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Research Article

Hotel Construction Management considering Sustainability Architecture and Environmental Issues

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Sustainable development and environment in the activities of the construction industry has attracted the attention of experts in most countries of the world. One of the obvious and problematic features of the construction industry of countries is the use of modern building materials using traditional construction methods. Changing the paradigm for sustainable buildings requires a change in the architectural design process. Today, smart buildings are buildings that are at a lower level in terms of energy consumption and operate in a dynamic and integrated environment, creating a perfect harmony between management, system, services, and structure. These qualities make plastics ideal products for construction and an essential component for a sustainable built environment. In the design of smart and sustainable buildings, the use of environmentally friendly materials increases the lifespan of the building and an effective step is taken towards the design of sustainable architecture. In this paper, we evaluate hotel construction based on sustainability issues with MCDM. The results show that alternative A4 is the best alternative in sustainable issues. With the increasing population and its concentration in large cities, the concern of energy supply and energy efficiency in buildings is one of the main concerns of urban planners, officials, and city residents. Construction projects mainly consume large amounts of materials and leave a huge amount of waste, and this problem sometimes includes existing buildings that cannot be demolished and need to be rebuilt and maintained.

1. Introduction

Sustainability and sustainable development in today's societies has become an important issue among decision-makers and policymakers in moving towards a healthier, more socially advanced, and more economically developed environment [1, 2]. The construction industry is more familiar with this concept among the existing industries, especially its environmental category [3–6]. What has attracted less attention among the various sectors of the construction industry is the industrial buildings sector [7]. In most countries, it is becoming more and more industrial, and therefore industrial buildings require more attention in this field [8–11]. Accordingly, having the importance of environmental assessment and energy performance of buildings in mind, it is vital to develop an overview of current theoretical perspectives, trends, applications, and constraints toward the development of green environmentally sustainable buildings.

With the development of innovative materials, products, and construction methods, it is necessary to move towards buildings with higher efficiency, better economic efficiency, and being environmentally friendly [12–15]. Smart buildings are one of the modern technologies and technologies of construction in architecture in which to optimize and control energy consumption, reduce its loss, create comfort, and increase the level of environmental security and save time and repair costs [16–20]. Building maintenance helps a lot [3, 12, 21, 22]. The use of intelligent technology in construction and architecture, appropriate and timely response to changes in environmental and climatic conditions, prevents energy waste and also increases the life of the building [23–26]. This process on a large scale increases the sustainability of the environment, which is one of the priorities, principles, and goals of sustainable architectural design [27–32]. However, although these scenarios could reduce some environmental impacts, they could also enhance others [33–37]. In order to improve the results of life cycle analysis, another variant that generates fewer impacts than previously simulated variants was developed by retaining the following environmental scenarios [38–41].

With the rapid advancement of technology and the subsequent expansion of the urbanization process and its negative effects [42–46] on the use and further destruction of land, natural resources and green space and pollution of virgin soil, clean water, and clean air, the category of sustainable development in construction is essential [22, 23, 27, 47]. Buildings are the most important elements of the city, so that in the sustainable development of the city attention to the sustainability of constructions is recognized as the most important aspect of sustainability and this importantly becomes more and more colorful with increasing urbanization and growing demand for social, industrial, and economic needs [48–50]. That is why many architects, engineers, contractors, and builders today are reevaluating how to build residential and commercial buildings and infrastructure projects [51–54]. Sustainable use of resources such as nature, man, and technology would meet the needs of human beings [55–57]. Studies also show that the largest consumers of natural resources are development projects. In addition, various national and international programs are underway with an incentive to encourage developers and state-owned companies to move towards green, and in some cases to specify in its application [42, 58–60]. In the present article, while focusing on the environmental approach in the sustainable development of construction projects, green construction is presented as its main part and its implementation solutions are proposed. In addition, the existing challenges facing green construction projects are discussed.

The increasing growth of primary resource extraction and the production of environmental pollutants are the two main challenges of contemporary man. Consumption of natural resources in 2005 has exceeded 60 billion tons and is estimated to increase to 100 billion tons per year in 2030 [48, 61–63]. In the current prevailing model, economic growth is directly related to the consumption of primary resources on the one hand and the amount of production waste on the other [3, 64–66]. In other words, more economic growth requires more resources and more waste production. Studies show that the amount of waste production in developing countries is 10–20% of developed countries. Obviously, with the economic growth of these countries, the amount of waste production will increase significantly. The construction industry is one of the areas that is directly related to these challenges. About 50% of the extracted raw materials are converted into construction products [2, 7, 67, 68]. The purpose of this article is to investigate the environmental sustainability and sustainable development in construction projects. Many assessment methodologies and tools exist and there have been numerous reviews of them. Statistical methods, mathematics, and artificial intelligence have many applications in the real world, such as risk assessment, energy optimization, the environment, and so on. The main objective and novelty of this research is to present an updated critical overview of all the sustainability evaluation alternatives developed in research studies in the fields of architectural design, construction, refurbishment, and restoration. To achieve this, the analysis follows a specific methodology based on recent similar reviews.

2. Sustainable Development

Sustainable development is growth which always addresses our needs today without undermining future generations' capacity to fulfill their expectations [8, 27]. The importance of the decision-making is so great that according to the standard of project management knowledge body, in addition to being mentioned as one of the individual skills in project management, in all ten areas of project knowledge management it has somehow addressed the issue [1, 48]. Sustainability approach to construction is unique in the context of each project, so that it is influenced by different local, regional, and international customers and stakeholders, as well as their priorities [1, 69–71]. Because of this, it is difficult to ensure decisions and it can potentially lead to significant economic, social, and environmental consequences [72–74]. Decision tools as part of sustainability tools, along with ranking tools, calculations, and guidelines to reduce the risk of projects related to sustainability and sustainable development and in the framework of evaluation of these projects by consulting engineers or universities in order to use. Different parts of infrastructure such as water, energy, transportation, and construction have been provided [75–77]. Comparing these tools and examining the specifications of each of them are helpful to select or produce similar tools for use in national and regional infrastructure projects [21, 78–80].

Sustainable development, which is one of the main topics discussed in development and planning circles today, is itself the result of different development ideas [81]. At the same time, this concept, like the concept of development itself, has been interpreted in various ways [81, 82]. The common denominator of all these ideas is sustainability and achieving a process of development that can be sustainable and sustainable [83]. The requirement for balance stability: in other words, on the other side of the coin of stability is balance, because an unbalanced system will also be unstable, and vice versa [7, 83]. The difference in different ideas is in the generalization of the concept of balance and stability, where one group suffices to balance in the relationship between man and the natural environment, and another group generalizes it to all aspects of human life, i.e., the relationship between man and environment and man with man and societies [84–87]. In sustainable human development, sustainability in all economic, social, and environmental dimensions is emphasized and it is believed that without stability and balance in all aspects of society a sustainable development cannot be achieved [88–91]. However, the existing research rarely reviews the importance views and performance levels of critical sustainability aspects (including economic, social, and environmental aspects) of prefabricated buildings, and the interdependence among criteria is ignored [92].

2.1. Sustainability of Building and Sustainable Construction. Sustainable architecture is one of the most important developments in the field of architecture, the purpose of which is to design based on the principles of sustainability and energy saving [93–95]. Sustainability and sustainable development in order to reduce environmental pollution and optimize energy consumption has been considered by designers and architects and is in fact a response to the crises in the industrial and modern world today [96–98]. In the present era, creating stability and its development is very necessary in architecture due to the problems of the industrial age and special attention should be paid to it [99]. This type of architecture reduces the damage caused by the design of the building to energy resources and the environment, so a building built with a sustainable design has the least incompatibility with the environment [96]. Sustainable architecture, also called green design, runs counter to common construction patterns and is based on ecological and nature-friendly design. Green design is actually a triangle, in which energy, ecology, and climate are its three vertices [100–102]. The main purpose of green design is to create conditions for the building that can be used to minimize the use of natural and mineral materials using recycled materials. As a result, a kind of balance is created in the cycle of nature and natural resources will not be lost for future generations [103].

Changes in the design and construction of buildings are done according to the needs of society, so if the relationship between new technologies and sustainability goals is taught, environmental problems will be reduced and new innovations and technologies will serve sustainability [104]. Sustainability means the continuation of life in the future and refers to economic, social, and environmental sustainability. This concept is based on the three principles of resource utilization, human design, and life cycle design [105]. In today's world, architects are looking for useful solutions to provide a desirable life for human beings. The strengths and weaknesses of a building have a direct impact on the environment, so architects have a critical task to sustain human life and preserve the environment [106]. Architects use the harmonious order that exists between the elements of nature as their design model and implement sustainable architecture called ecological architecture, environmental architecture, and green architecture. Green design is associated with structural, electrical, and mechanical engineering [107]. On the basis of the conclusion of the above PCA, the successful development of GH projects is mainly affected by project management factors, human resource factors, teamwork-oriented factors, personnel ability factors, and finance and constraint factors [108].

In designing a structure, in addition to texture, light, beauty, and fit, other environmental, human, and economic factors must also be considered. These factors include regional and cultural identity, climate, building materials, bed compatibility, meeting human needs, building facades, and so on [1]. Sustainability thinking is an effort to adapt architectural designs to the environment. In fact, this thinking uses environmentally friendly construction methods to minimize the negative effects of construction [109]. New technologies used in green architecture have led to the creation of new ways of life and the creation of new architectures. Using these technologies, the architectural shortcomings of the past can be eliminated and new methods for construction can be adopted [110]. Methods that waste less building materials with optimal implementation can be recycled after use. Production of construction materials and new construction are factors for achieving sustainable development in the construction industry [111]. The construction industry needs to spend huge amounts of money in the long run, so along with the growth of investment, it is necessary to get acquainted with the concepts and techniques of the world in the field of construction. New technologies improve the quality of a building and in addition to providing security lead to optimized energy consumption [112]. Table 1 shows the general goals of sustainable architecture.

2.2. Sustainable Design and Principles of Sustainable Thinking. In this type of architecture, the building not only adapts to the climatic conditions of its area, but also interacts with it. What is referred to today as sustainable development is a reformist rethinking of modernism and tradition [3]. Sustainable development is development that addresses current needs in a way that does not diminish the ability of future generations to meet those needs [2]. To this end, it is necessary to reduce the use of nature and natural resources as much as possible and to manage environmental pollutants and construction waste in such a way that the life cycle is not disrupted [1]. Sustainable architecture, which is in fact a subset of sustainable design, can perhaps be considered one of the most important contemporary trends that is a logical reaction to the problems of the industrial age. For example, 50% of fuel reserves are consumed in buildings, which in turn will lead to environmental crises. Therefore, the need to create and develop more sustainability in architecture is well visible [1]. Sustainable architecture, like other categories of architecture, has its own principles and rules and includes three stages [72]. Resources saving and its designation would return to the human's life cycle with their own strategies. Knowing and studying these measures will lead the architect to a better understanding of the environment he has to

Table 1: The goals of sustainable architecture.

Goals	References
Paying attention to human life and improving its physical and mental condition	[3]
The use of materials whose production, consumption, or destruction is environmentally friendly	[7, 8]
Adaptation and coordination with the environment	[72, 75]
Limited consumption of fossil fuels	[84, 88, 96, 126]
Use natural energy such as sunlight	[88, 126]
Minimal damage to the environment	[27]
Reduce carbon dioxide emissions	[88, 126]
Respect for nature and use its potentials	[72, 75]
Reuse of building materials and recycled materials	[88, 126]
Reduce the production of construction waste	[88, 126]
Increase the useful life of the building	[7, 8]
Avoid using building materials that are incompatible with nature	[88, 126]

design. The point to be noted is that sustainable or ecological architecture should not be confused with indigenous architecture. According to the definition, indigenous architecture is a branch of architecture that bases its work on the needs of the region and building materials that reflect the traditions of the region. And it has evolved over time and is based on environmental, cultural, technological, and historical background.

2.3. Sustainable Smart Building. The system in the smart building provides an efficient and comfortable environment for its residents; these systems operate in an intelligent building in an integrated way and put different devices in contact and interact with each other [113]. Smart buildings harmonize and combine the best ideas, materials, systems, and technologies. These components are combined to achieve better performance in the building [114]. The smart building provides an efficient and comfortable environment for its residents; these systems operate in an intelligent building in an integrated way and put different devices in communication and interaction with each other [115]. With this system, communications, office work, and building control can be entrusted to intelligent management using a comprehensive computer network. The existence of smart buildings is inevitable in the modern era; a smart building should be able to meet the needs of its users; high productivity and efficiency, energy storage, comfort, and increase the life of the building are examples of this type of goals. The construction of smart buildings is achieved; if a work can adapt to the possibilities and limitations according to its needs at any time, it can operate optimally with the best economic efficiency; smart materials play a significant role in economic and living conditions [113]. The most important benefits of smart building can be in increasing the environmental well-being and luxury of the building by mechanizing it, reducing energy consumption in the building by making optimal use of energy and preventing the loss of nonrenewable resources [114]. Reduce the cost of charging and maintenance of the building by using intelligent maintenance methods, increase the safety and security of the building by using monitoring and control systems, and increase the life of equipment used in the building by using them optimally and standard [113].

2.4. Principles of Sustainable Architectural Design. Giving importance to human life and preserving it now and in the future, using materials that cause the least damage to their environment, whether during production or during use or destruction, minimal use of fuel energy and efforts to use natural energy, reducing environmental degradation, and improving the physical and mental living conditions of humans and other living organisms can be called the primary goals of sustainable architecture [1, 48]. To achieve such goals, some principles need to be observed as shown in Table 2.

3. Research Method

3.1. Entropy Method under Uncertainty. The entropy method is a weighting method [116]. The method of weighting under uncertainty and hesitant fuzzy is a new method for weighing the criteria in a situation where there is a possibility of error between the judgment of experts for various reasons [117–120], such as a large number of experts, and it is necessary to weigh the problem under uncertainty [8, 23, 78]. The steps of this method are as follows [23]:

Step 1. Calculate the s_{ij} hesitant fuzzy score matrix on the Expert Opinions matrix using the following formula:

$$s\left(h_E(x)\right) = \sum_{j=1}^{l\left(h_E(x)\right)} h_E^{\sigma(j)} \frac{(x)}{l\left(h_E(x)\right)}. \tag{1}$$

Step 2. Computation of the normalized matrix S based on the previous step:

$$s_{ij}' = \frac{s_{ij}}{\sum_{i=1}^{m} s_{ij}}. \tag{2}$$

Step 3. By using De Luca-Termini normalized entropy in the field of hesitant fuzzy sets,

$$E_j = -\frac{1}{m \ln 2} \sum_{i=1}^{m} \left(s_{ij}' \ln s_{ij}' + \left(1 - s_{iy}'\right) \ln\left(1 - s_y'\right) \right), \quad j = 1, 2, \ldots, n. \tag{3}$$

Table 2: Principles of sustainable architectural design.

Principles of sustainable architectural design	References
(1) Reuse existing buildings and preserve the surroundings, place bush and greenhouse, and green plants as much as possible	[1, 2, 7, 8, 12, 27, 48, 114]
(2) Prevent water loss and collect and recycle used water and use rainwater	[1, 2, 7, 8, 12, 27, 48, 114]
(3) Increase energy efficiency in a variety of ways, including building a building that makes the most of sunlight and seasonal changes. Do not use devices that are not approved in terms of energy consumption, thermal and sound insulation.	[1, 2, 7, 8, 12, 27, 48, 114]
(4) Use of indigenous, recyclable materials, and those that require the least amount of energy to prepare. Such products, in addition to being durable, also contain the least amount of harmful chemicals.	[1, 2, 7, 8, 12, 27, 48, 114]
(5) Enjoy natural and clean energy such as solar and wind energy	[1, 2, 7, 8, 12, 27, 48, 114]

Step 4. The definition of the weight of the features is expressed by the following formula:

$$w_j = \frac{1 - E_j}{\sum_{j-1}^{n}\left(1 - E_j\right)}, \quad j = 1, 2, \ldots, n, \tag{4}$$

where W_J is the weight of the subcriteria [116, 121–123].

3.2. MAIRCA Method. This method is done in six steps [12, 93].

Step 1. Form a decision matrix.

In fact, this step is present in all decision-making methods. The decision matrix of this method is a criterion-choice decision matrix, i.e., the matrix in which the rows of research options and the columns of those criteria are located, and each cell of this matrix evaluates each option ratio, by any measure. For example, Figure 1 shows an example of a decision matrix. The decision matrix can be completed both by real numbers (quantitative) and by verbal (qualitative) spectra.

	C_1	C_2	…	C_n
A_1	H_{11}	H_{12}	…	H_{1n}
A_2	H_{21}	H_{22}	…	H_{2n}
…	…	…	…	…
A_m	H_{m1}	H_{m2}	…	H_{mn}

Figure 1: Decision matrix.

Step 2. Determine the priority based on the choice of options (P_{A_i}).

During the selection of the option, the decision-maker is neutral for the work process. In fact, he does not prefer any of the options offered. The main assumption is that the decision-maker does not consider the probabilities of each option. The decision-maker also understands other options, as if each of them could be visually equal, so the preference for choosing one of them from the possible m option is based on the following equation:

$$P_{A_i} = \frac{1}{m}, \qquad \sum_{i=1}^{m} P_{A_i} = 1, \quad i = 1, 2, \ldots, m. \tag{5}$$

In the above relation, m specifies the total number of options. In decision analysis, with the probabilities mentioned, we assume that the decision-maker is risk neutral. In this case, all preferences are equal according to the choice of specific options; i.e., all P_{A_i} are equal.

Step 3. Calculation of theoretical evaluation matrix elements (T_p).

Theoretical evaluation matrix (T_p) is created in $n * m$ format where n is the total number of criteria and m is the total number of options. The elements of the theoretical evaluation matrix (t_{pij}) are calculated as the coefficient of preference as P_{A_i} options and the weight of the criteria (W) as follows:

$$\begin{array}{c} w_1 \quad w_1 \quad \ldots \quad w_n \quad w_1 \quad w_1 \quad \ldots \quad w_n, \end{array}$$

$$T_p = \begin{array}{c} P_{A_1} \\ P_{A_2} \\ \cdots \\ P_{A_m} \end{array}\begin{bmatrix} t_{p11} & t_{p12} & \cdots & t_{p1n} \\ t_{p21} & t_{p22} & \cdots & t_{p2n} \\ \cdots & \cdots & \cdots & \cdots \\ t_{pm1} & t_{pm2} & \cdots & t_{pmn} \end{bmatrix} = \begin{array}{c} P_{A_1} \\ P_{A_2} \\ \cdots \\ P_{A_m} \end{array}\begin{bmatrix} P_{A_1 w_1} & P_{A_1 w_2} & \cdots & P_{A_1 w_n} \\ P_{A_2 w_1} & P_{A_2 w_2} & \cdots & P_{A_2 w_n} \\ \cdots & \cdots & \cdots & \cdots \\ P_{A_m w_1} & P_{A_m w_2} & \cdots & P_{A_m w_n} \end{bmatrix}. \tag{6}$$

Since the decision-maker for the initial selection of options is neutral, all preferences (P_{A_i}) are equal for all options. Then, the above equation can be shown in the following equation:

$$\begin{array}{c} w_1 \quad w_1 \quad \ldots \quad w_n \quad w_1 \quad w_1 \quad \ldots \quad w_n, \end{array}$$

$$T_p = P_{A_i}\left[t_{p1} \;\; t_{p2} \;\; \cdots \;\; t_{pn} \right] = P_{A_i}\left[P_{A_1 w_1} \;\; P_{A_i w_2} \;\; \cdots \;\; t_{A_i w_n} \right]. \tag{7}$$

Step 4. Determine the real evaluation equation.

The calculation of the elements of the real evaluation matrix (T_r) is done by multiplying the elements of the theoretical evaluation matrix (T_p) and the elements of the initial decision matrix (X) according to the following

Table 3: Criteria and subcriteria for evaluation of hotel construction.

Criterion	Under the criteria	Code	Resource
Resource and energy management	The system status in terms of sound insulation is the following:	EX1	[1, 55, 110]
	Fire prevention	EX2	[1, 55, 82]
	The executive method is unaffected by seasonal restrictions	EX3	[1, 110]
	Reduce system deployment energy consumption	EX4	[1, 55, 110]
	No use of heavy machinery is required	EX5	[1, 82, 111]
Economic	The rate of return on capital	EC1	[1, 55, 110]
	Affordable construction	EC2	[1, 55, 110]
	Construction time is short	EC3	[1, 82, 110]
Environmental and sustainable development	The ability to reuse and recycle materials	S1	[72]
	Green design and construction use less energy	S2	[72, 96, 114]
	There is no environmental pollution produced	S3	[72, 114]

equations. The first equation is for positive criteria and the second equation is for negative criteria.

$$t_{rij} = t_{pij}\left(\frac{x_{ij} - x_i^-}{x_i^+ - x_i^-}\right),$$
$$t_{rij} = t_{pij}\left(\frac{x_{ij} - x_i^+}{x_i^- - x_i^+}\right), \tag{8}$$

Step 5. Calculate the total gap matrix (G).

The elements of the G matrix are calculated as the difference (distance) between theoretical estimates (t_{pij}) and real estimates (t_{rij}), which are expressed in terms of the following equation. In fact, when g_{ij} tends to zero, it is because the option with the least difference between theoretical (t_{pij}) and real evaluation (t_{rij}) is chosen. In other words, for the C_i option compared to the C_i criterion, if the theoretical evaluation is equal to the actual evaluation, in the C_i criterion, the A_i option is the best.

$$\begin{aligned} G &= T_p - T_r \\ &= \begin{bmatrix} g_{11} & g_{12} & \cdots & g_{1n} \\ g_{21} & g_{22} & \cdots & g_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ g_{m1} & g_{m2} & \cdots & g_{mn} \end{bmatrix} \\ &= \begin{bmatrix} t_{p11} - t_{r11} & t_{p12} - t_{r12} & \cdots & t_{p1n} - t_{r1n} \\ t_{p21} - t_{r21} & t_{p22} - t_{r22} & \cdots & t_{p2n} - t_{r2n} \\ \cdots & \cdots & \cdots & \cdots \\ t_{pm1} - t_{rm1} & t_{pm2} - t_{rm2} & \cdots & t_{pmn} - t_{rmn} \end{bmatrix}. \end{aligned} \tag{9}$$

Step 6. Calculate the sum of the final values of the total gap (Q).

Based on the following equation, we get the final values for each option and they are ranked based on those options. In fact, the lower the final values for an option are, the higher the ranking will be.

$$Q_i = \sum_{j=1}^{n} g_{ij}, \quad i = 1, 2, \ldots, m. \tag{10}$$

4. Case Study

In order to identify the effective criteria in the process of selecting construction systems, in this study, a table of criteria was prepared using the study of previous articles. In this regard, various sources have been used to obtain the criteria. Finally, the criteria and subcriteria are obtained as in Table 3:

We examined the stability of the building in 4 5-star hotels in Iran, Khorasan Razavi (A1, A2, A3, and A4). This questionnaire was distributed and collected among experts in the field of construction industry. The sampling method in this research is Cochran's method. Because the exact value of the statistical community is not available, we use Cochran's formula for infinite communities:

$$n = \frac{z^2 pq}{d^2}, \tag{11}$$

where $z = 1.96$, $p = q = 0.5$, and d is the allowable error value. This error value was 96%. The report and description of the expertise and field of work of the experts are given in Table 4.

5. Findings

In the first step, we first obtain the weight of the subcriteria. First, we calculate S for the decision matrix in Table 5.

In the next step, we calculate the value of S' (Table 6).

Now, we get the values of E and $1 - E$ and use them to get the weight of the criteria shown in Table 7.

Now that the weight of the subcriteria has been obtained (Table 8), the options are ranked. Using the method, we have the following.

Now, because we have 4 options, the value of PA is 0.25. So by multiplying the matrix values by the cumulative decision in PA, the values of t_p are obtained as shown in Table 9.

Now, considering that all the criteria are positive, the values of t_r are obtained as shown in Table 10.

Table 4: Information about participated experts.

Category	Classification	No.
Field	Civil engineer	45
	Environmental engineer	30
	Construction management	16
	Architecture	5
Gender	Male	70
	Female	26
Work experience	3–5 years	3
	5–9 years	47
	More than 9 years	46
Education	Bachelor	55
	Master	25
	PhD	16

Table 5: S values.

EX1	EX2	EX3	EX4	EX5	EC1	EC2	EC3	S1	S2	S3	
0/24	0/56	0/5	0/67	0/91	0/72	0/46	0/69	0/53	0/11	0/75	
0/87	0/46	0/83	0/49	0/96	0/22	0/47	0/76	0/68	0/66	0/68	
0/28	0/14	0/79	0/59	0/96	0/2	0/58	0/13	0/38	0/96	0/99	
0/73	0/71	0/85	0/4	0/64	0/03	0/17	0/32	0/85	0/8	0/15	s_{ij}
0/19	0/47	0/12	0/13	0/75	0/73	0/39	0/14	0/09	0/74	0/24	
0/13	0/34	0/64	0/62	0/94	0/9	0/96	0/23	0/98	0/34	0/64	
2/420	2/660	3/720	2/910	5/170	2/700	3/040	2/280	3/530	3/620	3/440	Sum s_{ij}

Table 6: Value S'.

EX1	EX2	EX3	EX4	EX5	EC1	EC2	EC3	S1	S2	S3	
0/091476	0/194328	0/124665	0/214862	0/164012	0/239143	0/141188	0/282687	0/140427	0/028338	0/202174	
0/331598	0/159627	0/206944	0/157138	0/173024	0/073071	0/144258	0/311366	0/180171	0/170027	0/183304	
0/106721	0/048582	0/19697	0/189207	0/173024	0/066429	0/17802	0/05326	0/100684	0/247313	0/26687	
0/278237	0/24638	0/21193	0/128276	0/115349	0/009964	0/052179	0/131101	0/225213	0/206095	0/040435	s_{ij}'
0/072418	0/163097	0/02992	0/04169	0/135175	0/242464	0/119703	0/057357	0/023846	0/190637	0/064695	
0/049549	0/117985	0/159571	0/198827	0/169419	0/298929	0/294654	0/094229	0/259658	0/08759	0/172522	

Table 7: Weight of criteria.

EX1	EX2	EX3	EX4	EX5	EC1	EC2	EC3	S1	S2	S3	
−0/29897	−0/47669	−0/36643	−0/50268	−0/43321	−0/53015	−0/39603	−0/5712	−0/39472	−0/12683	−0/48694	$s'\ln s'+1$ $-s'\ln 1-s'$
−0/60581	−0/42639	−0/49297	−0/42244	−0/44681	−0/256	−0/40128	−0/5929	−0/45718	−0/44235	−0/46161	
−0/3314	−0/19071	−0/48019	−0/46979	−0/44681	−0/23931	−0/45409	−0/20403	−0/31887	−0/53863	−0/55744	
−0/56746	−0/53768	−0/49913	−0/37311	−0/34864	−0/05511	−0/20098	−0/37825	−0/51481	−0/4919	−0/16632	
−0/25438	−0/4318	−0/13226	−0/17018	−0/38554	−0/53363	−0/35705	−0/21534	−0/1109	−0/47173	−0/23483	
−0/1935	−0/35375	−0/4263	−0/48261	−0/44144	−0/58398	−0/58075	−0/30502	−0/55075	−0/29026	−0/44607	
−2/25151	−2/41701	−2/39728	−2/42082	−2/50245	−2/19819	−2/3902	−2/26673	−2/34723	−2/36171	−2/35323	Sum
0/518858	0/556998	0/552451	0/557876	0/576687	0/506569	0/550819	0/522366	0/540916	0/544255	0/542299	E_j
0/411142	0/373002	0/377549	0/372124	0/353313	0/423431	0/379181	0/407634	0/389084	0/385745	0/387701	$1-E_j$
0/089758	0/081432	0/082425	0/08124	0/077133	0/092441	0/082781	0/088993	0/084942	0/084214	0/084641	w_j

Finally, by subtracting the elements of the theoretical evaluation matrix and the elements of the real evaluation matrix, the total gap matrix is obtained as shown in Table 11.

This value indicates which option is better in each sub-criterion. In general, the value of t_b-t_r in each criterion for each option is zero, so that under that criterion that option is better. Now, the result of the overall ranking is as described in Table 12.

Table 8: Cumulative decision matrix.

w	0/089758	0/081432	0/082425	0/08124	0/077133	0/092441	0/082781	0/088993	0/084942	0/084214	0/084641
Type	+	+	+	+	+	+	+	+	+	+	+
	EX1	EX2	EX3	EX4	EX5	EC1	EC2	EC3	S1	S2	S3
A1	3/307	3/474	0/124	0/14	3/307	4/984	3/572	0/123	2/374	3/318	3/307
A2	0/125	3/694	2/445	3/474	3/137	3/267	4/23	3/694	2/445	3/267	3/137
A3	2/445	2/374	2/445	0/14	4/269	4/984	4/307	3/277	3/474	3/667	4/269
A4	5/12	4/984	4/31	3/31	4/984	5/1	5/12	4/984	4/31	3/31	5/1

Table 9: t_p values.

t_p	EX1	EX2	EX3	EX4	EX5	EC1	EC2	EC3	S1	S2	S3
A1	0/023405	0/021233	0/021492	0/021184	0/020113	0/024105	0/021585	0/023205	0/022149	0/021959	0/02207
A2	0/023405	0/021233	0/021492	0/021184	0/020113	0/024105	0/021585	0/023205	0/022149	0/021959	0/02207
A3	0/023405	0/021233	0/021492	0/021184	0/020113	0/024105	0/021585	0/023205	0/022149	0/021959	0/02207
A4	0/023405	0/021233	0/021492	0/021184	0/020113	0/024105	0/021585	0/023205	0/022149	0/021959	0/02207

Table 10: Values of t_r.

t_r	EX1	EX2	EX3	EX4	EX5	EC1	EC2	EC3	S1	S2	S3
A1	0/015371	0/009226	0	0/021839	0/018826	0/001573	0	0	0	0/019752	0/020783
A2	0	0/011071	0/012286	0	0/020735	0/02485	0/009459	0/017574	0/000837	0/022638	0/022753
A3	0/011208	0	0/012286	0/021837	0/008027	0/001573	0/010566	0/015521	0/012974	0	0/009632
A4	0/024129	0/02189	0/022157	0/001074	0	0	0/022253	0/023923	0/022834	0/020205	0

Table 11: Calculating the total gap matrix G.

t_p-t_r	EX1	EX2	EX3	EX4	EX5	EC1	EC2	EC3	S1	S2	S3
A1	0/008494	0/012284	0/021492	0	0/001851	0/022579	0/021585	0/023205	0/022149	0/002799	0/001911
A2	0/023405	0/010494	0/009576	0/021184	0	0	0/01241	0/006159	0/021337	0	0
A3	0/012533	0/021233	0/009576	$1/31E-06$	0/012327	0/022579	0/011336	0/00815	0/009564	0/021959	0/012727
A4	0	0	0	0/020141	0/020113	0/024105	0	0	0	0/002361	0/02207

Table 12: Ranking alternatives.

Alternatives	Q	Rank
A4	0/08879	1
A2	0/104564	2
A1	0/138352	3
A3	0/141986	4

The results show that alternative A4 is the best alternative in sustainable issues.

6. Conclusion

Designing sustainable and environmentally friendly buildings with the approach of reducing energy consumption in buildings [121–124] and optimal energy consumption in different parts of the building (cooling, heating, and lighting) is a smart solution to deal with this great concern [124–127]. Sustainable architecture is also called green architecture, a design that uses a natural building, which is energy-efficient in some way and has little or no effect on the nature and resources of a site [128–131]. Attention to energy consumption optimization has been considered in the design, construction, and use of these buildings [132–135]. The balance between development and attention to environmental needs design and construction in complete harmony and balance with the surrounding environment and this is the responsibility of the architect. Sustainable architecture plays a unique role in the field of sustainability [133–136].

Climate-based design principles also include two other important achievements: green architecture and sustainable architecture [61, 62, 137, 138]. Architects must apply their skills to adapt to the climate of each region, using their skills [21, 63, 79, 80]. In sustainable architecture, it should be noted that the application of sustainable architecture principles in the selection of materials and construction methods should be according to the climatic conditions of the same area and sometimes different strategies are used depending on each climate in the architectural process of the building [74, 139, 140]. In its broadest context, sustainability refers to a society ecosystem or any existing system's ability to operate indefinitely throughout the coming years (without being forced to discontinue due to depletion or lack of resources). Sustainable architecture embodies values such as the beauty of the environment, society, ethics, and politics. In fact, sustainable architecture is a balance between the needs of today's society and the future. Indigenous materials have been used in the construction of these buildings. They have a shape and volume that are compatible with the climate and weather conditions of their region.

Data Availability

Requests for access to these data should be made to the corresponding author via e-mail: hosseinimehr1363@sci.iaun.ac.ir.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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