Research Paper: Sustainable Materials and Their Role in Achieving the Goals of Sustainable Development in Rural Settlements (Case Study: Noshar Abad, Rasht Region in the North of Iran)

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Citation: Khorram, A., Hamidian Divkolaei, L.S., & Gholizade, F. (2021). Sustainable Materials and Their Role in Achieving the Goals of Sustainable Development in Rural Settlements (Case Study: Noshar Abad, Rasht Region in the North of Iran). *Journal of Sustainable Rural Development, 5*(2), 319-332. https://dorl.net/dor/20.1001.1.25383876.2021.5.2.12.8

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Article info:
Received: 11 Mar. 2021
Accepted: 20 Oct. 2021

Keywords:
Sustainable materials, sustainable development, Noshar Rural District, Rasht County

ABSTRACT

Purpose: The current research aimed at investigating sustainable materials and their place in achieving sustainable development goals in the rural settlements of Noshar Rural District in Rasht County.

Methods: The current study is applied in terms of purpose and analytical in terms of its method. It also uses quantitative research methods. Finally, SPSS software, FSORA + FKOPRAS models, and WASTPAS and FBMW models were used for data analysis.

Results: The findings indicated that sustainable items are the item of the expected life of materials with a value of 3.00 (technical dimension), the items of reducing the cost of disposal with a value of 3.12, beauty with a value of 3.21 (social dimension), and the potential recycling and reuse with the value of 3.00 (environmental dimension), in the villages of Noshar Rural District. Also, the spatial analysis results showed that in terms of (technical, socio-economic and environmental) dimensions, Moridan Village has the highest use of sustainable materials. Also, the results of the Spearman correlation test showed a significant and positive relationship between sustainable materials and the sustainable development of rural settlements. Moreover, the results of fuzzy ARAS and fuzzy COPRAS) models indicated that sustainable materials affected the physical dimension of sustainable development more than other dimensions. Also, the FBMW model showed that the most affected items from sustainable materials included safety and security with a value of 71.15 (physical dimension), using durable materials with a value of 17.01 (economical dimension), change in behaviors to change the consumption pattern with a value of 17.90 (social dimension), production of materials with low environmental impact with a value of 18.91 (environmental dimension).

Conclusion: In conclusion, for sustainable development of rural settlements in Noshar Rural District of Rasht County, policymakers should pay attention to sustainable materials in relation to dimensions of sustainable development. To this end, rural development, sustainable development and materials experts must be used.

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1. Introduction

Today, sustainable development is a framework for national, regional and local plans for prosperity and removing deprivation removal. It ensures regional economic and social improvement, fair distribution of income, employment and improvement of services. Sustainable development contains the three fundamental pillars of development: economic, socio-cultural and environmental development (Roomiani, 2013). Rural architecture and development have been a case in point for developing counties. In this regard, a strategy to improve the social and economic life of poor villagers and an effort to eliminate poverty are the objectives for national policies (Oddershede et al., 2007). There is a connection between rural development and national development (Cochrane, 2007). Sustainability is a concept that sustainability indicators can assess. One of the major indicators in achieving sustainable development goals is housing with sustainable rural materials. Due to housing quality in rural areas and the vulnerability to possible risks, the sustainability of rural housing is paramount and a key to rural development (Roomiani et al., 2018).

The rural settlements of Iran are geographical phenomena, which manifest spatial and natural, social, economic, political and cultural factors in the form of human-environment relations over time. In other words, owing to the regional diversity of the natural-ecological environment and the difference in political, social and economic factors, rural areas have been varied for a long time until now (Saeedi & Hosseini Hasel, 2009). The villagers have made their residential units with available materials and natural resources based on their job and living conditions (Qarah Nejad, 2002).

In this regard, the rural houses of Gilan are built based on the experience of years to utilize the energies of the sun, wind and other climatic elements and not be invasive to nature and the environment. Also, villagers have been using sustainability concepts by unitizing sustainable materials. However, today, they are using other materials in construction. Despite the traditional materials, the new materials have an urban identity and conflict with nature and the environment increasing air pollution and waste. The villages are replacing the new building with not too many old buildings. The new buildings are often built with non-indigenous materials such as clay bricks, slate, plaster, cement, steel and glass. After the destruction of buildings, the materials debris is accumulated on the outskirts of the villages, which is detrimental to the environment. Therefore, choosing materials is a major decision for architects in the design process because they should be assured of the irreversible damages. Therefore, it is necessary to maintain sustainable architecture in the villages of Noshar Rural District by using suitable and sustainable materials to design new rural buildings. In this regard, the current research aims to examine and explore the following questions:

To what extent are the construction materials in the villages of Noshar Rural District sustainable? Which villages have the highest and lowest amount of sustainable materials?

What is the relationship between sustainable materials and sustainable development of rural settlements? And which of the dimensions of sustainable development are effaced by sustainable materials?

2. Literature Review

Modern architecture, despite its valuable achievements, brings about complex problems related to the environment. The 21st century is accompanied by unstable development characterized by population growth, increased consumption and an unbalanced distribution of resources. Population growth and the western lifestyle imposed pressure on the natural environment, which has led to climate change, the ozone hole, deterioration of species and natural habitats. Sustainable development emerged in response to these transformations (Gorji Mahlabani & Yaran, 2010). The concept of sustainable development was first officially introduced in 1987 in the Brundtland report titled Our Common Future by the World Commission on Environment and Development. This commission defines sustainable development: Meeting the needs of the present generation without jeopardizing the capacities of the future generation to meet their needs (Wackernagel & Yount, 2000). Basically, a precise and correct definition of sustainable development is not possible. To define this complex concept, we can define two words separately; so "sustainable" means: Maintaining the existence without deficiency to provide livelihoods, and "development" means: The accumulation of capabilities and possibilities to achieve the best or most effective situation". Other perceptions of sustainable development include expressing perspectives (Lee, 1993), ethical development, social restructuring, the process of transformation towards a better future, not endangering the quality of the environment (Avijit, 1998), empowering people, creating new capacities, respecting local information and knowledge, increasing awareness (Dobie, 2004) Furthermore, it can be explained by the central

idea, which is meeting the needs of the present generation while considering the needs of future generations.

In this regard, experts pay more attention to sustainable development and sustainable architecture concepts (Gorji Mahlabani & Yaran, 2010). The common element of both concepts is the materials used in buildings, and they are an influential factor in the lifetime and level of stability of the building. In developed countries, materials are environmentally friendly and sustainable, which minimizes energy consumption and reduces construction and post-construction costs. However, many building materials are not renewable, and their inappropriate use will deprive the next generations of their consumption (Godfaurd et al., 2005). In addition, all construction materials affect the environment during their life cycle, and they might cause or prevent environmental hazards. Huberman and Pearlmutter state that two core questions about sustainable approaches to building materials are: what do they use? Are they using it well? They believe that sustainable materials have the following characteristics: Limiting non-renewable resources, adapting a natural life cycle and connected to the ecosystems, being non-toxic, consuming less water and energy consumption, made with recycled materials or the ability to recycle (Huberman & Pearlmutter, 2008: 837-848).

Regarding sustainable architecture, materials should consume minimum energy and create less pollution (Zimmermann et al., 2005; Calkins, 2008) and should not be dangerous for the environment when used (Wever, 1997: 143-146). Their constituents need to be renewable (Wever, 1997: 143-146), and they should consume less water and energy (Akrami, 2013: 13; Calkins, 2008: 41). Thus, the materials could need fewer raw materials, but their durability and strength should increase the life of the building (Godfaurd et al., 2005: 319-328; Isik & Tulbentci, 2008: 1426-1432). Other characteristics of sustainable materials are being not toxic and carcinogenic and not produce noise wastes (Zhou et al, 2009: 1209-1215; San-Jose et al., 2007: 3916-39 3923), while their cost of production is low (Veiseh et al., 2009). Moreover, sustainable materials have no pollution in production and can be recycled (Howarth & Hadfield, 2006; Gabriella et al., 2002). Sustainable architecture selects suitable materials for the environment to reduce energy consumption during building operations (Zimmermann et al., 2005) and also uses reversible (Powel & Craighill, 2001), reusable materials (Wever, 1997), with short transportation distance (Veiseh et al., 2009). In short, reducing resource consumption and reducing waste production is required to be in the entire life cycle of materials (Gabriella et al., 2002).

In this regard, indicators for sustainable materials were formulated in technical, socio-economic, and environmental dimensions. Figure 1, shows the conceptual model of the study.

Many studies have been conducted on sustainable materials, but there are not many studies on sustainable materials for sustainable development in rural settlements in Iran and other countries. This section reviewed some of the studies close to our research.

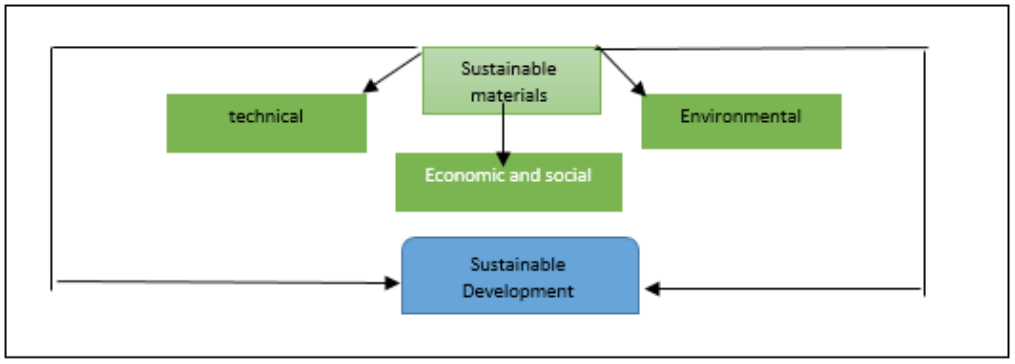

Figure 1. Conceptual framework of the study

Jalili Sadrabadi and Bolboli (2017), in a study entitled, the role of materials for urban view a sustainable urban development, concluded that bricks are more sustainable than concrete and aluminium to be used in buildings view. Roomiani et al. (2018), in their research entitled, structural-functional analysis of rural housing with a sustainable development approach, concluded that security factors, infrastructure development, integration with natural resources, productivity and space availability of residential units are able to explain more than 0.59% of the variance of indicators. The findings also showed that the rural house indicator in the sample villages is lower than the hypothetical indicators; nevertheless, it has had positive effects on the sustainability of rural houses. Imanian et al. (2017), in a study entitled, recognition of indigenous knowledge in wooden houses of Ziarat Village in Gorgan and its role in local, sustainable development, summed up that houses should be restored and renovated using materials in rural development plans and indigenous knowledge need to be utilized by recognizing the cultural, social and economic characteristics through the participation of local communities. Hajifathali et al. (2020), in their study titled, short-term strategies to reduce the harmful effects of heat islands in urban areas, found that the role of materials in the facades of buildings on the creation of heat islands and the minimization of fossil energies has a positive and significant effect. Pourali et al. (2020), in their research titled, teaching sustainable design in Iranian architecture (Farhad Ahmadi's viewpoint), concluded that for the sustainable architecture educators need a comprehensive and inclusive perspective in the educational curriculum about sustainability. Hejrati Larijani et al. (2021), in a study titled, the efficiency of new technology and materials for preventing the loss of residential building materials and sustainable development in Iran, concluded that two indicators of same size buildings and achieving efficiency thought new technology and materials, have the most significant impact on preventing construction wastes. Abdian (2021), in a study entitled, Analyzing the pattern of a sustainable city based on green architecture and new technologies, concluded that it is necessary to consider the factors of buildings, transportation, parks and green spaces, urban design and new technologies to achieve green architecture and new construction technologies goals. In addition, effective actions should be taken to build a sustainable city. Jin et al. (2017), in an empirical study entitled, perceptions towards construction and demolition waste recycling and reuse in China, stated that construction waste research is in six groups: waste prevention, investigating the impact of sustainability, waste materials and technical studies, determining the amount of waste production, emerging technologies, research methods and pioneer countries in the management of demolition and construction waste.

3. Methodology

The current study is descriptive-analytical and applied in terms of approach and aim, respectively. Also, the study used a quantitative survey technique. Document analysis and field methods to conduct this study. In the document analysis, the study gathered data from books, publications, maps and Internet websites. In the field study, we obtained the data by questionnaires and observing the residents of the villages of Noshar Rural District. The indicators (sustainable materials and sustainable development) were collected based on the study of theoretical foundations and research background and were used in the questionnaire (Tables 1 and 2). The opinions of university professors and experts were applied to ensure the validity of the questionnaires and the selected indicators. Also, 30 questionnaires were completed and used for a pre-test to check the accuracy of indicators. Using SPSS software and Cronbach's alpha method, the reliability of the questionnaires was calculated, and the value were 0.87 for sustainable materials and 0.82 for sustainable development. Therefore, the reliability of the questionnaires was accepted.

The statistical population in the current research consists of two groups. The first group is the residents of the villages of Noshar Rural District. According to the 2016 census, the number of households in this village is 3322, and the sampling group was determined to be 344 people based on Cochran's method. The distribution of the sample population in each of the studied villages in Noshar village was determined based on the percentage of the sample size. In the second group, the statistical population included experts and informants in the field of architecture and urban planning, and rural planning, who were selected as the sample population based on targeted sampling. Finally, SPSS software, FSORA + FKOPRAS models, and WASTPAS and FBMW models were used for data analysis. The ranking approaches of Fuzzy COPRAS and Fuzzy SORA as multi-indicator decision-making methods were used.

Table 1. Indicators and items of sustainable materials

Technical indicators	Socio-economic indicators	Environmental indicators
Maintainability Ease of construction	Reducing the cost of disposal Health and Safety	Recycling and reuse capability
Resistance to decay	Reduce maintenance cost	Reducing the adverse effect of materials on air quality
Fire resistance	Beauty	Zero or low toxicity
The expected life of materials (locality, resistance, durability, etc.)	Use of local materials	Minimizing air and land pollution Compliance with environmental regularities Reducing materials waste

Source: Vakili Ardabili & Shateri, 2016

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Table 2. Dimensions and items of sustainable development

Dimensions of sustainable development	Item
Economical	Changing patterns of production, distribution and consumption of resources Supplying the goods needed in the village (to reduce the cost of transportation) Using durable materials
Social	Using materials with regard to reducing energy consumption Sense of humanity and belonging Compatible with the spirit of the community Beauty Compatibility of materials with local culture Change in behaviors to change the consumption pattern
Environmental	Production of materials with low environmental impact Reduce pollution Recoverability of materials Non-toxic Water maintenance Higher lifespan of materials Building design with regard to minimizing waste Control of consumption amount The linear flow of construction materials Waste reduction Recycled Reducing energy consumption Natural materials
Physical	Sustainability of building frame Sustainability in terms of building quality Sustainability in terms of building density Safety and Security

Source: Jalili Sadrabadi & Bolboli, 2017

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Area of Study

Rasht County is located between 37 degrees and 30 seconds to 37 degrees 27 minutes 20 seconds north latitude and 49 degrees 27 minutes 42 seconds to 49 degrees 55 minutes 18 seconds east longitude. Rasht County is one of the coastal counties of Gilan Province in Iran, and Rasht City is the center of it. This county is next to the Caspian Sea and Khomam County from the north, Anzali County from the northwest, Someh Sara and Shaft Counties from the west, Rudbar County from the south, and Astana Ashrafieh, Lahijan and Siahkal County from the east. Rasht County includes five districts (Central, Lasht-e Nesha, Sanger, Khoshkebijar, Kuchesfahan). Noshar Rural District is in Khoshkebijar and Rasht County, and the population of this county is 9575 people or 3322 households, according to the census in 2016.

4. Findings

The study used a one-tailed t-test to examine the sustainability of materials in the villages of Noshar Rural District. The predicted average value for sustainability was three. Therefore, according to this value, all indicators of sustainable materials will be divided into unsustainable, semi-sustainable and sustainable categories.

As Table 3 shows, in the technical indicators, the unsustainable items are maintainability with a value of 2.43, ease of construction with a value of 2.44, resistance to decay with a value of 2.45, and fire resistance with a value of 2.51. However, the item of the expected life of materials (locality, resistance, durability, etc.) with a value of 3.00 is semi-sustainable.

As Table 4 shows, in the social-economical indicators, the unsustainable items are health and security, with a value of 2.89, and reduced maintenance cost, with a value of 2.44. On the other hand, the semi-sustainable items are reducing the cost of disposal with 3.12 and beauty with 3.21 values. And the sustainable item is the use of local materials with a value of 3.56.

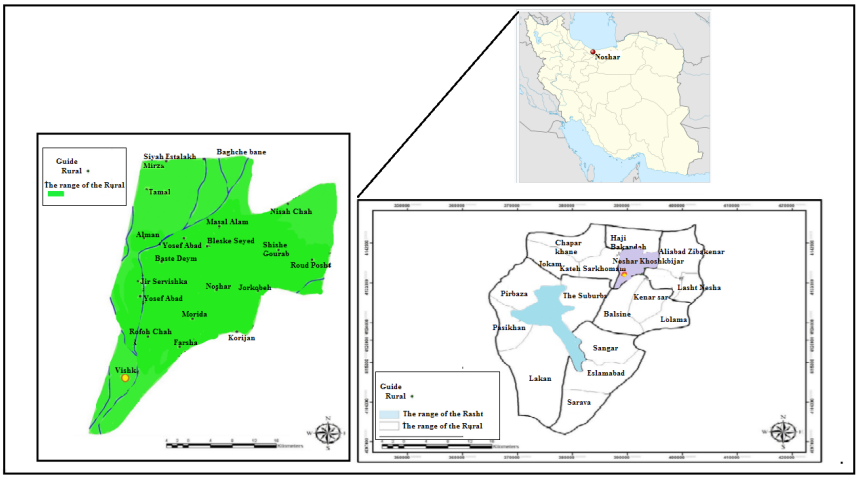

Figure 2. The geographical location of villages in Noshar Rural District

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Table 3. Assessment of technical indicators and items in Noshar Rural District

Item	Mean	T	Significance (2 tails)	The confidence interval for the difference in means is 0.95		Assessment of items
				High	Low	
Maintainability	2.43	22.445	0.000	2.54	2.22	Unsustainable
Ease of construction	2.44	22.446	0.000	2.55	2.23	Unsustainable
Resistance to decay	2.45	22.447	0.000	2.56	2.224	Unsustainable
Fire resistance	2.51	22.450	0.000	2.63	2.51	Unsustainable
Expected life of materials (locality, resistance, durability, etc.)	3.00	22.431	0.000	3.10	2.89	Semi-sustainable

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Table 4. Assessment of social-economical indicators and items in Noshar Rural District

Item	Mean	T	Significance (2 tails)	The confidence interval for the difference is 0.95		Assessment of items
				High	Low	
Reduce the cost of disposal	3.12	22.0. 221	0.000	3.21	3.04	Semi-sustainable
Health and safety	2.89	22.458	0.000	2.96	2.78	Unsustainable
Reduce maintenance cost	2.44	22.446	0.000	2.55	2.23	Unsustainable
Beauty	3.21	22.456	0.000	3.43	3.11	Semi-sustainable
Use of local materials	3.56	22.459	0.000	3.75	3.61	Sustainable

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Table 5. Assessment of environmental indicators and items in Noshar Rural District

Item	Mean	T	Significance (2 tails)	Confidence interval for difference is 0.95		Assessment of items
				High	Low	
Recycling and reuse capability	3.00	22.231	0.000	3.11	2.92	Semi-sustainable
Reducing the adverse effect of materials on air quality	2.34	22.432	0.000	2.43	3.23	Unsustainable
Zero or low toxicity	2.11	22.429	0.000	2.23	2.00	Unsustainable
Minimizing air and land pollution	2.19	22.230	0.000	2.34	2.09	Unsustainable
Compliance with environmental regularities	2.09	22.458	0.000	2.15	2.21	Unsustainable
Reducing materials waste	2.54	22.430	0.000	3.67	2.67	Unsustainable

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As Table 5 shows, in the environmental indicators, the unsustainable items are reducing the adverse effect of materials on air quality with a value of 2.34, zero or low toxicity with a value of 2.11, minimizing air and land pollution with a value of 2.19, compliance with environmental regularities with a value of 2.09, reducing materials waste with a value of 2.54. Moreover, the semi-sustainable item is Recycling and reuse capability with a value of 3.00. Furthermore, the study used the WASTPA model to rank the villages of Noshar Rural District for the use of sustainable materials. The results are illustrated in Table 6.

As seen in Tables 6 and 7, in the technical dimension, the highest material sustainability is in the villages Moridan, with a weight of 3.554, and the lowest score belongs to Neysa Chah Village with a weight of 2.322. Regarding material sustainability of the environmental dimension, the villages Moridan with a weight value of 3.476, and Noshar with a weight value of 2.721, have the highest and lowest scores, respectively. Also, in the social-economical dimension, Moridan Village, with a weight value of 3.521, and Noshar Village are more sustainable. The same obtained weights of villages indicate a significant and positive relationship between the technical, economic-social and environmental dimensions.

The Spearman correlation test was used to determine the relationship between two variables (sustainable materials and sustainable development) in rural settlements of Noshar Rural District. The results in table 8 show a significant and positive relationship between the dimensions of sustainable development (economic and social, environmental and physical) and sustainable materials at a level of 0.000.

The relationship between the independent and dependent variables is shown in Table 8. The study used FBMW models and FARAS + FKOPRAS combined models to rank the effect of the dimensions and items separately.

We suggested a qualitative index in FARAS + FKOPRAS) models which can estimate the effect of each dimension of sustainable development in Noshar Rural District with emphasis on sustainable materials. The scores between 0.00-0.30 show a red status and a very low effect for the dimension. From 0.30 to 0.40, the dimension is classified as red status with low effect. From 0.40 to 0.60, the status of dimension is classified yellow with medium effect. From 0.60 to 0.70, the status of the dimension is classified as yellow with high effect. From 0.70 to 0.80, the status of the dimension is classified as green with high effect, and from 0.80 to 0.100 the status of dimension is classified green with very high effect.

Table 6. Spatial analysis of the villages of Noshar Rural District based on technical and environmental dimensions

Technical				Environmental			
Village	λ	Qi	Ranking of the village	Village	λ	Qi	Ranking of the village
Basteh Dim	0. 989	3.432	4	Basteh Dim	0. 989	3.312	4
Jurkuyeh	0.989	3.443	2	Jurkuyeh	0.989	3.356	2
Rud Posht	0.989	3.437	3	Rud Posht	0.989	3.321	3
Rofooh Chah	0.989	3.332	5	Rofooh Chah	0.989	3.278	6
Forshom	0.989	3.432	4	Forshom	0.989	3.310	5
Moridan	0.989	3.554	1	Moridan	0.989	3.476	1
Tamal	0.989	3.093	12	Tamal	0.989	3.167	13
Siah Astalkh Mirza Rabi	0.989	083/3	13	Siah Estalkh Mirza Rabee	0.989	3.187	12
Baghche-Baneh	0.989	2.445	18	Baghche-Baneh	0.989	2.871	19
Alman	0.989	213/3	8	Alman	0.989	3.243	8
Jirsar-e Vishka	0.989	3.231	7	Jirsar-e Vishka	0.989	3.266	7
Yousef Abad	0.989	2.334	19	Yousef Abad	0.989	3.00	18
Kuri Jan	0.989	3.200	9	Kuri Jan	0.989	3.213	9
Noshar	0.989	2.342	20	Noshar	0.989	2.721	21
Baleskeleh-ye Seyyed Abol Qasem	0.989	3.113	10	Baleskeleh-ye Seyyed Abol Qasem	0.989	3.200	10
Yusef Mahaleh	0.989	3.103	11	Yusef Mahaleh	0.989	3.198	11
Mashal Alam	0.989	3.043	14	Mashal Alam	0.989	3.103	15
Shishe-Gorab	0.989	2.876	17	Shishe-Gorab	0.989	3.100	16
Gol Bazu	0.989	3.00	15	Gol Bazu	0.989	3.121	14
Neysa Chah	0.989	332/2	21	Neysa Chah	0.989	2.556	20
Vishka	0.989	998/2	16	Vishka	0.989	074/3	17

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Table 7. Spatial analysis of the villages of Noshar Rural District based on the social-economical dimension

Socio-economic indicators			
Village	λ	Qi	Ranking of the village
Basteh Dim	0.989	3.489	4
Jurkuyeh	0.989	3.513	3
Rud Posht	0.989	3.533	2
Rofooh Chah	0.989	3.354	6
Forshom	0.989	3.456	5
Moridan	0.989	3.521	1
Tamal	0.989	3.100	13
Siah Estalkh Mirza Rabee	0.989	3.108	12
Baghche-Baneh	0.989	3.862	18
Alman	0.989	3.221	7
Jirsar-e Vishka	0.989	3.231	8
Yousef Abad	0.989	2.721	19
Kuri Jan	0.989	3.213	9
Noshar	0.989	2.556	21
Baleskeleh-ye Seyyed Abol Qasem	0.989	3.145	11

Table 7. Spatial analysis of the villages of Noshar Rural District based on the social-economical dimension

Socio-economic indicators			
Village	**λ**	**Qi**	**Ranking of the village**
Yusef Mahaleh	0.989	3.153	10
Mashal Alam	0.989	3.056	14
Shishe-Gorab	0.989	3.00	16
Gol Bazu	0.989	3.043	15
Neysa Chah	0.989	2.413	20
Vishka	0.989	2.933	17

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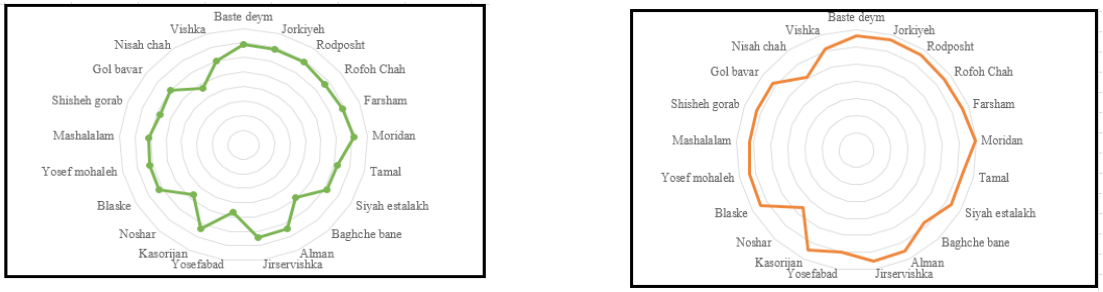

Figure 3. Radar chart of materials sustainability in the villages of Noshar Rural District in environmental and technical dimensions

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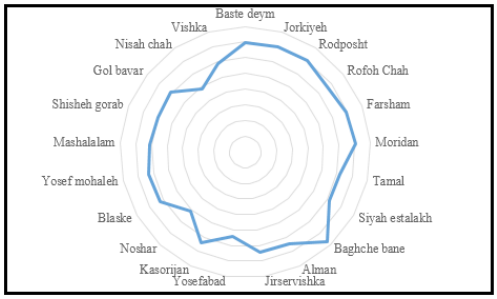

Figure 4. Radar chart of materials sustainability in the villages of Noshar Rural District in social-economical dimensions

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Table 8. Results of correlation analysis between sustainable materials and sustainable development

Dimensions of sustainable development	Independent variable	r	P
Economical	Sustainable materials	0.543	0.000
Social		0.556	0.000
Environmental		0.570	0.000
Physical		0.561	0.000

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Table 9. Analysis of sustainable materials impact on each sustainable development dimension

Dimensions	Obtained value (QL)	Maximum value (QMAX)	Minimum value (QMIN)	Difference between QMIN and QMAX	Value in 100
Economical	12.213	13.342	11.432	1.988	71.04
Social	12.321	13.443	11.214	2.231	70.04
Environmental	13.300	14.453	12.345	2.108	71.11
Physical	13.431	14.554	12.453	1.101	71.15

Source: Research Findings

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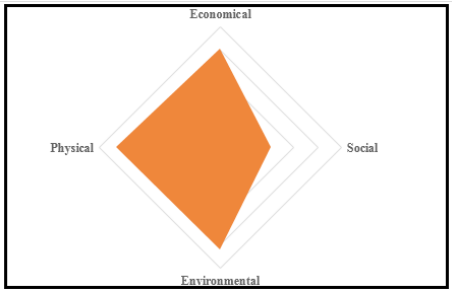

Figure 6. Radar Chart of sustainable materials impact on each sustainable development dimension

As Table 9 shows, sustainable materials affected the physical dimension, the environmental dimension, the economic dimension, and the social dimension with weights of 71.15, 71.11, 71.04, and 70.04, respectively

As shown in Table 10 and Figure 7, sustainable materials affected the items of economical dimension, including using durable materials, changing patterns of production, distribution and consumption of resources, supplying the goods needed in the village (to reduce the cost of transportation), in the order of impact with the weights of 17.01, 14.91, and 14.00, respectively.

Table 10. Radar Chart of sustainable materials impact on each sustainable development dimension

Dimensions of sustainable development	Weights of the dimensions	Item	Weights of the items	Final weights	The degree of dependency
Economical	70.04	Changing patterns of production, distribution and consumption of resources	0.213	14.91	2
		Supplying the goods needed in the village (to reduce the cost of transportation)	0.200	14.00	3
		Using durable materials	0.243	17.01	1
Social	71.04	Using materials with regard to reducing energy consumption	0.212	15.06	4
		Sense of humanity and belonging	0.198	14.06	6
		Compatible with the spirit of the community	0.221	15.69	3
		Beauty	0.211	14.98	5
		Compatibility of materials with local culture	0.241	17.12	2
		Change in behaviors to change the consumption pattern	0.252	17.90	1
Environmental	71.11	Production of materials with low environmental impact	0.266	18.91	1
		Reduce pollution	0.256	18.20	2
		Recoverability of materials	0.245	17.42	7
		Non-toxic	0.221	71/15	11
		Water maintenance	0.246	17.49	6
		Higher lifespan of materials	0.251	17.84	4
		Building design with regard to minimizing waste	0.244	17.35	8
		Control of consumption amount	0.231	16.42	10
		Waste reduction	0.212	15.07	12
		Recycled	0.255	18.13	3
		Reducing energy consumption	0.241	17.14	9
		Natural materials	0.266	18.91	1
Physical	71.15	Sustainability of building frame	0.341	24.26	3
		Sustainability in terms of building quality	0.334	23.76	4
		Sustainability in terms of building density	0.351	24.97	2
		Safety and Security	0.365	25.96	1

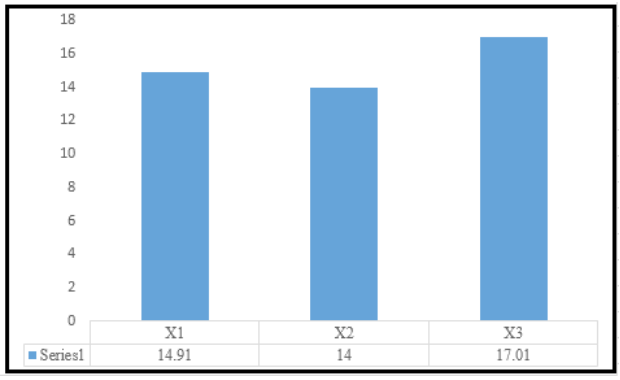

Figure 7. Radar Chart of the impact of the sustainable materials on each item of economical dimension in Nosher Rural District

As Table 10 and Figure 8 show, sustainable materials affected the items of social dimension, including change in behaviors to create change in behaviors to change the consumption pattern, compatibility of materials with local culture, compatible with the spirit of the community, using materials with regard to reducing energy consumption, beauty, sense of humanity and belonging, in the order of impact, with the weights of 17.90, 17.12, 15.69, 15.06, 14.08,14.06, receptively.

As Table 10 and Figure 9 show, the affected items of the environmental dimension, respectively, are as follows: production of materials with low environmental impact, reduce pollution, recycled, higher lifespan of materials, water maintenance, recyclability of materials, building design with regard to minimizing waste, control of consumption amount, non-toxicity of the materials, waste reduction. The weights of these items are 18.91, 18.20, 18.13, 17.84, 17.49, 17.42, 17.35, 16.42, 15.71, and 15.07, respectively.

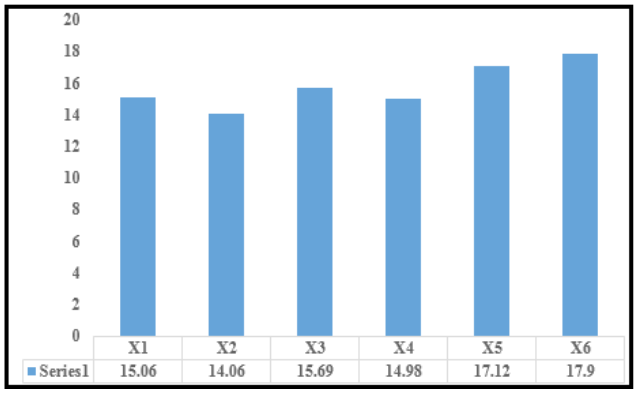

Figure 8. Radar Chart of the impact of the sustainable material on each item of Social dimension in Nosher Rural District

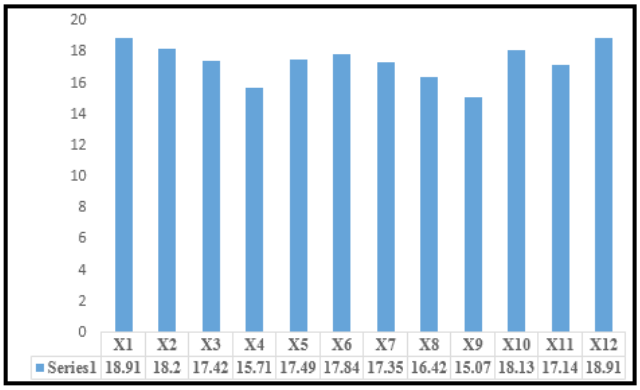

Figure 9. Radar Chart of the impact of the sustainable material on each item of the environmental dimension in Noshar Rural District

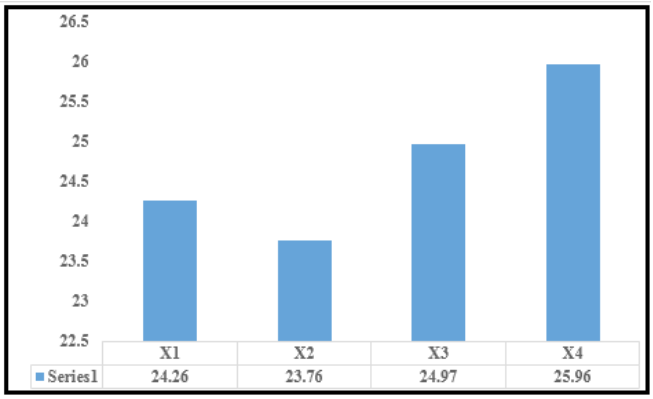

Figure 10. Radar Chart of the impact of the sustainable material on each item of the physical dimension in Noshar Rural District

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Table 10 and Figure 10 show that the items of physical dimension are affected by sustainable materials. Based on their order of impact, these items are safety and security with a weight of 25.96, sustainability in terms of building density with a weight of 24.97, sustainability of building frame with a weight of 24.26.

5. Discussion

The current research investigated sustainable materials and their roles in achieving sustainable development goals in Noshar Rural District in Rasht County. The findings indicated that the sustainable items are the item of the expected life of materials with a value of 3.00 (technical dimension), the items of reducing the cost of disposal with a value of 3.12, beauty with a value of 3.21 (social dimension), and the potential recycling and reuse with the value of 3.00 (environmental dimension), in the villages of Noshar Rural District. The other items are evaluated as unsustainable. Based on differences in geographical spaces, we evaluated the villages separately. The study found that in the technical dimension, the villages of Moridan, with a value of 3.554, and Neysa Chah, with a value of 2.322, have the highest and lowest use of sustainable materials in the villages of Noshar Rural District. In the environmental dimension, the villages of Moridan, with a value of 3.476 and Noshar, with a value of 2.721, have the highest and lowest use of sustainable materials. In the social and economic dimension, the villages of Moridan, with a value of 3.521, and Noshar, with a value of 2.556, have the highest and lowest use of sustainable materials. The same obtained weights of villages indicate that there is a significant and positive relationship between the technical, economic-social and environmental dimensions. We can conclude that communities that cannot use sustainable materials for their buildings and housing cannot achieve sustainable development. In other words, sustainable materials can explain many economic, social, environmental, and physical features of rural society.

Sustainable materials affected the physical, environmental, economic, and social dimensions with weights of 71.15, 71.11, 71.04, and 70.04, respectively. The most affected items from sustainable materials included safety and security (physical dimension), using durable materials (economical dimension), change in behaviors to change the consumption pattern (social dimension), and production of materials with low environmental impact (environmental dimension).

In conclusion, for sustainable development of rural settlements in Noshar Rural District of Rasht County, policymakers should pay attention to sustainable materials in relation to dimensions of sustainable development. To this end, rural development, sustainable development and materials experts must be used. Regarding sustainable materials and sustainable development, the findings of this study are consistent with Jalili Sadrabadi & Bolboli (2017) and Hejrati Larijani et al. (2021). However, there were some differences in methods. The main difference in the research method compared to the previous studies is the use of fuzzy models and spatial analysis.

Acknowledgements

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interest

The authors declared no conflicts of interest.

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