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تطوير نظام تصنيف المباني المكتبية المستدامة باستخدام إجراءات سيموس

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الخلاصة

مع زيادة الوعي بالقضايا البيئية ومحدودية الموارد الطبيعية، أصبحت الإستدامة هي المعيار لتطوير المنشآت الجديدة. أنظمة تقييم الإستدامة مثل الـ (LEED، Green Globes، and BREEAM) وغيرها كان لها تأثيراً كبيراً في تطوير المباني المستدامة. عادة ما تختلف معايير الاستدامة وأوزانها النسبية في أنظمة التقييم المختلفة بسبب الإختلافات في المتطلبات والظروف الإقليمية. ووفقاً لذلك، فإن هناك حاجة ماسة لتطوير نظام تقييم يناسب كل منطقة وفقاً لظروفها. تهدف هذه الورقة إلى تطوير نظام لتقييم المباني المكتبية والإدارية المستدامة في المملكة العربية السعودية. هذه المباني لها تأثيرات بيئية كبيرة كما تستهلك الكثير من المياه والطاقة والموارد الأخرى. تم تحديد 98 معياراً للإستدامة وتصنيفها ضمن خمس مجموعات رئيسية من خلال بحث سابق. بناء على هذه المعايير، تم إعداد استبيان لتحديد أهمية كل معيار مقارنةً مع المعايير الأخرى وفقا لمنهجية سيموس. تم الحصول على 377 رد على الإستبيان من قبل مهندسين وأكاديميين في مؤسسات عامة وخاصة تشارك في صناعة البناء والتشييد في المملكة العربية السعودية. تم استخدام إجراءات سيموس لتحديد أوزان الأهمية النسبية لكل من مجموعات ومعايير الإستدامة. بناء على ذلك، تم تحديد المعايير ذات الأهمية الكبيرة والمعايير ذات الأهمية الصغيرة من خلال تحليل باريتو. نتيجة لما سبق، تم تطوير نظام تصنيف باستخدام 57 معياراً ذات أهمية قصوى مع تحديد النقاط المتاحة لكل معيار. ينصح بشدة على سن بعض التشريعات التي تكفل تطبيق نظام التصنيف المقترح في تقييم المباني وفقا لمتطلبات الإستدامة من أجل تحقيق مباني مستدامة والتي تستخدم المياه والطاقة بكفاءة وكذلك تحد من التأثيرات السلبية على البيئة.

Developing a rating system for sustainable office buildings using Simos' procedure

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ABSTRACT

Sustainability has become the norm for developing new construction with the increasing consciousness of environmental issues and natural resource limitations. Sustainability rating systems, such as LEED, Green Globes, BREEAM and many others, had a significant impact on developing sustainable buildings. In these rating systems, the sustainability criteria and their weights usually differ due to differences in the regional conditions and requirements. Accordingly, there is a critical need to develop a rating system that suits each region according to its circumstances. This paper aims to develop a rating system for sustainable office and administrative buildings in Saudi Arabia. These buildings have significant environmental impacts along with high consumption of water, energy and other resources. A list of 98 sustainability criteria within five main clusters, have been identified through previous research. Based on these criteria, a questionnaire survey has been developed to identify the importance of each criterion compared to other criteria according to the Simos procedure methodology. A total of 377 responses have been obtained from practicing engineers and academia and from public and private organizations that are involved in the construction industry in Saudi Arabia. The Simos procedure has been used to identify the importance weights for the sustainability clusters and criteria. Accordingly, the most trivial and significant criteria have been identified through a Pareto analysis. Consequently, the rating system has been developed based on 57 of the most significant criteria along with their credentials. It is highly recommended to enact some legislations that ensure implementing the proposed rating system in evaluating buildings according to sustainability requirements in order to achieve sustainable buildings that use water and energy efficiently and reduce the negative impacts on the environment.

Keywords: Office building; pareto analysis; rating system; Simos' procedure; sustainability.

INTRODUCTION

Sustainability issues have been widely discussed in recent years and have become a very important issue in the construction industry (Holton *et al*., 2010). Despite the importance of implementing sustainability in the construction sector, it seems to be lagging behind other sectors, and it is still difficult for engineers to incorporate sustainability into their work (Tsai & Chang, 2012). Many studies have indicated that the construction industry is responsible for serious impacts on the global and local environment (ECTP, 2005; Melchert, 2007; Majdalani *et* *al*., 2006; Clarke *et al*., 2008; Macleay *et al*., 2012; Bakhoum & Brown, 2012). The U.S. Green Building Council (USGBC) reported that buildings are among the most substantial consumers of natural resources and also account for a significant portion of carbon emissions that affect climate change (USGBC, 2015). The construction sector accounts for 40% of all resource consumption (ECTP, 2005). Additionally, at least 50% of all energy consumption in Europe and more than 50% of all carbon emissions in the UK have been attributed to the creation and operation of buildings (Petri *et al*., 2014). In the U.S.A., buildings account for 38% of all CO2 emissions, 73% of all electricity consumption, 41% of all energy consumption, and 13.6% of all potable water (or 15 trillion gallons per year), as well as 40% of all raw materials used globally (3 billion tons annually) (USGBC, 2015). In Saudi Arabia, the energy consumption is classified among the highest in the world with 6.7 tons oil equivalent (toe) per capita, while the world average is 1.9 toe (World Bank Group, 2012). This consumption grows with a time unlike the international trend, resulting in increasing the energy intensity in Saudi Arabia to be 137 toe of energy use per 1000$ gross domestic product (GDP) comparing with 95 toe in Europe (Nachet & Aoun, 2015). Accordingly, the Kingdom is the largest oil consumer in the Middle East and the 6th largest oil consumer worldwide with more than 3 million of oil barrels per day (Nachet & Aoun, 2015). This huge consumption of fuel cause high gas emissions that have a negative impact on humans, environment, and natural resources. The average per capita CO2 emission about 18 metric ton per person, which represent a very high number comparing with the average CO2 emission in the world (about 4 metric ton per person) (Alrashed & Asif, 2014). Furthermore, Saudi Arabia suffers from an extreme water shortage due to the scarcity of natural resource of fresh water (Abderrahman, 2006). The average annual share per capita of water in the Kingdom is about 296 cubic meters per year, which lie under the water poverty line (1000 cubic meters per person per year) (Ministry of Water & Electricity Kingdom of Saudi Arabia, 2012). Developing sustainable buildings reduces the negative impact on the environment and improves the efficiency of buildings. Sustainable buildings consume 25% less energy and 11% less water, have 19% lower maintenance costs, 27% higher occupant satisfaction, and 34% lower greenhouse gas emissions (USGBC, 2015). Accordingly, the construction industry is under pressure to increase the implementation of sustainability in its practices (Petri *et al*., 2014).

Implementing specific measures for sustainability helps to create sustainable buildings and to minimize their environmental impact (Abdallah *et al*., 2013). The sustainability criteria along with their weights represent the main pillars for a sustainability rating system. More than 600 sustainability rating systems are available worldwide (BRE, 2008). This huge number of rating systems is due to the differences between regional conditions that lead to generating different sustainability criteria and weights. Various aspects influence identifying the criteria of sustainability assessment tools such as economic, social, environmental, and cultural aspects. Hence, standard international approaches for evaluating the sustainability of construction projects in all regions does not exist yet (Banani *et al*., 2013), taking into account differences in all of these aspects. Accordingly, each region needs to develop its own sustainability rating system that is compatible with its conditions and requirements (Reed, 2009; Larsson, 2012; Banani *et al*., 2013; Shaawat & Jamil, 2014). Furthermore, the sustainability criteria and their weights usually vary depending on the type of building, such as homes, offices, healthcare buildings, industrial buildings, education buildings, and so on. Many of the sustainability rating systems provide different rating systems depending on the building type. Office and administrative buildings are very common buildings that usually consume large amounts of energy, and responsible for a large amount of CO2 emissions (Pérez *et al*., 2008). There are many obvious environmental, social, and economic advantages of incorporating sustainability in office buildings for occupiers and owners (Eichholtz *et al*., 2010; Wilkinson *et al*., 2011). Accordingly, many international rating systems developed a customized rating system for this type of buildings such as BREEAM, Green Star, Hong Kong building environmental assessment method (HKBEAM), and Building environmental performance assessment criteria (BEPAC) (Ding, 2008). Therefore, developing a rating system for this type of buildings helps to minimize this high consumption of natural resources and to reduce negative environmental impacts.

In Saudi Arabia, the extreme weather conditions and resource limitations increase the need for a sustainability rating system that fits with these special conditions for different types of buildings. Despite this need, efforts in this field are still limited. Alyami *et al*. (2013) tried to identify sustainability criteria for residential buildings in Saudi Arabia. However, they did not investigate the weights of the criteria to help in estimating the criteria credits. In addition, their study did not cover another type of buildings, such as office buildings. BREEAM-Gulf was introduced in 2008 and was adapted to match the environmental requirements in the Gulf region, including Saudi Arabia. However, it was withdrawn in 2010 and cannot be used currently (Shaawat & Jamil, 2014). Shaawat & Jamil (2014) compared the green building rating systems and indicated the important and urgent need for developing a separate sustainable rating system for Saudi Arabia. They concluded that an assessment system developed for a specific region is applicable only for that region and may not be applied to any other region. The assessment systems being considered in Saudi Arabia are based on the factors of European and American rating systems, which do not address the different climate, the available energy resources or scarcity of water in their standards (Shaawat & Jamil, 2014). This paper aims to develop a sustainability rating system for office and administrative buildings in Saudi Arabia using the Simos procedure and Pareto analysis along with other statistical approaches. The proposed system helps to achieve sustainable office buildings that minimize the significant impact on the environment and resources of this type of building in Saudi Arabia.

BACKGROUND

During the 1971–2013 period, Saudi Arabia experienced fast economic and industrial growth, which has led to rapid urbanization. This fast economic development was accompanied by a high consumption rate of oil. In 2013, the total oil consumption was approximately 3.07 million barrels per day (mbd), and a large portion of this oil consumption is used for electricity (Alkhathlan & Javid, 2015). High consumption of energy results in high greenhouse gas emissions, which is responsible for global warming. CO2 emissions are part of the total greenhouse gas emissions; the per capita CO2 emissions in Saudi Arabia were the highest in the world during the 2006–2010 period (Alrashed & Asif, 2014). Because of the rapid urbanization and improvements in quality of life, high energy demands are now required in Saudi Arabian buildings. In 2010, buildings in

Saudi Arabia consumed approximately 65% of the total electricity, which was 47% higher than the world average at that time (Alaidroos & Krarti, 2015). To mitigate the adverse impacts of energy consumption, the Saudi government has paid significant attention during the last few decades to the country's economic growth and its impact on both natural resources and the environment. Achieving sustainable development is one of the main objectives of the economic and social development plan of Saudi Arabia (Alrashed & Asif, 2014).

The increasing attention to sustainability has extended to the construction sector, which has significant environmental, social and economic impacts on society. Sustainable building is part of the concept of promoting sustainability (Chan *et al*., 2009). Sustainable buildings save energy, land, water and materials while considering ecologically based principles (Zuo & Zhao, 2014, Shi *et al*., 2013). Many factors lead to the success of sustainable specifications, such as green technology and techniques, reliability and quality of specification, leadership, and responsibility, stakeholder involvement, and guiding and benchmarking systems (Lam *et al*., 2010). However, adoption of green construction may face some barriers similar to those being encountered in Shanghai, which include additional cost, incremental time and limited availability of green suppliers and information (Shi *et al*., 2013).

Currently, a number of green building rating systems have been developed to facilitate sustainable building developments. Each of these systems allocates marks or scores to various aspects of sustainability. They are designed for different types of projects, and all of the rating systems are voluntary rather than mandatory. The green building rating systems include, but are not limited to, Leadership in energy and environmental design (LEED), developed by the U.S. Green building council (USGBC) in 1998; Building research establishment's environmental assessment method (BREEAM), developed in the UK in 1990; Green building council of Australia green star (GBCA), launched in 2003 in Australia; Comprehensive assessment system for built environment efficiency (CASBEE), developed in Japan in 2001; Hong Kong building environmental assessment method (HK BEAM), developed in Hong Kong in 1996; SBTOOL, developed by the Green building challenge (GBC) in Canada in 1996; Collaborative for high performance schools (CHPS), developed in the USA in 1999; GREEN GLOBES, developed in the USA and Canada in 2000; Green guide for health care (GGHC), developed by the American s for healthcare engineering (ASHE) in the USA in 2003; High quality environmental standard (HQE), developed by the ASSOHQE in France in 2004; India green rating for integrated habitat assessment (GRIHA), developed by the TERI (Energy and resources institute) in India in 2005; Singapore building and construction authority green mark (BCA), developed by the Singapore building and construction authority and the national environment agency in Singapore in 2005; ESTIDAMA - Pearls rating system, developed by the Abu Dhabi urban planning council in the UAE in 2010; German sustainable building certification (GSBC), developed by the German sustainable building council (DGNB) in 2009; and the green building index, developed in Malaysia. The building assessments were performed by accredited professionals who were authorized by the green building council (Zuo & Zhao, 2014, Nguyen & Altan, 2011, Jingwei *et al*., 2011).

Through reviewing the previous rating systems, it can be observed that these systems include several sustainability criteria that usually classified within several clusters such as sustainable site, water efficiency, energy efficiency, material and recycle indoor environmental quality, innovation, and Design and Management culture. The sustainable site cluster includes the sustainability criteria that deals with evaluating the impact of building site on the community and the environment. While the water efficiency cluster includes the criteria that deal mainly with reducing pollution of waterways and reducing water usage, the energy efficiency cluster includes set of sustainability criteria related to improving energy efficiency within buildings. The material and recycle cluster includes the sustainability criteria that deal with selecting material that improves the environmental outcomes associated with the manufacture, transport, installation and disposal of these materials. The indoor environmental quality cluster includes the criteria that deal with reducing indoor pollutants and providing a healthy indoor environment. Innovation cluster deals with criteria that encouraging using innovative practices in design and construction that contribute to enhancing the sustainability of buildings. Design and management cluster includes criteria related to improving the management design, and construction practices in order to obtain the maximum environmental benefits.

METHODOLOGY

The research methodology starts with the identification of a list of criteria for sustainable office and administrative buildings that suit the special conditions and requirements for Saudi Arabia, as shown in Figure 1, which illustrates the research methodology process. In a previous phase of this study, Marzouk *et al*. (2014a) identified a list of 112 initial criteria for sustainable office and administrative buildings in Saudi Arabia, which were classified into seven main groups (shown in Table 1), through benchmarking regional and international rating systems. Al-Gahtani *et al*. (2016), investigated the appropriateness of these criteria through a questionnaire survey and used the severity index (SI) and exploratory factor analysis to analyze the data collected. They eliminated the inappropriate criteria from their list as a result of data analysis, which were SS-6, SS-16, WE-13, MS-19, MS-21, IR-3, DM-1, DM-2, DM-4, DM-5, DM-8, DM-9, DM-12, and DM-18. The remaining 98 sustainability criteria have been considered in this study as a first step in developing the sustainability rating system.

The next step in this study was developing a survey questionnaire to help identify the weights for the sustainability criteria based on the Simos procedure. Simos' procedure, originally developed by J. Simos in 1990 (Simos, 1990a, b), was later improved by Figueira & Roy for single decision-making processes (Figueira & Roy, 2002) and then was extended to group decision-making by Shanian *et al*. (2008). This technique depends on a "card playing" procedure to classify different criteria into different levels by each decision maker, followed by the ranking and then weighting of these levels (Shanian *et al*., 2012). In this technique, each criterion is placed on one card and given to decision makers to view and think about these criteria. Then, the decision makers are asked to rank these cards in ascending order according to their importance, where the first card in the ranking is the least important criterion and the last card in the ranking is the most important criterion. The determination of the weights must take into account the fact that the importance of two successive criteria in the ranking can be more or less close. Thus, the decision makers are asked to put white cards between two successive cards if needed to express the difference in weights between these criteria. The cards are held together with a clip or rubber band if they have the same importance (Figueira & Roy, 2002). The Simos procedure allows any decision maker to express the way in which he wishes to order the different criteria within a family in a given context (Figueira & Roy, 2002). The questionnaire included four main parts. The first part gathered information about the respondents, such as organization type, the number of employees, respondent's position, and years of experience. This part also investigated the respondents' background in sustainability to exclude the respondents who did not have previous knowledge of this topic. The participants who did not have previous knowledge moved directly to the end of the questionnaire, and their responses have been excluded. The second part asked the respondents to arrange the sustainability clusters in ascending order (1 represented the least important criterion while the largest number represented the most important criterion) with the ability to use the same number, if more than one criterion had the same importance. The third part asked the respondents to arrange the criteria within each cluster in a similar way to part 2. The fourth and final part provided the respondents with contact information, if they had any questions or inquiries. In the data collection step, an online questionnaire was designed to facilitate the data collection. The targeted population was academia and engineers from different organizations related to the construction industry in Saudi Arabia.

The data analysis step started with the analysis of the first section of the questionnaire related to the general information of the respondents. Then, the Simos procedure was used to calculate the weights of the sustainability clusters and criteria. The Simos procedure is a very useful tool for estimating the criteria and cluster weights (Marzouk *et al*., 2013; Marzouk *et al*., 2014b). The analytical hierarchy process (AHP) is another powerful tool for identifying the weights of the criteria. However, the implementation of this technique becomes very difficult with large numbers of criteria (Marzouk *et al*., 2013). For example, if the number of criteria in a cluster is 15, the decision matrix size will be 15×15. In this case, filling the decision matrix will be confusing and time-consuming for participants. In addition, the probability of obtaining inconsistent answers is likely to be very high (Marzouk *et al*., 2013). Pareto analysis was used to identify the most important criteria according to their weights that were calculated through the Simos procedure. In 1897, the Italian economist Vilfred Pareto presented the Pareto analysis for the first time. He proposed that 80% of a nation's wealth was held by 20% of its population (Aibinu & Odeyinka, 2006). Therefore, this analysis is also called the 80/20 rule. This analysis is used in research in different fields to classify the factors as either vital or trivial. For example, Juran (1974) used this analysis to identify key problems of quality control and also to identify the less important problems that can be ignored. For a similar purpose, Aibinu & Odeyinka (2006) conducted an analysis of the distribution pattern of 44 delay factors based on the Pareto concept. Hosny & Abdel-Razek (1991) used this method to study the hypotheses that 70% of the construction project costs were contained in approximately 30% of the bill of quantity items. This study conducted a Pareto analysis for the sustainability criteria to identify the significant criteria and to eliminate the trivial criteria. The application of sustainability systems becomes more difficult with an increasing number of criteria that requires too much data. Accordingly, eliminating trivial criteria makes the system more applicable and also saves the time and effort required for these criteria. Using this technique in this research helps in identifying the key sustainability criteria that can be used for developing the rating system. Based on the results of the previous steps, the sustainability rating system was developed for evaluating the environmental performance of office and administrative buildings, which includes the final list of the most important criteria along with their weights.

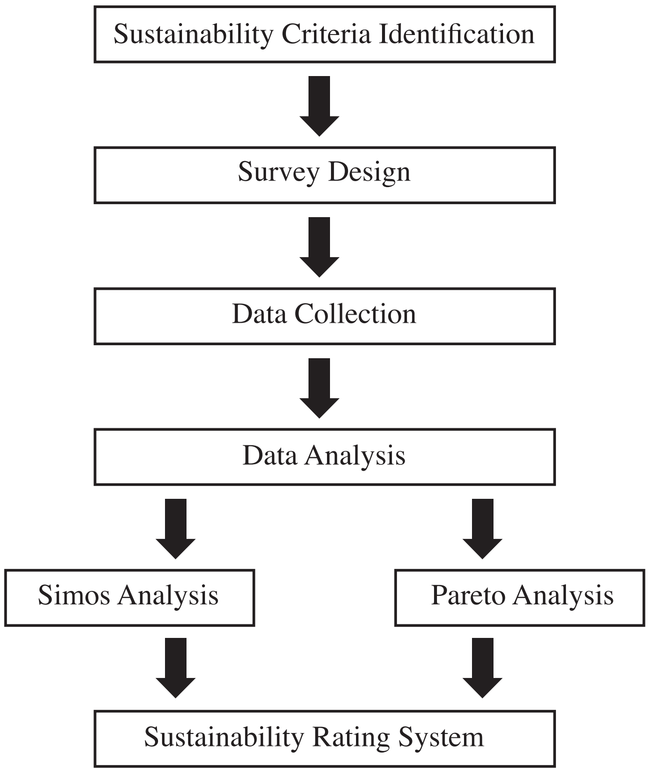

Fig. 1. Research methodology flowchart

Table 1. Sustainability criteria

Custer	Code	Criteria	Cluster	Code	Criteria
Sustainable Sites (SS)	SS-1	Site Selection	*Material Selection and Recycling (continued)*	MS-11	Building Product Optimization
	SS-2	Construction Activity Pollution Prevention		MS-12	Use of Higher Durability Materials
	SS-3	Reuse of Land		MS-13	Use of Prefabricated Elements
	SS-4	Remediation of Contaminated Land		MS-14	Design for Disassembly
	SS-5	Provision of Public Transport		MS-15	Modular Flooring Systems
	SS-6	Bicycle Facilities		MS-16	Organic Waste Management
	SS-7	Low-Emitting Vehicles		MS-17	Operational Waste Management
	SS-8	Parking Capacity		MS-18	Construction Waste Management
	SS-9	Protection of Habitat		MS-19	Recycled Aggregates
	SS-10	Enhancing Site Ecology		MS-20	Recyclable Waste Storage
	SS-11	Maximize Open Space		MS-21	Floor Finishes
	SS-12	Light Pollution Reduction		MS-22	Life Cycle Cost
	SS-13	Reduce Heat Island Effect		MS-23	High Thermal Mass Material
	SS-14	Site Assessment			
	SS-15	Proximity to Amenities	*Indoor Environmental Quality (IE)*	IE-1	Low-Emitting Materials
	SS-16	Travel Plan		IE-2	Smoking Control
	SS-17	Respect for Sites of Historic or Cultural Interest		IE-3	Acoustic Performance
	SS-18	Development Density and Community Connectivity		IE-4	Ventilation System
	SS-19	Private Outdoor Space		IE-5	Thermal Comfort
				IE-6	Interior Lighting
Water Efficiency and Conservation (WE)	WE-1	Indoor Water Consumption		IE-7	Thermal Zoning
	WE-2	Outdoor Water Consumption		IE-8	Daylight
	WE-3	Water Consumption Monitoring		IE-9	Quality Views
	WE-4	Water Leakage Detection		IE-10	Minimum Indoor Air Quality Performance
	WE-5	Efficient Water Use During Construction		IE-11	Outdoor Air Delivery Monitoring
	WE-6	Sanitary Pipe Used		IE-12	Construction Indoor Air Quality Management Plan
	WE-7	Storm Water Management		IE-13	Legionella Prevention
	WE-8	Waste Water Management		IE-14	Control of Indoor Pollutants
	WE-9	Innovative Wastewater Technologies		IE-15	Car Park Air Quality Management
	WE-10	Harvesting of Rain Water		IE-16	Internal Landscape
	WE-11	Conservation Strategy			

Custer	Code	Criteria
	WE-12	Quality of Drinking Water
	WE-13	Cooling Tower Water Use
Energy Efficiency and Conservation (EE)	EE-1	Minimum Energy Performance
	EE-2	Measurement and Verification
	EE-3	Ozone Impacts
	EE-4	Improved Energy Performance
	EE-5	Vertical Transportation
	EE-6	Green and Renewable Energy
	EE-7	Energy Efficient Appliances
	EE-8	Cool Building Strategies
	EE-9	Peak Load Reduction
	EE-10	Environmental Impact
	EE-11	External Lighting
	EE-12	Energy and Carbon Inventories
	EE-13	HVAC System
	EE-14	Demand Response
Material Selevction and Recycling (MS)	MS-1	Regional Materials
	MS-2	Materials Reuse
	MS-3	Building Reuse
	MS-4	Rapidly Renewable Materials
	MS-5	Use of Recycled Materials
	MS-6	Low Impact Materials
	MS-7	Responsible Sourcing of Materials
	MS-8	Insulation
	MS-9	Designing for Robustness
	MS-10	Elimination of Exposure to Hazardous Materials

Cluster	Code	Criteria
Innovation and Regional Priority (IR)	IR-1	Innovation
	IR-2	Regional Priority
	IR-3	Exceeding Benchmarks
	IR-4	Gendered Spaces
	IR-5	Effects of Customs on the Built Environment
	IR-6	Islamic Design Requirements
	IR-7	Documentation in the Arabic Language
Design and Management (DM)	DM-1	Commissioning
	DM-2	Considerate Constructors
	DM-3	Construction Environmental Management
	DM-4	Building User Guide
	DM-5	Security
	DM-6	Integrated Development Strategy
	DM-7	Environmental Purchasing
	DM-8	Emergency Response Plan
	DM-9	Guest Worker Accommodation
	DM-10	Building Envelope Verification
	DM-11	Sustainability Communication
	DM-12	Access for Lorries
	DM-13	Identified and Separated Storage Areas
	DM-14	Employing Waste Recycling Workers on Site
	DM-15	Engaging a Company Specialized in Recycling and Disposal
	DM-16	Protecting Water Sources from Pollution
	DM-17	Control of Equipment Emissions and Pollutants
	DM-18	Providing a Periodic Maintenance Schedule
	DM-19	Sandstorm Protection
	DM-20	Stakeholders Involvement

GENERAL CHARACTERISTICS OF RESPONDENTS

The questionnaires were distributed to practicing engineers from public and private organizations involved in the construction industry in Saudi Arabia. The questionnaires were also sent to the Saudi Council of Engineers, which includes a large number of engineers and academia from different organizations. A total of 377 responses were received from 54 owners, 140 contractors, 127 consultants, and 56 academics and engineers from other types of organizations. Tables 2 and 3 show the details of the number of employees and the respondents' experience for each group. The high experience of respondents gives the responses more reliability. To increase the response accuracy, the questionnaire investigated the previous knowledge of the participants about sustainable construction, as shown in Table 4. Of the respondents, 15% did not have previous knowledge of sustainable building, and their responses had been excluded from the total number of responses, making the considered number of responses 322.

Table 2. Number of employees in participating organizations

Number of Employees	Number of Respondents (Frequency)				Total	Percentage (%)
	Owner	Contractor	Consultant	Others		
5–50	5	18	35	10	68	18
51–100	6	20	16	9	51	13
101–150	12	25	15	7	59	16
More than 150	31	77	61	30	199	53
Total	54	140	127	56	377	100

Table 3. Respondents' years of experience

Years of Experience	Number of Respondents (Frequency)				Total	Percentage (%)
	Owner	Contractor	Consultant	Others		
1–5	11	27	11	9	58	15
6–10	15	34	29	17	95	25
More than 10	29	79	87	30	225	60
Total	54	140	127	56	377	100

Table 4. Respondents' previous knowledge of sustainable construction

Sustainability knowledge	Number of Respondents				Total	Percentage (%)
	Owner	Contractor	Consultant	Others		
Previous knowledge	38	117	120	47	322	85
No knowledge	16	23	7	9	55	15
Total	54	140	127	56	377	100

SIMOS ANALYSIS

In this study, the questionnaire was prepared according to Simos' procedure requirements to investigate the weights of the sustainability criteria for office and administrative buildings. This questionnaire, aside from assigning the relative importance of the criteria, also required the participants to assign the relative importance of the seven main clusters to which all of the factors belong. The sustainability clusters included sustainable sites (SS), water efficiency and conservation (WE), energy efficiency and conservation (EE), material selection and recycling (MS), indoor environmental quality (IE), innovation and regional priority (IR), and design and management (DM). The results were developed by taking the average position of a card and its relative importance for each criterion. Based on the card position results, a sorting process was performed based on the Simos algorithm. The result of the sorting process was added to the next column. Accordingly, the normalized weights for each cluster and criterion were calculated and assigned to the final column, as shown in Tables 5 and 6. The water and energy clusters had the highest importance weights compared to the rest of the clusters, which were 25% and 21.43%, respectively, while the innovation and regional priority and design and management clusters had the lowest importance weights with 3.57% and 7.14%, respectively. This indicates the critical need for these two elements in Saudi Arabia due to the extreme environmental conditions that lead to increased energy and water consumption. Despite limited freshwater resources, Saudi Arabia is classified as the third largest water consumer worldwide. According to the Saudi Ministry of Water and Electricity, 60% of the water sources in Saudi Arabia depend on seawater desalination. However, the average per capita water consumption reached 265 liters in Saudi Arabia, which is equivalent to twice that of the European Union per capita consumption (Saudi Ministry of Water and Electricity 2013). Furthermore, water and energy projects consume a significant portion of the Kingdom budget, in which the Saudi government has earmarked about $160 billion for various water and energy projects over the next decade. The criteria that had the highest importance weights within each cluster were parking capacity (SS-8), quality of drinking water (WE-12), cool building strategies (EE-8), elimination of exposure to hazardous materials (MS-10), ventilation system (IE-4), Islamic design requirements (IR-6), and protecting water sources from pollution (DM-16). The criteria that had lowest importance weights within each cluster were reuse of land (SS-3), storm water management (WE-7), vertical transportation (EE-5), modular flooring systems (MS-15), construction indoor air quality management plan (IE-12), documentation in Arabic language (IR-7), and employing waste recycling workers on site (DM-14).

Table 5. Relative weights of the sustainability clusters

Cluster Code	Positions	Simos Rank	Normalized Weights
SS	5.10	5	17.86
WE	6.04	7	25.00
EE	5.49	6	21.43
MS	4.71	4	14.29
IE	4.04	3	10.71
IR	2.84	1	3.57
DM	3.88	2	7.14

Table 6. Relative weights of the sustainability criteria

Criteria Code	Positions	Simos Rank	Normalized Weights
SS-1	11.47	8	5.23
SS-2	11.53	11	7.19
SS-3	5.61	1	0.65
SS-4	9.50	5	3.27
SS-5	13.02	16	10.46
SS-7	12.06	14	9.15
SS-8	14.09	17	11.11
SS-9	7.19	3	1.96
SS-10	10.08	7	4.58
SS-11	11.52	10	6.54
SS-12	8.64	4	2.61
SS-13	9.59	6	3.92
SS-14	11.95	13	8.50
SS-15	6.85	2	1.31
SS-17	12.15	15	9.80
SS-18	11.86	12	7.84
SS-19	11.50	9	5.88
WE-1	8.81	8	10.26
WE-2	5.62	3	3.85
WE-3	7.91	7	8.97
WE-4	9.31	10	12.82
WE-5	4.15	2	2.56
WE-6	6.65	5	6.41
WE-7	3.69	1	1.28
WE-8	9.28	9	11.54
WE-9	7.65	6	7.69
WE-10	6.54	4	5.13
WE-11	9.48	11	14.10
WE-12	10.66	12	15.38
EE-1	9.54	8	7.62
EE-2	7.05	5	4.76
EE-3	6.64	4	3.81
EE-4	10.43	9	8.57
EE-5	3.78	1	0.95
EE-6	11.17	13	12.38
EE-7	10.46	10	9.52
EE-8	11.64	14	13.33
EE-9	10.46	11	10.48
EE-10	8.91	7	6.67
EE-11	6.09	3	2.86
EE-12	4.83	2	1.90
EE-13	11.07	12	11.43
EE-14	7.92	6	5.71
MS-1	13.14	12	5.19
MS-2	13.15	13	5.63
MS-3	14.38	18	7.79
MS-4	14.21	16	6.93
MS-5	14.14	15	6.49
MS-6	14.21	17	7.36
MS-7	10.59	9	3.90
MS-8	16.21	20	8.66
MS-9	8.56	6	2.60
MS-10	17.36	21	9.09
MS-11	14.13	14	6.06
MS-12	15.24	19	8.23
MS-13	6.59	5	2.16
MS-14	6.15	3	1.30
MS-15	4.87	1	0.43
MS-16	8.82	7	3.03
MS-17	9.55	8	3.46
MS-18	10.84	10	4.33
MS-20	11.24	11	4.76
MS-22	6.12	2	0.87
MS-23	6.27	4	1.73
IE-1	11.55	8	5.88
IE-2	11.70	9	6.62
IE-3	11.40	7	5.15
IE-4	13.29	16	11.76
IE-5	12.67	14	10.29
IE-6	11.99	12	8.82
IE-7	11.88	10	7.35
IE-8	12.97	15	11.03
IE-9	8.96	4	2.94
IE-10	12.53	13	9.56
IE-11	7.21	3	2.21
IE-12	4.07	1	0.74
IE-13	8.99	5	3.68
IE-14	11.90	11	8.09
IE-15	6.36	2	1.47
IE-16	9.26	6	4.41
IR-1	4.75	5	23.81
IR-2	3.66	2	9.52
IR-4	3.91	3	14.29
IR-5	4.03	4	19.05
IR-6	5.13	6	28.57
IR-7	3.01	1	4.76
DM-3	8.26	7	8.97
DM-6	8.54	10	12.82
DM-7	8.37	8	10.26
DM-10	8.43	9	11.54
DM-11	6.08	5	6.41
DM-13	8.19	6	7.69
DM-14	3.34	1	1.28
DM-15	5.77	4	5.13
DM-16	9.86	12	15.38
DM-17	8.74	11	14.10
DM-19	5.75	3	3.85
DM-20	5.30	2	2.56

PARETO ANALYSIS

A Pareto analysis provides a systematic tool for ranking the criteria in the descending order according to their importance and identifying the vital criteria that occupy a substantial amount of cumulative importance (80 percent) (Knights, 2001; Karuppusami & Gandhinathan, 2006). In other words, through this technique, the criteria can be classified into vital and trivial criteria (Aibinu & Odeyinka, 2006).

To implement the Pareto analysis in this study, the criteria within each cluster was ranked based on their normalized importance weights that were calculated in Table 6. Following the importance ranking of the criteria from the highest to the lowest, the Pareto analysis was performed for criteria within each cluster, as shown in Figures 2–8. According to the 80/20 rule, the criteria within the 80% zone can be considered the most significant criteria where it obtained 80% of the importance weight, while the rest of the criteria achieved only 20%. Only the most significant criteria will be considered for the following phases of this study.

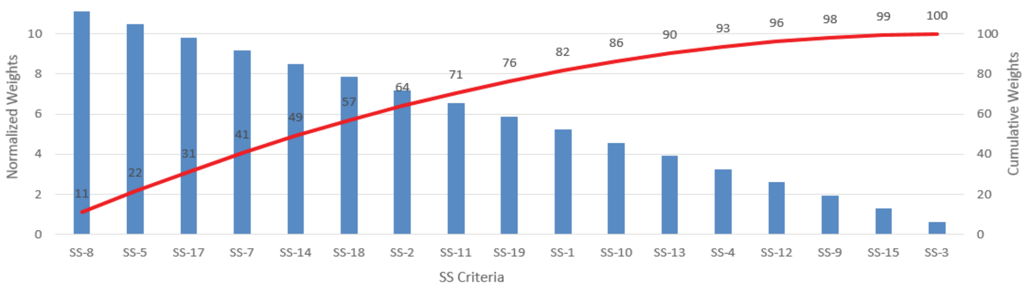

Fig. 2. Pareto analysis of the sustainable sites criteria

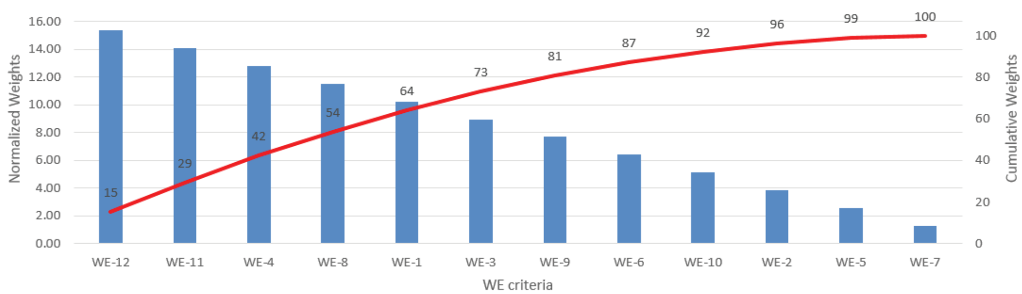

Fig. 3. Pareto analysis of water efficiency and the conservation criteria

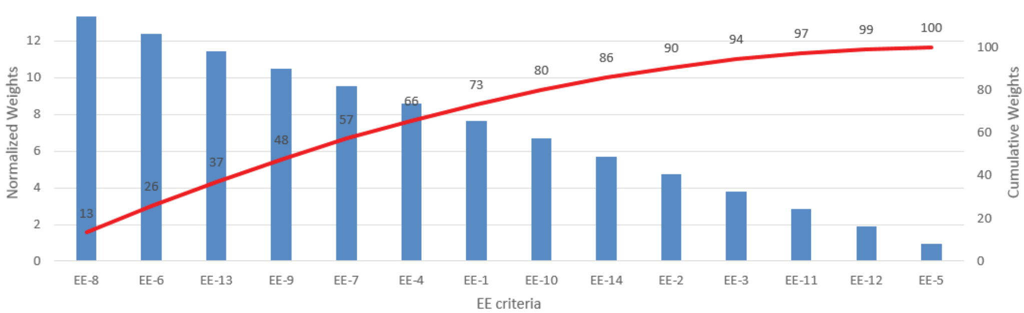

Fig. 4. Pareto analysis of energy efficiency and the conservation criteria

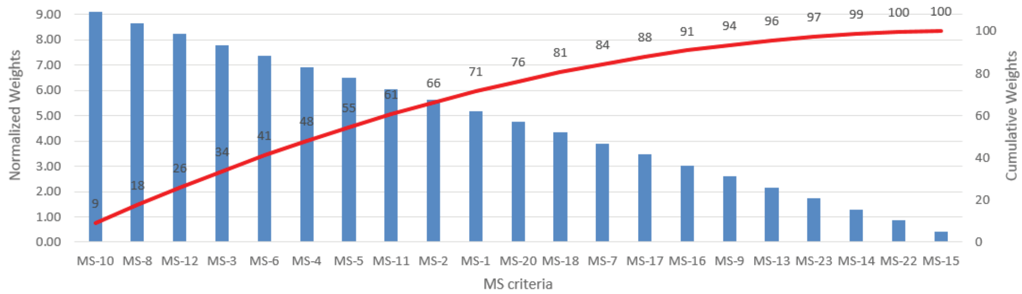

Fig. 5. Pareto analysis of material selection and the recycling criteria

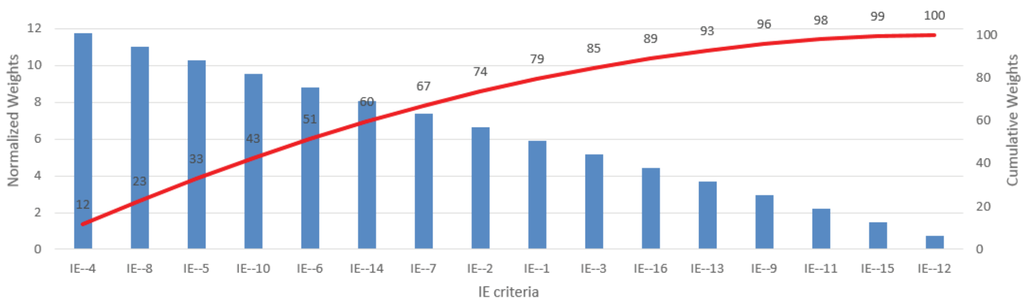

Fig. 6. Pareto analysis of the indoor environmental quality criteria

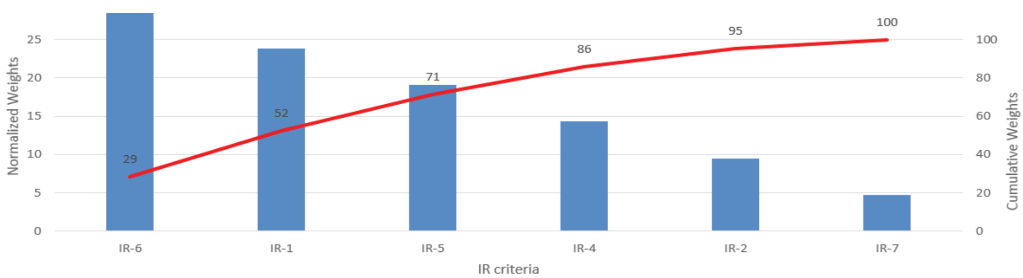

Fig. 7. Pareto analysis of the innovation and regional priority criteria

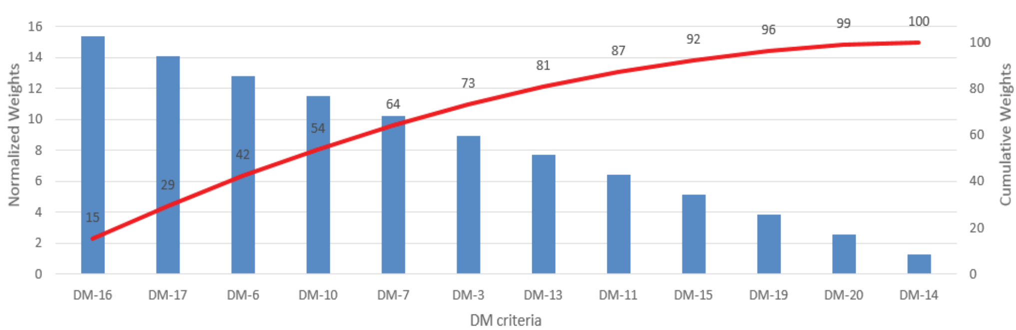

Fig. 8. Pareto analysis of the design and management criteria

SUSTAINABILITY RATING SYSTEM

The market for the design and construction of sustainable buildings is dynamic and evolving. Throughout the building industry, professionals use the assessment rating systems to evaluate their product or design (Fowler & Rauch, 2006). Sustainability rating systems provide a systematic approach for evaluating the suitability of buildings based on specific measures along with their credits. This section proposes a rating system for office and administrative buildings in Saudi Arabia based on the results from the previous sections of this study. The first column in Table 7 shows the most significant criteria in each cluster from the Pareto analysis. The second column in this table presents the modified normalized weights of these criteria, which were normalized again by dividing their previous normalized weights by the summation of their weights. Accordingly, the global weight of each criterion can be calculated by multiplying the new normalized weight of each criterion by their respective cluster weight, as shown in the third and fourth columns in Table 7. After obtaining the global weights for the criteria using Simos' procedure, a rating system for sustainable office and administrative buildings is proposed considering the credits that are listed in the last column of Table 7. The total credit value is 100 credits distributed among the seven clusters (shown in Figure 9) as follows: 17 for sustainable sites, 25 for water efficiency and conservation, 22 for energy efficiency and conservation, 14 for material selection and recycling, 11 for indoor environmental quality, 4 for innovation and regional priority, and 7 for design and management. Five levels of the rating system of office and administrative buildings are proposed to judge the extent of sustainability according to the credits obtained, as shown in Table 8.

Table 7. Global weights and points for sustainability criteria

Clusters Code	Criteria Code	Normalized Weight - Modified	Cluster Weight	Global Weight	Sustainability Credits
SS	SS-8	13.55	17.86	2.42	2.00
	SS-5	12.75		2.28	2.00
	SS-17	11.96		2.14	2.00
	SS-7	11.16		1.99	2.00
	SS-14	10.36		1.85	2.00
	SS-18	9.56		1.71	2.00
	SS-2	8.77		1.57	2.00
	SS-11	7.97		1.42	1.00
	SS-19	7.17		1.28	1.00
	SS-1	6.38		1.14	1.00
				Cluster Credits	17.00
WE	WE-12	19.05	25.00	4.76	5.00
	WE-11	17.46		4.37	4.00
	WE-4	15.87		3.97	4.00
	WE-8	14.29		3.57	4.00
	WE-1	12.70		3.17	3.00
	WE-3	11.11		2.78	3.00
	WE-9	9.52		2.38	2.00
				Cluster Credits	25.00
EE	EE-8	16.67	21.43	3.57	4.00
	EE-6	15.48		3.32	3.00
	EE-13	14.29		3.06	3.00
	EE-9	13.10		2.81	3.00
	EE-7	11.90		2.55	3.00
	EE-4	10.71		2.30	2.00
	EE-1	9.52		2.04	2.00
	EE-10	8.33		1.79	2.00
				Cluster Credits	22.00

MS	MS-10	11.29	14.29	1.61	2.00
	MS-8	10.75		1.54	2.00
	MS-12	10.22		1.46	1.00
	MS-3	9.68		1.38	1.00
	MS-6	9.14		1.31	1.00
	MS-4	8.60		1.23	1.00
	MS-5	8.06		1.15	1.00
	MS-11	7.53		1.08	1.00
	MS-2	6.99		1.00	1.00
	MS-1	6.45		0.92	1.00
	MS-20	5.91		0.84	1.00
	MS-18	5.38		0.77	1.00
				Cluster Credits	14.00
IE	IE-4	14.81	10.71	1.59	2.00
	IE-8	13.89		1.51	2.00
	IE-5	12.96		1.39	1.00
	IE-10	12.04		1.29	1.00
	IE-6	11.11		1.19	1.00
	IE-14	10.19		1.09	1.00
	IE-7	9.26		0.99	1.00
	IE-2	8.33		0.89	1.00
	IE-1	7.41		0.79	1.00
				Cluster Credits	11.00
IR	IR-6	33.33	3.57	1.19	1.00
	IR-1	27.78		0.99	1.00
	IR-5	22.22		0.79	1.00
	IR-4	16.67		0.60	1.00
				Cluster Credits	4.00
DM	DM-16	19.05	7.14	1.36	1.00
	DM-17	17.46		1.25	1.00
	DM-6	15.87		1.13	1.00
	DM-10	14.29		1.02	1.00
	DM-7	12.70		0.91	1.00
	DM-3	11.11		0.79	1.00
	DM-13	9.52		0.68	1.00
				Cluster Credits	7.00
				Total Credits	100.00

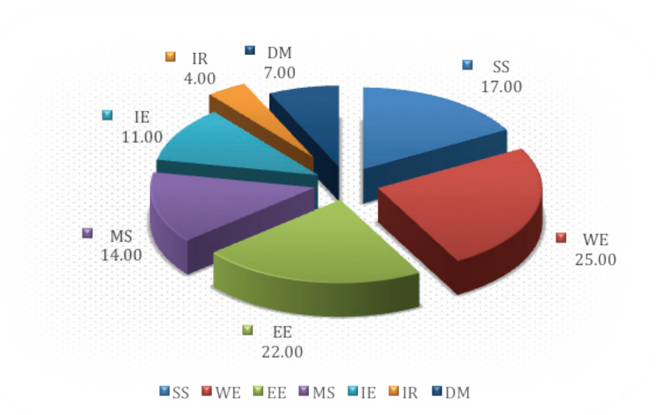

Fig.9. Credits for the sustainability clusters

Table 8. Sustainability rating system levels

Building credits	Building description	Rating
0–20	Traditional Building	One-Star Building
21–40	Low Sustainable Building	Two-Star Building
41–60	Sustainable Building	Three-Star Building
61–80	Highly Sustainable Building	Four-Star Building
81–100	Extremely Sustainable Building	Five-Star Building

Appendix-A shows a brief description and credit points requirements for the sustainability criteria included in the developed rating system. These requirements has been identified through reviewing the related rating systems that had been used for identifying the initial suitability criteria in a previous phase of this study, including LEED, BREEAM Offices, Green Globes, Green Pyramid Rating System (GPRS), and Pearl (LEED-NC, 2009) (BREEAM Offices, 2008) (Green Globes, 2004) (GPRS, 2011) (Pearl, 2010). The requirements for credit points help the assessor (sustainability expert) to judge and give credit on each criterion based on the rating system.

The applicability of the developed rating system has been tested through using this system for assessing the sustainability of administrative building in one of government universities in Saudi Arabia. The building area is 3150 m2. The assessment process has been used the information available in the project's documents, while some other required information has been investigated through personal meeting with the designer. The assessment results are shown in Table 9. The results indicate that the building achieved good credit points in indoor environmental quality, water efficiency, and site clusters, however, the building got moderate and low credit points in other clusters. The total achieved credit points for the project were 51 out of 100 of total available credit points. Accordingly, the building achieves 3 stars out of 6 stars available in the rating system levels shown in Table 8. As a result, the building needs to address the criteria that achieved low credit points to be more sustainable building.

Table 9. Sustainability assessment results of case study

Custer	Criteria	Available Credit points	Achieved Credit points
SS	SS-8	2.00	1.00
	SS-5	2.00	2.00
	SS-17	2.00	2.00
	SS-7	2.00	0.00
	SS-14	2.00	0.00
	SS-18	2.00	2.00
	SS-2	2.00	0.00
	SS-11	1.00	1.00
	SS-19	1.00	1.00
	SS-1	1.00	1.00
	Total	17.00	10.00
WE	WE-12	5.00	5.00
	WE-11	4.00	2.00
	WE-4	4.00	0.00
	WE-8	4.00	4.00
	WE-1	3.00	1.00
	WE-3	3.00	3.00
	WE-9	2.00	2.00
	Total	25.00	17.00

Custer	Criteria	Available Credit points	Achieved Credit points
EE	EE-8	4.00	2.00
	EE-6	3.00	0.00
	EE-13	3.00	0.00
	EE-9	3.00	1.00
	EE-7	3.00	0.00
	EE-4	2.00	0.00
	EE-1	2.00	0.00
	EE-10	2.00	2.00
	Total	22.00	5.00
MS	MS-10	2.00	2.00
	MS-8	2.00	2.00
	MS-12	1.00	1.00
	MS-3	1.00	0.00
	MS-6	1.00	0.00
	MS-4	1.00	1.00
	MS-5	1.00	0.00
	MS-11	1.00	0.00
	MS-2	1.00	0.00
	MS-1	1.00	1.00
	MS-20	1.00	0.00
	MS-18	1.00	0.00
	Total	14.00	7.00

Custer	Criteria	Available Credit points	Achieved Credit points
IE	IE-4	2.00	2.00
	IE-8	2.00	1.00
	IE-5	1.00	1.00
	IE-10	1.00	1.00
	IE-6	1.00	1.00
	IE-14	1.00	1.00
	IE-7	1.00	1.00
	IE-2	1.00	1.00
	IE-1	1.00	0.00
	Total	11.00	9.00
IR	IR-6	1.00	1.00
	IR-1	1.00	0.00
	IR-5	1.00	0.00
	IR-4	1.00	0.00
	Total	4.00	1.00
DM	DM-16	1.00	0.00
	DM-17	1.00	0.00
	DM-6	1.00	1.00
	DM-10	1.00	1.00
	DM-7	1.00	0.00
	DM-3	1.00	0.00
	DM-13	1.00	0.00
	Total	7.00	2.00

Total available credit points	100
Total achieved credit points	51

CONCLUSION

Sustainable development helps to achieve long-term growth in different environmental, social, and economic aspects. Measurement and continuous improvement are vital to ensuring sustained improvements in sustainability performance. Sustainability rating systems provide a systematic approach for measuring the sustainability through a set of weighted criteria. This study developed a sustainability rating system for office and administrative buildings in Saudi Arabia by identifying the sustainability criteria and their credits using the Simos procedure and a Pareto analysis. This system included seven main clusters of sustainable sites, water efficiency and conservation, energy efficiency and conservation, material selection and recycling, indoor environmental quality, innovation and regional priority, and design and management. The results indicate that the water and energy clusters were the most significant clusters for evaluating the sustainability of buildings. Implementing the proposed rating system helps to develop sustainable buildings that reduce water, energy, and natural resource consumption and also to minimize negative impacts on the environment. Mandatory application of the proposed system helps in wide implementation of this system and achieves its desired benefits. Accordingly, it is highly recommended to develop some regulations that ensure compulsory application for sustainability rating system for buildings such as the necessity of getting a specific score for design in this system as a prerequisite for building permit.

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Appendix A- requirements for credit points for sustainability criteria

Custer	Criteria	Credit Points Requirements		Cluster	Criteria	Credit Points Requirements
SS	SS-8	Decrease land development impacts and pollution resulting from automobile use. Provide preferred parking for carpools for 5% of the total parking spaces.		MS	MS-6	Promote the usage construction materials that have a low environmental impact over the full life cycle of the building. Credit can be awarded by demonstrating that the material used achieved this requirement.
	SS-5	Support development of land that is close to networks of public transport to decrease the need for a private automobile, and therefore decrease transport-related emissions and traffic jam. The requirements include locating the building within 400 meters from public transportation.			MS-4	Support the using of rapidly renewable materials as an alternative to long-cycle renewable materials and finite resources. Credit points can be obtained by using renewable materials for 2.5% of total materials.
	SS-17	Maintain remains of historic or cultural interest which are part of or nearby the site. The credit points can be obtained through developing a strategy to ensure do not affect any historic or cultural interest around the building›s site.			MS-5	Minimize impacts produced by extraction and processing of virgin materials by increasing demand for building products that incorporate recycled content materials. Credit points can be obtained by using recycled materials for 20% of total materials.
	SS-7	Encourage use of such vehicles to decrease pollution and land development impacts. The requirements include providing 5% of parking capacity for low emitting vehicles.			MS-11	Credit points can be obtained by choosing reliable products that chemical ingredients in the product are inventoried using an accepted methodology.
	SS-14	Support early analysis of site conditions to inform design. The credit points can be obtained through developing an ecological study for a site.			MS-2	Minimize the demand for natural resources and reduce waste by reusing building materials and products. Credit points can be obtained by using salvaged or reused materials for 10% of total material.

Custer	Criteria	Credit Points Requirements		Cluster	Criteria	Credit Points Requirements
SS	SS-18	To direct development to urban areas with existing infrastructure, maintain habitat and natural resources, and protect Greenfields. The credit points can be obtained through construct the building on a developed site with low community density.		MS	MS-1	Encourage the use of indigenous resources and decrease the environmental impacts resulting from transportation by increasing the choosing of building materials and products that are extracted and manufactured within the region. Credit points can be obtained by using percentage regional materials for 20% of total material.
	SS-2	Decrease the pollution amount resulting from construction activities by controlling some factors such as waterway sedimentation, soil erosion, and airborne dust generation. The credit points can be obtained through developing and implementing a plan for mitigating the pollution caused by construction activities.			MS-20	Credit can be obtained by providing storage for collecting and classifying materials for recycling.
	SS-11	Provide a high ratio of open space to development footprint to enhance biodiversity. The credit points can be obtained through customizing 20% of total building site area for vegetated space.			MS-18	Minimize the long-term environmental impacts associated with construction waste collection, transport, and disposal. The credit can be awarded by providing a strategy for waste management.
	SS-19	Provide private outdoor space that can be used for specific users. The credit can be obtained through customizing a private outdoor space can be used only by specific users.				

Custer	Criteria	Credit Points Requirements	Cluster	Criteria	Credit Points Requirements
WE	SS-1	Minimize the environmental impact from the location of a building on a site and avoid the using of inappropriate sites. The credit can be obtained through do not develop the building on farmland or the habitat lands.	IE	IE-4	Ensure the wellbeing and comfort of occupants by providing efficient ventilation. The credit points can be obtained by designing ventilation system using the ventilation procedure rate defined by an applicable code such as ASHRAE.
				IE-8	Encourage building designs that increase the use of natural daylight indoors. The credit can be awarded by achieving the daylight in 75% of occupied spaces.
	WE-12	Credit can be awarded by ensuring that the quality of drinking water is in accordance with the drinking water standards for Saudi Arabia.		IE-5	Enhance occupant productivity and well-being by providing a comfortable thermal environment. The credit points can be obtained by designing heating, and air conditioning (HVAC) systems to meet the requirements of applicable code such as ASHRAE.
	WE-11	Settle most effective solutions towards water conservation by incorporating passive design strategies as a priority. The credit can be obtained through developing strategies for water conservation.		IE-10	The credit points can be obtained by identifying minimum indoor air quality (IAQ) through applicable standards such as ASHRAE to enhance indoor air quality in the building.
	WE-4	Find and stop the water leak through a leak detection system that covers all main water distribution pipes within the project. The credit can be obtained through providing system for leak detection and easily accessible for the water meters.		IE-6	Minimize the light pollution from the building and site and its associated impacts on a human. Credit points can be obtained by designing the lights to meets the applicable standards.
	WE-8	The untreated water must not affect the local environment. The credit can be obtained through ensuring that the untreated water will not affect the local environment and also through reused treated wastewater.		IE-14	Ensure occupant wellbeing and comfort by reducing contaminants in the indoor air. The credit points can be obtained through providing a strategy for control and minimize the contaminants such as considering some procedures for preventing the growth of mold, bacteria, and fungus.

Custer	Criteria	Credit Points Requirements		Cluster	Criteria	Credit Points Requirements
WE	WE-1	Heighten the water efficiency within the building by decreasing the project's interior potable water consumption. The credit point can be obtained when the building has the ability to achieve a sensible reduction in the consumption of indoor potable water.		IE	IE-7	The credit points can be obtained by a designing system that allows users control of zoned areas within the building.
	WE-3	Support reductions in water consumption by ensuring that the water consumption can be monitored (through water meters) and managed. The credit points can be obtained through providing efficient water meters.			IE-2	Remove or reduce exposure of building occupants to the harmful effects of tobacco smoke. The credit points can be obtained by providing designated smoking rooms.
	WE-9	Supply innovative technologies for wastewater in order to decrease wastewater generation. Supply innovative technologies for wastewater in order to decrease wastewater generation. The credit can be achieved when the building has the ability to treat 50% of wastewater on-site.			IE-1	The credit points can be obtained by ensuring that all sealants and adhesives used in the building comply with the requirements included in applicable codes such as Coast Air Quality Management District (SCAQMD).
EE	EE-8	Specify the best method to reduce cooling demand for buildings. Credit points can be awarded by providing strategies for reducing the heat gain for the building.		IR	IR-6	Credit can be awarded by providing prayers/ Ablution zoning and avoid the development of inappropriate anti-Islamic designs
	EE-6	Encourage the development and use of on-site renewable energy technologies on a net zero pollution basis and thus decrease carbon emissions and atmospheric pollution. Credit points can be awarded by using on-site renewable energy systems.			IR-1	Provide the chance for design teams and projects to accomplish innovative design or construction practices that have a significant measurable environmental benefit. Credit can be achieved through providing innovative design or construction practices that have environmental benefits and not considered by other criteria.

Custer	Criteria	Credit Points Requirements		Cluster	Criteria	Credit Points Requirements
EE	EE-13	Credit points can be awarded by using an efficient HVAC and thus help to ensure energy efficiency without altering occupant comfortability.		IR	IR-5	Credit can be obtained by locating the most efficient solution to decreasing a habits and customs effects on the built environment without altering comfort of occupants.
	EE-9	Decrease demand for energy and consequent increased infrastructure requirements to cater for loads at peak use times. Credit points can be awarded for demonstrating that peak electrical load less than 60-80% of the annual average electrical load.			IR-4	Simplify the provision of adequate separated male and female spaces.
	EE-7	Reduce the consumption of energy by using building energy efficient appliances. Credit points can be awarded for demonstrating that the building uses this type of appliances.				
	EE-4	Decrease environmental and economic impacts associated with excessive energy use by encouraging a further decrease in the projects energy consumption. Credit points can be awarded for demonstrating that there is 10-60% improvement in the building energy performance comparing with the baseline performance that can be calculated by approved standards such as ASHRAE.		DM	DM-16	Credit points can be awarded by providing a plan for protecting the water sources from pollution resulting from building operations.
	EE-1	Minimize environmental and economic impacts associated with excessive energy use by establishing the minimum level of energy efficiency for the proposed building and systems. Credit points can be awarded for demonstrating that there is 10% improvement in the building energy performance comparing with the baseline performance that can be calculated by approved standards such as ASHRAE.			DM-17	Credit points can be obtained by providing a plan for reducing the exhaust emissions and noise from equipment and machinery on site.

Custer	Criteria	Credit Points Requirements		Cluster	Criteria	Credit Points Requirements
EE	EE-10	Encourage the choosing of refrigerants and fire suppression systems that lower impacts on the environment. Credit points can be awarded for demonstrating that the fire systems and refrigerants have an equivalent global warming potential (GWP) meets or less than the law requirements.		DM	DM-6	Credit points can be obtained by ensuring adopting the Integrated Development Process (IDP) to achieve synergy between project systems.
MS				DM	DM-10	The credit points can be obtained by providing a plan for reducing the building impact from air infiltration, water ingress, and improper drainage by ensuring that the building envelope meets the design intent.
MS	MS-10	Credit can be awarded by ensuring not exposure to any hazardous and toxic materials when to use this material in construction.		DM	DM-7	The credit points can be obtained by applying environmental purchasing criteria available on some codes such as National Master Specification (NMS).
MS	MS-8	Credit can be awarded Identify by using of thermal responsibly sourced insulation that has a low environmental impact.		DM	DM-3	Credit can be obtained by providing a management plan for minimizing the environmental impacts resulting from the construction process.
MS	MS-12	Reduce the frequency of use of replacement materials by enhancing the use materials with high resistance to abrasion and minimal costs for maintenance comparing with conventional materials. Credit points can be awarded by proofing that at least 25% of total materials achieve this requirement.			DM-13	Credit points can be awarded by providing site storage areas for separation of toxic and flammable materials and avoiding of soil contamination in these areas.
MS	MS-3	Increase the life cycle of existing building preserve resources, and decrease environmental impacts of new buildings as they relate to transport and manufacturing of materials. Credit points can be obtained based on the percentage of building reuse.				