

Formulating an Optimal Model for Designing and Assessing the Sustainable Housing Indices in Rural Areas (Case Study: Quchan Atigh Dehestan)

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Abstract

Purpose- sustainable rural housing can be considered as an important index in rural development. Hence, preparing plans in the area of sustainable rural housing requires different aspects and components of sustainable housing to be identified and analyzed. Designing and employing sustainable housing indices is especially important in rural planning as an essential instrument to express physical, socioeconomic, and environmental aspects of sustainable housing. The present study aims at identifying and explaining appropriate indices and criteria to evaluate housing sustainability and to operate the indices in the country villages. This is done by emphasizing Ghouchan Atigh rural district and presenting a modern methodological framework through a survey among the scientific elites by Delphi method. The present study is seeking to find out which indices are more valid and valuable for evaluating housing sustainability in Ghouchan Atigh rural district; and how is the process of designing appropriate indices and criteria to evaluate sustainable housing in rural areas.

Design/methodology/approach- the methodology of the present study is based on descriptive-analytic methods as well as quantitative-qualitative mixed method.

Findings- the findings of the study indicate that among 128 designed indices, 70 key indices were appropriate to rural housing structure especially in Ghouchan Atigh rural district. They include 28 indices to evaluate physical-infrastructure sustainability, 23 indices to evaluate social sustainability, 15 indices to evaluate economic sustainability, and 4 indices to evaluate environmental sustainability. The results also indicate that regarding analysis of the selected **indices**, **physical**-infrastructure indices are mostly valid in sustainability analysis with the score of 8.02. Environmental indices with the score of 7.89, social indices with the score of 7.65, and economic indices with the score of 7.49 are at the next ranks.

Key words- Sustainability, sustainability indices, housing, rural housing, Ghouchan Atigh Dehestan.

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1. Introduction

Not only housing is one of the most important basic needs of human beings and overrides all other needs (Lotfi, Ahmadi, & Hasanzadeh, 2009), it plays an essential role in sustainable development because constructions with different functions take 45% of the world energy consumption and as a result damage the environment seriously by producing polluting gasses. The type of house designing, the use of heating systems, and the supply of energy in buildings play an important role in decreasing energy consumption and the amount of Carbon Di Oxide produced (ChamCham, Mirakzadeh, & Mehravan, 2016). In this regard, there is a general opinion that house construction should be accompanied by changes in energy direction. The concept of housing sustainability refers to the adaptability of the constructed houses to environment. Accordingly, sustainability in house construction should be accompanied by the decrease in destructive effects on the environment (Mohammadi Yeganeh, Cheraghi, & Nazari, 2015). One of the most important issues that has attracted a lot of attention is housing and its sustainable development along with human development. An important point considered in the documents of the second United Nations' conference on human settlements is the importance of sustainable settlement and supplying appropriate housing for people in the process of development. Therefore, rural housing can be considered as one important index in rural development; hence recognizing the rural housing characteristics and how to supply it becomes more important (Chaparly, 2007). Due to the evolutions happened in rural communities in recent years, dealing with housing in sustainable rural development such that all the characteristics of a perfect architecture are covered becomes more important (Boshagh, Agha Amraei, & Taghdisi, 2014). Therefore, in order to achieve sustainable development, sustainable, favorable, and appropriate housing should be embedded in policy-making acts; and all its aspects and their relationship to other sections should be considered. Housing goals and policies have always been a part of development plans in Iran. Increased investment in the housing sector, settlement accessibility for poor people through

constructing cheap houses, housing market, optimal use of the potential capacities of production factors in the housing sector, mass production, and the participation of the private sector in house construction through encouraging rules are among the development planning strategies to achieve sustainable development in housing and construction in Iran (Basiri Parsa, 2014). However, on one hand these goals have not been realized completely, and on the other hand they don't explicitly refer to a sustainable and appropriate housing. Moreover, not all sustainable housing indices have been embodied in the development plans in Iran, and mostly the economic aspects have been considered.

Due to the importance of measuring or estimating the amount of sustainability closeness, or even the route to achieve it, it seems necessary to determine a set of indices in order to set goals and make decisions in planning and management process. Yet, a challenge to do this is how to measure the power of policies and plans of different countries to achieve sustainable development. To this end, there have been a lot of efforts to develop sustainability indices and ways to measure them, since the Brandt Land Commission and Earth summit conference were held; these efforts have sometimes been successful in some areas of sustainable development, especially in economic areas (Farahani, 2006). However, because of the dominant attitudes and values in the societies, there is not a consensus on the indices of sustainable housing and how to measure them.

Accordingly, the present study aims at identifying and explaining appropriate indices and criteria to evaluate housing sustainability and operationalizing these indices all over the villages in the country. We emphasize on Ghouchan Atigh rural district and present a methodological modern framework through surveys among scientific elites using Delphi. For this purpose, the need for an appropriate complex of indices to measure housing sustainability in a particular area such as the villages in Ghouchan Atigh rural district and a regular plan is felt. The present study seeks to describe and extend an optimal model to explain and design sustainable housing indices and operational modifiers in rural areas in Ghouchan Atigh Dehestan. The following questions are

raised in this regard: 1. Which indices are more valid and valuable to evaluate and measure housing sustainability in Ghouchan Atigh rural district? 2. In which way appropriate measuring indices and criteria are designed?

2. Research Theoretical Literature

2.1 Sustainable Rural Housing

Sustainable development originates from the report "our common future" by Brandt Land Commission. The most well-known definition for sustainable development is fulfilling the present time needs without spending next generation abilities (Siwar, Mahmudul Alam, Wahid Murad, & Al-Amin, 2009). Therefore, sustainable development is a philosophy of social, economic, and environmental dimensions in a balanced way (Cirella & Tao, 2010). Tylor believes that the concept of sustainable development is a significant stage in the environmental theory because it proves how a society must organize itself (Taylor, 2002). Hence, sustainability can be considered as an invitation to achieve an evident balance among the sociocultural, economic, and political factors emphasizing the need for protecting the natural living environment (Ebrahimi & Kalantari, 2003). Housing and particularly sustainable housing is considered as one of the most important rural sustainable development indices. Housing as an important development index has different aspects including economic, livelihood, social, and cultural aspects (Rezvani, Rastegar, Bayat, & Darestan, 2014). Moreover, as a shelter, house is a fundamental need of human beings (Babatunde Fami & Hayat Khan, 2014). House is one of the most important components composing the rural texture which has been affected by human and natural factors; so, any change in natural and human factors is manifested in housing in different ways (Saeidi & Amini, 2010).

In 1948, the United Nations described in the Universal Declaration of Human Rights that everybody has a right to achieve a standard level of life for the health of his family and himself, including food, clothing, and housing (Charles, 2007). Today, housing issues have become a universal affair, and different countries and communities are faced with a lot of problems in this regard; such that currently 640 million people in the world are homeless (Veltmeyer, 2010). There are housing problems all over the world; yet, in developing countries this problem has become critical because of the rapid pace of population and urbanization growth, internal migrations, lack of

sufficient financial resources, the problems associated to land supply, construction materials, and the lack of expert human resources, and more importantly lack of guidelines and policies with regard to land and house (Boshagh, Taghdisi, Agha Amraei, & Denesh, 2016). Many researchers believe that the lack of sustainable housing in rural areas will lead to problems like low quality of life (Wilkinson & Pickett, 2009), low access to health and welfare in rural areas (Wet, Plagerson, Harpham, & Mathee, 2011), rural migrations, education dropout, high level of crimes, and lack of physical and psychological health (Herrman & Svarin, 2009), and increased social inequalities (WHO, 2010). These are followed by psychological disorders in these areas (Howell, Harris, & Popkin, 2005), and increased risk of diseases and weak nutrition (Ruel, Deirdre Oakley, Elton, & Robert, 2010). In fact sustainable housing is a response to fundamental needs of human beings and improves their life quality (Maliene & Malys, 2009). Housing sustainability is an indicator of a condition of rural development which is not only favorable from the environmental point of view, but also it presents variety and long-term success (Rezvani, Mansourian, & Ahmadi, 2010). Sustainable housing is economically appropriate, socially acceptable, physically feasible, and environmentally adaptable (Charles, 2007). The concept of sustainable housing does not mean that the houses remain forever, but that materials, energy, and water consumption help the sustainability of the earth by decreasing consumption data to maintain human economy (Salarvand, 2011). That kind of housing is sustainable which fulfills the needs of today generation based on energy and natural resources efficiency and at the same time creates safe and attractive places, considering ecologic, cultural, and social issues (Edwards & Turret, 2000). Also, sustainable housing has the minimum incompatibility with the surrounding natural environment (Bazi, Kiani, & Razi, 2010). Maline and Malys (2009) believe that sustainable houses are defined based on particular factors including security and the exploitation of more energy for more houses, utilizing ecologic energy (heating and cooling systems), using ecologic construction materials (domestic resources), sustainable management of waste water, beautiful design, and welfare and comfort. In fact, sustainable housing process must consider five areas: 1. protecting the natural environment (earth, energy, water); 2. Logical use of man-made resources; 3.

Protecting the ecosystem and the potentials to revive it; 4. Fairness among productions, human, and categories; and 5. Predicting health, security, and safety (Edwards & Turret, 2000). Generally, the principles that must be considered for a building to be categorized as sustainable are as follows:

Principle 1: protecting energy; principle 2: harmony with climate; principle 3: decreasing use of new resources; principle 4: fulfilling inhabitants' needs; principle 5: harmony with policy; and principle 6: wholeness (Zandiyeh & Parvardinejad, 2010). Selecting materials for house is an important factor for sustainable housing. Construction materials in housing sector have an important effect on the environment and ecosystem (Salmani, Ramezanzadeh Lasbouie, & Muhammadjani, 2008). House construction is an effective factor on climate change; hence, regarding environmental sustainability the followings must be considered: utilizing natural resources and correct use of renewable resources, protecting production factors such as water and land (Chen & Chambers, 1999), using renewable energy, energy range, water efficiency, proficiency of the materials, air pollution, controlling pollution, and protecting and promoting natural resources and creating manageable houses (Abidin & Paskoir, 2007).

Regarding economic sustainability, sustainable housing means to construct houses suitable for their inhabitants' economic conditions (Huchzermeyer, 2001). Regarding social sustainability, sustainable housing not only considers public facilities and services for the inhabitants' welfare based on their culture, style, and traditions (Rokn-al-Din Eftekhari, Pourtaheri, & Mirjalali, 2013).

There are lots of studies about rural housing sustainability. The findings by Bhojar et al. (2014) indicate that rural houses are more sustainable than urban houses. The most important reasons for unsustainability in urban housing are power consumption (33%) and transportation (35%) while unsustainability in rural houses is related mostly to fuel and cooking (36%). Kuzyk (2012) didn't find any difference in sustainability between rural and urban houses. Vitousek (1994) investigated housing sustainability in the USA and found that houses in this country are unsustainable because they produce greenhouse gasses by consuming power more than the capacity of biosphere. Baltruszewicz (2014) examined the environmental effects of new-built houses in Norway from 1980 to 1990 and found that

these houses are moving toward unsustainability by increasing power consumption. Stefinlongo (1986) introduced the new concept "environmental architecture" and suggested that environmental architecture will lead to protecting people from the environment and even a new culture in deal with innovations. This kind of architecture refers to a biologic (environmental) relationship in which ancient of traditional (domestic) architecture is protected from human intervention and artificial crafts made by him. Mahravan & Vale (2012) counted factors such as repairing existing buildings using sustainable architecture patterns, utilizing renewable resources to fulfill heating and cooling needs, using local and firm materials for construction based on the law of ecological footprint, and so on as the most important indices of environmental architecture associated with sustainable ecotourism which in turn leads to sustainable life. Among the studies, Lotfi et al. (2009) found that recognizing and employing rural housing indices will evolve rural housing in long-term, which leads to presenting an appropriate pattern for rural housing in the country. Adeli Gilani (2010) found that the sustainable pattern of rural housing in Guilan should be designed according to socioeconomic and cultural factors and based on the natural bed. Chamcham et al. (2016) concluded that the new-built houses in Polbaba village tend to sustainability in 4 aspects: economic, social, environmental, and technical and physical. However, economic-innovative mixed index was the most sustainable among others.

2.2 Sustainability Criteria and Indices

The most acceptable approach to measure sustainability and sustainable development and consequently to evaluate rural housing sustainability is using the modifiers and indices (Bell & Morse, 2003). An index is merely a scale for measuring what we value. In all definitions and theories, they are expressed as indicators (Farahani, 2006). Sustainability indices and modifiers are new concepts presented aiming at evaluating sustainability in planning and development; they reflect fundamental and basic components for economic, social, and environmental health in the long-term in urban and rural communities (Kazemi & Shakouie, 2002). Basically, considering indices as tools to observe the quality and quantity of the policies and actions, and measuring the effects and consequences, and evaluating the situation, dates back to long ago. Creating and developing indices was first raised in

1930s, and during the following decades, the movement of index development was formed seriously. The indices first included economic aspects, and the indices like gross domestic product (GDP) and gross national product (GNP) were generalized as the total welfare indices. In 1960s and 1970s some researchers criticized this criteria and method, until the social indices were considered as well. William Augbourn was the first figure who created statistical criteria to explore the procedures and social changes (Choi & Sirakaya, 2006). Sustainability indices were presented in an effort to show indices able to create the links between economic, social, and environmental subjects. Therefore, such indices are mostly the tools to be applied at the local management level (Rezvani, 2009). Since today, operating indices in the management body is considered as fundamental, and using extended technical indices (direct/ indirect, descriptive/ analytic, and objective/ subjective) and specialized indices (economic indices, social indices, or environmental indices) has become spread. Today, many national and international organizations have created sustainability indices, including United Nations, International Institute for Sustainable Development, Sustainable Development Commission of the United Nations, Seattle Sustainable Conference, National Environment and Economics Meeting, Development Plan of the United Nations and the World, Modern Economy Foundations and Oxfam, and the Interagency Work Group on Sustainable Development in the United States. These efforts have been focused on public development in macro-scale (compared to physical environment and economy) (Rokn-al-Din Eftekhari, Mahdavi, & Pourtaheri, 2011). In the framework of sustainable development, the indices are not only tools for measurement, but also they are like guidelines to how sustainable development is perceived. Hence, evaluating the effects of new policies using a set of indices can be the requisite for executing sustainable development. However, selecting indices without paying attention to the existing frameworks in doing so may cause the results not to be reflected and even to be affected by irrelevant matters (Khosrobeygi, Shayan, sojasi Qidari, & Sadeghlou, 2011).

An important way to get aware of the housing conditions in the process of rural planning is using housing indices (Azizi, 2005). These indices, on one hand, indicate the qualitative and quantitative condition of rural houses in each period of time, and

on the other hand, they are effective guidelines to improve housing planning for the future (the key to draw housing future perspective) (Sattarzadeh, 2009). Also, to get familiar to access the predicted goals in the principles of the constitution as well as long-term development programs, defining indices and criteria for evaluating the existing conditions in rural housing is required; because indices are appropriate tools to evaluate the existing conditions and the realization of the plans, as well as clarification in supervising the performance of the relevant organizations (Lotfi et al., 2009). Indices like the size of house and enough space, enough number of houses, house quality, hygiene requirements, access to the facilities and markets, appropriate environment, infrastructures, and residential services such as power and water are all indicators of healthy and sustainable housing (Bazi et al., 2010). Selecting criteria and the indices for measuring sustainability at the national level is an ultra-sectional act by managing and guiding different sectors. Since the indices are various and sometimes even inapplicable, it is important to use domestic experts and elites' opinions.

3. Research Methodology

3.1 Geographical Scope of the Recsearch

Ghouchan Atigh rural district is located in west of the central part of Ghouchan city, in geographical coordinates 55° 36' to 15° 37' of northern width and 10° 58' to 32° 58' of eastern length. According to the census in 2011 it has 46

Villages with 6663 households and 23226 people (Statistical Center of Iran, 2012). Figure 1 shows the location of the area

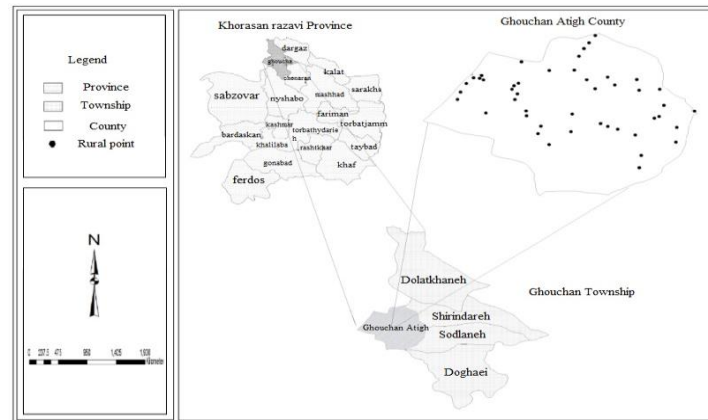


Figure 1. The location of the studied area in the province
Source: Research findings, 2016

3.2 Methods

Since the main goal of this study was to achieve a set of indices for rural sustainable housing, emphasizing Ghouchan Atigh rural district, we tried to realize it using a descriptive-analytic method and survey (survey from experts and elites) as well as the qualitative-quantitative mixed method. The data analysis relied on Microsoft Excel, version 2010, using statistical methods like mean and Difference range. At the first step and after codifying the theoretical principles, a set of indices related to rural sustainable housing in social, economic, environmental, and physical aspects was determined; then, questionnaires were distributed among the scholars and elites in order to select and explore the indices related to the subject under study. One hundred and twentyeight indices were embedded in the questionnaires. In the next step, the collected information was

analyzed in Excel; and finally, coherent sustainability indices among the houses in the villages of Ghouchan Atigh rural district with determined values are extracted. The number of respondents in this study was 30 people including elites and researchers in geography departments (rural and urban planning, tourism, and climate) and urbanism. Thus, according to the above mentioned points and due to the methodology of the study, designing and explaining the process of rural sustainable housing can be expressed by figures. According to the studies about rural housing sustainability indices, there are different processes to measure the indices; but a systematic process (figure 2) can be presented based on the similarities; the process includes 7 fundamental steps. It indicates that the mentioned components must be present to be able to design, express, and localize sustainable indices.

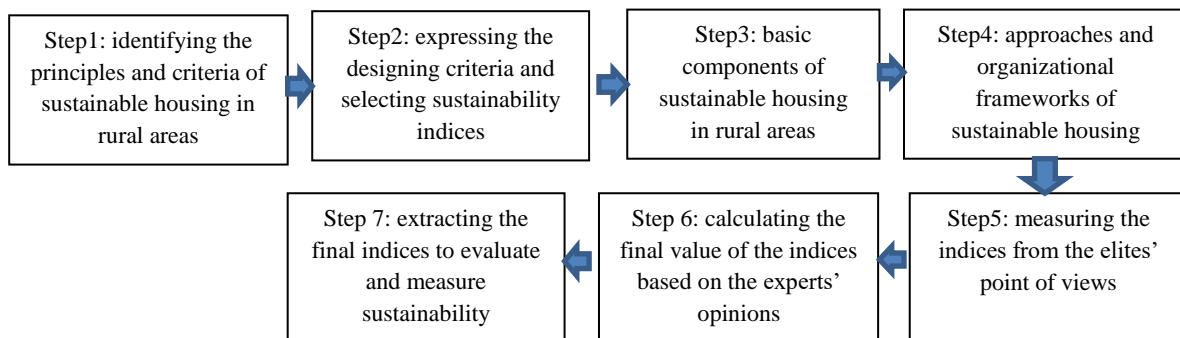


Figure 2. The process of designing rural sustainable indices
Source: (Rokn-al-Din Eftekhari et al, 2011)

4. Research Findings

Designing and Expressing Rural Housing Sustainability Indices (Framework and Process)

Step 1: Identifying the principles and criteria of sustainable housing in rural areas: Today the concept of sustainable development has become a basic important concept in policy making. In this regard, the issue of rural sustainable housing has been a main factor in the field of rural development. The promising start point for rural housing sustainability is using the world guidelines to achieve a fundamental and basic sustainability. There are a vast number of studies regarding rural sustainable housing; however, more studies are required so that its aspects get clearer and the solutions get more feasible. [Choguili \(1993\)](#) presents four criteria for sustainable development policies: the first criterion is associated with sustainable ecologic aspects. The second is related to sustainable economic development. The families with lower incomes should be able to provide their homes. The third criterion is the need for social sustainable development. The fourth one is using technology ([Divsalar, Fanni, Farhoodi, & Barzegar, 2014](#)). Therefore, it is obvious that any village needs to formulate its own criteria for sustainable housing to respond to environmental, economic, and social conditions.

Step 2: Expressing the designing criteria and selecting sustainability indices: One of the main steps in the process of preparing indices is to select the required indices and modifiers; the main question here is that what are the criteria for selecting the indices to cover the goals and principles of sustainable housing in line with the realities in the society? So, selecting criteria means “what does indicate good indices and modifiers?”. Therefore, selecting sustainable housing indices and modifiers should include basic characteristics that must be considered. Also, with regard to the criteria for selecting the index presented by the World Organization and the experts, the criteria for evaluating the operationalization of the indices are: 1. relevant to the subject, 2. access to data (capacity to collect and process), 3. data validity, 4. clarity and understandability, and 5. comparability in time all over the juristic areas.

Step 3: Basic components of rural sustainable housing: Sustainable development justifies the quality of the relationship between human being and his surrounded environment due to the fact that all unsustainability in living environments is resulted from disruption of the balance between these two main elements. Sustainability approach tries to organize the human-environment interaction and thereby create healthy human beings and environment ([Yariehesar, Badri, Pourtaheri, & Faraji Sabokbar, 2013](#)). Basic main components of rural sustainable housing cannot be sustainable without paying attention to approach, goals, and the principles of sustainable development, because these components are actually the main characteristics of each subsystem. Therefore, in order to realize the holistic principle, coincidence and synergy among the subsystems of sustainable housing or its interactive aspects (environmental, social, and economic) is required, so that the components of rural housing sustainability are based on the main specifications of each aspect.

In the framework shown in ([figure 3](#)), the main components of rural sustainable housing are presented, which can be the start and linking point between sustainable development approach and sustainability indices. The above mentioned conceptual images must be based on the theory of sustainable development appropriate to land requirements because sustainable development is based on a holistic and systematic point of view encompassing all composing aspects and components of rural development system and basically, comprehensiveness is the prerequisite for sustainable housing.

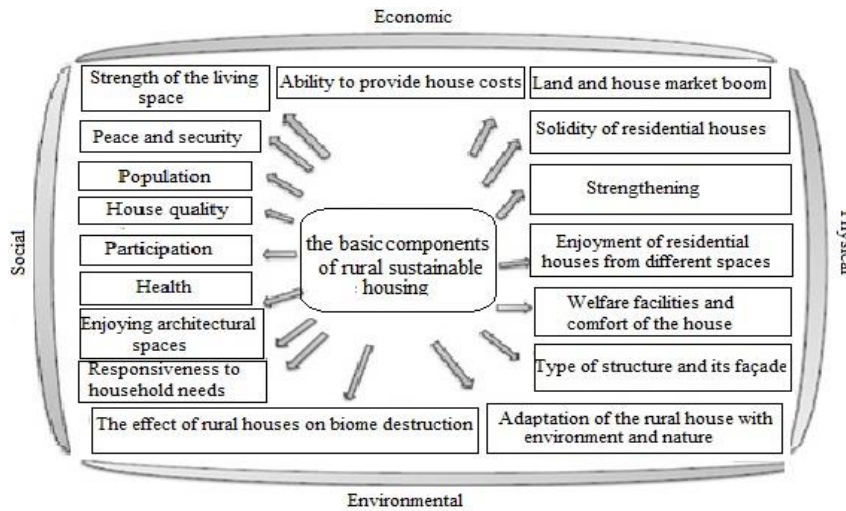


Figure 3. The basic components of rural sustainable housing
Source: Research findings, 2016

Step 4: Approaches and the framework of organizing and developing rural sustainable housing indices: Reviewing the studies about sustainable development indices proves that every institute at national and international level as well as every expert has applied a different form of the structural approaches of creating and developing indices. Totally, the approaches can be categorized in three groups: 1. the approach of wide range of sustainability indices, 2. the approach of simple main and combined indices, and 3. the approach of limited combined indices (Yariehesar et al., 2013). Determining sustainability indices requires loading systematic and comprehensive approaches due to its wide inclusion range; in the present framework,

the approach of wide range of sustainability indices is more valid and applicable. It allows the researcher to identify all the required aspects, components, criteria and indices and minimize the error. Accordingly, in the present study, the following framework is presented which is designed based on the approach of wide range of sustainability indices (table 1). In such a framework, for each aspect of sustainable housing, basic components are determined; and for each component some criteria are presented. This framework allows for selecting relevant indices comprehensively and seamlessly. The approach and framework for organizing the indices (aspects, components, criteria, and combined indices).

Table 1. Approach and framework for organizing the indices (aspects, components, criteria, and combined index
Source: Ferriss, 2000; Hemmasi & Prorok, 2002; Royuela, Surinach & Reyes, 2003; Westaway, 2006, Maline & Malys, 2009, p. 123; Sartipipour, 2007, pp. 51-57, and Beshagh, Slarvand, and Seydaei, 2013, 2014, pp. 32-34.

System	Sub system	Component	Criterion (combined index)
Natural ecosystem	Physical sustainability	Solidity of residential houses	Durability of the materials used in construction
			Durability of residential structures
			Age of the residential units
		Enjoyment of residential houses from different spaces	Density and under construction area
			Enjoyment of the house from facilities
		Welfare facilities and comfort of the house	Access level to the facilities
			Enjoyment of the villages from infrastructures
		Type of structure and its façade	Materials
			Change in appearance of the village
		Strengthening	Tendency to strengthening residential houses
			Localization
			Technical regulations

Table 1.

System	Sub system	Component	Criterion (combined index)		
Natural ecosystem	Environmental sustainability	The effect of rural houses on biome destruction	Environmental pollution		
			Consuming resources		
			Operation change		
		Adaptation of the rural house with environment and nature	Energy		
			Ecologic		
Human ecosystem	Economic sustainability	Livelihood role of the house	Using living space of the house		
		Strength of the living space	Area dedicated to living space		
			Ability to provide house costs	Durability of the materials in living space	
		Durability of the living space structure			
		Land and house market boom	Current costs of the house		
			Fixed costs of the house		
		Housing sector productivity	Using financial aids to provide house costs		
			Investment		
		Social sustainability	Peace and security	Population	Employment
					Supplying suitable houses
	House quality		Enjoying architectural spaces	Demand	
				Productivity in house production	
	Participation		Responsiveness to household needs	Security of the houses and peace	
				Density and stability	
	Health		Participation	Place belongingness	
				Satisfaction with house architecture	
	Health		Participation	House resistance	
				Architecture plan	
	Health	Participation	Participation in designing the plans and use of the materials		
			House elements		
Health	Participation	Participation in designing the plans and use of the materials			
		Environmental hygiene and health facilities			

Step 5: Evaluating the indices from the experts' point of view: In this step, in order to achieve more operational indices and localize the indices based on the conditions of the rural areas, the main indices were judged by a group of

experts (table 2). They were asked to give a score from zero (invaluable and invalid to evaluate rural housing sustainability for Ghouchan Atigh rural district) to 9 (the most valuable and valid).

Table 2. Checklist for selecting rural housing sustainability indices from experts' point of view
Source: Research findings, 2016

Aspects	Component	Criterion	Index	Value and relevance to rural housing sustainability evaluation in Ghouchan Atigh rural district											
				0	1	2	3	4	5	6	7	8	9		
Social	Population	Density and stability	Density per person in the room												
	Population Housing quality		Place belongingness	Household density											
		Satisfaction with house architecture		Satisfaction with house architecture	Willingness to stay										
Satisfaction with house architecture	Satisfaction with house architecture		Children willingness to stay												
		Satisfaction with house architecture	Satisfaction with house architecture	Satisfaction with the materials	Reduction of migrations										
Satisfaction with house architecture	Satisfaction with house architecture				Satisfaction with the materials	Satisfaction with the internal architecture									
		Satisfaction with house architecture	Satisfaction with house architecture	Satisfaction with the materials		Satisfaction with the external architecture									
Satisfaction with house architecture	Satisfaction with house architecture				Satisfaction with the materials	Satisfaction with the materials									



Where: F_p is the final value of the index, $\sum x_i$ is the sum of values of the indices extracted from the questionnaires, and $\sum q_i$ is the total completed questionnaires. The number obtained from this formula will be 0 to 9. Zero means invaluable and 9 means the most relevant of the indices with the topic. In the next step and after standardization, the indices with higher scores are selected. In the present study, based on the topic of the study, the final values of the indices were close together, and so only the indices with final value more than 7 were selected. Accordingly, among 128 indices presented to the respondents, 70 indices were selected including 28 indices in physical aspect, 23 indices in social aspect, 15 indices in economic aspect, and 4 indices in environmental aspect. (table 3) shows the selected indices in each aspect.

As you can see, in this questionnaire, dependence and hierarchical link among indices, criteria, components, and aspects of sustainability are determined to facilitate the judgement and value the indices. The number of questionnaires completed in this step was 30.

Step 6: Calculating the final value of the indices according to the experts' point of view:

The first step in this phase was extracting the final value of each index based on the completed questionnaires. Due to the relatively high volume of the indices and the number of the questionnaires, first the list of questionnaires was made using Excel; then the final score of each index was obtained through the following formula:

$$F_p: \sum x_i \div \sum q_i$$

Table 3. The selected indices for each sustainability criterion and aspect

Source: Research findings, 2016

Aspects	Number of components	Number of criteria	The number of indices presented to the experts	The number of selected indices
Physical	5	12	45	28
Social	7	9	40	23
Economic	3	12	27	15
Environmental	2	5	16	4
Total	17	38	128	70

One of the most important steps in this process is calculating the Difference range of indices values which allows for determining the difference between the values presented by the experts. In other words, in this step, it is determined how much the difference between the highest score granted to an index and the lowest score is. To calculate this difference, the following formula is used:

$$D: \sum \max^{x_i} \div \sum \min^{x_i};$$

Where D is the Difference range of the values of each index, $\sum \max^{x_i}$ is the highest index value, and $\sum \min^{x_i}$ is the lowest value for indicator i.

Step 7: Extracting the final indices to evaluate sustainability

a) The list of physical and infrastructural indices: Life quality and satisfaction with residence, especially in rural communities, is one the most important factors affecting sustainability. Forty five indices were presented to recognize the physical-infrastructural aspect of sustainability in Ghouchan Atigh rural district, among which finally 28 indices were selected (table 4). The average of final values of infrastructural-physical indices was 8.02 and the Difference range was 2.5 indicating minimum difference with regard to consensus on the sustainability indices.

Table 4. List of the selected infrastructural-physical indices of sustainability in Ghouchan Atigh rural district

Source: Research findings, 2016

component	Criterion	index	Difference range of the values		Total	Mean
			minimum	maximum		
Solidity of the houses	Durability of the materials used	Using durable materials	8	9	247	8.23
		Durability of the materials used on the foundation	8	9	250	8.33

Table 4.

Component	Criterion	Index	Difference range of the values		Total	Mean
			minimum	maximum		
Solidity of the houses	Durability of the structures	Durability of the materials used in the walls	8	9	259	8.63
		Durability of the materials used on the roof	7	9	246	8.2
		Durability of the materials used on the bottom	5	9	231	7.7
		Durability of the skeletons	8	9	253	8.73
		Durability of the roof structures	7	9	233	7.76
		Anti-earthquake facilities	8	9	262	8.73
Component	Facility enjoyment	Infrastructural installations (kitchen, bathroom, ...)	8	9	243	8.1
		Welfare facilities (heating and cooling systems ...)	8	9	249	8.3
		Hygiene installations (WC, livestock stable ...)	7	9	229	7.63
	Access to facilities	Access to shopping centers (retail, supermarket ...)	5	9	215	7.16
		Access to public transportation	6	9	217	7.23
		Access to educational centers	6	9	232	7.73
		Access to health centers (health house, clinic, public physician)	8	9	246	8.2
		Access to cultural centers mosques and libraries	6	9	217	7.23
		Communication facilities	5	9	216	7.2
		Communication facilities	5	9	216	7.2
	Enjoying Infrastructures	Communication roads	6	9	246	8.2
	Structure and appearance	Change in appearance	Tendency to optimize the passages (streets, tabling ...)	5	9	211
Technical Criteria	Tendency to strengthening	Tendency to construction based on appropriate localization	5	9	238	7.93
		Tendency to construction based on engineering principles and planning	6	9	242	8.06
		Tendency to take bank loans for renewal	8	9	258	8.6
	Observing localization principles	Avoiding house construction in steep and dangerous lands	7	9	262	8.73
		Avoiding establishing houses in territories of the rivers	6	9	250	8.33
	Technical regulations	Observing technical regulations of housing foundation regarding roads and passages territories	6	9	242	8
		Using technical regulations of strengthening (engineering supervision ...)	5	9	242	8.06
		House construction based on standards	6	9	250	8.33
		Using new findings regarding house strengthening	7	9	246	8.2

b) List of social sustainability indices: Social goals of sustainable development are emphasized in concepts like equal opportunities (inter and intra- generation), empowerment, promoting life quality, human dignity and rights, poverty alleviation, cultural variety, social solidarity, social participation, institutionalized capacitating, social security, responsibility, social welfare, and place belongingness (Pourtaheri, Sojasi Qidari, &

Sadeghlou, 2011). Accordingly, a list of social sustainability indices were prepared and evaluated. Among the indices presented to the experts, 22 indices were selected (table 5). The verage final value of the social indices was 7.65 and the Difference range was 3 indicating a close proximity and minimum difference among the experts' votes.

Table 5. The list of selected social sustainability indices for Ghouchan Atigh rural district
Source: Research findings, 2016

Aspects	Component	Criterion	Index	Difference range of the values		total	Mean	
				Minimum	maximum			
Social sustainability	Population Peace and security	Security of the houses	Issuing deed for strengthened houses	5	8	218	7.06	
			Feeling secure and peaceful	5	8	228	7.6	
			House insurance against natural dangers	7	9	255	8.5	
		Density and stability	density in room per person	6	8	220	7.33	
			Household density	6	9	217	7.23	
		Place belongingness	Tendency to stay in the village	5	9	242	8.06	
			Tendency of the children to stay	6	9	246	8.2	
			Reduction of rural migrations	5	9	222	7.4	
		Architectural spaces	Architectural plan	Presence of serving room	5	9	210	7
	Separate rooms for sleeping and studying			5	9	222	7.4	
	House parts		Furnace and place for baking bread	5	8	213	7.49	
			Place for taking care of livestock	6	9	211	7.03	
	Household needs		Place for keeping provision	7	9	236	7.86	
			Place for producing local products (dairy, fruit drying ...)	5	9	228	7.6	
	Participation in plans and use of		Participation in selecting plan of the houses	5	9	242	8.06	
			Participation on selecting materials	5	9	226	7.53	
			Participation in construction phases	5	9	238	7.93	
	Materials		Participation in localization	5	8	220	7.33	
			Participation in activities related to decrease vulnerability	5	9	214	7.13	
			House resistance	Considering the bed and type of soil in construction	5	8	212	7.06
			Hygiene and health facilities	Sufficient lighting in rooms	7	9	250	8.33
				Accessibility of water network	8	9	262	8.73
				Natural or artificial lighting and ventilation in the kitchen, bathrooms, and WC	8	9	245	8.16

c) The list of economic sustainability indices:

From economic sustainability point of view, sustainability is related to a wide range of factors (whether at the local level or at the universal level). The most important economic drivers for adapting sustainable principles include: increasing efficiency and durability of the property resulted from maintenance and operational costs of

housing project. Accordingly, in the present study, 45 economic indices were presented to the respondents to evaluate. Finally, 15 indices were extracted for evaluating economic sustainability in the area under study (table 6). The average of the final values of economic indices was 7.49 and the Difference range was 4 indicating relative proximity of the experts' votes.

Table 6. The list of selected housing economic sustainability for Ghouchan Atigh rural district
Source: Research findings, 2016

Aspects	Component	Criterion	Index	Difference range of the values		Total	Mean
				minimum	maximum		
Economic sustainability	Solidity of living space	Durability of the materials used in living space	Durability of the materials used in foundation of living space	5	9	211	7.03
			Durability of the materials used in walls of living space	5	9	213	7.1
			Durability of the materials used in the ceiling of living space	6	8	224	7.46
		Durability of the structure of living space	Durability of the skeleton	6	9	218	7.26
			Durability of the roof in living space	5	9	210	7
			Anti-earthquake facilities in living space	6	9	214	7.13
	Ability to provide house costs	Current costs of houses	Ability to provide owning costs like rent ...	5	8	206	7.03
			Financial ability for costs like water, power ...	6	9	246	8.2
		Fixed costs of houses	Ability to buy house	5	9	238	7.93
			Ability to provide house construction costs	5	9	238	7.93
			Ability to provide costs for fundamental repairs like renewal	5	9	224	7.46
		Using financial aids to provide house costs	Using bank loans for construction or repairs	6	9	252	8.4
	Using gratuitous aids for construction or fundamental repairs		6	9	250	8.33	
	Land and house market boom	Employment	Skill of the forces working in housing industry	5	9	213	7.1
			Use of domestic work force	5	9	212	7.06

d) The list of environmental indices: house construction is a main factor affecting climate change; therefore in environmental sustainability aspect, using natural resources, correct use of renewable resources, protecting production factors like water and soil must be considered.

Accordingly, a list of environmental sustainability indices was prepared and evaluated. Finally, 4 indices (table 7) were selected. The average of the final values of the environmental indices was 7.89 and the Difference range was 2.5 indicating a minimum difference in the votes of the experts.

Table 7. List of environmental indices of housing sustainability in Ghouchan Atigh rural district
Source: Research findings, 2016

Aspect	Component	Criterion	Index	Difference range of the values		total	Mean
				minimum	maximum		
Environmental sustainability	The effect of rural houses on destruction of biome	Environmental pollution	Using appropriate systems to collect and repel the garbage	7	9	237	7.9

Table 7.

Aspect	Component	Criterion	Index	Difference range of the values		total	Mean
				minimum	maximum		
Environmental sustainability	The effect of rural houses on destruction of biome	Environmental pollution	Using appropriate methods light sewage disposal (dish washing, hand washing ...)	6	9	218	7.26
	Adaptation of rural houses with environment	Nativism	Considering domestic criteria in constructing house	7	9	246	8.2
			Considering the role of weather in selecting the materials for construction	6	9	246	8.2

Analyzing the scores and the values of the indices indicates that there is no significant difference

among the experts regarding the selected indices, and they are coherent and solid enough (table 8).

Table 8. The average of the final values of the indices in the four aspects of sustainability from the experts' points of view

Source: Research findings, 2016

Sustainability aspects	Physical	Social	Economic	Environmental
Sum of the scores	6732	5293	3369	947
The average of the final values	8.02	7.65	7.49	7.89

As it can be seen, the average of the final values of the indices is 7.89 and physical-infrastructural indices with the average of 8.02 obtained high scores. Environmental indices with 7.89 scores are at the second rank. Social and economic indices with respectively 7.65 and 7.49 scores are at the third and fourth places.

5. Discussion and Conclusion

Sustainable development requires the promotion of the level of economic, social, environmental, technical, and physical standards of the rural houses. The concept of sustainability is so important in the present era that any new discussion regarding development is incomplete unless this is considered. Using sustainable development indices in economic, social, physical, and environmental aspects can be an appropriate criterion to determine the place of rural houses and plan to achieve sustainability. In order to evaluate rural sustainable housing, the effective social, physical, economic, and environmental indices must be taken into consideration comprehensively. Therefore, in spite of the wide range of sets of indices introducing sustainability or unsustainability, any kind of study with regard to rural housing

sustainability requires localization of its basic indices. In other words, since there is not a standard set of indices regarding the concept of sustainability due to the relative nature of this concept, extracting an integrated set of indices can help to make a clear definition of it. In this regard, the lack of a methodological framework is the most important barrier. In this study, we tried to remove this barrier and localize the evaluation indices of rural housing sustainability by presenting a systematic methodology based on the experts' points of view.

The results of the present study indicate that in the physical aspect, 28 indices compose sustainability backgrounds in Ghouchan Atigh rural area which are: using durable materials, enjoying fundamental installations, welfare, hygiene installations, access to shopping centers, access to public transformations, access to educational, health, and cultural centers, and so on. Regarding social sustainability, 23 indices were selected which compose the social sustainability of the rural houses in Ghouchan Atigh district. They are: peace and security feeling, house insurance against natural dangers, density (space per person), household density, reduction of rural migrations, and so on. In economic dimension, 15

indices were selected including: the ability to provide the owning costs, ability to provide the costs of buying a house, ability to provide the costs of house construction, and so on. Regarding environmental sustainability, 4 indices including appropriate systems to collect and repel the garbage, appropriate methods for light sewage disposal (dish washing and hand washing, etc.), considering local architecture criteria in house construction, and considering the role of climate in selecting the materials are the main bases for environmental sustainability among the houses in Ghouchan Atigh rural district. Additionally, localizing the indices based on the experts' opinions led to other results regarding the extracted indices which are: designing and organizing rural housing sustainability indices

using an integrated approach which covers all the aspects of rural life in the considered community. Hence, the selected indices are completely related regarding content and idea. Also, the selected indices are prepared based on land requirements and conditions; they are appropriate factors in measuring sustainability and are capable to be tested and operationalized in the villages all over the country. Rural sustainable development is an appropriate ground and a powerful method to localize housing sustainability indices. Using this method to express and extract rural sustainability indices is an inevitable need.

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تدوین مدل بهینه به منظور طراحی و ارزیابی شاخص‌های پایداری مسکن در نواحی روستایی

(مطالعه موردی: دهستان قوچان عتیق)

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چکیده مبسوط

۱. مقدمه

یکی از مسائلی که به شدت توجه همگان را به خود معطوف داشته، مسکن و توسعه پایدار آن همگام با توسعه انسانی است. نکته مهمی که در اسناد دومین اجلاس اسکان بشر بدان توجه شده است، اهمیت نقش اسکان پایدار و تأمین مسکن مناسب برای مردم در روند توسعه است، مسکن پایدار روستایی را می‌توان یکی از شاخص‌های مهم در توسعه و عمران روستایی محسوب نمود و از این جهت شناخت ویژگی‌های مسکن روستایی و روش‌های تأمین آن اهمیت پیدا می‌کند. هدف تحقیق حاضر شناسایی و تبیین شاخص‌ها و معیارهای مناسب برای سنجش پایداری مسکن و عملیاتی کردن این شاخص‌ها در سطح روستاهای کشور، با تأکید بر دهستان قوچان عتیق و ارائه یک چارچوب روش‌شناختی نوین با استفاده از نظر سنجی از نخبگان علمی به روش دلفی می‌باشد. بدین منظور مجموعه‌ای مناسب از شاخص‌ها برای اندازه‌گیری پایداری مسکن در منطقه‌ای خاص همانند روستاهای دهستان قوچان عتیق، ضرورت ایجاد برنامه منظم مشاوره‌ای و در نظر گرفتن دیدگاه‌های خبرگان و متخصصان امر، نهادهای مختلف و سایر ذینفع‌ها مشاهده می‌شود.

۲. مبانی نظری

ریشه مباحث توسعه پایدار از گزارش کمیسیون برانت لند تحت عنوان آینده مشترک ما نشأت می‌گیرد. شناخت شده‌ترین تعریف درباره توسعه پایدار نیز در همین گزارش ارائه گردید. مسکن و بخصوص مسکن پایدار از عوامل مهم در توسعه پایدار روستایی محسوب می‌شود.

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مسکن به عنوان یکی از شاخص‌های مهم توسعه دارای ابعاد مختلف اقتصادی، معیشتی، اجتماعی و فرهنگی است. امروزه مسائل مربوط به حوزه مسکن به یک امر جهانی تبدیل شده و جوامع و کشورهای مختلف با مشکلات زیادی در این حوزه روبرو می‌باشند. وجود مسکن پایدار به نیازهای اساسی انسان پاسخ داده و باعث بهبود کیفیت زندگی انسان می‌شود. پایداری مسکن روستایی بیانگر وضعیتی از توسعه روستایی می‌باشد که نه تنها از لحاظ محیطی مطلوب بلکه تنوع و موفقیت‌های طولانی مدت را نیز عرضه می‌کند. مسکن پایدار عبارت است از مسکنی که از لحاظ اقتصادی متناسب، از لحاظ اجتماعی قابل قبول، از نظر فنی و کالبدی امکان‌پذیر و مستحکم و سازگار با محیط زیست باشد.

۳. روش تحقیق

پس از تدوین مبانی نظری، مجموعه‌ای از شاخص‌های مرتبط با مسکن پایدار روستایی در ابعاد اجتماعی، اقتصادی، محیطی و کالبدی که از کاربرد بیشتری برخوردارند، مشخص و سپس با استفاده از روش پرسشنامه‌ای، جهت انتخاب و پایش شاخص‌های مرتبط با موضوع مورد مطالعه در اختیار خبرگان و پژوهشگران قرار گرفته است. در خصوص شاخص‌های پایداری مسکن روستایی فرایندهای متفاوتی هر چند اندک از شاخص‌ها تا اندازه‌گیری آن‌ها مشاهده می‌شود، که این فرایند مبتنی بر ۷ گام بوده است. گام اول: شناسایی اصول و معیارهای مسکن پایدار روستایی، گام دوم: تبیین معیارهای طراحی و انتخاب شاخص‌های پایداری، گام سوم: مؤلفه‌های مبنایی مسکن پایدار روستایی، گام چهارم: رهیافت‌ها و چارچوب سازماندهی و توسعه شاخص‌های مسکن پایدار روستایی، گام پنجم: سنجش شاخص‌ها از دید خبرگان کشور،

سازماندهی شاخص‌های پایداری مسکن روستایی با اتخاذ رویکردی یکپارچه از منظر روش شناسانه است و همه وجوه حیات مقصد مسکن روستایی را در بر می‌گیرد. از این رو شاخص‌های انتخاب شده از بعد محتوایی و مبانی اندیشه‌ای، الزامات برنامه‌ریزی و ساختار اجرایی ارتباط کامل با هم دارند. علاوه بر آن شاخص‌های انتخابی با توجه به شرایط و مقتضیات سرزمینی کشور تهیه شده‌اند و از جمله عوامل مناسب در اندازه‌گیری پایداری به شمار می‌آیند و قابلیت آزمون‌پذیری و عملیاتی کردن در سطح روستاهای کشور را دارند. همچنین توسعه پایدار روستایی بستر مناسب و روش تبیینی قوی برای بومی کردن شاخص‌های پایداری مسکن و سپس اندازه‌گیری شاخص‌ها ایجاد کرده است که نشان می‌دهد استفاده از آن در تبیین و استخراج شاخص‌های مسکن روستایی ضرورتی اجتناب‌ناپذیر به شمار می‌آید.

کلیدواژه‌ها: پایداری، شاخص‌های پایداری، مسکن، مسکن روستایی، دهستان قوچان عتیق.

تشکر و قدرانی

پژوهش حاضر حامی مالی نداشته و حاصل فعالیت علمی نویسندگان است.

مرحله ششم: محاسبه ارزش نهایی شاخص‌ها بر اساس نظریات خبرگان علمی، گام هفتم: استخراج شاخص‌های نهایی برای سنجش و ارزیابی پایداری است.

۴. یافته‌های تحقیق

نتایج تحقیق نشان دهنده آن است که تعداد ۷۰ شاخص کلیدی از بین تعداد ۱۲۸ شاخص طراحی شده با ساختار مسکن روستایی بویژه در دهستان قوچان عتیق متناسب بوده است که شامل ۲۸ شاخص برای ارزیابی پایداری کالبدی - زیرساختی، تعداد ۲۳ شاخص برای ارزیابی پایداری اجتماعی، تعداد ۱۵ شاخص برای ارزیابی پایداری اقتصادی و تعداد ۴ شاخص برای ارزیابی پایداری محیطی می‌باشد. همچنین نتایج تحقیق نشان می‌دهد که در ارتباط با تحلیل متوسط ارزش شاخص‌های انتخاب شده شاخص‌های کالبدی - زیرساختی با ۸۰۲ امتیاز از اعتبار بیشتری در تحلیل پایداری برخوردارند. شاخص‌های محیطی با ۷۸۹ امتیاز، شاخص‌های اجتماعی با ۷۶۵ امتیاز و شاخص‌های اقتصادی با ۷۴۹ امتیاز در رتبه‌های بعدی قرار دارند.

۵. بحث و نتیجه‌گیری

بومی کردن شاخص‌ها با توجه به دیدگاه خبرگان، به نتایج دیگری در خصوص شاخص‌های استخراج شده منجر می‌شود از جمله: طراحی و

ارجاع: فراهانی، ح. و جهانسوزی، م. (۱۳۹۷). تدوین مدل بهینه به منظور طراحی و ارزیابی شاخص‌های پایداری مسکن در نواحی روستایی (مطالعه موردی: دهستان قوچان عتیق). *مجله پژوهش و برنامه‌ریزی روستایی*، ۷(۲)، ۱۰۳-۱۲۲.

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