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Investigating Green Hospital Criteria Using Delphi Method for Fars Province, Southwest of Iran, 2019

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ABSTRACT

Introduction: Designing and constructing hospitals using green approach, renewable resources reduce energy consumption and carbon emissions, and improve environmental air quality. The purpose of the present study was to determine Green hospital's criteria in Fars province, Southwest of Iran, 2019.

Methods: In the Qualitative study, first, the criteria were identified systematically. Then, the criteria for establishing a green hospital were determined by content analysis and software methods. Then, for localization, using the Delphi method, the effective criteria for establishing a green hospital in Fars province were selected. Thirty experts in the field were selected using purposive sampling. Excel 2016 software was used for analysis. This study was a mixed-method study that was conducted from 2018 to the first half of the year 2019. At first, the criteria were identified by the systematic review method, and then the data extraction was analyzed using the content method. Finally, the criteria identified by the questionnaire were provided to 30 health experts. Experts were selected by purposeful sampling. In the present study, Excel 2016 software was used for analysis.

Results: Green Hospital's criteria were 72 criteria out of 21 common angles in the systematic review stage. In Fars province, 34 criteria in 13 dimensions of site stability, construction stage (architecture), environmental quality, management, resources, bio purchase, Experts selected energy efficiency, water, wastewater, waste and waste recycling, transportation, healthcare, and innovation. The most important aspects for Fars province are the management costs.

Conclusion: The approved criteria for Fars province, as well as other valid models in the field of the green hospital, management, water efficiency, and energy, were approved. In general, the reasons for choosing approved dimensions can be due to the various models emphasizing these dimensions and the relevance of dimensions to hospitals' challenges.

Keywords: Criterion, Green hospital, Delphi method, Scoping review.

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Introduction

Green hospitals have emerged as an approach to resolve environmental challenges and meet the needs of society (1). With sustainable environmental approaches and a healthy economy, the Healthcare industry is one of the leading advocates of environmental protection globally. In addition to its traditional role in providing quality healthcare, the health sector, via decreasing environmental consequences, can create common health as well as economic and social benefits and improve people's health (2).

es and local communities have put pressure on healthcare organizations for further environmental control. These pressures range from energy conservation to medical waste disposal and safe management of highly potent drugs (3). Since there is no single and uniform model for green and healthy hospitals and most hospitals and health systems worldwide have made efforts to reduce environmental footprints, participate in public health and do savings in costs simultaneously, most of which have been based on environmental standards (4).

The Green Hospital sees the environment as part of its service quality processes and seeks to do no harm to itself and others by employing effective approaches in each of its dimensions, including management, water, energy, building, waste, medicine, and shopping((5). Hospitals consume a large amount of energy and other resources to provide high-quality care (6).

For example, the Pittsburgh Children Hospital in the United States has a LEED (Energy Leadership and Environmental Design (7). It has applied energy productivity, leadership, chemicals, waste, energy, water, transportation by applying energy efficiency criteria for food, drugs, building, and shopping (8).

In Iran, measures have been taken for a green hospital in accordance with environmental standards. In this regard, the Iranian Green Management Association has adapted the German Green Hospital Pattern and compiled a Checklist for Green Hospital with a validation approach (9, 10).In a study, Shabani and Shamgoli et al. proposed the dimensions of water, management, chemicals, waste, energy, garbage, site sustainability, innovation, indoor quality, environmental preferred purchasing, transportation, and noise pollution for Ir (11, 12).

Of the 69 Social Security Hospitals, 19 have fully implemented the International Standard on Environmental Management, according to statistics provided by the Department of Health Deputy of Social Security Organization (6, 11). This research investigated all aspects of this approach by identifying the factors of green hospital establishment in different countries and developing criteria for green hospital establishment in Fars Province.

Methods

The present study is a Qualitative study conducted by using the qualitative method. In the first step, the research was extracted using information resources and related studies conducted in the green hospital field, based on a Scoping Review of green hospital criteria and standards using relevant keywords. The search was done based on the key concepts of the components or criteria or dimensions of approaches or indicators of the green hospital or bio-friendly hospital through different keywords. The concepts and keywords related to it were selected based on a review of previous articles in this field and the experts' opinions. In the third step, the selection criteria were defined.

Searches were done in the databases of PubMed, SCOPUS, Science Direct, Web of Science, World Health Organization, google scholar and magiran.com, SID.ir Chrane Library, Springer, from 2015/01/01 to 2019/10/01. A list of references of the related articles and the journals related to this field was searched manually. It should be mentioned that the articles published in Farsi and English were reviewed. The articles and the studies in the green hospital field were selected based on the research strategy (research protocol) developed by the researcher, among the published articles related to the green hospital.

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Table 1. Keywords used to search for articles using PubMed

search	Add to builder	Query
#4	Add	Search ((((((((((model[Title/Abstract]) OR pattern[Title/Abstract]) OR dimension[Title/Abstract]) OR component[Title/Abstract]) OR standard[Title/Abstract]) OR requirement[Title/Abstract]) OR approach[Title/Abstract]) OR initiative[Title/Abstract])) AND (((green[Title/Abstract]) OR Eco-Friendly[Title/Abstract]) OR healthy[Title/Abstract])) AND Hospital[Title/Abstract]

In the first stage of the research, the articles or research that discussed and analyzed the following items: Green hospital definition, definition and explanation of prerequisites and priorities for green hospital implementation, and the definition of the environmental standard. The studies that their full texts were not available were excluded.

In the second stage of research, the classification of the information was done using the content analysis method. In the stage of extracting the green hospital's criteria and dimensions, first, the first person of the information entered the extraction form, and then the second person was re-examined. In cases where there was a difference between the two researchers, the discussion was resolved with discussion and exchange. Otherwise, the views of the third researcher were used without resolving the dispute as planned.

The content validity method was used to confirm the extracted framework's validity, and the Kappa coefficient was used to confirm its reliability. Accordingly, two researchers separately analyzed the models using the framework, and then the results were compared, and the differences in their opinions were resolved by a third person. The dimensions of the models were extracted Using content analysis.

In the second stage of the research, using the extracted criteria, the areas were investigated in three main parts in the form of a questionnaire. The first part included responsive demographic characteristics, the second part included the research questions on green hospital criteria, and the third part contained experts' personal opinions. The questionnaire was given to experts in two rounds, and a consensus was reached. Then, the comments were analyzed to determine the validity of the studied Round based on a Delphi method.

The purpose of the Delphi method is to reach a consensus in a particular field through several rounds of distribution of questionnaires of collecting the answers. This method is used for extracting the options to confirm the validity of the models derived from the research.

The research population included 30 health experts, 10 university professors, and 20 managers of hospitals. Characteristics of the experts were two years of work experience related to health care management, postgraduate qualifications related to health care management, availability, and willingness to participate in research. The most important point in determining the experts was academic experts' presence against the professional and empirical experts of hospital management to ensure the comprehensiveness of different perspectives. Since this research uses the expert population, so there is no statistical sample in this research.

Initially, a structured Delphi questionnaire or instrument was sent to 30 experts on the subject. Then, the average score of each criterion and the individual's score in the previous stage were announced so the person could make a new decision. At this stage, participants were asked to review the answers again and review their opinions and judgments if necessary (Appendix1). Due to the convergence between experts' opinions, Delphi was completed in two stages with a threshold of three tenths.

The questionnaire was provided to the participants via a google form and a formal letter introducing the researcher and explaining the objective. The participants were asked to insert their comments in the questionnaire. Then, the

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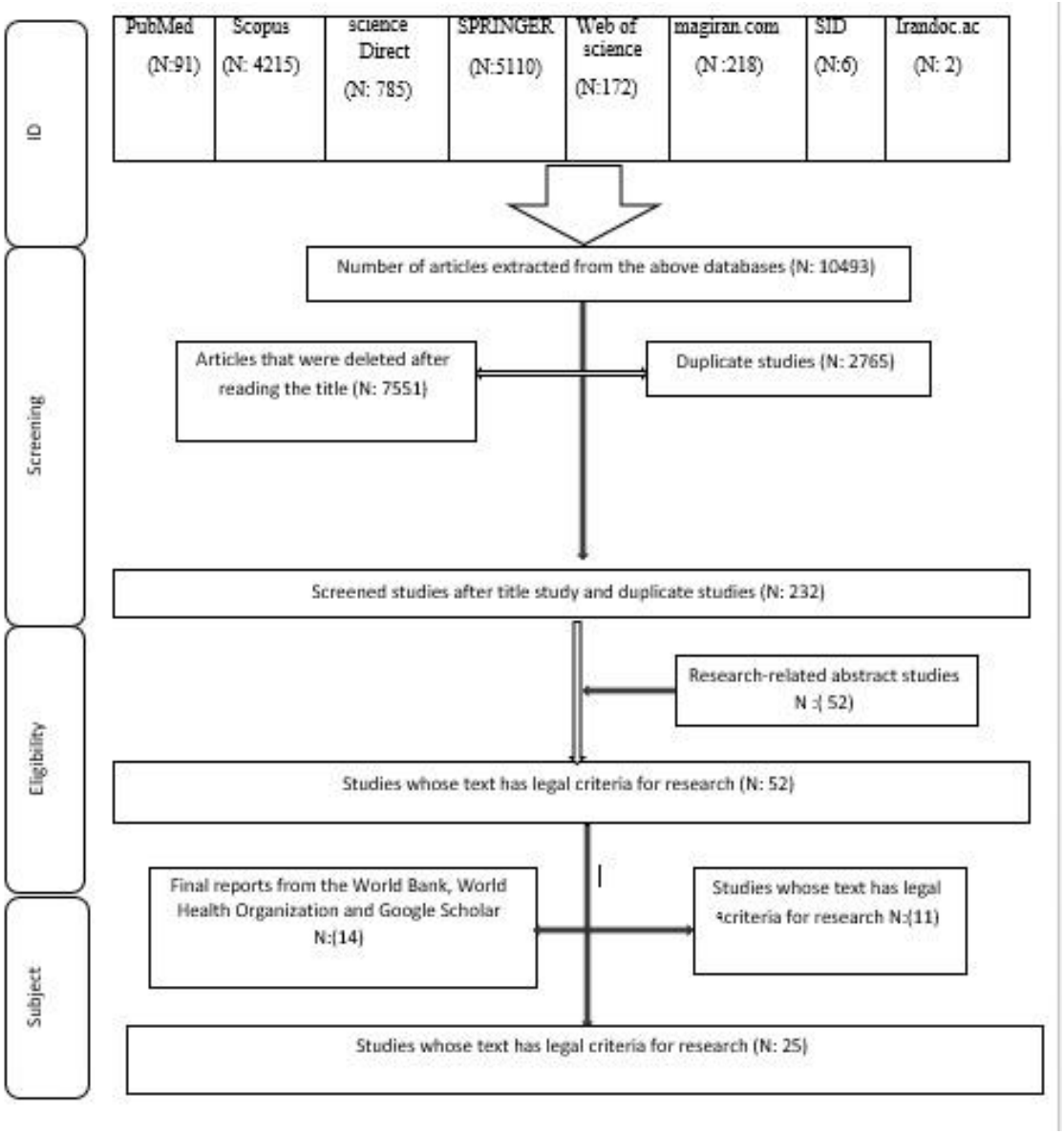
average score of each criterion and the individual's score in the previous stage were announced so that the person could make a new decision. At this stage, participants were asked to review the answers again and review their opinions and judgments if necessary (Appendix2).

Due to the convergence between experts' opinions, Delphi was completed in two stages with a threshold of three tenths. Finally, the researcher collected and analyzed the questionnaires. For this purpose, a scoring system from 1 to 5 was considered. After analyzing the data, options with a score below 4 were removed. Data were analyzed using Microsoft Excel 2016 software.

Results

A search of databases yielded 10,493 articles. After reviewing the various steps, 25 articles were reviewed in full text, from which the data were extracted.

To identify the effective factors in Green Hospital, the criteria were identified by reviewing the articles and following dimensions for Green Hospital implementation.



Flowchart 1. Systematic review of Green Hospital using Prisma

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Table 2. Findings from Scoping Review on Green Hospital Criteria

Row	Model	Country	Dimension of Green Hospital
1	LEED [1]	America	Dimensions of sustainable sites, water efficiency, energy and atmosphere, materials and resources, environmental quality, innovation (5, 6, 8, 12-31), and India's IGBC(3, 13), and Africa's Green GSH(14), the Chinese GBL pattern are an adaptation of the LEED model (3, 15)
2	BREEAM [2]	The UK	Management, Health, Energy, Transport, Water, Materials, Waste, Land Use, Environment, Pollution, Innovation. The Duurzaamheidsmeter Zorg method is adapted from the English model of hospital green evaluation (3, 13, 15-20)
3	GBIAP [3]	Malaysia	Energy productivity, Indoor Environmental Quality, Planning and Management, Materials and Resources, Water Productivity, Innovation (3, 14, 15, 17, 19-21)
4	DGNB[4]	Germany	Economic, Social Environmental Quality, Technology, Process, Site and dimensions of Energy, Management, Chemical, Building, Purchasing, Medication, Waste, Water (6, 22)
5	GREEN STAR [5]	Australia	Management, Environmental Quality, Energy, Transport, Water, Materials, Land Use and Environment, Innovation (3, 13, 14, 17, 19, 23)
6	CASBEE [6]	Japan	Pre-design, New Construction, Existing Buildings, Reconstruction and dimensions of Energy Efficiency, Site Selection, Indoor Environmental Quality, Resources and Materials, Water Conservation (3, 13, 15, 24)
7	WH0 with model GGHC [7]		Energy, Pollution, Environment, Shopping, Green Building Design, Transportation, Food, refuse & Waste, Water, Healthy Environment and Sustainable Health, Focus on Health Promotion and Prevention (14, 20, 25, 26)
8	ISO 14001 [8]		Energy, hazardous and infectious waste management, water, sewage, pollutants, water, preferred environmental purchase (4, 6, 7, 10, 26, 27)
9	WELL [9]		The health of air, water, nutrition, light, fitness, comfort and mind, water, sleep, and ergonomic factors of chemical inhibitors (28)

[1] Design Leadership in Energy and Environmental
[2] Building Research Establishment Global Limited
[3] Green Building Index
[4] Institute for Housing and the Environment, Germany
[5] Australian Green Star Method GREEN STAR
[6] Japan Sustainable Buildings Consortium
[7] GGHC Green guide for health care
[8] International organization for standardization
[9] Global environmental health ND sustainability

The Delphi method was used to localize and apply the identified factors to the green hospital under study. The experts reached a consensus in two phases. In the second phase in the Delphi method, 13 dimensions are assigned to the accepted theory described in Table1. Findings of the analysis of Field Studies of Texts showed that each country had almost chosen its own model with specific criteria proportional to the country's conditions to achieve the best results. Iran is not fully compatible with all of these models, but with parts of each model.

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Table 3. Classification, dimensions, and criteria of green hospital extracted from papers

Class	Dimensions	Criteria	Class	Dimensions	Criteria
Environment	Site sustainability (land use and ecology)	For parks and green roads, hiking route, building orientation, attention to specific properties of areas	Society	Indoor environmental quality	Lighting, environmental acoustics, atmospheric conditions, safe for residents and users
	Building	Proper design, innovative design, construction method, ventilation, lighting, orientation, outdoor, attention to local architecture		Transportation	Alternative fuels for public hospital vehicles, hiking, and bicycles
	Energy efficiency	Natural ventilation, natural lighting, renewable energy, saving, alternative energy production methods, attention to local energy, optimal energy consumption		Management	Standard requirements, careful implementation, laboratory, laundry, kitchen, consumption
	Water and external water use	Water-efficient equipment installation, rainwater harvesting, water conservation	Economics	Eco-friendly purchase	Food (local food), eco-friendly medicine
	Wastewater	Wastewater treatment, greywater use		Resources and materials	No toxic chemicals, persistent, natural resources, longevity, compatibility, flexibility, material properties, attention to local sources
	Waste and recycling	Reduced solid and liquid waste, reuse, recycling, composting, waste incineration alternatives			
	Pollution	Air, acoustic, pollutant emissions	Healthcare	Patient and staff	Patient education, staff, and patient mind convenience, safe for staff and patients, acoustic comfort, visual comfort, olfactory comfort, cleaning, and disinfection
	Waste	Toxic, chemical, separation, reprocessing Single-use medical devices			
			Innovation	Innovation in each of the above dimensions	Innovation in each of the above dimensions

The above table indicates the dimensions and criteria for green hospitals that provided five dimensions and criteria for green hospitals and Iran, with features such as low water saving in environmental status and international sanctions in the economic status, requires paying more attention to some dimensions and criteria in order to have faster and easier access to green hospital models. For example, optimal water resources use and waste prevention are two critical criteria for Iranian hospitals in the current situation.

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Table 4. Local criteria for the green hospital in accordance with experts for Fars Province

Dimension	Criteria	mean 1	SD 1	mean 2	SD 2
Site sustainability	Specific conditions of each region in sustainability (topography and slope)	4.121212	0.788461	4.1375	0.717599
	Planning for hospital establishment based on real needs of the society	4.333333	0.659047	4.238889	0.614159
Construction phase	Principles of hospital building location (proximity to population centers)	4.015152	0.788024	4.138889	0.762651
	Proper building orientation (proper use of sunlight and natural ventilation)	4.409091	0.778056	4.309722	0.779043
Architecture	Use of precise and durable structures during hospital construction	4.484848	0.633471	4.377778	0.600822
Indoor environmental quality	Toxic substances control in the hospital	4.575758	0.629107	4.448611	0.662634
	Identifying air pollution sources	4.378788	0.793251	4.241667	0.881484
	Noise control and noise pollution	4.287879	0.84862	4.170833	0.819351
	Using global environmental guidelines for wards	4.030303	0.815934	4.034722	0.795101
	Implementation of green management system (green management strategies)	4.151515	0.701566	4.206944	0.747409
Management	Planning for waste reduction	4.106061	0.781001	4.138889	0.762651
	Management of consumer and non-consumer requests in wards	4.015152	0.807023	4.068056	0.771639
Resources	Guidelines and staff safety (green disinfectants)	4.348485	0.590132	4.243056	0.614079
	Reuse of existing non-structural and internal elements	3.757576	0.798874	3.830556	0.859178
	Considering environmental criteria when purchasing	4.106061	0.872627	4.170833	0.933454
	Using electronic services (file, office correspondence and accountability)	4.409091	0.673689	4.380556	0.703063
Eco-friendly purchase	Food (continuous local food delivery for staff and patients)	4.469697	0.528569	4.516667	0.491313
Energy efficiency	Plans for energy saving	4.363636	0.642824	4.277778	0.678142
Water use	Natural light	4.30303	0.797148		
	Drip irrigation and timely irrigation	4.015152	0.861507	4.070833	0.853719
	Installing water saving equipment	4.181818	0.814808	4.066667	0.85375
	Energy assessment of hospital equipment and required consumables prior to purchase	4.075758	0.82224	4.140278	0.845637
Wastewater	Assessment of the water equipment required before purchase	4.030303	0.758182	4.069444	0.727147
	Hospital wastewater treatment by wards	4.19697	0.908207	4.173611	0.733466
Waste and recycling	Separation and identification of hazardous waste	4.606061	0.624713	4.515278	0.612229
	Suitable site for waste	4.545455	0.607574	4.483333	0.612146
	Training and awareness of staff for safe disposal of medical waste	4.530303	0.556496	4.551389	0.552947
Transportation	Standard disinfectants	4.242424	0.719019	4.241667	0.714386
	Control of materials containing mercury, PVC and plastic	4.287879	0.793251	4.241667	0.802297
Healthcare	Electronic records to transfer information	4.227273	0.79383	4.276389	0.770137
	Patient education methods (medicines)	4.560606	0.525956	4.619444	0.477107
	Disinfection methods compatible with green criteria	4.560606	0.525956	4.619444	0.477107
Innovation	Electronic innovations (Pax systems, telemedicine, etc.)	4.393939	0.67147	4.309722	0.688167
	Innovation in each of the dimensions	4.136364	0.795563	4.134722	0.805341

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The highest arithmetic mean and median associated with dimension, waste, and recycling with training criteria and awareness of staff for safe disposal of medical waste with mean, and the lowest arithmetic mean related to the dimension of resources and reuse criteria are the non-structural and interior elements. According to the experts, the highest number of criteria obtained from the management group and criteria for using global environmental guidelines for the wards, implementation of the green management system (green management strategies), waste reduction planning, management of consumer and non-consumer requests in the wards, guidelines and staff safety (green disinfectants) are for establishing a green hospital in Fars Province.

Discussion

Green hospitals with a sustainable structure benefit from advantages such as cost-saving and continuous improvement (1, 29, 30). As hospitals move towards sustainability, development, and health, they inevitably use green hospital models. Green hospital establishment is a solution for progress and environmental conservation (20). Studies have shown that the study on sustainability assessment systems has been the focus of attention since the study by Crowley and Ao in 1999 (31).

The findings of the systematic review included 72 criteria (subsets) and were classified into 15 dimensions (sets) and five categories (Table 3). The living environment with 13 dimensions, site sustainability (land use and ecology), building, energy efficiency, water and external water use, sewage, waste and recycling, waste, pollution with an abundance of 126 is the most important floor in the reviewed articles. Energy efficiency with seven natural ventilation criteria, natural light, renewable energy, saving, alternative energy production methods, attention to indigenous energy, optimal energy consumption, and frequency 22 has been the most important criterion in systematic studies.

In general, the reasons for choosing approved dimensions can be attributed to the emphasis of different green evaluation models on these dimensions and the relevance of these dimensions to the challenges that hospitals typically face (14) as Nuraisyah Chua Abdullah used the GBI method in a study (15). In addition, Hesam Sadat Fafi used the LEED method in a Washington hospital study (16), and Tanisha Barbara used the LEED, WHO models for the Green Hospital (17). Mohad Effendi has used GBI, LEED, and My CREST methods in a study (18). Yvonne Ryan-Fogart has used ISO 14001-HESG patterns (19).

Like other valid Green Hospital models, five categories of environment, community, economy, health, and innovation were identified in 15 dimensions and 72 criteria in the present study. Most researchers explicitly confirm and introduce social and economic performance criteria (19, 24-26, 21). The environment is the most important floor of the green hospital (11). Also, the existence of different criteria in green building patterns can be due to differences in environmental, economic classes, and social approaches of countries (20)

Based on the Delphi technique's obtained results, the main criteria for designing the model of establishing a green hospital in Fars province in 13 dimensions and 34 criteria were selected by experts, which are detailed in (Table 4). Based on the Delphi management method results, waste management and waste recycling, water and energy consumption have the essential criteria for the localization of green hospitals in Fars province. According to experts, the model of establishing a green hospital in Fars province.

Ali Taleshi et al. believes that the most important obstacles to achieving green hospital standards are insufficient attention to environmental protection strategies, lack of adequate environmental education, inadequate waste management, and inadequate budget allocation for wastewater management and air pollutants from training hospitals in the city of Yazd (24). Besides, Arzmani et al. in a study emphasized the importance of managing consumption, waste, energy, and water consumption (28).

Farrokh Shahi, in a study, emphasizes the use of methods to save energy, the use of building energy management systems (BEMS), proper waste management, and wastewater treatment in all

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hospitals to provide effective services to patients and help stabilize the rate of health services (25). Sahamer and Zakaria believe that health buildings using advanced medical equipment make hospitals one of the largest consumers of energy and therefore require intensive planning and consumption optimization (11), which is consistent with the findings of the present study.

In research, Ryan Fogarty et al. have dealt with the importance of management, supervision, and innovation (32). Also, in research, Sahamir & Zakaria discussed the obligation to implement green management, green hospital standards, and the establishment of an environmental management system (green management systems) without formal procedures for obtaining voluntary standards (33, 34). BREEAM, LEED, SBTool, and CASBEE patterns have dealt with innovation (31, 35).

Ali Taleshi et al. believes that sound management and planning are of paramount importance in green hospital standards. Management approaches in today's hospitals have severely depressed the environment and have had a serious impact on society's health while increasing hospital costs. In other words, hospitals were captured by a managerial paradox (4). According to researchers, all internal and external research points to the importance of environmental quality (33, 34).

In the study, Ridolfia, Andreisb, Panzieric et al. concluded that indirect aspects are mainly related to land supervision and planning. Indicators based on the classical pressure-state approach and based on CO2 equilibrium, sustainable analysis exposed to the environment have been used to evaluate EMS environmental performance (36).

Also, aspects such as site sustainability and architecture, indoor environmental quality, site sustainability, resources, preferring bio purchasing, healthcare, and transportation emphasize the dimensions of the green hospital since the mentioned items are among the issues that hospitals are constantly involved with them and for better management in this area, they define strategic and quantitative goals. Accordingly, high scores of these dimensions are justified. This result is in line with that of other studies.

According to studies, it is important to note that the decision-making and the benchmarking process is dynamic. So, interventions that are not currently allowed to be done over time may be in the dimensions and criteria. For example, demographic change or access to new technology and environmental and climatic changes can change the criteria and use different methods. The present study examines the limitations of articles, websites, and reports published in English and Farsi and does not include others.

Conclusion

Findings of the study showed that variations in specific economic (resource limitation), social (local architecture), and environmental (regional climate) conditions of every country cause differences in the criteria used. As a result, it is obvious that in management policy-making and healthcare projects, in particular hospitals, great efforts are made to pay attention to the green hospital and its related criteria. This is based on the localization of green hospital criteria from external sources. After formulating relevant green hospital standards, the localized model can be implemented and evaluated to construct and complete these projects as a general and strategic policy. In Fars Province, due to its specific climatic conditions and spatial planning, there is a need for criteria consistent with climate zone and resources.

Finally, it is suggested that hospital authorities in Iran, in particular Fars Province, pay specific attention to both environmental and economic aspects of the green hospital model, conserve water and environmental resources and make optimal and maximum use of financial budgets in order to pass the current requirements and achieve the healthcare goal of hospitals. In the current situation, the most important and prioritized thing is the scarcity of water and financial resources (due to unprecedented international sanctions) for the country's management and, consequently, hospitals.

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Regarding the most up-to-date and the latest standards of the green hospital standards, the present study recommends assessing hospitals by using green criteria and establishing an environmental management team in hospitals to achieve the green hospital standards.

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Author contribution

Sh.v developed the theoretical formalism, performed the analytic calculations and performed the numerical simulations. Both SH.V and S.H authors contributed to the final version of the manuscript. B.C. supervised the project.

Conflicts of Interests

The authors declare no conflict of interest.

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