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Article

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Toward Developing Energy Star Rating Development in Jordan

Majeda Yakhlef[1], Yazeed Yasin Ghadi[2], Ali M. Baniyounes[1]*, Mazen Alnabulsi[1], Eyad Radwan[1]

[1]Department of Architecture and Electrical Engineering, Applied Science Private University, Jordan, [2]Software Engineering and Computer Science, Al Ain University of Science and Technology, UAE. *Email: al_younes@asu.edu.jo

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ABSTRACT

The objective of this article is to provide an efficient means of enforcing green building in Jordan, the Middle East. The paper is proposing assessment tool of Energy Star Rating Scheme and also explaining its role for achieving sustainable development during buildings lifecycle and hence reducing energy and water usage. The scheme development will remove considerable environmental, social and economic issues as Jordan is a country that renowned for its poor energy and water resources. The article provides technical aspects, means, technologies and processes for proposing and implementation green star ratings for buildings. The star ratings are based on integrating renewable energy technologies, water recourses and its consumption management and waste recycling and its management throughout the buildings' life cycle including its design, installation and operation.

Keywords: Energy Star Ratings, Energy and Water, Sustainable Energy, Environment
JEL Classifications: K32, O13

1. INTRODUCTION

In Jordan, buildings and building's sector including domestic and commercial buildings is responsible for large portion of energy consumption. Energy consumption in buildings consumes up to 40 of total energy usage around the globe Baniyounes et al. (2012) and this is expected to increase by almost 20% in the next two decades as announced by Fumo and Biswas (2015). buildings heating, ventilation, and air conditioning (HVAC) is the biggest energy consumer which accounts for almost 35% of total energy consumption within building Kordjamshidi et al. (2005) and this is due to the increase in using energy in residential buildings. The previous fact is show how it is necessary to look for energy efficient architectural design and development which is based on renewable energy and passive energy harvesting techniques. After fuel sore prices researchers have emphasized the obligation of sustainable and energy efficient development in order to lessen energy usage and also minimizing its negative impact on the environment by reducing greenhouse gas (GHG) emissions. Accordingly, priority and advantages are always provided to energy efficient design and development in both residential and commercial buildings sector.

Nowadays there are significant numbers of computer aided software and programs are used to project, evaluate and estimate energy usage during design phase. Those software packages are used in order to determine best scenario possible of design that used minimum energy such as revit, three dimension (3D) studios and etc. In this article, buildings energy star ratings (BESR) is highly encouraged and recommended to be developed and used extensively specially when obtaining buildings permit and necessary licensing of operation as this will force developers and stakeholders to save energy and force sustainable designs throughout the country taking into account here that the software packages and computer programs are built in a way that it does meet the country codes and policy in regards energy and energy consumption and hence its negative impact on the environment which is represented by GHG emissions.

A standard BESR is able to supply necessary data and information about buildings' sustainable and energy efficient design and its level (how efficient or how sustainable is the design) for example a one-star rating is a building that achieve minimal energy efficiency design requirement and 6-star rating is the building design that it does consider all requirements of energy and sustainability requirements design. In short, the star rating task will be carried on by assessing energy efficiency compared to standard buildings design and development also the system will be able to compare between buildings in regards of its gross energy and water usage necessities.

Consequently, an efficient buildings' star rating scheme will inspire architects, developers and designers to focus on energy efficiency and sustainability in their design, and to take advantages of renewable and passive harvesting and preserving techniques which currently without compromising indoor thermal comfort and indoor air quality (IAQ).

Throughout literature there are a numerous amount of research, articles and activities including websites development. Worth mentioning have publish an article in regards how architects and designer have better understanding on energy efficiency and the sustainable measures and conservation Shaikh et al. (2017). Also Zuo et al. (2017) has developed a star rating guides for concrete buildings. In addition, Illankoon et al. (2017) have showed an important about green buildings evaluation from life cycle view.

Jordan is classed between those countries with minimal energy and water resources and hence lowest per capita base. The situation is getting worse due to demographic growth as a result of refugee flux from neighboring countries e.g. Syria and Iraq the situation is expected to get poorer. The scarcity of energy recourses in Jordan is the country most significant restrains and challenge as the country's growth and development is absolutely depends on energy availability and hence very important factor of economic improvement. However, the most of research activities hardly mention the situation in the Middle East specially Jordan. Accordingly, this article will discuss and propose a new building, star ratings which is based on energy efficiency, water management, waste management and sustainability.

The main intention of this research study is to evaluate the suitability of buildings by applying star rating schemes in buildings. This rating is evaluated based on the installation, operation, consumption and monitoring of energy, water resources and waste management data. Knowing that, green or sustainable building is buildings that consider certain criteria and techniques are integrated in buildings which conserve energy, water resources and waste management, building architecture, landscaping, maintenance and housekeeping in order to guarantee sustainable future. These criteria and techniques will include sustainability measure on buildings planning, design and installation, buildings architecture including nature and location, water and energy resources, the usage of renewable and passive technologies, and related GHG emissions.

2. DEVELOPMENT OF BUILDINGS' ENERGY RATING EVALUATING SCHEME

Buildings energy rating evaluating scheme is a basic measure that assess energy efficiency of newly constructed or existing building and its associated GHG emission. The assessment basis is including energy will be used by lighting, HVAC, water pumping and firefighting system and also its associate cost, emissions and its projected efficiency. BESR are applied widely and effective in various countries such as Australia and New Zealand Le et al. (2018). BESRs are constructed to project energy consumption and its GHG requirements in order to issue a certificate. Overall BESRs are regarded whilst looking for an optimum objective in order to reduce energy consumption and its related standards throughout applying sets of energy efficient tools and scenarios. These tools are regarded as inclusive environmental evaluation scheme such as BREEAM (United Kingdom) BREEM (2019), GBTool (Canada) Gu (2018), leadership in energy and environmental design (LEED) (US) LEED (2019) and etc. the previously mentioned bodies assessment tools and scenarios are based on life cycle analysis and for the buildings' sectors. The majority of these processes have intended to be utilized for the process of choosing and deciding buildings' design, materials, energy supply and resources including renewable energy, waste management including recycling and transport Ali and Al Nsairat (2009). In addition to the previously mentioned bodies there are a significant number of software and computer aided tools applied in this field such as EnergyPlus, TRNSYS, REVET, 3D studio, and etc.

The most of those software packages utilize factual models, in a way that the buildings data and its technical specifications are evaluated digitally and then added on and implemented in a mathematical model in order to simulate the buildings' indoor thermal and visual comfort Kordjamshidi et al. (2005). Also, all information and data about the local climatic are utilized and modeled and then its effect on the building climate and its energy usage can be evaluated and computed based on projected conditions and activity so indoor occupation density and indoor activity are both considered. The local governmental and unions authorities in Jordan are all invited to develop BSERs and enforce this BSER in all future design and developments. Currently there are a wide range of buildings' energy and water usage easement tools are existed. Those tools are ranged from simple tools to very sophisticated ones that able to simulate the whole of the building and hence virtual reality simulation tools.

3. BUILDINGS STAR RATING STRUCTURE

Globally, the common method of buildings' star ratings index is based on energy usage, energy efficiency, water usage and water recycling and waste management. This rating index will mostly depend on energy usage. Commercial buildings use the most of energy in every single local markets taking into account that, more than 40% of this energy is used by buildings, HVAC system Baniyounes et al. (2013) taking into account here that index completely depends on the conditioned space gross area and its volume. It has been reported by Lo (1995) that smaller areas and volume is the main factor of HVAC systems energy usage. One of the reasons behind the previously mentioned fact that the buildings' envelop and volume ratio as small buildings have bigger ratio Kordjamshidi et al. (2005). In addition Giridharan and Emmanuel (2018) have reported that contents and textile heat flux per floor area unit is higher in small houses than big ones. According to Mattoni et al. (2018) and Giridharan and Emmanuel

(2018) the buildings' cooling load conditions of bigger buildings with higher energy star ratings e.g. 5-or 4-star rating were found to be significantly lower to buildings with low 3-star ratings, which becomes lately applicable in too many countries around the globe.

3.1. Buildings Sustainable Design and Planning

With the intention to reduce the effect of buildings development negative impact on the environment and local areas, several policies and recommendations were developed as a guide for ERES such as segregation of buildings' by constructing and installing dust filter around the construction site area in order to avoid the environment air pollution and the spell of contamination resulted from construction. In addition, good quality soil should be dig out, and stored in order to preserve it outside the concerned buildings' construction site. Additionally, and in order to protect trees, a loss control mechanism must be implemented also trying the best possible way to keep around the construction site safe. Also, ERES must seek the increment of buildings' structural strength meanwhile and minimizing heat effect that will be caused by hard pavement and concrete usage throughout buildings. It is worth mentioning her that Vyas et al. (2014) have advised that gross paving throughout newly constructed buildings should not exceed more than 17%, also not more than 50% of the pavement areas protected by sun blockers and trees. ERES also must mind irrigation water so it should also be reduced to around 50%.

3.2. Energy Conservation

Buildings' energy conservation is defined as the all sort of activity that has been made in order to minimize energy consumption in buildings. This could be done throughout the buildings by consuming energy efficiently meanwhile keeping in mind lowering the volume of required services expected to be used such as reducing HVAC and lighting load. Energy conservation minimizes the usage of fossil fuel and also minimize its negative impact on the environment. Additionally, it lesser buildings' operational cost by cutting off fossil fuel energy costs. Moreover, energy conservation can be achieved by minimizing waste and reducing energy losses, developing energy efficient technical systems, its maintenance and operation.

3.3. Renewable Energy Technologies

Renewable energy technologies that can be used within buildings' applications and systems are solar energy includes thermal and photovoltaic, wind energy, geothermal energy, as well as bio-mass energy. In order to select proper renewable energy system to operate to existing building or to newly designed or constructed building, it is significant to investigate various existing conditions e.g. technologies market availability, available renewable energy resources, the technologies' required space and available space for technologies' within the building, energy cost from author providers, tax and incentives availability based on using renewable energy technologies, buildings' aesthetics and its unique architectural features.

3.3.1. Photovoltaic systems (PV)

PV panels are a technology where the sun radiation is converted into electricity. In PV systems, solar panels are connected together to make up what called solar modules. Next solar modules are connected together to form what called solar arrays where they can be mounted on buildings' roof or round it as shown in Figure 1 Sousa et al. (2019). A power inverter converts the direct current generated by the system into grid-quality alternating current electricity.

3.3.2. Solar thermal energy

The production of hot water and hot air using the sun power are economic, cost-competitive and environmentally friendly technique where there is no need for electricity or conventional fossil fuel for the production process.

Whether heating water or air, the heat is produced by solar collectors where the heat is absorbed by those collectors and then is transferred the heat to air or water. In some cases, especially when heating water, the hot is then is stored in a tank until used. The previously mentioned systems are classified upon the output temperature namely low collectors' temperature e.g. Flat plate collectors where output is ranged from 50°C to 90°C, medium collectors' temperature e.g. evacuated tube collectors where output is ranged between 90°C and 250°C and high collectors' temperature e.g. open trough collectors where output is above 250°C. Despite the high temperature of the open trough collector's temperature, the most suitable collectors in buildings are flat plate collectors and evacuated tube collectors as shown in Figure 2 Mesthrige and Chan (2019).

3.3.3. Other renewable energy recourses

The other renewable energy recourses that can be are including wind energy and bioenergy. Wind energy is generated by equal heating of the earth's surface by the sun creating wind current. The wind current which comes in the form of motion or motion energy, can be exploited by wind turbines generating electricity using rotating blades. However, installing wind turbine in the top of buildings require mega structure requirements as well as big acoustic protection requirements due to the blades noise during movement accordingly using wind energy is not common.

Bioenergy depends on organic materials e.g. as plantations, excess from farming, agriculture and forestry, as well as the organic matters of metropolitan including manufacturing wastes which normally utilized in order to generate fuel, and thus energy. Using bioenergy within buildings is possible but, the process requires big capital that will increase the cost on stakeholders.

3.3.4. Mechanical ventilation versus natural ventilation of buildings rating index

Naturally ventilated buildings main advantages are to reduce energy consumption while improving IAQ. IAQ mainly depends on using and circulating outdoor fresh air inside building. The more of fresh air is used and circulated, the better is IAQ. Buildings' natural ventilation performance is mainly depending on various conditions such as winds' speed and winds' direction, mostly round reference buildings causing what known as microclimate change Hang et al. (2012). If a new large-scale tower is placed amongst a large city of low-rise buildings, the effect of the new building on the UHI, on the wind in the street and the structure of the lapse rate of temperatures is problematic. This paper is exploring what the literature can tell us on this subject Hayter and Kandt (2011).

Figure 1: Applied science private university solar roofs (Faculty of Engineering)

Figure 2: Evacuated tube collectors

3.3.5. Water management and conservation

Water and water availability are a prime element for mankind survivor and his existence as well as people important several interests around the globe. Jordan as a country is renowned for water scarcity which mandate the importance of water portable water generation and the possibility of its recycling and thus, this will lead to reduction in energy usage and also reduction of GHG emissions and its negative impact on the environment. The previous highlighted fact makes water usage conservation and management including its recycling a very important factor of sustainable development and its assessment.

Buildings are a big water consumer which accounts for about about 16% of freshwater usage. Consequently, enormous weight is set to water usage, conservation, management and efficiency as the at most sustainability buildings rating factor around the globe. Consequently, there are enormous buildings' sustainability evaluation indicator tools Sousa et al. (2019). Water sustainability indicators concentrate on various fields of buildings' sustainable developments also they are planned to fit most of existing developed buildings or newly constructed ones Mesthrige and Chan (2019). An example of those water sustainability indicators or rating schemes are Building Research Establishment (BREEM) Environmental Assessment Method which was established in the year 1992, followed by LEED which was initiated in the United States of America in the year 1996 and as well the establishment of Green Star Australia in the year 2003 and etc.

3.3.6. Waste management

Sustainable buildings as well as renowned for their environmentally friendly and green structuring in addition to its consumables resources waste efficient management during the buildings' life-cycle which range from between the design process, construction and installations, readiness and operation, scheduled and emergency maintenance, after words renovation, and usable waste and its management. Nowadays the environment problems and the distress for sustainability is inspiring efficient consumption and management of energy, water and consequent waste management, to guarantee the avoidance of any type of waste, implement environmentally reasonable and economic as well as environmentally friendly building's execution including its design, the process of construction and required operation.

4. CONCLUSION

This study has proposed initial ratings regarding buildings' energy, water resources and waste management, building architecture, landscaping, maintenance and housekeeping status in order to encourage more sustainable and green building in Jordan, the Middle East.

The purpose of buildings green star ratings is to encourage the development of the global built in environment regarding sustainability and environmentally friendly installations given significant priority to energy, water resources and waste management, building architecture, landscaping, maintenance and housekeeping status of buildings. The study has highlighted the base that should be implemented in sustainable buildings and thus its evaluation based on energy including the utilization of renewables, mechanical and natural ventilation, water management, and waste management. In addition, this study provides the at most aspects of all designs of green and sustainable buildings developments and its ratings in Jordan.

Introducing criteria for star green buildings' ratings will significantly push through towards enhancing an improve buildings' energy and water management performance and hence reducing nonenvironmental friendly GHG without comprising indoor and outdoor comfort condition in order to save energy and water.

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