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Assessing environmental and economic indicators of sustainable development in mining-extractive cities (A case study of Asaluyeh, Iran)

Reza Mokhtari Malekabadi[1]**-** *Assistant Professor of Geography and Urban Planning, Payam Noor University, Tehran, Iran*
Nafiseh Marsusi- *Associate Professor of Geography and Urban Planning, Payam Noor University, Tehran, Iran*
Mohammad Gholami- *PhD candidate of Geography and Urban Planning, Payam Noor University, Tehran, Iran*

Abstract
Among various types of cities, mining cities have special features including a high concentration of industrial activities associated with the exploration, extraction, refining, processing and export of groundwater resources, the risk of reduction and termination of non-renewable resources, high degree of environmental pollution, high production of domestic and industrial waste and social issues related to job migration and cultural duality which can create or exacerbate unsustainability matter on environmental, economic, socio-cultural and physical scales in urban environment of such cities. The aim of this study was to analyze and evaluate the environmental and economic dimensions of sustainable urban development in Asalouyeh situated in southern Iran, northern coast of Persian Gulf and in terms of methodology, this research employs a descriptive- analytical approach. Information required was collected through reviewing documents, fieldworks and questionnaire and were analyzed applying SPSS and Likert scale to value indicators. The results of data analysis using T-test, Wilcoxon and Friedman test, implied that the mining activity in the coastal town of Asaluyeh not only did not contribute to the stability of this city but it also led to greater instability. In the environmental sustainability component, pollution control component, as one the most important parameters in the presence or absence of the issue of sustainability in Asaluyeh, had the lowest rank and priority (1.05) between components of this dimension. Also, on the economic stability dimension, activity and employment components (2.03) and investment (1.41) are not in good condition.

Key Words: *Assessment, Mining-extractive City, Sustainability indicators, Asalouyeh, Sustainable urban development*

1. Corresponding Author, Tel: 09173811538, Email Address: mokhtaryus@yahoo.com

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Introduction

1.1.Statement of the problem

City is a term which gets its meaning from the population structure, various types of activity and usage in a geographic context. In the variety of available cities, there are certain types of cities known by terms such as mining towns, the resource – based and the extractive. Such cities are cities formed by the extraction of mineral resources and gradually grow as a city. Their emergence and development are primarily dependent on certain types of natural mineral resources. Sources of export and raw materials are among the characteristics of resource-based economic region. Its main function is a type of city which supports mineral products and processed products (Wang et al. 2009, p.1647). In resource-based and extractive cities especially due to the exploitation of crude oil and the urban economy's dependence on non-renewable resources, the development process follows an unsustainable pattern. Since approaching the end of reserves, economic and social life will be faced with serious challenges. Among the examples of such a perspective is Masjed Soleyman, Iran's first oil town. The city, once considered as a legendary city and one of the most modern cities in his time, lost its prosperity with the gradual reduction of oil resources in the 1970s and it was followed by a sharp drop in the urban life, so that now the city is poor and lacks facilities (Bahreini & Jahani Moqadam 2004). These cities have faster development processes than other regions due to their specific nature. Concentration of population, industrial and economic activities, etc., which occur in a short time with the attraction of major financial and human resources and national and international interest, increase their vulnerability in environmental, social and physical dimensions.

Extractive cities are among the urban areas that due to the different conditions of formation and development and different forces emanating from extraction and activities associated with mining and industrial activities have a different face and a different impact on the natural environment and their community. The major issue in these cities is the evaluation of the concept of sustainability in environmental, economic, physical and socio-cultural aspects. The main and initial objective for sustainable development of mining towns is creating a balance between the different aspects that sometimes have paradox (For example economic development which is accompanied with the increased extraction of resources and the establishment of high volume of industrial units was opposed to environmental issues). Therefore, considering the problems that these cities have, noting the fundamentals and principles of sustainable urban development is essential in the planning process for their development. Asaluyeh coastal town can be considered typical of mining towns which once being a rural region, has become a national and international city in a short time and is affected by activities associated with the extraction, refining and exportation of gas. This city is among the regions that have been widely used in industrial investment in less than 10 years and for various reasons, social and cultural considerations have not been met in the construction of industrial facilities (Talebian et al. 2008). Capital centralization and employment opportunities have resulted in the concentration of population and commerce, services and economic activities. Features of accelerated development of industries affected by resource extraction activities and the establishment of industrial units in Asaluyeh (which are mainly situated in the coastal narrow strip and is environmentally sensitive and important) have caused instability in the social and natural environment. Industrial development and establishment of gas processing centers and various petrochemical products has been started since 1995 and after the discovery of huge natural gas reserves in South Pars and several activities have been defined to promote this project

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and to achieve higher levels of gas resource utilization. Huge investment in rural milieu of Asaluyeh has caused numerous issues that are the outcome of the conflict between the undeveloped social environment and industrial aspects (Talebian et al. 2008). With the advent of oil and gas, many injuries in different ecological, cultural and social levels have been emerged in South Pars and in most areas the region is facing many problems. Therefore, this study attempts to identify the stability and the underlying factors of instability of the development of Asaluyeh and issues related to indicators of sustainable urban development.

1.2. Research questions and hypotheses

In line with the research question and the situation in Asaluyeh, the key question and related hypotheses were formulated as follows:

With regard to the dimensions of urban sustainable development and sustainability indicators, is the development of Asaluyeh, sustainable and balanced?

It seems that the development in Asaluyeh has not led to the formation of the sustainable development paradigm in environmental aspects yet.

It seems that the development in Asaluyeh has not led to the formation of the sustainable development paradigm in economic aspects yet.

1.3. Review of Literature

A number of international research conducted on the sustainability of extractive cities are as follows:

Yu et al (2008) in their investigative attempt entitled 'The sustainability of China's major mining cities' identified principal factors controlling the Degree of Sustainable Development of Mineral Resources (DSDMR) of mining cities and then their developing trends. The authors used 78 Chinese mining cities for this purpose. Their results showed that the DSDMR decreases from petroleum to multi-resources to non-metal to coal to metal cities. They also found that large and very large cities have higher DSDMR values than middle- and small-sized cities.

Wei and Jie (2010) in another attempt entitled 'A Research on Problems for Sustainable Development of Mining Cities in China' discussed the intrinsic and extrinsic reasons for problems of the mining cities from the perspective of sustainable development. Their results show that the economic development level of the mining cities is lower than the average level of countrywide cities. The economic benefit of the mining cities is increasing owing to the economic scale, and the economic situations of oil-mining cites and iron-mining cites are relatively better than those of other types of mining cities.

Hong et al. (2011) in another study entitled 'Research on sustainable development of resource-based small industrial and mining cities' took small industrial mining cities in Shanxi province as the research subject. The authors proposed five strategies to promote the transformation and development of urban functions of these mining cities. Shanxi province is a town on the economic development axis with an area of about 74.3 square kilometers with a total 40000 population that despite having coal and bauxite resources, is dealing with serious environmental pollution brought by industries and transportation and the limited land in the city.

Shao and Zhou's (2011) study entitled 'Study on the Influences of Industry Transformation on the Sustainable Development of Resource-Exhausted City Space' analyzes the industrial transformation and its effects on urban spatial structure of resource-exhausted cities and investigates the mechanisms through which the industrial transformation affect the sustainable development of urban space. In this study, some guidelines to improve the coordination and harmony of urban spatial structure and industrial structure are provided so as to promote the smooth transformation of resource-exhausted cities and achieve the sustainable development. The authors believe that such cities are problematic in the sustainable development of China.

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Yupu et al. (2012) in an article entitled 'Sustainable development of coal cities in Heilongjiang province based on AHP method' evaluated the sustainable development of system of coal mining cities of Northeast China applying the analytic hierarchy process (AHP) method. The results of their study showed that economic development and environment quality are the most important indices of the targeted layer influencing the sustainable development of coal mining cities of Heilongjiang. Industrial economic benefit and the ratio of environmental protection investment are the key elements influencing these two aspects.

1.4. Research Method

The present study is an applied research and applying the mixed method (quantitative and qualitative) and the descriptive-inferential approaches, it identifies impacts and socio-cultural changes in Asaluyeh as an extractive city. For the analysis of quantitative data obtained from the completed questionnaires, inferential analysis using SPSS software, one sample T test, Wilcoxon and Friedman were applied. The population consisted of all residents of Asaluyeh. The sample population was estimated applying Cochran formula with the confidence level of 95% and it was equal to 386.

1.5.Introducing variables and indicators

The most widely accepted approach for measuring sustainability and sustainable development is employing indicators and standardized measurements (Bell & Morse 2003). As Singh et al. (2012) rightly assert 'sustainability indicators and composite index are gaining lot of importance and increasingly recognized as a powerful tool for policy making and public communication in providing information on countries and corporate performance in fields such as environment, economic, social, or technological improvement' (p. 281). Indicators are not a new invention. They transform changes in complex systems into an individual sign that is responsive and comprehensible and allows us to focus on what is important. They warn us about the dangers so that they would not become crises and tell us whether or not we have made some positive changes (Abdi et al. 2010). Sustainability indicators may be the most important tool for individuals, institutions, communities and societies to take different and better choices for their future (Teimouri et al 2012). These indicators are not the answer per se, but can lead us to a better response about the things we value in life in case the information is reliable (Badri & Eftekhari 2003; Mosa Kazemi & Shekouei 2002). Sustainability indicators should encompass aspects of sustainable development. For example, based on the chapters of Agenda 21, sustainable development indicators include social, economic, environmental and institutional indicators (Milner-Gulland & Akcakaya 2001). Sustainable development indicators play a significant role in developing basic information for defining goals and identifying functions required to perform them. They can be applied in monitoring and evaluating the performance of the urban development process and in communicating the tangible and concrete results suitable for involving other social actors and interested public in social issues. There is a wide variety of indicators of sustainable development each describing certain aspects of urban functionality and dysfunctionalities (Bănică 2010). In this study, based on information and data available and the proposed indicators at the international level and according to the specific conditions of extractive cities and Iran, a number of indicators were selected as described in Table 1.

1.6. The studied area

This study has been conducted in Asaluyeh as an example of Iran's extractive cities. The city is situated in 27° and 82 minutes north latitude and 52° and 36 minutes east longitude and at an altitude of 5 meters above the sea level (Jafari 1990).

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Dimension	Major index	
Economic	Activity and Employment	11
	Income and its distribution	6
	Cost of Living	6
	Investment	5
Environmental	Land Resources	9
	Pollution control	7
	Environmental awareness	5

Table 1. List of dimensions, measures and indicators used in the study; Adopted from Bănică 2010; Dempesy et al,2012; Donatilo 2001; Li et al 2009; Rezvani et al 2012; UN 2007; WHO 1997

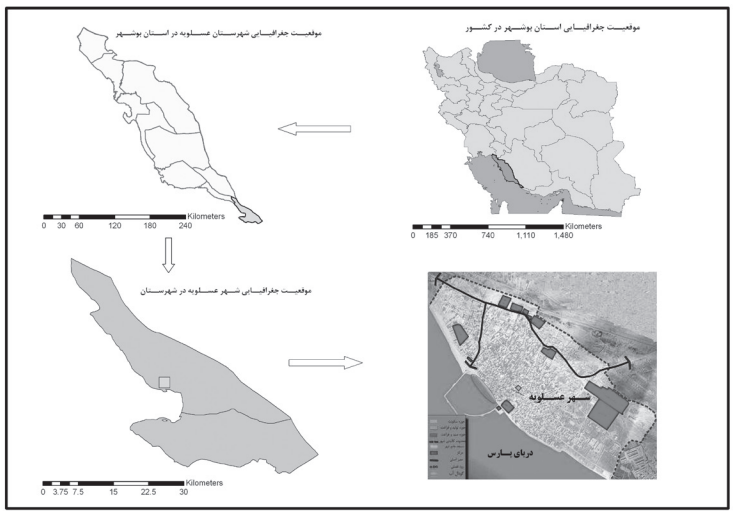


Figure 1. the geographic location of the studied area (Source: Authors)

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2. Theoretical Foundations

2.1. Definitions and Concepts

Sustainable development is a general and vague term that tries to encompass a growing concern about the future of the planet through addressing the complex relationship between environment and development. Despite the international reputation of the term, there is no agreed international definition of sustainable development. In Radcliffe's view, the lack of a definition for the term is precisely because of the numerous and various perspectives on the term development (Potter & Evans 2005). The concept of sustainable development and sustainability has been defined from different perspectives, with each definition for a specific purpose and used in different areas (Winograd & Farrow 2010). Ideas of sustainable development have a long history in the literatures of both development and environmentalism (Elliott 2006, p.7). This type of development requires encompasses the relationship between humans and between humans and nature in the current time and over time (Fani 1990). In the concept of sustainability, preservation of human, environmental, social and economic capital is attended in line with intergenerational justice (Pourtaheri et al. 2011). The new concept of sustainable development is holistic and involves all social, economic, cultural aspects and notes meeting other human needs. Surely, the most important attraction of sustainable development is its holistic perspective and interconnectedness and organized economic, environmental and social relationship (Burger 1997).

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Sustainable urban development is a dynamic and constantly changing approach in response to economic, environmental and social pressures (Haughton &Graham1994), which has a significant role in the concept of sustainable development (Xing et al 2009, p.209). Sustainable urban development has gradually become a new and dominant model in common theoretical and scientific literature on the city development and planning in recent decades (Rahnamaee & Pour Musavi 2006).

To sum up, all definitions and concepts of sustainable development refer to the fact that sustainable development is a balancing development with environmental, economic, sociocultural and physical considerations at global, regional, national and local scale so that they both meet the needs of the present generation and reduce the concern of satisfying the needs of future generations. This important fact can be achieved by global consensus in the use of technology compatible with the natural environment, supply of clean energy which is gained through the use of natural renewable resources (wind, sun, etc.) and reducing consumption. Surely, in developing and underdeveloped societies, the issue of economic growth and meeting the minimum salaries is a priority despite having faith in sustainable development. This point can expose serious doubts on the paradigm of achieving comprehensive sustainable development at a global level.

2.2.Mining cities and Urban sustainability issue

Mining and resource-based cities are formed by mineral exploitation, and gradually develop into a city. In other words, their natural resources as a source of the emergence of this type of cities give them the possibility of being developed, but their emergence and development strongly depends on the type of resources extracted (Wang et al 2008). Resource-based cities are driven by the extraction of mineral resources. They are characterized by resource- basic industries and professional production. In these small towns, more than 40 percent of the workforce is used directly or indirectly in various forms of extraction, production and commercial exploitation of resources (Hong et al 2011). Limited and non-renewable resources determine the changes in the urban spatial structure and industrial development of such types of cities (Shao & Zhou 2011). The increasing growth of mining towns is strongly dependent on the extraction of mineral resources. Collection of buildings and labor camps which are created and installed near the resources would never have the concept of mining town unless there is a growing mining which attracts industry especially services in the city itself and that does not mean that towns which were created solely on extractive industries and still have not succeeded in the development of processing industries, would not be regarded as mining towns. Since the discovery of the mines and conducting basic research and exploration and drilling of minerals indicates the evolution of mining towns and with increase in production, the process of recruiting required staff and building human settlements will be started (Farid 1996). The main function of this kind of cities is providing mining materials and other primary processed materials (Wei & Jie 2010), which plays an important role in national economic development (Wang et al 2008). Among the features of mining cities in economic and civic life is that unlike renewable resources such as water, soil, mineral resources (which are the basis of life in this cities) are non-renewable and they increasingly decrease in amount (Yu et al 2008). The contradiction in the economic, social and environmental-ecological aspects of the mining towns is being more and more revealed (Wang et al 2008). In resource-based and extractive cities, in particular, oil-rich cities, due to raw exploitations and the urban economy's dependence on nonrenewable resources, the development pattern is unsustainable. Since when approached to the end of the natural re-

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Dimensions	T-statistics	Significance (Two-tailed)	Mean	Results
Activity and employment	-18.459	.001	2.7427	Less than average
Income and its distribution	16.296	.001	3.3482	Less than average
Cost of living	10.8	.001	3.3074	More than average
Investment	-26.229	.001	2.4067	Less than average
The average number of cases = 3				

Table 2. the results of one-sample t-test for economic sustainability and its indicators

sources, economic and social life will be faced with serious challenges. Among the examples of such a perspective is Masjed Soleyman, Iran's first oil town. The city, once considered as a legendary city and one of the most modern cities in his time, lost its prosperity with the gradual reduction of oil resources in the 1970s and it was followed by a sharp drop in the urban life, so that now the city is poor and lacks facilities (Bahreini & Jahani Moqadam 2004). These cities have faster development processes than other regions due to their specific nature. Concentration of population, industrial and economic activities, etc., which occur in a short time with the attraction of major financial and human resources and national and international interest, increase their vulnerability in environmental, social and physical dimensions.

Extractive cities are among the urban areas that due to the different conditions of formation and development and different forces emanating from extraction and activities associated with mining and industrial activities have a different face and a different impact on the natural environment and their community. The major issue in these cities is the evaluation of the concept of sustainability in environmental, economic, physical and sociocultural aspects. The main and initial objective for sustainable development of mining towns is creating a balance between the different aspects that sometimes have paradox (For example Economic Development which is accompanied with the increased extraction of resources and the establishment of high volume of industrial units was opposed to environmental issues). Urban sustainable development has a significant role in the concept of sustainable development (Xing 2009, p.209). Mining activities can make a wide range of impacts on the local landscapes, biodiversity, population, marine environments, rivers and catchment areas, local communities, indigenous peoples and workers (Rae et al 2002). The United Nations Environment Program knows the destruction of natural ecosystems, changes in river regimes and aquifers and other dangerous ecological effects as environmental impact of mining (UNEP 2000, p.3). These types of activities profoundly affected socioeconomic prospects and patterns of involved communities and countries. But there is no consensus on how to explain sustainability by extractive activities. The limited nature of mineral resources protects sustainable development, while many people consider the nature of extractive industries unstable (Fitzpatrik 2011).

3. The analysis of economic sustainability

The analysis of economic sustainability indicators in urban environment of Asaluyeh through one sample t-test shows that among the existing components, the components of

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Dimensions	T-statistics	Significance	Mean	Results
Land resources	58.038	0.000	3.8549	More than average
Pollution control	-53.692	0.000	2.1779	Less than average
Environmental awareness	2.698	0.007	3.0622	More than average
The average case=3				

Table 3. the results of one-sample t-test for environmental sustainability and its indicators

Components	Wilcoxon test	Significance (two-tailed)	Results
Land resources	74691	0.000	Significant Alternative hypothesis is accepted
Pollution control	0	1	Not significant Null hypothesis is accepted
Environmental awareness	21843	0.002	Significant Alternative hypothesis is accepted
Environmental sustainability	41972.5	0.000	Significant Alternative hypothesis is accepted

Table 6. The results of one sample Wilcoxon test for environmental sustainable development

activity and employment , income distribution and investment are lower than average and cost of living component is higher than average. Table 2 shows the status of economic indicators in Asaluyeh coastal-extractive city in 2013.

4.The analysis of environmental sustainability

The analysis of environmental sustainability indicators in urban environment of Asaluyeh through one sample t-test shows that among the existing components, the components of land resources and environmental awareness are higher than average and pollution control component is lower than average. Table 3 shows the status of environmental indicators in Asaluyeh coastal-extractive city in 2013.

5. Reviewing the research hypotheses

It seems that the development in Asaluyeh has not led to the formation of the sustainable development paradigm in environmental aspects yet.

To investigate this hypothesis, at the significance level of 95, the following statistical hypotheses are considered:

•Null hypothesis: In respondents' views, the development in Asaluyeh has not led to the formation of the sustainable development paradigm in environmental aspects yet.

•Alternative hypothesis: In respondents' views, the development in Asaluyeh has led to the formation of the sustainable development paradigm in environmental aspects yet.

The results of one sample Wilcoxon test are brought in Table 6:

The results of one sample Wilcoxon test show that among the in respondents' views, among the three sub-dimensions, "land resources" and "environmental awareness" has led to the formation of the sustainable development paradigm in environmental aspects, at the significance level of 95%. The major

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variable 'environmental sustainability' which is gained from the sub-criteria has a median of 3.035 at the significance level of 95% and since the meaningful level is less than 0.05, we can conclude that the variable "environmental sustainability" had a significant difference with the median (which was 3), and it is more; thus the alternative hypothesis which posited that the development in Asaluyeh has led to the formation of the sustainable development paradigm in environmental aspects is confirmed and the null hypothesis is rejected. To compare components in each dimension, Friedman test was run. First, this test checks whether there is any significant difference between the different components of the hypothesis in respondents' views; then, based on the mean scores obtained, the components are ranked in order of importance.

Value	Description
386	N
703122	Chi-square
2	df
0.000	Asymp.Sig.

Table 7. The results of Friedman test for environmental sustainability

According to the above table, the significance level of Friedman test is less than 0.05; thus, there is a significant difference between components in respondents' views. Followed, items will be ranked in order of importance based on the average of ratings calculated. Components that did not have a significant impact in respondents' views are shown in red.

5.2. Second hypothesis

It seems that the development in Asaluyeh has not led to the formation of the sustainable development paradigm in economic aspects yet. To investigate this hypothesis, at the significance level of 95, the following statistical hypotheses are considered:

Mean rank	Component
2.94	Land resources
1.05	Pollution control
2.01	Environmental awareness

Table 8. the average rating of questions on environmental sustainability dimension

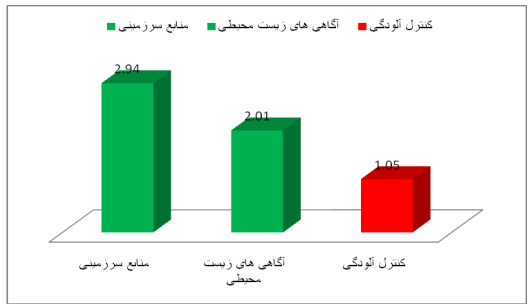


Figure 2. Rankings of environmental sustainability components

•**Null hypothesis:** In respondents' views, the development in Asaluyeh has not led to the formation of the sustainable development paradigm in economic aspects yet.

•**Alternative hypothesis:** In respondents' views, the development in Asaluyeh has led to the formation of the sustainable development paradigm in economic aspects yet.

The results of one sample Wilcoxon test are brought in Table 9.

The results of one sample Wilcoxon test show that among the in respondents' views, among the four sub-dimensions, only "income and its distribution" and "cost of living" has led to the formation of the sustainable development paradigm in economic aspects, at the significance level of 95%. The major variable 'economic sustainability' which is gained from the sub-criteria has a median of 2.945 at the significance level of 95% and since the meaningful level is more than 0.05, we can conclude that the variable "economic sustainability" did not have a significant difference with the median (which was 3), and it is more; thus the alternative hypothesis which posited that the development in Asaluyeh has led to the formation of the sustainable development paradigm in economic aspects is rejected and the null hypothesis is accepted. To compare components in each dimension, Friedman test was run. First, this test checks whether there is any significant difference between the differ-

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Components	Wilcoxon test	Significance (two-tailed)	Results
Activity and Employment	5549	1	Not significant Null hypothesis is accepted
Income and its distribution	51174.5	0.000	Significant Alternative hypothesis is accepted
Cost of Living	34245	0.000	Significant Alternative hypothesis is accepted
Investment	1252.5	1	Not significant Null hypothesis is accepted
Economic Stability	26395.5	1	Not significant Null hypothesis is accepted

Table 9. The results of one sample Wilcoxon test for economic sustainable development

ent components of the hypothesis in respondents' views; then, based on the mean scores obtained, the components are ranked in order of importance.

According to the above table, the significance level of Friedman test is less than 0.05; thus, there is a significant difference between components in respondents' views. Followed, items will be ranked in order of importance based on the average of ratings calculated. Components that did not have a significant impact in respondents' views are shown in red.

Value	Description
386	N
616538	Chi-square
3	df
0.000	Asymp.Sig.

Table 10. The results of Friedman test for economic sustainability

Mean rank	Component
2.05	Activity and Employment
3.33	Income and its distribution
3.22	Cost of Living
1.41	Investment

Table 11. the average rating of questions on economic sustainability dimension

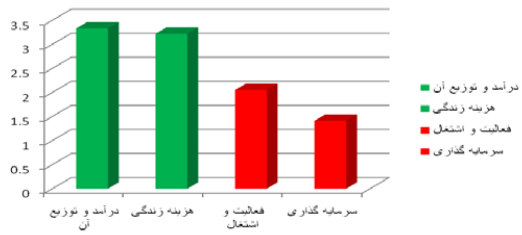


Figure 3. Rankings of economic sustainability components

6. Results

Recently, sustainability as an established concept has become a general framework for the analysis of urban and rural settlements. Evaluation of the conducted studies indicated that this approach has a high potentiality in recognizing problems in urban areas. Thus, this approach has been the basis of most of the studies conducted on urban life, especially since 1970s. Among all types of cities, extractive (mining and resource-based) cities have special features including a high concentration of industrial activities associated with the exploration, extraction, refining, processing and export of groundwater resources, the risk of reduction and termination of non-renewable resources, high degree of environmental pollution, high production of domestic and industrial waste and social issues related to job migration and cultural duality which can cre-

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ate or exacerbate unsustainability matter on environmental, economic, socio-cultural and physical scales in urban environment of such cities. Thus, it is necessary to investigate the efficiency of industrial-mining activities on urban sustainability of Asaluyeh in Bushehr Province as an extractive city. These cities have faster development processes than other regions due to their specific nature. Concentration of population, industrial and economic activities, etc., which occur in a short time with the attraction of major financial and human resources and national and international interest, increase their vulnerability in environmental, social and physical dimensions. Extractive cities are among the urban areas that due to the different conditions of formation and development and different forces emanating from extraction and activities associated with mining and industrial activities have a different face and a different impact on the natural environment and their community. The major issue in these cities is the evaluation of the concept of sustainability in environmental, economic, physical and socio-cultural aspects. The main and initial objective for sustainable development of mining towns is creating a balance between the different aspects that sometimes have paradox (For example Economic Development which is accompanied with the increased extraction of resources and the establishment of high volume of industrial units was opposed to environmental issues). Therefore, considering the problems that these cities have, noting the fundamentals and principles of sustainable urban development is essential in the planning process for their development. Thus, this study posed some questions on the mechanisms through which the industrial activities affect the sustainable development of urban space of Asaluyeh and tried to find the answers systematically and coherently.

Among the most important results of this study are as follows:

1.The results of the analysis of sustainability-related indicators of Asaluyeh extractive city pointed to the unsustainability of development trend in the dimensions studied in this coastal-extractive city.

2.In the dimension of environmental sustainability, the pollution control component was one of the most important parameters in the issue of presence or absence of stability in the studied city had the lowest rank (1.05) among all components of this dimension. This fact refers to the lack of compliance with environmental considerations and careful monitoring in the issue of pollution control as one of the important factors predisposing environmental-ecological instability in Asaluyeh. Lack of compliance with environmental considerations and pollution control can threaten both land resources (water, soil, marine, biodiversity, etc.) and can harm individuals living and working at the industrial area by having adverse effects on the respiratory, skin and causing blood diseases and mental disorders.

3.In the dimension of economic sustainability, as one of the important dimensions in sustainable or unsustainable trend of extractive cities, the components of Activity and Employment and Investment were not in good condition.

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