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National Building Regulations of Iran Benchmarked with BREEAM and LEED: A Comparative Analysis for Regional Adaptations

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Building sector is responsible for consuming nearly 40 percent of the total primary energy in Iran. There have been implemented several efforts to diminish the amount of energy utilization in building sector. In early 90s, Iranian Ministry of Housing and Urbanism released the first version of building codes under the appellation of Issue 19. Although these codes address the importance of energy saving in building, they are deemed to be ineffective in fully mitigating the energy consumption in building sector. This paper attempts to benchmark the two most widely-used sustainable assessment tools, LEED and BREEAM, against Issue 19 in order to underline their strengths in dealing with the energy utilization and environmental issues of building sector. The primary aim of this paper is to identify the potential areas in Issue 19 for considering future improvements based on the acquired results. This study found that, LEED & BREEAM and Issue 19 have various differences in their approaches toward sustainable built environment, and energy usage in building sector. These differences are classified into five categories, 'the environmental concerns', 'energy optimization', 'waste management', 'indoor air quality', and 'innovation'. Accordingly, this study puts forward necessary recommendations which can be potentially considered for the future improvements of Issue 19.

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1. INTRODUCTION

Building sector plays a significant role in affecting the built environmental due to their contributions to use the primary energy. This sector is responsible for consuming one-sixth of world's fresh water withdrawals, one-quarter of wood harvested, and two-fifths of all material and energy flows [1]. This problem is even more serious in developing countries such as Iran that has a relatively high level of energy consumption compared to the world average [2]. Iran is considered as one of the most energy intensive countries in the world where the per capita energy consumption in this country is 15 times of Japan, and 10 times of European Union [3]. There can be counted several reasons determining the building energy usage, namely size and location of building [4], structural building factors [4], energy efficiency regulations [5], socioeconomic and behavioral occupants factors such as using the efficient lightbulbs [6,7]. Additionally, the absence of an environmental assessment tool capable of providing a comprehensive evaluation about the energy and environmental performance of building can be announced as a major contributor to the increasing trend of building energy utilization [8].

The first attempt to establish an environmental building rating system can be dated back to 1990 when the Building Research Establishment Assessment Method (BREEAM) was presented in UK [8]. Afterwards, this evolutionary process of inventing environmental rating system was expanded to other courtiers resulted in emerging different sustainable assessment systems. For instance, Leadership in Energy and Environmental Design (LEED) developed in US [9], SBTool developed in Canada [8], CASBEE (Comprehensive Assessment System for Building Environment Efficiency) developed in Japan [10], Green Star developed in Australia [11], ITACA developed in Italy [12], Hong Kong Building Environmental Assessment Method Plus developed in Hong Kong (BEAM Plus, formally known as HKBEAM), and China Green Building Label (GBL) developed in China [13], and etc. Moreover, different international standards have been established to ameliorate the environmental performance of building sector [14-18].

In 1991, the first version of Iranian building codes was compiled aiming to enhance the building sustainability. Issue 19 of Iran National Building Regulations (Issue 19 INBR) is the only reference that addresses the importance of energy saving in building sector. Afterwards, the preliminary version of this building codes has been evolved throughout the times, as the third version which is the latest version of this building codes was released in 2010 [19]. Despite of these efforts, building sector is still responsible for consuming a considerable proportion of primary energy in Iran [19]. Statistical records also indicated that, the energy usage in building sector experienced an upward trend during the last decades (Fig. 1). One of the main reason for increasing the energy use in Iranian building sector is related to the failure of Iranian building codes in addressing all the significant criteria concerning to the building energy and environmental performances. This study attempts to compare the Issue 19 INBR against the two most widely-used building rating systems with the purpose of underlying the differences between them. The final outcomes of this paper can be helpful in finding the potential areas for future improvements of Issue 19 INBR.

2. LITERATURE REVIEW

This paper categorized studies that used environmental rating systems to analyze the building performances into three groups (Table 1). First group contains studies that employed the rating systems in order to assess the energy and environmental performances of targeted buildings. For instance, Ismail & Rashid [20] utilized LEED for Home (LEED-H) rating methods to analyze the performances of three Malaysian green homes: 'Demonstration, Cool and Energy Efficient House (DCEEH)', 'Smart and Cool Home (SCH)' and 'CoolTek House (CTH)'. They rated these selected buildings as closely as possible to the standards mentioned in LEED-H. It was concluded that, none of case studies had complied with at least 12 mandatory prerequisites out of 23, as outlined in LEED-H. In another attempt, Chen et al. [21] assessed the energy performance (represented by energy and energy cost savings) of three office buildings located in China through utilizing the China Building Energy Codes (CBEC) and LEED. The energy and energy cost savings of the three buildings were predicted based on hour-by-hour simulations. The results indicated that, LEED set more accurate requirements related to the indoor design conditions, building envelope characteristics, and air-conditioning system features in comparison with CBEC. Alshamrani et al. [22] also put forward an integrated life cycle assessment (LCA)-LEED model with the purpose of achieving the highest level of sustainability for the structure and envelope systems of Canadian school buildings. Three categories of the LEED rating system; energy and atmosphere, materials and resources, and LCA (incorporated under the innovation and design process category of LEED) were used to select the most sustainable structure and envelope type for school buildings. It was shown that, concrete with minimum used insulation can obtain the highest total LEED score (19), following by masonry (17), while steel and steel-masonry buildings had the least score (14).

Second group of studies are focused on comparing the national rating systems against the well-known international rating systems, namely LEED or BREEAM. The primary purpose of these studies are mainly set out to reveal the differences between the local and renowned international systems, and investigate proper measures for considering further improvements in the local systems. For instance, Komurlu et al. [23] reviewed existing inspection agencies, standards, adversities encountered in usage, education, technical know-how, experience, and renewable energy supply with respect to the energy and atmosphere in three countries, India, Abu Dhabi (UAE), and Turkey. They compared the indicators of these countries against the situation in US. The findings showed that, India had slightly modified the US system, Abu Dhabi developed its own certification system, and Turkey appeared to be at the early stages of developing a certification system. They stated that, the existing differences between these systems can be stemmed from different standards, laws, and regulations that are being practiced in these countries.

In another study, Asdrubali et al, compared two different rating systems, LEED and ITACA (Italy), by evaluating the sustainability of buildings located in Italy [12]. Five areas (site, water, energy, materials, and indoor environmental quality) were identified in this study in order to compare the two methods and normalize their scores. The comparison showed that, LEED was more focused on the site choice and materials, while ITACA considered more energy and water management aspects. Indoor environmental quality results were important in both LEED and ITACA to ensure an adequate quality of confined spaces.

Third group contains the studies attempted to develop a new building rating system based on investigating the renowned environmental rating system. Alyami & Rezgui believed that, the existing rating methods cannot be applied to all regions due to the regional variations in climates [8]. They investigated the most globally widespread environmental assessment methods such as BREEAM, LEED, SBTool, and CASBEE to identify the areas of convergence and distinction between these systems. Regarding to the identified areas, they tried to consolidate the environmental criteria into new potential schemes. They aimed to identify the best environmental rating systems, which could provide a generic model for the development of an effective environmental assessment method in Saudi Arabia. Mateus & Bragança [26] also presented an innovative approach for supporting sustainable building design as well as predicting the sustainability of residential buildings. They presented a methodology based on the international Sustainable Building Tool (SBTool) method. The proposed method can be used to assess the sustainability of existing, new and renovated residential buildings in urban areas, specifically in the Portuguese context. In another study, Ali and Al Nsairat [27] studied different international green building assessment tools, namely LEED, CASBEE, BREEAM, GBTool in order to define a new assessment indicators with respect to the local conditions of Jordan. As the result, they proposed a green building assessment tool that suits the Jordanian context in terms of environmental, social and economical perspectives.

Table 1. Studies conducted on the application of building rating systems

Application of building rating system	References
Analyzing the energy and environmental performance of a building	[20-22]
Comparing a national rating system against the widely-used rating systems	[12,23-25]
Developing new rating methods by investigating the renowned environmental rating systems	[8,26,27]

Despite of growing body of literature in correlation with using the sustainable rating system, minimal attempts were made in Iran to study Issue19 INBR against famous sustainable assessment methods. Correspondingly, this study tries to compare the perspective of Issue 19 INBR with LEED, and BREEAM towards the energy and environmental performance of buildings. This comparison is conducted descriptively, and no case study has been selected for this purpose.

3. THE STATUS OF ENERGY CONSUMPTION IN IRAN

During the last few decades, Iran has experienced an increasing trend in consuming energy, mainly due to the rapid industrialization and urbanization. During recent decades, energy consumption in domestic and commercial sectors of Iran has significantly increased. Building sector is responsible for consuming nearly 40% of the total energy consumption in the country (Fig. 1) [19]. Fig. 1 indicates that, the demands for energy between the years of 2000 and 2011 had been sharply increased by 60%.

Iran possesses 18% of the world natural gas reserves, which is the biggest reserves in the world [29]. The possession of a considerable natural gas reserves caused the fossil fuels, specifically natural gas, to be the most common source for supplying the required energy in Iranian building sector. The recent governmental policy for substituting the oil products with natural gas led to rapid development of natural gas distribution pipelines and 130% growth in natural gas consumption, from 16.2 Mtoe in 2000 to 37.3 Mtoe in 2011 [30]. After the natural gas, the utilization of oil product is the second largest source of supplying energy in the building sector in Iran [31]. The wide use of fossil fuels in Iran, caused this country to record a considerable growth rate in CO_2 production by approximately 500% during the last forty years (Fig. 2). Government recently initiated several measures to decelerate the growth of energy consumption and CO_2 emissions such as increasing the energy prices and gradually cutting the energy subsidies in 2009 [31]. Besides, the government introduced different incentive schemes for highly efficient equipment, namely cooling systems and solar water heaters. It is believed that, taking these policies have been relatively successful in slumping the energy use in Iran as, the growth rate of oil and electricity consumption between 2009 and 2011 dropped from 15% to 8%, respectively [31].

The development of building energy codes (BEC) can be also considered as one of the promising strategy to minimize the energy utilization in Iranian building sector. The first set of BECs was established in 1991 under the name of Issue 19, and it was later developed in 2005. The implementation of Issue 19 was voluntary at first, but the government made it mandatory for the capital in 2004. The application of Issue 19 was further expanded to big cities in 2007, and finally in small cities in 2011 [32,33]. Section 5.0 provided an overview about the Issue19 INBR.

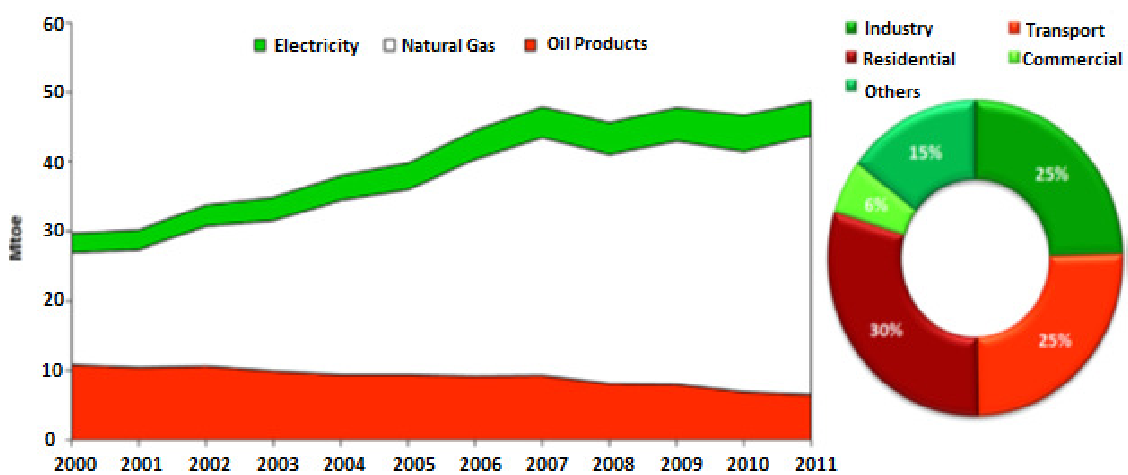

Fig. 1. Sectorial shares of total energy consumption in Iran [28]

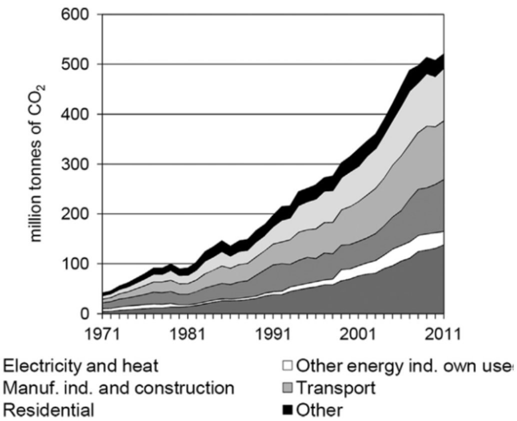

Fig. 2. Sectorial CO_2 emissions in Iran from 1971 to 2011 [34]

4. OVERVIEW OF INTERNATIONAL BUILDING RATING SYSTEMS

This section intends to provide an overview of the two most widely-used rating systems. LEED and BREEAM are being applied for the purpose of environmentally evaluating buildings in various countries. The aim of this section is to highlight the working procedures of these systems as well as their major principles for rating the targeted buildings.

4.1 Overview to LEED 2009

LEED is defined as a '*voluntary certification program developed by the US Green Building Council (USGBC) through a consensus process which involves key stakeholders in order to provide an inclusive simple framework for assessing building performance and meeting sustainability goals*' [21,35]. The first version of LEED (LEED 1.0) was launched at USGBC Membership Summit in August 1998 aiming to address the new constructions [36]. After considering extensive modifications, LEED Green Building Rating System Version 2.0 was released in March 2000, two years later LEED Version 2.1 was released in 2002, and LEED Version 2.2 established in 2005 [37]. The evolutionary process of LEED has continued during the last years in order to respond to the new emerging marketing demands, and also include other types of buildings and constructions, namely LEED for Core & Shell, LEED for New Construction, LEED for Schools, LEED for Neighborhood Development, LEED for Retail, LEED for Healthcare, LEED for Homes, and LEED for Commercial Interiors [37]. After the first launch, this rating system received a strong reputation for its worldwide credibility, as 79,781 projects are globally certified by this system since 19 June 19, 2015 [38]. It is believed that, LEED is being utilized for the purpose of environmentally assessment in USA and 30 other countries [12]. The analysis presented in this paper is based on the New Construction and Major Renovations scheme for LEED 2009.

In LEED 2009, the allocation of points between credits is based on the environmental impacts and human benefits of each credit with respect to a set of impact categories. The impacts are defined as the effects of design, construction, operation, and maintenance of the building on the environmental or human well-being [37]. In order to quantify the impacts of each parameters, a combination of approaches, including energy modeling, LCA, and transportation analysis can be used. LEED 2009 is comprised of five main categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, in which each of these categories have their own sub-categories (Table 2). There have been determined specific credits for each categories, and relative points have been assigned to each credit. The points earned from these credits are summed up to demonstrate the final score for the studied building. The maximum credits that a building can possibly achieve from the five categories is 100. There are also two additional categories, Innovation in Design and Regional Priority, which provide 10 additional bonus points for the projects [37].

Table 2. Areas and score of LEED certification [37]

LEED areas	Maximum score
Sustainable sites	26
Water efficiency	10
Energy and atmosphere	35
Materials and resources	14
Indoor environmental quality	15
Total	**100**
Innovation in design	6
Regional priority	4

According to Horvat and Fazio [39], there are three main types of requirements within all LEED standards, i) prerequisites criteria that must be included before a project can be assessed, ii) core credits that must be given for meeting or exceeding the requirements in the five categories, iii) innovation credits that must be given for exemplary performance in addition to the core credits.

There are some basic principles in the LEED rating system requiring to be considered to distribute the credits. i) all LEED credits are worth a minimum of 1 point, ii) all LEED credits are positive and whole numbers; there are no fractions or negative values, iii) all LEED credits receive a single, static weight in each rating system; there are no individualized scorecards based on project location, iv) all LEED rating systems have 100 base points; Innovation in Design (or Operations) and Regional Priority credits provide 10 extra bonus points. After distributing the relative credits, the highest points earned, the highest certification will be conferred (Table 3).

Table 3. Levels for achieving LEED certification [37]

Level of certification	Score
Not certified	0-39
Certified	40-49
Silver	50-59
Gold	60–79
Platinum	80 +

4.2 Overview of BREEAM

BREEAM was originally developed in UK by Building Research Establishment Global Limited (BRE Global Ltd.) in 1990 [40]. BREEAM was further supported by several independent organizations named National Scheme Operators (NSO) [12,41]. BREEAM laid a foundation to conduct the best practices in sustainable design leading to become the most effective scheme around the world to measure the environmental performance of a building [8]. There have been presented various assessment methods by the BREEAM aiming to meet the local and international demands for sustainable assessment. 'Country-specific schemes' has been adopted by the NSOs in order to be utilized for the local conditions, and 'international schemes' also adopted to cover the projects across the globe which cannot be addressed by the country-specific schemes [40]. BREEAM possesses a holistic approach towards investigating the building environmental issues aiming to 'provide a common framework of assessment that is tailored to meet the local context including regulation, climate and sector' [42]. Based on the latest record, BREEAM has been used to certify over 260,000 buildings in over 50 countries [43].

UK, Germany, Netherlands, Norway, Spain, Sweden, and Austria are the countries which are mentioned in the list of cross-country scheme of BREEAM. However, projects locating in the countries, which are not affiliated with the NSO-should apply for an international scheme. The international scheme initiates a methodology that is capable of recognizing the local standards and codes, as well as issues of cultural and climatic variations [44]. After proceeding the evaluation, if the existing standards would recognize to be insufficient, BREEAM introduces an authorized Assessor for the project in order to propose new practice construction codes which are not recognized yet. Apart from these schemes, BREEAM has foreseen another scheme for those projects that are unable to fall under the aforementioned programs. BREEAM Bespoke assessment is a scheme enables criteria to be generated on a 'project by project' basis for the candidate buildings based on their functions and locations [40].

BREEAM uses a pre-defined weighting system (Table 4), which has been developed as the result of national consultative process for evaluation the environmental performances of buildings [45]. After distribution of credits in ten categories, BREEAM enables the practitioners to compare the building's performances in each category with expected performances based on earned credits. Each category has a number of different allocated criteria, with pre-weighed credits that can be either cumulative or dependent on the building performance against certain specified standards such as Standard Assessment Procedure [8]. These credits will be further summed up together to produce a single overall score on the scale of Pass, Good, Very Good, Excellent and Outstanding [40] (Table 5).

Environmental weightings are fundamental to any building environmental assessment method as they provide a means of defining, and therefore ranking, the relative impact of environmental issues. BREEAM uses an explicit weighting system derived from a combination of consensus based weightings and ranking by a panel of experts. The outputs will be used to determine the relative values of the environmental sections in BREEAM and their contributions to the overall BREEAM scores [44]. In the BREEAM international scheme, the section of environmental weightings are adjusted according to the local conditions. The provision of data can be collected through collaborating with experts or organizations that have the required knowledge and expertise on the related regional environmental conditions. After collecting the required data, the authorized BREEAM Assessor will present the information to BRE Global, where the suitable weightings will be determined for that specific country or region. Ten environmental categories or sections are regarded as 'global' or 'local', based on whether it has a global impact, and does not depend on local factors, or can vary regarding the local social, environmental, political, and economic parameters [41].

Table 4. Environmental section weightings of BREEAM [44]

Category	Weightings %
Management	12
Health & wellbeing	15
Energy	19
Transport	8
Water	6
Materials	12.5
Waste	7.5
Land use & ecology	10
Pollution	10
Total	**100**
Innovation (additional)	10

Table 5. BREEAM rating system [43]

BREEAM rating	% Score
Outstanding	≥ 85
Excellent	≥ 70
Very good	≥ 55
Good	≥ 45
Pass	≥ 30
Unclassified	< 30

5. ISSUE 19 OF IRAN NATIONAL BUILDING REGULATION (ISSUE. 19 INBR)

The first version of Issue 19 INBR was released in 1991 by the Ministry of Housing and Urbanism (MHU) under the appellation of 'saving energy' [19]. The major parts of the early version of Issue 19 INBR revolved around designing the outer thermal insulation of building shell. Despite the efforts performed in the first version to improve the building sustainability, the implementation of these codes had been widely ignored either in constructing the governmental or private buildings. The chief reason for this failure was the lack of knowledge among the building specialists and constructors about the criteria enacted in Issue 19 INBR. Therefore, MHU published the first guide of Issue 19 INBR aiming to improve the knowledge and understandings among the specialists. This guidance generally discusses about the major principles of utilizing the thermal insulation on the building shell. In 2002, the second version was revised and improved with respect to the international standards. The scope of second version was extended to address more subjects related to the sustainable performance of buildings. In the second version, mechanical and lighting systems were included, besides the building shell. In 2010, the third version, which is the latest version of Issue 19 INBR, was released. In comparison with the two previous versions, the third version was more comprehensive and completed, as the mechanical, electrical, lighting, and building shell are largely addressed. The issues targeted by the version 3 of Issue 19 INBR can be generally categorized into four categories, in which each of them have their own sub-categories (Fig. 3).

5.1 General Principles for Building Design and Execution

There are basic principles requiring to be followed in order to initiate the construction process of building. These principles can be classified into six categories (Fig. 3). I) At first, it is incumbent upon the owner to obtain all the necessary documents for starting the project, namely building plans, technical specifications for materials used in thermal insulation, and technical specifications for mechanical and lighting systems. II) The second step is to consider the significant factors affecting the energy performance of building by taking into account such parameters as, type of building (whether it would be residential, commercial, and etc.), building orientation, the occupied area by building, and particular climatic condition of the building location. III) Third group is related to the other important factors which can potentially influence the optimization of building energy usage such as the utilization of solar radiation. In this stage, the possibility for maximum use of solar radiation will be investigated. IV) Methods for designing the building shell should be specified at this stage, and also important criteria for designing the building shell such as thickness, or type of thermal insulation should be

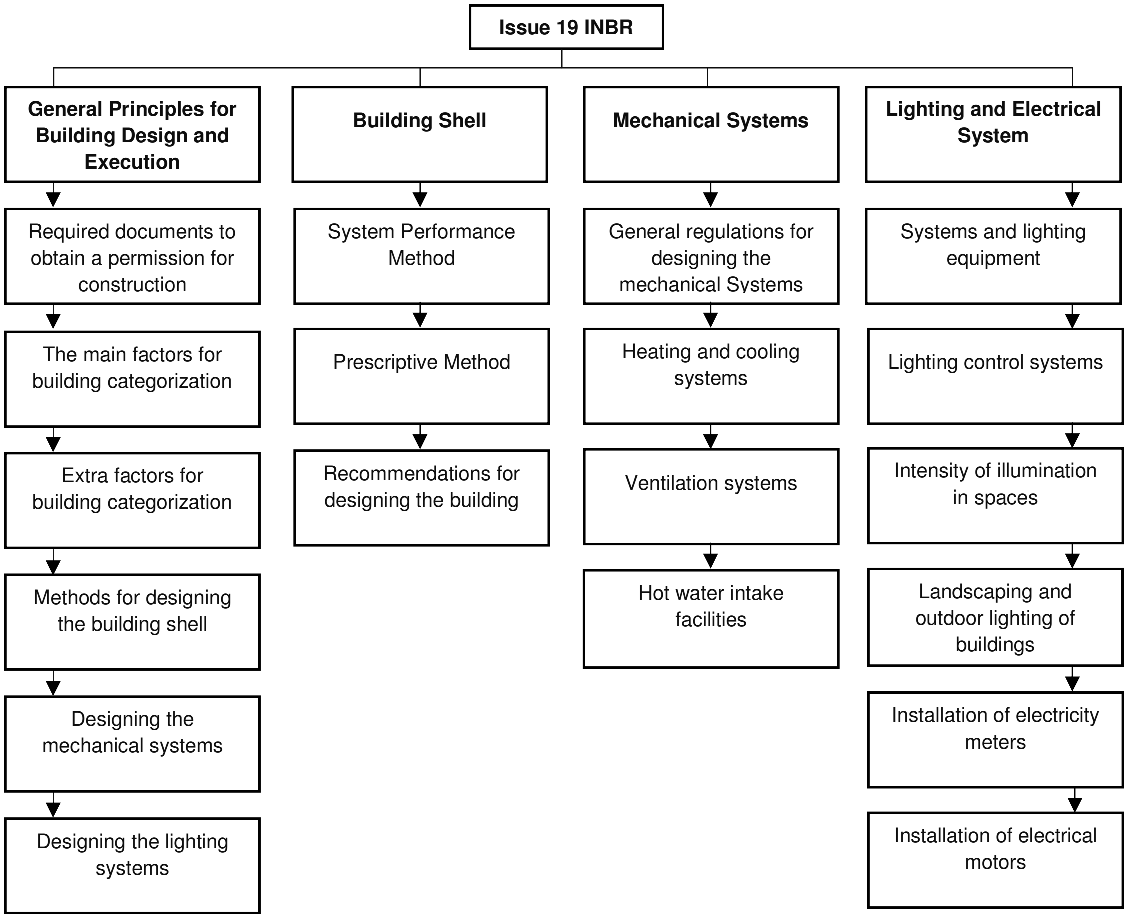

Fig. 3. Different areas of building addressed by Issue 19 INBR [19]

investigated at this stage. There are two methods, System Performance Method and Prescriptive Method which are discussed in the following. V) Technical specifications for designing an optimum mechanical system has been specified at this stage. VI) Based on the building type, there have been determined particular specifications for installing the lighting systems.

5.2 Building Shell

There have been presented two methods, System Performance Method and Prescriptive Method, for designing an energy efficient building shell. In the system performance method, total heat loss of the building is calculated and compared with the total heat loss of the same building (reference building) when its U- values meet the requirements of the code. The result should be always less than the reference building. This method can be used for different types of buildings, but it requires extensive calculations in order to achieve the optimum technical specifications for thermal insulation. In prescriptive method which is used for small buildings, R value for each building component is assigned and designers should calculate the thickness of thermal insulation according to the construction layers of the component. In this section, different recommendations are also given concerning to the optimum design of the building envelope. For example, the best form for the building has been recommended based on the building location, and its particular climates. Additionally, the best layout configuration for internal spaces has been also recommended with regards to the importance of these spaces and their necessities for receiving the solar radiations. Under this section, the importance of shading devices on optimizing the building energy consumption also discussed, and the optimum angles and sizes for shading devices in different cities have been recommended.

5.3 Mechanical System

In this section, various recommendations and technical solutions for designing an optimum mechanical system are given. For example, proper practice of insulating the heating and cooling channels are recommended in order to prevent losing the energy throughout the cycle of building ventilations.

5.4 Lighting and Electrical Systems

In this section, importance of reducing the electrical energy has been highlighted due to its significant role in consuming energy. Several solutions are given with the aim of modulating the electrical energy use in building. For instance, it is recommended to use the lights with low energy utilization for public places where the in-use time of these equipment is long. Issue 19 INBR also recommends to use the automatic and intelligent systems for controlling the set-off and set-on status of lights.

6. RESULTS AND DISCUSSION

Regarding to the fact that, LEED and BREEAM are being employed internationally, these sustainable assessment systems are expected to have a more comprehensive perspective towards sustainability. These programs have experienced several evolutionary alterations ever since their emergence in order to be regionally adopted. Therefore, benchmarking the widely-used international systems against the regional sustainable codes can offer the opportunity for adopting new approaches by national sustainable codes aiming to ameliorate the building sustainability.

It can be generally mentioned that, the primary aims of these three systems are the same, as they are endeavoring to promote the sustainability principles in building sector. Moreover, these sustainable systems are aimed at addressing the design stage of the construction process where the possibility to practice a sustainable building is higher than the other phases. Despite of these similarities, there can be found several differences between Issue 19 INBR, and LEED and BREEAM which are mainly pertained to their approaches toward practicing the sustainable building. These differences are outlined in the following five sections.

6.1 Environmental Concerns

Issue 19 INBR has paid scant attention on the importance of environmental issues, and meagre consideration provided for practitioners. On the other hand, LEED and BREEAM addressed the significance of environmental issues. These considerations can be classified into five categories.

- The importance of building site selection and its connection with the basic services; it is stated that, building should be located in a close proximity (1/2 miles) with basic services, namely bank, school, supermarket, and etc. Because, in this case, the demand for using private car will be reduced, consequently, the amount of emitted CO_2 and other deleterious gases will be diminished.
- The importance of maintaining green spaces; it is stated that, the number of vegetation planted in the construction site might be eliminated due to the construction activities. Therefore, there is a need for redeveloping the lost greeneries as well as minimizing the impacts of construction activities on existing site ecology. As the result, the magnitude of dangerous effects of building activities can be reduced.
- The importance of water optimization; water on the building sites can be stormwater, landscaping water, or potable water. LEED and BREEAM provide different solutions for optimizing the water utilization such as limiting the disruption of natural hydrology by reducing impervious cover, increasing on-site infiltration, reducing or eliminating pollution from stormwater runoff and eliminating contaminants.
- The importance of reducing heat island; Heat Island is defined as ‘thermal gradient differences between developed and undeveloped areas’. Heat Island can result in increasing summertime peak energy demands, air conditioning costs, air pollution and greenhouse gas emissions, and heat-related illness. LEED offers solutions for controlling heat island.
- The importance of reducing refrigerants; in order to decrease the ozone depletion and minimize direct contributions to climate change, the application of equipment capable of minimizing or eliminating the emission of compounds contributing to

ozone depletion and climate change has been recommended.

6.2 Energy Optimization

In terms of increasing the energy optimization, Issue 19 INBR provides sufficient measures to reduce the energy utilization in buildings. It mainly focuses on the importance of using thermal insulation on the building envelope as well as taking the architectural considerations into account such as building forms and its orientation, internal layout configurations, application of shading devices, considerations for natural ventilation, thermal inertia, and particular climatic conditions of building location. However, there can be underlined some differences between Issue 19 INBR and LEED & BREEAM. One of the differences is related to the usage of 'whole building energy simulation' in order to model the energy performance of building throughout its life cycle. The simulation can offer the opportunity to the practitioners to gain a better understanding about the building performance, and implement required measures to decrease the energy use. Another significant factor missing in the Issue 19 INBR, is the necessity for applying renewable energy in the building and its site. LEED & BREEAM have sufficiently reflected the need for using the renewable energy. They encourage increasing the levels of renewable energy either in building or in the site building in order to mitigate the environmental and economic impacts associated with fossil fuel energy use. BREEAM allocates points to the buildings that use passive design and passive technologies, namely passive walls [46], for further improving the building energy efficiency. The employment of passive technologies enables buildings to achieve the lowest energy requirements through striking a balance between the heat losses, and the heat gains [47].

6.3 Waste Management

The nature of construction activities are not environmentally friendly due to their contributions to the environmental degradation [48-50]. The non-recycled and non-reused construction wastages, which are stocked on the building site can end up contaminating the air, soil, and groundwater. As such, the importance of waste management during the project execution should be stressed by the building codes and other sustainable assessment tools. However, Issue 19 INBR paid minimal attention in this area, whereas LEED & BREEAM have adequately highlighted the significance of waste management. LEED & BREEAM determine independent chapters (LEED: Material and Resources, and BREEAM: Waste) in order to expatiate the significance of construction waste management. Various provisions and measures are stipulated in these chapters assisting to deal with generated waste, namely recycled aggregates, operational waste, materials reuse, utilization the regional materials, or employment of certified wood. Taking the importance of construction waste management into consideration can be an efficacious measure to alleviate the environmental concerns of building sector. This criterion should be properly reflected in building codes, and required attempts implement to enforce the involved parties such as contractors, or other construction specialists for executing it.

6.4 Indoor Air Quality

The provision of sufficient Indoor Air Quality (IAQ) can be materialized by employing the mechanical and natural ventilation systems. Issue 19 INBR paid much attention to this area by providing several considerations on the mechanical ventilation systems, lighting systems, and necessary architectural considerations for facilitating the natural ventilations in buildings. However, there can be underlined several differences in the approaches of Issue 19 INBR, and LEED & BREEAM toward IAQ. For instance, Issue 19 INBR ignored the importance of building materials' effects on jeopardizing the IAQ and, subsequently, the occupants' well-being. LEED provides various measures in order to tackle the harmful impacts of building materials, such as defining several requirements for using the adhesives and sealants, or paints and coatings on the interior surface of the building [37]. Besides the provisions of mechanical and natural ventilations, BREEAM also determines several standards to improve the building IAQ. For example, application of sound insulation aiming to enhance the building acoustic performance [43].

6.5 Innovation

The last part of LEED and BREEAM is allocated to a chapter named Invention, which is inviting the construction practitioners to express their innovative ideas to improve the environmental sustainability. These ideas can address the issues 'outside the box' to achieve the exceptional performances above the requirements set by LEED and BREEAM. The existence of this chapter makes these two famous sustainable rating systems flexible and potential to continue their evolutionary processes through the time. However, Issue 19 INBR does not offer such opportunity to its users to express their innovative ideas.

7. RECOMMENDATIONS

Although considerable efforts have been made in order to control the increasing trend of building energy consumption in Iran, but building sector is still deemed to be one of the major determinants in using energy. The necessity for reducing energy utilization in building sector will be highly sensed in the future, as the demographical records projected an increase in Iran population from 78 million to reach more than 90 million up to the 2025 [51]. The increase in population will bring demands for constructing more buildings. As such, failure in improving the building sustainability and optimizing the energy efficiency will result in increasing the buildings' share in consuming the national energy. One of the promising solution to tackle energy challenge is to augment the effectiveness of Issue 19 INBR utilization in building sector. To realize this objective, attempts should be made to upgrade the content of Issue 19 INBR through various ways. Benchmarking against different sustainable assessment tools such as LEED and BREEM can be an effective measure to identify the potential areas for future improvements. Furthermore, different incentive and compulsive schemes can be also initiated by MHU in order to ensure the proper employment of Issue 19 in building sector.

The results of comparison showed that, marginal attention has been paid to the environmental effects derived from construction activities. Additionally, the importance of utilizing renewable energy to supply the requiring demands is also neglected by Issue 19. Therefore, the primary recommendations can be related to the optimization of energy use in building, and improvement of environmental considerations provided by Issue 19. In terms of energy optimization, significant attentions should be allocated to the use of passive strategies [46]. Moreover, using the renewable source of energy, namely solar radiations, is one of the adequate solutions to optimize the energy utilization in building. Correspondingly, sufficient provisions should be offered by Issue 19 to proliferate the use of renewable energy either in building or building site. Regarding to the environmental concerns, the importance of building site selection should be highlighted, namely considering the proximity of building site with basic services (back, metro station, bus station, supermarket, etc.). Furthermore, the need for preserving the available green spaces in the construction sites can be reflected by Issue 19 as well as the necessity for redeveloping the destroyed the plantations.

Construction waste management is another significant parameter which can be covered by Issue 19. It can be recommended that, various provisions should be allocated to recycling, and reusing the generated construction waste. Proper practice of waste management in building sector will enhance the sustainability of built environment through preventing the contamination of air, soil, and groundwater. Regarding to IAQ, the use of materials with harmful impacts on the occupants' health, and built environment should be limited. Strict conditions need to be also provided by Issue 19 regarding to the construction materials using for the interior spaces. Issue 19 paid insufficient considerations to the screening process for material selection, thus rigorous measures are required to improve this weakness. To this end, the necessity for encouraging the users of Issue 19 to express their innovative ideas can be also recommended in order to facilitate the constant enhancement of its quality in the future.

8. CONCLUSION

In Iran, building sector is responsible for consuming a considerable proportion of primary energy. In order to diminish the contribution of building sector in using energy, the Ministry of Housing and Urbanism released the first version of Iranian building codes under the name of Issue 19 INBR in 1991. Afterwards, two other versions also compiled aiming to ameliorate the building sustainability and retard increasing trend of energy consumption in the country. However, after the passage of more than two decades, building sector still recognizes as the principle determinants for consuming energy in Iran. This study attempted to compare Issue 19 INBR against the two most widely-used building rating systems with the aim of underlining the major differences between them. The results are classified into five categories; environmental concerns, energy optimization, waste management, indoor air quality (IAQ), and innovation.

It was found that, Issue 19 INBR paid sufficient attention to the architectural considerations for optimizing the building energy use. For example, designing the optimum form and orientation building, designing the internal layout configurations, installing the shading devices, providing considerations for natural ventilation, thermal inertia, and particular climatic conditions of building location. In comparison with the LEED and BREEAM, however, the most significant difference can be the scant attentions paid to the utilization of renewable energy in buildings. Similarly, the importance of minimizing the environmental effects derived from the constructional activities is also neglected by Issue 19 INBR, whereas LEED and BREEAM addressed widely the significance of environmental concerns. The third difference was pertained to the ignorance of construction waste management. Issue 19 INBR does not provide any considerations for recycling, and reusing the construction wastages. The failure in adequately managing the generated waste can severely impose deleterious impacts on the built environment. The forth difference was related to the definition of specific standards addressing indoor air quality. LEED and BREEAM set certain standards for the materials applicable to be used for the interior spaces to avoid utilization of materials that can threaten the occupants' well-being. However, this issue is not addressed by Issue 19 INBR.

Finally, the last distinction was related to the encouragement offered by LEED and BREEAM to their users for expressing their innovative ideas. These two sustainable rating systems allocate additional 10 scores for buildings, which have utilized innovations. The existence of this chapter can encourage the practitioners to participate in further improving the quality of these systems, and stimulate them to put forward novel performances beyond the requirements determined by the LEED and BREEAM. Hence, these systems will always have the opportunity to update and upgrade in accordance with the new emerging demands. On the opposite side, Issue 19 INBR does not provide the chance for its users to share their innovative ideas to tackle the environmental issues and energy utilization in buildings.

Accordingly, recommendations can be given based on the results of carried out comparison aiming to enhance the quality of Issue 19 INBR for addressing the building environmental concerns, and building energy usage. These recommendations can cover the whole gamut of five identified differences in this study.

- *Environmental concerns*, considering the importance of site selection, maintaining the existing green spaces in the building site, water optimization including the Stormwater, landscaping water, or potable water, reducing the heat island, and reducing the refrigerants.
- *Energy optimization*, encouraging the use of renewable energy, utilizing passive strategies in building design, and integrating the new passive technologies with buildings such as photovoltaic (PV) panels.
- *Waste management*, considering the importance of recycling and reusing the construction wastages.
- *Indoor air quality*, considering the effects of utilizing materials on the occupants' well-being as well as built environment, especially those materials which are intended to use for interior spaces.
- *Innovation*, encouraging the users to express their innovative ideas to achieve exceptional performances beyond the requirements determined by the Issue 19 INBR.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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