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Comparative Analysis of Building Rating Systems and Occupant Rating Systems

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Abstract

To begin with, rating systems are a beneficial tool in determining the efficiency of a building's ability to utilise its resources effectively. In this study, the two elements under comparison are the Building Rating Systems (BRSs) and Occupant Rating Systems (ORSs). The main objective of this paper is to be able to examine the most commonly applied international and national BRS and ORS and, based on that, discover the possibility of developing an integration of both the BRS and ORS into one rating system. Quite simply, a BRS is a method by which buildings are assessed and given a score based on numerous features such as the efficiency of each of the services, total energy consumption, and alternate options of consumption. There are various BRSs that are implemented globally, each with its own set of criteria and specifications. Thus, based on the analysis of the benefits and drawbacks of both types of rating systems, it could be deduced that a well-rounded rating system with all technical and non-technical aspects combined would be beneficial to both the efficiency of the building as well as the building occupants' health and well-being.

Keywords

Building Rating Systems, Energy Efficiency, Net-Zero Buildings, Occupancy, Rating Systems, Renewable Energy Technologies

1. Introduction

To begin with, rating systems are a beneficial tool in determining the efficiency of a building's ability to utilise its resources effectively. Not only are rating systems beneficial in providing a rating for a building's efficient use of energy sources, but it is beneficial in also providing building users, owners, or even managers a way of identifying various methods to curb a building's energy consumption in

ways the building users may have never considered; this is a preventative technique. In brief, it is the careful analytical comparison of the technical-proposed guidelines that define a building's sustainable characteristics. In this study, the two elements under comparison are the Building Rating Systems (BRSs) and Occupant Rating Systems (ORSs).

There are certain factors that affect the relevance or suitability of the type of rating systems used to guide a building's energy performance; these include: the building's function, region (*i.e.* inclusive of both weather and cultural factors), climate, daily profile, number of occupants, as well as requirements (e.g. required electricity supply during certain occupancy hours, accurate lighting levels appropriate for certain room conditions, etc.).

Before discussing the different types of rating systems, it is essential to understand how exactly such rating systems are used. Quite simply, a BRS is a method by which buildings are assessed and given a score based on numerous features such as the efficiency of each of the services, total energy consumption, and alternate options of consumption. This score or rating can be given throughout the design phase of the building, construction phase, operational phase, or all 3 phases. This is accomplished by means of establishing a unique set of tools and building service performance standards [1].

However, for ORS, priority is given to occupant comfort and behavior. The guidelines set by ORS tend to revolve around building features that would focus on the occupant by addressing concepts such as movement within the occupant's space, acoustic nuisance, thermal comfort, community, etc. Furthermore, there are common elements between BRS and ORS, it's clear that BRS focuses primarily on building efficiency through reduced resource consumption, while ORS essentially focuses on the well-being of building occupants.

With that, it is important to note that, to this day, most countries in the MENA region have applied either a BRS or an ORS for their buildings separately. At the moment, there are no buildings that have integrated both types of rating systems; hence, by proposing a set of guidelines that integrate both components, the building and its occupants would essentially benefit from both strong suits of a BRS and an ORS.

2. Objectives

The main objective of this paper is to be able to examine the most commonly applied international and national BRS and ORS and, based on that, discover the possibility of developing an integration of both the BRS and ORS into one rating system. Furthermore, the paper will evaluate and analyse the components of the most commonly applied international and national BRS and ORS, highlighting their respective strengths and weaknesses.

3. Building Rating Systems

Firstly, it is important to understand and define the essence of a BRS. According

to the U.S. Green Building Council (USGBC), a BRS "provides a framework for healthy, highly efficient, and cost-saving green buildings" [2]. There are various BRS that are implemented globally, each with its own set of criteria and specifications. Each BRS has its own type of standard, attributes, managing organization and areas of focus. For instance, most BRS including LEED, Green Pyramid, Tarsheed, Estidama and the Living Building Challenge are considered multi-attribute BRS (*i.e.* multiple building components are assessed).

The most applicable and efficient BRS is one that, not only contemplates the overall carbon footprint, but also takes into consideration all the components the components pertaining to the local energy industry; this includes considering building energy, transport, agriculture, conservation, regulations, electricity, water use and Renewable Energy Technologies (RETs). The three pillars of sustainability are composed of economic, social, and environmental factors. However, energy is a key aspect of the broad term, sustainability. The areas of considering energy in buildings comprise conservation, end uses, regulations, and sources. These four areas form the foundation of opportunities to reduce energy demand in buildings and the instruments used to drive uptake of these within the industry.

To be specific, energy standards are a measurement by which a building's energy consumption is compared with the appropriate standard or guide. This energy usage analysis of the building gives the users insight on how to, ultimately, improve the way in which energy is consumed through methods the building is capable of. In fact, by taking different recordings and measurements of buildings energy consumption (e.g. lighting, HVAC, electricity, etc.), not only will the building be rated amongst other buildings within the same division, but building users will also realise the building's full potential to reduce energy consumption; a feature that remains unknown unless energy benchmarking is performed [1].

In Egypt, a variety of BRS are implemented; the rating system that is typically applied with North-American Standards tend to be the LEED rating system, which is also referred to as the Leadership in Energy and Environmental Design [2]. The LEED rating system is a credit-based scale ranging from 40 - 49 points, which result in a certification, to 80 points and above, which result in a platinum certification [3].

Consequently, Tarsheed is a BRS that is implemented in Egypt by Egypt Green Building Council (Egypt GBC). The Tarsheed BRS offers building users adequate guidance on the ways in which water and energy consumption (among various other elements), could be mitigated and controlled [4]. While Tarsheed considers similar building components to LEED, it remains unique in its overall focus to assess three important categories: energy, water and habitat. In doing so, the benefits of implementing Tarsheed include reducing the building's CO_2 footprint, reducing cost of consumption, promoting a sustainable environment for building users and even encouraging better operational efficiency of all building types (this includes new and existing buildings) [5].

Similarly, the Green Pyramid Rating System (GPRS) is another BRS that is implemented in Egypt in 2009. This BRS was developed by the Housing and Build-

ing Research Center (HBRC) with the main aim of achieving Egypt's goals for the 2030 vision [5]. The BRS was meant to incorporate the local lifestyle and community in its technical feasibility and economic practicality.

In the UAE, the Green Building Regulations (GBRs) are energy related standards that are implemented in Dubai, while the Estidama Pearl Building Rating System (PBRS) is implemented in Abu Dhabi. While, the GBR tend to be more generic this may be due to the innovation or recent introduction of the regulations [5]. However, the GBR are more relevant to the region in comparison to other codes such as ASHRAE or CIBSE. Hence, it is inferred that, with time, the uptake and implementation of GBR will ameliorate building performance as well as become an industry norm or trend. Despite this, the PBRS is becoming acknowledged more and more due to its sustainability rating scale range from "1 pearl", meaning the building has achieved minimum energy requirements; to "5 pearls" is an over-achieved rating [5].

Consequently, Living Building Challenge, a BRS developed and implemented by the International Living Future Institute (ILFI) in 2006, meets similar objectives [6]. The most unique selling point of the Living Building Challenge, however, is its recognition for implementing more stringent ORS in an attempt to achieve net-zero in the built environment. Of course, net-zero includes, but is not limited to, ensuring that all building materials are free of toxins and the overall energy and carbon footprints of the building in question is mitigated greatly [6]. The main performance measures involved in the Living Building Challenge include beauty, energy, equity, health and happiness, place and water [6]. The Living Building Challenge attempts to change the way we look at planning and building as a chance to significantly enhance the broader community of the built environment and our local societies' social structure.

4. Occupancy Rating Systems

To begin with, the idea of occupant health and wellbeing are quickly gaining popularity as critical components of building initiatives. The trend reflects emerging worries about the contemporary workplace's influence, as seen by a latest study linking office surroundings to workforce health and performance. Therefore, a variety of long-standing BRS have included health and wellbeing concerns into their criteria through time, awarding certification points for resources and materials that provide demonstrated health benefits when compared to similar more conventional products.

As a matter of fact, as more organisations strive to enhance labour performance while lowering expenses, worker health and wellbeing has now become a major focus. Nevertheless, it was found that well over 90% of the over HR professionals polled believed that workers' personal wellness has a substantial influence on their organisational commitment [7]. Additionally, the most workers stated that elements such as worker well-being and health are crucial aspects of their corporate objectives, with over 93% citing worker well-being as a priority for

HR targets [7].

That being said, it is important to be able to identify the components of an ORS that have a direct impact on worker health and well-being. These components include air quality, lighting, thermal comfort and interior layout and furnishings. To be specific, a component such as air quality includes the movement and circulation of air both outside and inside the building as well as mitigating the existence Volatile Organic Compounds (VOCs) among other pollutants [7]. With that, lighting refers to the exposure to artificial and natural light, the light levels in different spaces and lighting technologies (this component could affect occupant eyesight or have photobiological impacts) [7]. Furthermore, the thermal comfort component pertains specifically to humidity level or temperature range (which impact occupant productivity if uncomfortable) [6]. Finally, interior layout and furnishings refer to the walkability, acoustics, material toxins and furniture arrangement, which refers to the potential for occupants to have Sick Building Syndrome (SBS), ergonomic furniture, etc. [7].

With that, there are ORS that are developed specifically with the aim to ameliorate occupant health and well-being in buildings. For instance, WELL, Fitwel, and CASBEE are all different international ORS that center their focus on occupant health and well-being. Of course, each ORS has a different approach to achieve the same goal.

First of all, WELL is one of the world's most renowned and fast-growing ORS that is managed and developed by the International Well Building Institute (IWBI) [8]. Technically-speaking, WELL focuses on analysing 11 components of the built environment. This includes assessing air, community, innovation, light, materials, mind, movement, nourishment, thermal comfort, sound and water. At the same time, the WELL ORS is performance-based; this approach is useful in for assessing, certifying, and monitoring aspects of the built environment that may impact occupant health and well-being [8]. For example, WELL also takes into consideration occupants' diet, exercise, mood, sleep habits, and performance are all aimed towards preventing chronic illnesses [8]. WELL also provides interesting possibilities to lead by example in a domain that is quickly evolving. Whether that's to recruit the finest workers, gain a competitive edge, or demonstrate commitment to such a critical problem, being WELL certified is a primary topic of interest for several businesses.

Moreover, the Comprehensive Assessment System for Build Energy Environment Efficiency (CASBEE) is an international ORS that is implemented in Japan by the Japan Sustainable Building Consortium (JSBC) in 2004 [9]. Additionally, in over 24 Japanese districts, obtaining a CASBEE certification has become a requirement [9]. In fact, in 2014, CASBEE expanded worldwide with the certification of a building in Tianjin, China [9]. It is known that resources and energy efficiency, as well as interior and exterior environments, are the emphasis of this curriculum. Thus, CASBEE was developed to minimise resource consumption throughout its life cycle while also enhancing occupants' lifestyle as well as the broader community.

Finally, through a client internet platform, Fitwel promotes wider acceptance of wellness measures. It thus occurs at a point where, in due to higher occupant demand, health is now particularly essential to building managers and planners [9]. Fitwel is rapidly expanding, with an ever-increasing outreach in the number of citizens and communities, this is a result of the community's common goal to achieve a healthier and more sustainable way of living. With a main focus on external and internal spaces as well as spatial layout and walkability, Fitwel aims to enhance daily lifestyles in workspaces and at home.

It demonstrates where the selected BCSs' ability for improving certain issues lies, and as a result, it gives meaningful information for the evolution of the BCSs. For the measurement of occupancy information, a large number of studies have been conducted. For instance, there are several elements that are assessed and measured to collect the relevant data. For example, measuring techniques include the use of various sensors, particularly image/video-based approaches.

5. BRS versus ORS

Now, after understanding and defining BRS and ORS separately, it is important to be able to establish their major differences and identify the components both rating systems have in common. The major goal of this study is to determine whether issues connected to occupant health and well-being are covered in certain BRS and ORS that engage with the sustainability of previously built structures, what the themes explicitly pertain to, and how they are interpreted. This also aids developers in deciding to choose whether or not conduct optional certification, which assesses an existing building's health and well-being of its inhabitants. It is important to clearly identify the similarities and differences of BRS and ORS; this is further demonstrated in Figure 1.

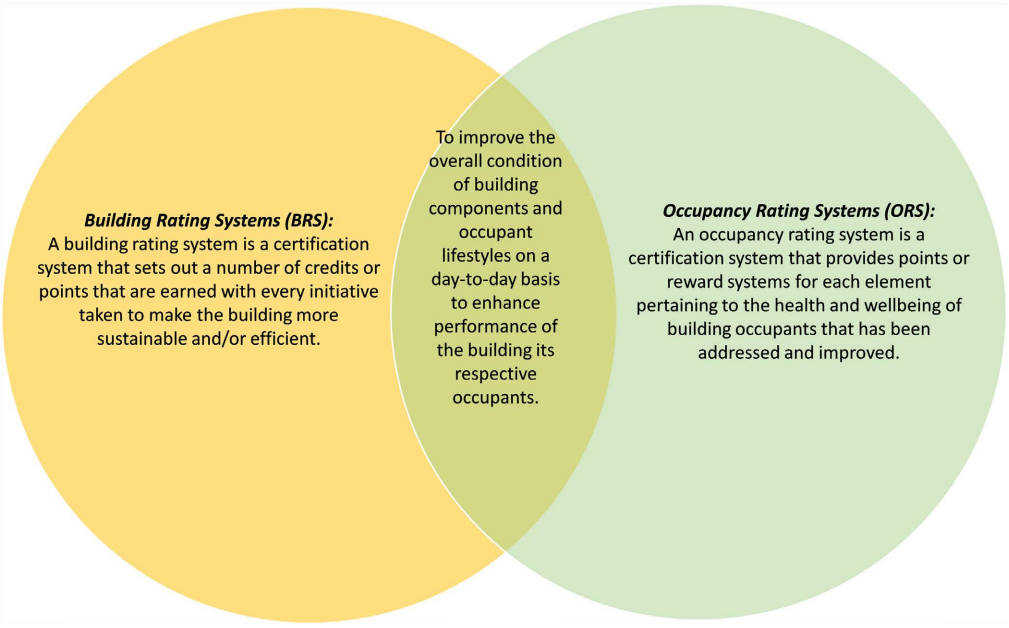

Figure 1. The definitions of BRS and ORS as well as the main attribute that is similar in both cases.

While there are some common factors between BRS and ORS, there is yet to remain an international rating system that integrates both rating systems' components to consider the technical aspects of the building as well as the health and well-being of building occupants. On one hand, a conventional BRS aims to implement a quantitative and more technical-based scoring system that aims at analysing elements such as—but not limited to—the energy and water efficiency of buildings. On the other hand, while an ORS has a similar purpose (*i.e.* to make a building more sustainable), its approach is different in that it focuses more on the health and well-being of building occupants in a more qualitative methodology. Thus, it would be ideal to develop a unique rating system that applies both components instead of applying a BRS and a ORS to each building separately.

6. Cross-Comparison of BRS and ORS Components

There are several different ways in which all standards can be compared. However, it is essential to identify the similar categories in which all standards can be compared. For instance, on a general note, HVAC, electrical, water, and construction material standards tend to have the highest emphasis on a building's energy consumption and efficiency. For that reason, these categories dominate the highest amount of guidelines in all BRS.

As shown in **Table 1** and **Table 2**, there is a set of parameters that are specific to BRS and ORS, respectively. Basically, all ORS have many components in common with some unique differences. For example, while LEED involves developing infrastructure, CASBEE, Fitwel and WELL systems are more concerned with the occupant health and well-being and the built environment. The only main concern with CASBEE is that its ORS incorporates a lot of the social and cultural building lifestyles in Japan, which may not necessarily be practical outside of Japan [10]. The Fitwel approach is quick, affordable, transparent, straightforward, and more practical than WELL, which delivers greater performance levels and increased competitiveness with a much more sophisticated approach at a greater cost that could be viewed as an impediment for certain applications [10]. Of course, it's great news for clientele with large portfolios or anyone who doesn't have the funds or time to go through the entire WELL certification procedure but still want to promote healthier workplaces.

More specifically, in **Table 2**, it is clear that while most of the parameters seem qualitative as the components mainly pertain to the health and well-being of building occupants, other parameters could be quantified. For instance, components such as beauty, mind, nourishment, mainly involve building aesthetics, ease or comfort of mind, and having healthy means of sustenance, respectively. On the other hand, there are a variety of components that are measured quantitatively. For example, thermal comfort could be measured in terms of Clothing (CLO), Basal Metabolic Rates (BMRs) of occupants, and average indoor temperature (˚C) ranges. Also, Indoor Environmental Quality (IEQ) is measured in terms of

Table 1. The different components of the BRS from LEED, Estidama Pearl Building Rating System, Green Pyramid and Tarsheed.

Building Standards Building Components	LEED	Estidama	GPRS	Tarsheed	Living Building Challenge
Community					
Energy	✓	✓	✓	✓	✓
Habitat				✓	✓
Health and Wellness					✓
Indoor Environmental Quality	✓		✓		✓
Integrated Development Process		✓			
Innovation	✓	✓	✓		✓
Light					✓
Liveable Buildings: Indoors		✓			
Liveable Buildings: Outdoors		✓			
Location	✓				✓
Management			✓		
Materials	✓	✓	✓		✓
Mind					
Movement					
Natural Systems		✓			
Nourishment					
Sound					
Sustainable Sites	✓		✓		
Water	✓	✓	✓	✓	✓

contaminants of pollutants in the air. Additionally, light is measured in lux level that is relevant to the space type (*i.e.* work spaces would have higher lux levels than washrooms or storage facilities). While energy and water components are either non-existent or very limited in the ORS, these two components are generally measured in kWh and liters for the consumption within the building. These are the ways in which ORS components could be quantified—or, if not—deemed qualitative.

With that, it is important to establish a set of specified factors that considers

Table 2. The different components of the building rating systems from Well, Fitwell, CASBEE and the Living Building Challenge.

Building Standards Building Components	WELL	Fitwel	CASBEE
Beauty		✓	
Building Access		✓	
Community	✓		
Energy			✓
Entrance		✓	
Emergency Procedures		✓	
Health and Wellness	✓	✓	✓
Indoor Environmental Quality	✓	✓	✓
Light	✓		
Location	✓	✓	✓
Materials	✓		
Mind	✓		
Movement	✓		
Nourishment	✓		
Outdoor Spaces		✓	✓
Sound	✓		
Stairs		✓	
Resources			✓
Thermal Comfort	✓	✓	✓
Vending Machines and Snack Bars		✓	
Water	✓		
Workspaces/Shared Spaces		✓	

the components of a successful NZB. First of all, one factor that is crucial to establishing a well-planned NZB is cost-efficiency, which involves the overall financial investments and expenditure throughout the entire process of the rating

process. Another factor includes resources, which entails the material's lifecycle, in terms of carbon footprint (*i.e.* considers waste, energy, water, materials, etc.), as well as availability of local building materials [11]. Additionally, feasibility is crucial in assessing the ability to make NZBs common as opposed to being exceptions. Furthermore, practicality is essential in the analysis of reason behind the implementation of the relevant building rating systems on NZBs. Also, an underrated factor is innovation; the new and unique component that makes the building rating system stand out amongst others. Consequently, simplicity is key to ensuring the user-friendliness of applying building rating systems to NZBs, from implementing the rating system to officially certifying the NZB. Finally, approaching Net-Zero is, potentially, the most important factor among other factors in that it evaluates the components of a building rating system that pave the path to developing NZBs.

Of course, the above-mentioned components for each building rating system will be analysed further through a set of criteria that would help to decide the strengths and weaknesses of each building rating system. These set of criteria could be filtered down to 4 essential pillars: 1) economics/financial feasibility, 2) environmental impact, 3) social features, and 4) health and well-being; otherwise better known as the pillars of sustainability with the addition of the health and well-being component which is so often overlooked and disregarded despite its vast importance and value in today's built environment sector.

7. Economics and Feasibility of Implementing Rating Systems

To be efficient, these rating schemes need varied levels of professional sustainable design training. The time and expense involved with this specific expertise are significant considerations. The time predicted to produce the rating system paperwork for all systems is dependent on the expertise level of the persons engaged and the intricacy of the building [12]. The costs and problems of employing a system are predicted to be greater at first, but to drop over time as the system becomes more familiar to design professionals, of course, assuming no major rating system changes have occurred [12]. Building requirements are stringent, and paperwork demonstrating that structures satisfy such criteria is necessary [12].

Typically, building owners or clients tend to prioritize the ecological and sustainability principles of sustainability, and might even examine features such as user health and safety conditions, indoor comfort, weather conditions, capital cost, O&M cost, and IEAQ conditions [13]. On the other hand, contractors usually aim to attain wants to earn more green credits under tight budgets, thus taking into consideration factors such as overall O&M costs, material recycling, limited building site procedures, regionally accessible resources or supplies, and land contamination [13]. The suggested technique has the potential to promote green building and net-zero building construction practices that would not be likely to arise from traditional practices.

8. Conclusion

In conclusion, it can be found that there is a multitude of strong points in both types of rating systems. There is no such thing as a one-size-fits-all solution when it comes to creating a work environment that promotes wellness and health. The most essential element is to guarantee that all building occupants have healthy outcomes as a result of their home and work environments. Different choices provide possibilities to find the finest solutions for the well-being of building owners and the community. As shown in this study, conventional environmental BRS methodologies have constraints that reduce their efficacy. All building stakeholders (from the building designer to the building owner) must take more initiatives to incorporate sustainability into buildings. With that, it is crucial to remain focused on meeting the needs of building occupants and their respective priorities, while also enhancing wellness through a more well-balanced rating system. Thus, based on the analysis of the benefits and drawbacks of both types of rating systems, it could be deduced that a well-rounded rating system with all technical and non-technical aspects combined would be beneficial to both the efficiency of the building as well as the building occupants' health and well-being.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Acronyms

BRS Building Rating System
CASBEE Comprehensive Assessment System for Build Energy Environment Efficiency
GBR Green Building Regulation
GPRS Green Pyramid Rating System
HBRC Housing and Building Research Center
ILFI International Living Future Institute
IWBI International Well Building Institute
JSBC Japan Sustainable Building Consortium
LEED Leadership in Energy and Environmental Design
ORS Occupancy Rating System
PBRS Pearl Building Rating System
RET Renewable Energy Technology
USGBC United States Green Building Council
VOC Volatile Organic Compound