PERCEPTIONS OF PROFESSIONALS ON ENERGY EFFICIENCY IN GREEN BUILDING RATING SYSTEM FOR THE AIM OF IMPLEMENTATION IN SUDAN

BY

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A dissertation submitted in fulfilment of the requirement for the degree of Master of Science in Building Services Engineering

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ABSTRACT

In most countries of the world, 'Green-building' rating systems have transformed the sustainability of the built environment. The most important aspect of these is Energy use. Sudan, like many other developing countries, has yet to implement such guidelines in spite of their importance for energy conservation in the global development context. This research aimed to formulate assessment-criteria for energy-efficiency in a green-building rating system for Sudan. This was achieved by examining the perceptions of officials involved in implementing the Malaysian Green Building Index (GBI), as well as other professionals in the Sudanese building industry. A review and comparison of the information obtained helped to explore possible assessment-criteria for efficient and sustainable energy-use in Sudan. Furthermore, a survey assessing the practicality of adopting the Malaysian system in Sudan, was carried out. The findings and results of the study were encouraging, with the provision that the relevant bodies and officials were open to modifications and adjustments in the existing systems.

خلاصة البحث

إن أنظمة معايرة تقييم الأبنية الخضراء في معظم دول العالم انما وضعت لتخدم عملية تحول العمران إلى الاستدامة. يعتبر استخدام الطاقة من أهم الجوانب المستهدفة بأنظمة معايرة الأبنية الخضراء حول العالم. السودان ومعظم الدول النامية لم تطبق بعد هذه الأنظمة العالية الأداء بالرغم من أهميتها للعملية التنموية الجارية بهذه الدول حالياً في إطارها العالمي. هذا البحث يهدف إلى صياغة مصفوفة لتقييم كفاءة الطاقة ضمن نظام معايرة محتمل لتقييم الأبنية الخضراء لتطبيقها بالسودان وذلك باستطلاع آراء المهنيين، سواء المسجلين منهم كمستشارين تحت نظام المعايرة الماليزي المعروف بـ "مقياس الأبنية الخضراء جي بي أي" (Green Building Index "GBI") أو الذين يمارسون الأعمال المهنية الهندسية المختلفة بحقل البناء بالسودان. بمراجعة الأدبيات ذات الصلة ومناقشتها وإجراء المقارنات بين عدد من الأنظمة تكونت الصورة العامة حول كيف يجب أن تكون مصفوفة تقييم الطاقة. ثم إن استطلاعات الرأي المهني قد أجريت لمعرفة مدى معقولية و عملية فكرة تبني المصفوفة العاملة في بلد ما لاسخدامها في بلد آخر. نتائج البحث جاءت مشجعة مع الوضع في الاعتبار لزوم التعديل و التنقيح .

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Master of Science in Building Services Engineering.

……..
Maisarah Ali
Supervisor

I certify that I have read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Master of Science in Building Services Engineering.

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This dissertation was submitted to the Department of Architecture, and is accepted as a fulfilment of the requirement for the degree of Master of Science in Building Services Engineering.

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This dissertation was submitted to the Kulliyah of Architecture and Environmental Design and is accepted as a fulfilment of the requirement for the degree of Master of Science in Building Services Engineering.

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Alias Bin Abdullah
Dean, Kulliyyah of Architecture and Environmental Design

DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

Hamror Shikheldin

Signature …… Date ……

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DECLARATION OF COPYRIGHT AND AFFIRMATION OF FAIR USE OF UNPUBLISHED RESEARCH

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Signature Date

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LIST OF ABBREVIATIONS

ACP	Alternative Compliance Path (LEED)
BEI	Building Energy Intensity
BEMS	Building Energy Management System
BIPV	Building-Integrated Photovoltaic
BREEAM	Building Research Establishment Environmental Assessment Method (UK)
CASBEE	Comprehensive Assessment System on Built Environment Efficiency (Japan)
CBECS	Commercial Building Energy Consumption Survey (USA)
CO_2 eq.	Equivalent to CO_2 – a measure of greenhouse gas emission effect
CVA	Completion and Verification Assessment (GBI)
DA	Design Assessment (GBI)
EMS	Energy Management System
EPR	Energy Performance Ratio (BREEAM)
Estidama	Arabic word, meaning; Sustainability (Abu Dhabi)
ETTV	Envelope Thermal Transfer Value (Green Mark)
EUI	Energy Use Intensity in (kBtu/sf/yr): (kWH/sqm/yr)
GHG	Green House Gas(es)
GSA	General Services Administration (USA)
GWP	Global Warming Potential (Estidama)
HCENR	Higher Council for Environment and Natural Resources – Sudan
IAQ	Internal Air Quality
IPCC	Intergovernmental Panel for Climate Change (UN)
LCA	Life Cycle Analysis, or Life Cycle Assessment
LEED	Leadership in Environmental and Energy Design (USA)
MW	Mega Watt
ODG	Ozone Depleting Gases
ODP	Ozone Depleting Potential (Estidama)
OECD	Organization for the Economic Co-operation and Development: (36 countries)
OTTV	Overall Thermal Transfer Value (GBI)
POE	Post-Occupancy Evaluation
RTTV	Roof Thermal Transfer Value (GBI)
TOE, MTOE	Ton of Oil Equivalent, Mega Ton of Oil Equivalent
UN	United Nations' Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNITAR	United Nations Institute for Training And Research
VOC	Volatile Organic Compound
ZEB	Zero Energy Building

CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

Green design and construction are practices that significantly reduce or eliminate the negative impact of buildings on the environment and occupants. A green building, through better sitting, design, construction, operation and maintenance, seeks to achieve increased efficiency in the use of resources. It seeks to achieve high efficiency in the consumption of energy, water and material while at the same time reduce impact on the environment and on human health during the building's lifecycle (Turner and Frankle, 2008)

After World War II, industrialized countries developed a now wide-spread building style that had little regard for energy efficiency or other ecological aspects. The sole belief in technical progress, together with the abundance of cheap fossil fuel at that time, deepened this problem.

The green building movement, in its current institutional version, has emerged and spread worldwide at a relatively high rate since the beginning of the nineties of the last century. The main driving power behind this momentum is the global concern over climate change, the world's energy crisis and the serious related environmental issues during this period. Studies and surveys conducted in developed countries raised the alarm over various industries and human activities to pay attention to the destiny of the mother planet and the future human generations inhabiting thereon (Fowler and Rauch, 2006)

Among human activities that are depleting earth's material stocks, consuming available finite energy resources and harming the overall natural environment of the

earth, is the building industry. Buildings are deemed to be a big end user of energy all through their lifecycles; from construction, operation and to demolition. They are, as well, responsible for a great part of harmful emissions of greenhouse gasses, ozone depleting substances, and the disposal of solid waste. As the global population increases, the need for all kind of buildings escalates and consequently the impact on the global environment is getting more and more detrimental.

The green building movement is the global awareness and consensus-based endeavour to address the problems of the impact of buildings on the environment without compromising the functions of neither the buildings nor their objectives towards comfort and productivity of occupants (Timothy et al., 2006)

The need for a meaningful measuring tool-set has been a central issue in the striving to achieve reduced impacts on environment. Green Building Rating Systems are tools that are increasingly being developed in many countries and regions around the world to establish a road map for the players in the building industry towards the transformation of the built environment standards and measures, to meet the emerging and pressing demand for sustainability, conservation of natural resources, mitigation of negative impact of buildings on the global environment and, overall, the improvement of the total functional and comfort performance of the buildings and the services within (Turner, 2006)

1.2 BACKGROUND

Design decisions are made through the holistic consideration and calculation of numerous parameters. The challenge is at the matching of various parameters of physical, economic, cultural and social qualities with all their subsequent divisions to upgrade the performance. The role of regulatory bodies in this respect is to set

measurable checklists to keep the ranges of each parameter within the required limits. Design decision makers would match their clients' requirements with conformity to the limits of regulations, acts, standards and by-laws (Circo, 2008)

Sustainable building councils and institutions emerged during the last two decades, and have faced the difficulty of initiating the new understanding of what and how sustainability could be achieved in buildings. The big challenge of promoting a new concept is to educate the respective market on it.

Energy efficiency gained importance during the oil crisis of the 1970s, which drew the attention of researchers to the options of alternative energy, renewable energy and clean (green) energy. In the 1970s also there were the efforts of recycling in USA, which came to the attention of the building industry. In the 1980s "sick building syndrome" emerged, and concern for workers' health and productivity became a new issue for the industry. Water scarcity in areas where some projects were to be carried out, has also led to focus on water conservation. Although not effectively defined, "green design" began to emerge focusing primarily on one issue at a time. Energy efficiency and use of recycled materials were the first issues to be mainly addressed (Garzon, 2006). Institutions, green designers and researchers began to realize that integration of all the factors mentioned would produce the best results that could be called "high performance" buildings.

A variety of assessment programmes have been developed around environmental and energy impacts of buildings worldwide. The Building Research Establishment (BRE) has created the first environmental certification system in the UK. BRE Environmental Assessment Method (BREEAM) was launched in 1990. In 1998, the US Green Building Council launched the rating system titled Leadership in Energy and Environmental Design (LEED). Later on in 2005, the Green Building

Initiative (GBI) in USA introduced Green Globes adapting the Canadian version of BREEAM and distributing it in the U.S. Market (Turner, 2006)

The period between 2005 to 2012 had witnessed the birth of a big number of rating systems around the world as reproduction processes of modified versions from available precedent systems. Green Building Index of Malaysia has been launched in the year 2009 at the mid-stream of the global trend (Looi and Izdihar, 2012)

The World Green Building Council (WGBC) was established in 2007 as a collaborative body involving today more than 90 Green Building Councils from around the Globe. WGBC is supported by many international organizations such as Climate Leadership Group (C40-Cities), World Business Council for Sustainable Development, Local Governments for Sustainability, and more under UNHABITAT. (worldgbc.org)

WGBC is conducting continuous research and studies observing the trends and indications of the green building movement worldwide. Annual reports published by WGBC are purposed to assist leading and orienting the circulation of this rapid growing snowball of sustainability in the building industry. (worldgbc.org)

The aim of this research is to identify the most suitable format of energy-related items out of the green building rating criteria currently available, in order to adopt and modify them as necessary to best fit for use in Sudan. It is an attempt to develop a complete proposal that could constitute a framework of how energy efficiency might be measured and rated. Green Building Rating Systems are yet to be launched in most of the developing countries including Sudan. Establishing such a high performance building rating system in a country is actually a task to be seen at the pinnacle of comprehensive building industry continuous developing endeavour that has to be based on industrial standards, by-laws and codes of practice.

It is widely understood that most developing countries are on a struggle to set the basic standards of their industry regulations to catch up with the globalization procession. However, this is no longer a question of complete novelty for all cases. There are short-cuts experienced all over the world: setting basic rules depending on the British, American, French, and other standards. This practice is acceptable and logical in many ways; at least saving time and effort of reinventing the wheel.

The repeated international organisations' declarations, together with the real experience of global climate change have raised the alert everywhere. The concurrently booming communication and information revolution has also accelerated this fast spread of the green building concept during the last decade, and it will continue doing so, as fast as becoming unbeatable by traditional decision making mechanisms.

Green building rating systems, worldwide, usually cover around six main areas of building performance assessment criteria. They are all around energy efficiency, water safeguarding, material use, indoor environmental quality, site planning and conservation of biodiversity. Each of these elements, and other elements, has a number of items that typically have their assessment methods and verification procedures at various stages; from design to construction to post-occupancy to maintenance.

To be practical, and to avoid many complications and an out-of–scale volume of data to be handled, this research shall only be limited to the Energy Efficiency aspect of each of the selected systems and/or buildings to be involved.

The study shall comprise an overview of selected rating systems from around the Globe to identify the parameters of the assessment especially with energy related

items. The researcher has no intention to look into the administrative or project registration matters that are related to rating procedures.

Having compiled the different assessment items, professional opinion shall be needed, both from territories applying the rating practices, and from the new territory where the study is targeting to suggest a format, which, in this case shall be Sudan.

1.3 PROBLEM STATEMENT

Less Developed Countries (LDCs) are yet to show their contributions and take advantage of their shares out of the Global participation in the green movement. Excessive use of fossil fuel and electricity for industrial, commercial and residential activities has its negative impacts on the environment whereas it is not really helping the comfort and productivity of building occupants.

Looking into the building sector in Sudan, it is found that energy efficiency has not been given the necessary importance and consideration through the last few decades while energy resources are being diversified and the building stock in the country is rapidly growing. Energy efficiency is a major parameter for measuring the degree of sustainability and conformity to green building concept requirements. Available directives and regulations on energy sector look only after safety matters and have very little concern about efficiency in building energy use.

This study is an attempt to form a method of energy efficiency assessment criteria within a typical framework of a green building rating system, through learning from the criteria and experience of Malaysian *Green Building Index* (GBI).

1.4 AIM OF RESEARCH

The aim of this research is to learn from the experience of the Malaysian *Green Building Index* (GBI) the formulating of a process to develop a framework of building energy efficiency assessment criteria for use in Sudan.

1.5 RESEARCH OBJECTIVES

1. To identify the significance of different Green Building Rating Systems (GBRSs) in terms of energy efficiency and related aspects in a simple comparison between a few of them from around the Globe including the Malaysian Green Building Index (GBI).
2. To examine the opinion of relevant professionals on the important parameters of the GBI framework challenging the points of strength inherent in their energy category and subsequent criteria.
3. To explore the perception of professionals on the problem dimensions of not having an energy efficiency assessment system in Sudan as a developing country, and what could be the parameters to contribute to the shaping of a new assessment guideline for use in building design and construction within the country.

1.6 RESEARCH QUESTIONS:

Questions raised and meant to find answers by this research are as follow:

1. Are all rating systems just the same in their contents and their objectives towards achieving sustainability in buildings? And in what sense could they be different?

2. Could there be a rating system that is applicable for all countries of the world?
3. How important is the energy efficiency among other criteria for the sustainability concept and for different rating systems.
4. How well is the implementation of GBI causing energy to be saved –and efficiently used- in the buildings that have been rated and certified thereby?

1.7 RESEARCH METHODS

Literature review and secondary data collection would be used as a background on what is the reality of green building movement and contribution of the institutional trend in ranking and labelling high performance projects. Secondary data collected were those constitute the criteria of measuring and rating escalating numbers of buildings seeking recognition and certification on their performance. In most cases, these data are publicly accessible and they are generally, rich with valuable details.

Professional opinion survey were conducted to GBI facilitators (Malaysia); as these are the professionals who handle and use the GBI tools to measure and rate the degree of sustainability of the design and technical solutions of a building. Their perceptions on the validity and effectiveness of the tools are of a basic importance.

Professional opinion survey were also done over building industry players in Sudan. That is because it is suitable that the architects and engineers who run the various activities of the building industry in the country, must have their say on the change meant by the green movement, especially, when it comes to issues related to their own workplace.

Data collected by surveys would be analysed by simple statistical formulae such as the *Related Index* (RI) to examine community perception.

The research shall be finalised by a discussion of results and conclusions that would relate the elements of the findings to the objectives of the study.

1.8 SIGNIFICANCE OF THE TOPIC AND THE RESEARCH

Over the last decade, Green building rating systems have been launched and developed rapidly around the world. They are subjected to continuous revision, updating, upgrading and dissemination, so that the topic of green building is becoming always alive and of interest to building industry professionals.

Energy concerns are, as well, among the most crucial and dynamic driving powers of the global green momentum.

The significance of the green building rating systems topic is that it is crossing borders. Seeking solutions for sustainability problems at the local level cannot be a reason to limit the vision only within country boundaries. It is a global field by nature and has to be handled by sharing and inter-benchmarking in wider scopes.

About the significance of the research, this study has touched, within its context, a new issue, as for Sudan building industry to look into forming a framework for energy efficiency, and also for GBI, as a model, to be considered for being adopting outside the Malaysian territory.

1.9 SCOPE AND LIMITATION

The area this research explores is defined as followed:

Topic: a selected number of GBRSs, with sole focus on their energy efficiency criteria. Not all GBRSs will be covered in this study. Also, not all the criteria included in the selected GBRSs will be covered—only their energy efficiency sections.

Data collection: voluntary opinion surveys disseminated to professionals in the building industries of only two countries: Malaysia and Sudan. The data collected does not claim to be statistically more representative or robust than an online opinion survey can be.

Timeframe: the literature review and data collection take place between mid-March and mid-July 2013 as required to satisfy the conditions for the academic degree for which this research is a partly fulfilment.

This work is not a turn-key assignment that should come up with a definite completed framework for energy efficiency category ready to be implemented. It is rather an attempt to look into the method to reach such aim, and first step in building momentum for a full-fledged assessment.

1.10 THESIS REPORT ORGANIZATION

This dissertation comprises five chapters, including the current one. Chapter 1 provides an introduction to the research and area, and elaborates on the research background, problem statement, aim and objectives of the research. Chapter 2 is a literature review. It begins with an overview to the literature on GBR systems around the world, followed by presenting a background on energy in buildings, energy efficiency and renewable energy. It covers as well a background of energy and environmental issues in Sudan. Chapter 2 also covers an overview of secondary data on energy assessment criteria of selected GBR systems, in a comparative manner, with a highlight on the Malaysian GBI

Chapter 3 discusses the research methodology including comparison found at previous chapter of literature review as a part of the methodology. It describes also collecting of professional opinion in Malaysia by survey and interview. The methodology, as well, includes a survey of professional opinion in Sudan, for the perception of the transformation concept. In Chapter 4 is the discussion of the findings of the investigation parameters (GBI professional opinion and Sudan professional opinion), and the analysis of their effects on suggesting measuring tools.

Chapter 5 is the concluding chapter of the report. This chapter summarize results and compares them with the original objectives and hypotheses of the study. Finally, recommendations are provided for further future studies on the subject.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

Green building is the name given to the standard of "high performance building" that is addressing the overall architectural concern on design decisions' impacts. It is a trend, a move towards a new attitude. Involving academicians, professionals and common industry stakeholders, green building norms have created consensus based sets of protocols. This institutional transformation is being approached by the setting of standards and measurements on each and every detail of the building industry. Increasing numbers of specialized institutions are being established and setting new initiatives and new assessment tools to serve the new global trend (Wang et al.).

Design decisions are made through the holistic consideration and calculation of numerous parameters. The challenge is at matching of various parameters of physical, economic, cultural and social qualities with all their subsequent divisions to upgrade the performance. The role of regulatory bodies in this respect is to set measurable checklists to keep ranges of each parameter within required limits. Design decision makers would match their clients' requirements with conformity to the limits of regulations, acts, standards and by-laws.

2.2 GREEN BUILDING WORLDWIDE

Sustainable building councils and institutions emerged during the last two decades, and have faced the difficulty of initiating the new understanding of what and how sustainability could be achieved in buildings. The big challenge of promoting a new concept is to educate the markets on it. The other obstacle which, in most cases, could