful central districts, open spaces, appropriate accessibility to neighborhood, preserve natural resource , decreasing use of automobile and encourage to use of public transport (ibid). In addition, smart

growth uses low-cost and efficient policies to decrease use of personal automobile (GHORBANI and NUSHAD, 2008).

Many disputations are about smart growth's insufficiency. Critics believe that smart growth makes increase density and worsen resident's conditions, air pollution, accidents, expensive public facilities, crime and poverty. Also they believe that smart growth could be the cause of approving laws that decreasing people's freedom (LITMAN, 2005).

By1990's, new urbanism has been suggested. New urbanism tries to readout traditional concepts. It proposes concepts like improvement of human society, quality of life, participation of citizen in creating cities, change urban space's structure, housing, transportation, social interactions, and introduce city as live and complicated organism (FALCONER et al, 2010). This approach tries to solve problems of metropolises by factors as neighborhoods, activities districts, and network (FORD, 1999). «Traditional Neighborhood Development» and «Transit Oriented Development» are based on New urbanism (FORD, 1999).

URBAN PHYSICAL SUSTAINABILITY

Urban physical dimension includes form, morphology, and pattern of development till urban details such building features. Carmona (2009), in«public places, urban spaces»believes that morphology is the studying form and shape of settlement. Morphologists believe that settlements have several dimensions. Canzen suggests such dimensions like land use, building structure, pattern of blocks and networks. Although Canigia believes that these dimensions are urban fabric (CARMONA, 2009).

In late 20 century, because of environmental and ecological crises and then environmental problems, urban sustainable form was proposed. In this regard many urban patterns have been suggested, for example:

1- Compact city (FADAYI, 2009; THINH et al, 2002)

2- Urban-village (FADAYI, 2009)

3- Urban ecological design (FADAYI, 2009; CHIESURA, 2008)

4- Walk able and biking city's pattern (YANG et al, 2008)

5- Car-free city(FADAYI, 2009; YANG et al, 2008)

Also, Suggested urban sustainable forms include Neo-traditional development, Urban containment, compact city, Eco-city (JABAREEN, 2006).

Pattern of compact city is important in achieving urban sustainability. According to Elkin et al (1991), compact city is suitable for walking, riding and public transport. This city has high building and population density so that encourages social interactions. In this way, the third or fourth floor is suggested in urban areas of European and English cities. In this form, each building has entrance to street, and every one access to garden or yard. Also, Dumreicher et al believe that sustainable city should be compact, dense, diverse and united. In their opinion, urban form should be walk able. It should be such small that residents needn't to driving. In other hand, it should be big so that sufficient services and facilities exist for wealthy life.

Infill development is on way to achieving smart growth. This policy is suggested for a long side connected (create town surround big cities)and disconnected (create new town)developments. Some people tell that this development can respond to residents' needs like settlement of extra urban population and improvement of urban services areas. Until this development is possible, other policies are unscientific and irrational (CENTER FOR URBAN POLICY RESEARCH, 2006).

Infill development is complex, multi dimension, middle sectoral, out sectoral. This policy has social, cultural, economical, environmental and physical dimensions. In this, cities are expanded vertically and old and inefficient buildings are rebuilt. Also, useless and abandoned lands are utilized and incompatible land uses such as prisons, military garrisons, trouble makers companies and industries are replaced. Roads and network, green spaces and other land uses are improved toward achieving urban planning standards (ibid).

There is a strong relationship between sustainable city and density. The Oner's researches discuss the relation between land use, density and urban framework and they are looking for production profits in use of energy. The sustainable city helps to environmental efficiency and sustainable development by (AZIZI, 2004, p.58):

a- Selecting urban forms and distributing land use and densities to decreasing inner-city travels

b- Improving physical environment in order to decrease the need of domestic and industrial energy

Urban density is the ratio between numbers of people or housings over area. It impresses sustainability by the use of energy, material, and needed land for housing, transport and urban infrastructure. Actually, Density is one of the important factors related to transportation. It is supposed that high density decreases the manner of driving and car's ownership. High housing density has impact on selection of travel's type. Also, mixed use in high density districts encourages residents to walking, riding or both of them and therefore makes driving less common (JABAREEN, 2006).

Important policies in these approaches are zoning prevention and mixed use. Mixed use policy suggests combination of land uses and thus decreasing the distances. Jacobs is one of critics who objects with zoning and suggests mixed use. They believe that mixed use causes a decrease in use of energy, an increase in urban vitality and improvement of walkability (VAHIDI, nd).

Carmona (2009) ,in his book- «Public Spaces, Urban Places»-mentioned the role of public spaces and urban open spaces to create vitality and improve urban aspect, and survey quality of beauty and sense in these spaces. He suggests the order in space, rhythm, coordinator, relations, spatial cohesion, and dynamic spaces. He says that Kaplan believes complexity, cohesion, being mysterious and legibility are very important in urban spaces. In this regard, Krier believes that urban spaces are consisting of two types: streets and squares. He believes that the shapes of urban spaces, use of soft and hard spaces in city, urban furniture's, and sky line are important in dependency of city and urban design. He suggests urban façade, color, fabric, decoration, masses, plans and sections in urban environmental landscape. Krier believes that sustainable city is created by regarding standards and principles. The important factors of legibility and identity are ease of identification and creation of relation between urban elements and other spaces. The sense of city has a direct relationship with spatial shape and its quality and also it has independence with

people's culture. Legibility is the important factor of sustainability and urban symbols help to legibility. These symbols can be specific building, landscape or physical elements. In other hand, changing in height and distinctive design are important. Attending to the urban prebuilt fabric and type of land use also is so effective (MOSHAVER ZADEMEHRABI et al, 2009).

CASE STUDY

Andisheh is a new town with 1400 Hectare and located in20 kilometer from southwest of Tehran. It's located in east of shielding district of Karaj and north- west of Shahriar. Besides, it is located near Chitgar, Shahriar-Eshtehard road. Its location was determined by Tehran Urban and Architecture Ministry. This area is limited from east to Karaj River, from west to development plan of Karaj, from south to Karaj-Alishahvaz road, and from north to lands of Haftjooy. According to the developmental plan of Andishehin1368, 40,000population were predicted for this city. In 1371,60,000 inhabitants/people and1495 hectares were predicted. Finally, in 2000, its developmental plan was approved by103,500 people and 1,400 hectare (CIVIL AND RESEARCH CONSULTING ENGINEER, 1997; PLAN AND CITY CONSULTING ENGINEER, 2003).

Figur1: Location of Andisheh
Source: engineering consultant of city and planning: 2003

This city consists of 6districts.Suggested building density of Andisheh has been100% in floor, two apartments in one floor, and Net Square of any apartment is 101m^2. Suggested Building density is average for creating diversity and improvement of accessibility around centers of service, and it's allowed more density in these centers, although surrounding areas have low density (PLAN AND CITY ENGINEER, 2003).

In Andishe, cars and its ownership are very important in designing and development patterns, but walkability and riding are less. This concept in designing influences urban vision of this city, fabric, vitality and other factors to creating sense of place (MOJREEKERMANI, 2006).

Visibility of a large number of buildings in city is result of their architectural form, their distinction from surrounding buildings and urban fabric. One of the most impressive factors in physical distinction is building or urban collection's visibility that

buildings are reminded in people's memory. The physical elements with specific style can be old or current, but their location has important roles in urban legibility.

Memorial places of Andisheh are:

1- City's memorial with 15,000m^2;

2- martyrs memorial with 12,000m^2;

3- (Azadi Square), entrance square of phase 3.

Results of peoples' interviews show that these places aren't enough effective and memorial. Because Surveys show that half of residents don't mention theses places as symbols of their city. So that a few of respondents mentioned Monument in Azadi Square and none of them memorial of martyrs. According to this survey, the Andisheh urban markets and daily markets are the best urban symbols. Subsequently, Mosque of third district and special entrance of some Condominium such as: Baharestan and Golestan are expressed as urban landmarks. Generally, the symbols and landmarks of New town of Andisheh are not only enough desirable and attractive, but also the improper relationship these elements make the legibility and understanding of city difficult (MOJREE KERMANI, 2006).

INDICATORS OF RESEARCH

According to the Conceptual framework, indicators were obtained and localized. Table 1 describes these factors.

Table 1 – physical Criteria and Sub criteria

Criteria	Sub criteria
Housing	Accordance climate with building
	Considering density proportional location
	Minimizing energy consumption
	According to resident's need of housing design
	Security and safety
Transport	Reduce the need for car
	Definition of hierarchical access networks
	Determine the optimal width of passages
Infrastructure	Energy
	Water
	Waste
Land use	Functional diversity
	Walkability
	Equitable and efficient distribution of services
Form and morphology	Compact urban development
	Diversity in the city block
	Giving priority to public urban spaces
Density	Diversity in density pattern
	Vertical urban development
Vision and urban landscape	Legibility
	Security
	Landscape architecture

Source: writers

ASSESSING AND ANALYZING SUSTAINABILITY OF ANDISHEH BY AHP ANALYTICAL HIERARCHY

Physical sustainability, as research's goal, the software of expert choice is used to determine priorities of criteria and sub criteria.

Table 2 – determine priorities of criteria

	Housing	transport	Infrastructure	Land use	Form and morphology	Density	Vision and urban landscape
Housing		2	1	2	4	3	5
Transport			2	1/3	2	2	3
Infrastructure				1	3	2	4
Land use					2	2	5
Form and morphology						2	2
Density							2
Vision and urban landscape							

Source: writers

Table 3 – determine priorities of sub criteria of housing

	Accordance climate with building	Considering density proportional location	Minimizing energy consumption	According to resident's need of housing design	Security and safety
Accordance climate with building		2	½	2	1/3
Considering density proportional location			½	2	1/3
Minimizing energy consumption				4	1
According to resident's need of housing design					1/5
Security and safety					

Source: writers

Table 4 – determine priorities of sub criteria of transport

	Reduce the need for car	Definition of hierarchical access networks	Determine the optimal width of passages
Reduce the need for car		2	1
Definition of hierarchical access networks			1
Determine the optimal width of passages			

Source: writers

Table 5 – determine priorities of sub criteria of Infrastructure

	Energy	Water	Waste
Energy		½	1
Water			2
Waste			

Source: writers

Table 6 – determine priorities of sub criteria of Land use

	Functional diversity	Walkability	Equitable and efficient distribution of services
Functional diversity		1	1/2
Walkability			1/2
Equitable and efficient distribution of services			

Source: writers

Table 7 – determine priorities of sub criteria of Form and morphology

	Compact urban development	Diversity in the city block	Giving priority to public urban spaces
Compact urban development		2	1
Diversity in the city block			1/2
Giving priority to public urban spaces			

Source: writers

Table 8 – determine priorities of sub criteria of Density

	Diversity in density pattern	Vertical urban development
Diversity in density pattern		1/2
Vertical urban development		

Source: writers

Table 9 – determine priorities of sub criteria of Vision and urban landscape

	Legibility	Security	Landscape architecture
Compact urban development		2	1
Diversity in the city block			1/2
Giving priority to public urban spaces			

Source: writers

Finally, according to Conceptual framework, minimum and maximum of score of sub criteria was calculated. Then, the score of sub criteria was calculated in existing conditions.

Table 10 – determine priorities of sub criteria of housing

Criteria	sub criteria	Maximum of score	Minimum of score	score of existing conditions
Housing	Accordance climate with building	4	0	2.5
	Considering density proportional location	2	0	0.5
	Minimizing energy consumption	5	0	1
	According to resident's need of housing design	3	0	1
	Security and safety	4	0	1
Transport	Reduce the need for car	10	0	0.5
	Definition of hierarchical access networks	8	0	3
	Determine the optimal width of passages	2	0	1
Infrastructure	Energy	5	0	0.5
	Water	12	0	2
	Waste	5	0	0
Land use	Functional diversity	10	0	6
	Walkability	3	0	0
	Equitable and efficient distribution of services	1	0	0
Form and morphology	Compact urban development	7	0	3
	Diversity in the city block	1	0	1
	Giving priority to public urban spaces	4	0	1
Density	Diversity in density pattern	3	0	2
	Vertical urban development	1	0	0
Vision and urban landscape	Legibility	6	0	2
	Security	6	0	3
	Landscape architecture	7	0	3

Source: writers

The analysis shows that from the maximum score (0.791)in physical sustainability, Andisheh is obtained0.209. According to the score of 26% in physical sustainability, it's assessed that Andisheh' s sustainability is low.

Table 11 – amount of sustainability compared with existing percentage

sustainability percentage	amount of sustainability
0-20	Very low
20-40	Low
40-60	Average
60-80	High
80-100	Very high

Source: writers

Among indicators, in order of preference, housing, Land use, Infrastructure, transport, Form and morphology, Density, Vision and urban landscape are more sustainable. In this model, incompatibility is 0.05 .
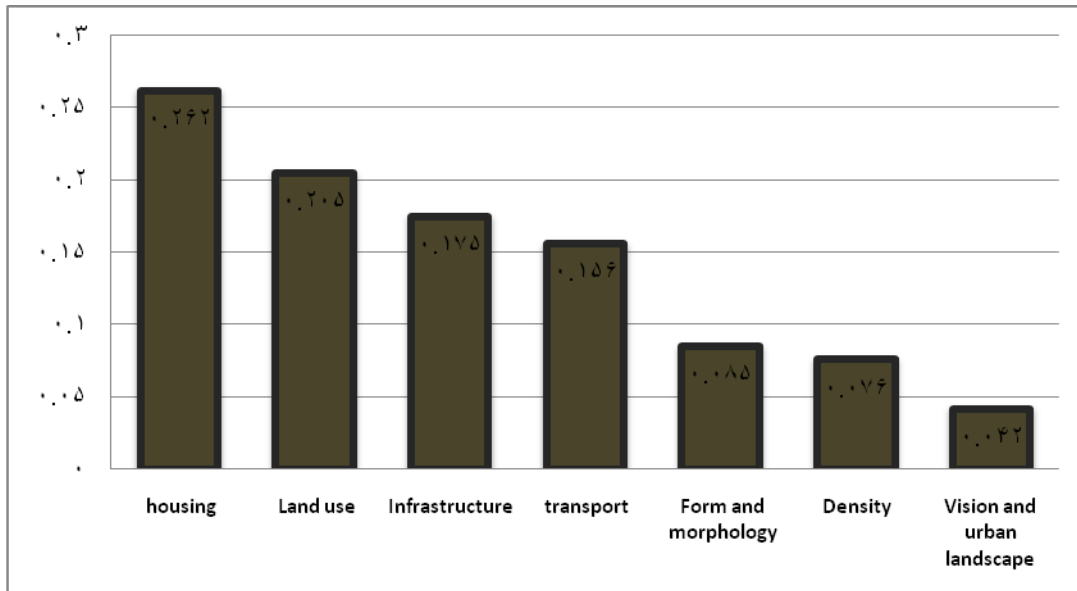

Chart 1: amount of criteria's sustainability in Andisheh
Source: writers based on the results of expert choice analysis

With comparing the score of any indicator, in existing and optimal conditions, sustainability of housing is 30%, sustainability of Land use is 14.6%, sustainability of Infrastructure is 15%, sustainability of transport is 28%, sustainability of Form and morphology is 47%, sustainability of Density is 33% and sustainability of Vision and urban landscape is 44%.

As it's told, housing has the maximum of sustainability. Among of sub criteria of housing, *Security and safety* has the maximum of sustainability with 36%. Then, the score of *Minimizing energy consumption* is 29%, *Accordance climate with*

building is 16%,*Considering density proportional location* is 12% and *According to resident's need of housing design* is 7%. Therefore, *Security and safety* has average sustainability. *Minimizing energy consumption* has low sustainability and *Accordance climate with building*, *Considering density proportional location*, *According to resident's need of housing design* have very low sustainability.

Table 12 – amount of physical sustainability in Andisheh

Criteria	sub criteria	percentage of sustainability	amount of sustainability
Housing	Accordance climate with building	16	Very low
	Considering density proportional location	12	Very low
	Minimizing energy consumption	29	Low
	According to resident's need of housing design	7	Very low
	Security and safety	36	Average
Land use	Functional diversity	25	Low
	Walkability	25	Low
	Equitable and efficient distribution of services	50	Average
Infrastructure	Energy	25	Low
	Water	50	Average
	Waste	25	Low
Transport	Reduce the need for car	41	Average
	Definition of hierarchical access networks	26	Low
	Determine the optimal width of passages	32	Low
Form and morphology	Compact urban development	40	Average
	Diversity in the city block	20	Low
	Giving priority to public urban spaces	40	Average
Density	Diversity in density pattern	33	Low
	Vertical urban development	66	High
Vision and urban landscape	Legibility	24	Low
	Security	55	Average
	Landscape architecture	21	Low

Source: writers

Among of sub criteria of *Land use*, *Equitable and efficient distribution of services* has the maximum of sustainability with 50%. Then, the score of *Functional diversity* is 25% and *Walkability* is 25%. Therefore *Equitable and efficient distribution of services* has average sustainability and *Functional diversity* and *Walkability* have low sustainability.

Among of sub criteria of *Infrastructure*, *the sustainability of Water* is 50%. *The sustainability of Waste and Energy* is 25%. It shows that *water* has average sustainability ,and *Energy and Waste* have low sustainability.

Among of sub criteria of *transport*, *Reduce the need for car* has the maximum of sustainability with 41%. Then, the score of *Determine the optimal width of passages* is 32% and *Definition of hierarchical access networks* is 26%.Amount of sustainability in all sub criteria is given in table 12.

According to the results of AHP, sub criteria *compact urban development and Giving priority to public urban spaces* has maximum sustainability(40%).Then, the score of *Diversity in the city block* is 20%.

Among of sub criteria of *Density*, *Vertical urban development* has the maximum of sustainability with 66% that it shows it's high sustainability. Then, *Diversity in density pattern* with 33% has low sustainability. Also, Among sub criteria of *Vision and urban landscape*, *Security* has average sustainability with 55%. Then, *Legibility* and *Landscape architecture* with 24% and 21 have low sustainability.

CONCLUSION

For improving Andisheh's physical sustainability, critical points and changing issues are determined by BCG matrix (investment priorities). This matrix shows the priorities based on the amount of sustainability of items. that On the base of research, Andisheh's physical sustainability is low. In BCG matrix, if a case is in up-up setting, it will be optimal, but if this is in down-down setting, it will have problem, and will is in the worst condition. Also, If this is in down-up or up-down setting, it should be is in action's priority. Therefore, for improving Andisheh's sustainability, indicators as «access to water»,«Equitable distribution of services», «Vertical urban development» and «Security»is in priority.

Supplement – BCG matrix for determine physical sustainability in Andisheh

Goal sub criteria		physical sustainability in Andisheh	
		Up	Down
Accordance climate with building	Up		
	Down		■
Considering density proportional location	Up		
	Down		■
Minimizing energy consumption	Up		
	Down		■
According to resident's need of housing design	Up		
	Down		■
Security and safety	Up		
	Down		■
Reduce the need for car	Up		
	Down		■
Definition of hierarchical access networks	Up		
	Down		■
Determine the optimal width of passages	Up		
	Down		■
Energy	Up		
	Down		■
Water	Up		■
	Down		
Waste	Up		
	Down		■
Functional diversity	Up		
	Down		■
Walkability	Up		
	Down		■
Equitable and efficient distribution of services	Up		■
	Down		
Compact urban development	Up		
	Down		■
Diversity in the city block	Up		
	Down		■

Giving priority to public urban spaces	Up		
	Down		▓
Diversity in density pattern	Up		
	Down		▓
Vertical urban development	Up		▓
	Down		
Legibility	Up		
	Down		▓
Security	Up		▓
	Down		
Landscape architecture	Up		
	Down		▓

Source: writers

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