REVIEW

HUMAN FACTORS ISSUES IN MALAYSIAN GREEN BUILDING DEVELOPMENT: A REVIEW

Tsau Kar Yen[1], Izran Sarrazin Mohammad[2], Rohaya Abdul Jalil[3], Abdul Hakim Bin Mohammed[4]

[1,4]*Faculty of Geoinformation and Real Estate,* [2,3]*Centre for Real Estate Studies, Universiti Teknologi Malaysia, Malaysia.*

Corresponding author: kytsau1989@gmail.com[1]

ABSTRACT

This paper reviews the importance of incorporating human factors and ergonomics (HFE) in the development of Malaysian green buildings. Apparently, the development of green buildings is often focussed on achieving energy efficiency, low carbon emission, and lower operation and maintenance cost. However, green buildings should not only be environmentally and economically sustainable. Instead, it should also be socially sustainable. Social sustainability is connected to HFE and this could help to improve the quality of green development. It is imperative to consider HFE in green buildings as it is a discipline related to the understanding of the interaction among humans and other elements of a system in order to optimise human well-being and overall system performance. However, many tend to overlook the importance of human factors in green buildings and this may lead to some of the green features failed to be implemented, performed or not utilised in a way that maximises the performance of green buildings, thus restraining the green features' usability and their potential benefits. Therefore, based on literature review, this paper reviews the need to incorporate human factors in the green building development and how this could benefit to improve the performance of green buildings in the Malaysian context. The findings show that HFE is still in its infancy stage in Malaysia. HFE is mostly implemented in the workplace focusing on occupational safety and health to reduce musculoskeletal disorder, risk, absenteeism and illness. The findings presented in this paper could create awareness among the practitioners on the benefits of creating flexible and ergonomic green buildings that accommodate building users, promote a healthy, comfortable and productive environment.

Keywords: *Green Building, Human Factors and Ergonomics (HFE), Green Building Performance*

INTRODUCTION

Green real estate investment is not new. It is perceived as highly demanded in the construction sector due to its well-recognised benefits to the environment, economic and social aspects. However, there are arguments within the construction industry whether or not green rated buildings are actually outperforming their non-green counterparts. There are evidence claiming that green buildings are experiencing discrepancies between predicted and actual performance, especially in regards to energy performance[11,21], causing pressure to the practitioners to take the accountability and increase their efforts to respond to this matter. This is due to clients may be tempted to claim compensation from the professional team due to the performance deficiencies of the building compared to the predicted performance.

These discrepancies are often caused by factors such as poor data input in building energy model, inappropriate modelling tools, poor building management and control, occupancy behaviour and the quality of buildings[11,21]. Changes must occur in this complex sociotechnical system in green buildings and human factors and ergonomics (HFE) can assist greatly in this aspect. However, studies pertaining to incorporating HFE are still rare in Malaysia.

HFE is well recognised as a discipline that operates in a sociotechnical context and aims to enhance the system performance in multiple dimensions. The integration of HFE is vitally important for green building development because the outcome tends to maximise all three dimensions of a green building which are the environment, economy and social aspects. Therefore, this study outlines (i) what human factors is (ii) why it is well-suited to implement in green building development (iii) the needs of incorporating human factors in green buildings, and (iv) the challenges of integrating HFE in Malaysian green buildings.

OVERVIEW OF MALAYSIAN GREEN BUILDINGS

Green buildings are developed to magnify the positive and mitigate the negative impacts on the environment and human health throughout the entire life-cycle. There are different definitions of green building. However, it is

commonly recognised as a building that incorporates design, construction, operation practices that significantly diminish or eliminate its negative impact on the environment and occupants.

In Malaysia, green buildings have embarked to burgeon since the concept was established in 2007. The rating system which to certify and accredit green rated building was known as the Green Building Index (GBI) was introduced in May 2009. GBI was designed based on BREEAM from the UK and LEED from the US. It defines green building function to increase the efficiency of resource use (energy, water and materials) while reducing building impact on human health and the environment through better siting, design, construction, operation, maintenance and removal[14]. While different rating systems from different countries have their own objectives and goals. However, the objectives have moved from energy efficiency agenda towards renewable energy and then, social justice has only begun recently in many countries. Malaysia, however, is still lingering on energy efficiency.

Most of the green buildings in Malaysia are located in the Klang Valley, the centre of Kuala Lumpur. The great concentration of tertiary services and businesses, the improvement of transportation networks, the development of multinational companies and industries have increased the necessity for companies and households to be located in the Klang Valley. This has created an impetus on the emergence of green office and residential buildings in the Klang Valley. Currently, a total of 738 buildings is being considered for the GBI green certification[14]. To date, 355 buildings have received their green certification which included 15 buildings with PLATINUM, 83 buildings with GOLD, 39 buildings with SILVER and 218 with CERTIFIED rating[14].

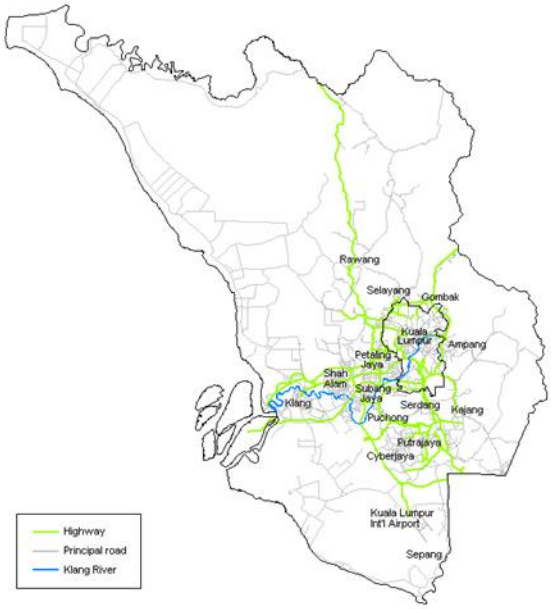

Figure 1- The Klang Valley, Kuala Lumpur

Table 2- Green Building Index Certified Project by Categories

Green Building	Total
Applied	738
Registered	689
Total Certified	355

Source: Green Building Index, 2016

Table 3- Green Building Index Certified Project by Rating Categories

Green Building Rating	Total
PLATINUM 86 - 100 points	15
GOLD 76 - 85 points	83
SILVER 66 - 75 points	39
CERTIFIED 50 - 65 points	218
Total Certified	355

Source: Green Building Index, 2016

PERFORMANCE ISSUES IN MALAYSIAN GREEN BUILDINGS

The advent of green buildings is not without its own dispute. Despite the echoing claims on the benefits of green building effort, the most common issue that rises up in green building is the poor building performance. There is an increasing concern about a mismatch between the predicted and actual performance of green buildings and this is typically addressed as 'the performance gap'[11,21]. Studies claimed that such discrepancies occur due to shortcomings of current modelling programs, poor assumptions in

building modelling, poor building management and control, occupancy behaviour, and lack of monitoring in construction quality[8,11,21]. This is due to the lack of response regarding the actual use and operation of buildings or the present simulation tools which do not precisely model the influence of users and management in green buildings.

Malaysia's green buildings have seen tremendous growth in the last few years. To date, Malaysia has a total of 355 certified green buildings and more is expected to come. Many research studies have been done for green buildings. The results show that not all green buildings are performing well. According to Ng & Akasah (2011), the Malaysian Green Technology Corporation office building was not performing on the basis of energy performance due to poor air movement and cooling system. This caused the building to require more energy to reduce the room temperature. Further investigation on the Low Energy Office (LEO) building in Malaysia shows that the temperature in the LEO building is often not stable and hard to sustain at 24 degree Celsius. This is because the system which fails to maintain the desired temperature needs constant fine-tuning[5].Another study by Ng & Akasah (2013) shows that the green office buildings in Malaysia have a poor level of thermal comfort and lighting condition. They also claimed that even though the green office building was certified by the Green Building Index, Platinum rating and Green Mark, Platinum rating, it has gained low satisfaction among the occupants in terms of comfort. The occupants were facing glare problems in the green office building due to the excessive maximisation of day lighting (to reduce energy use for artificial lighting) by having large windows in many parts of the building.

In conjunction with these issues, it is suggested that HFE should play an important role in green building development. It is an approach to blend in such technical and social system in green buildings in order to create a user-friendly, healthy and high performing building.

INTRODUCING HUMAN FACTORS TO MALAYSIAN GREEN BUILDING

It is well recognised that HFE is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimise human well-being and the overall system performance[16]. It is a discipline that contributes to the design and evaluation of tasks, products or built environment to create a system which is companionable with the needs, cognitive abilities and limitation of human by engrossing human feedback and involvement.

In previous studies, HFE is always engaged in fulfilling the objectives of occupational health and safety and human productivity. It is related to the design of furniture, machines and equipment, whether they are causing sprain injuries or musculoskeletal disorders to users which can lead to physical and psychological illness or long-term disability. For instance, the LEED green rating system promotes HFE as a comprehensive strategy[15] in green buildings. However, it can be seen that those HFE criteria mostly refer to machines, equipment, furniture and tools that help to reduce musculoskeletal disorders and users discomfort but not architectural details to shape the whole building. In fact, HFE should not only look at human occupational health and safety but looking into broader sense like integrating HFE into the architectural design to improve human interaction towards the built environment[4].

In green building concept, one of the goals is to improve the social aspect of buildings, which is to create spaces where people want to spend their time there[7]. Apparently, humans live inside buildings which consume energy, emit heats, need to be cooled and ventilated. However, the focus is mainly on technical aspects because it involves complicated and high technology system applications that always drag the attention of engineers to deal with. Users are always being neglected to cause poor building performance during occupancy.

When integrating HFE in green buildings, the built environment is the system and this system will be designed to fit its users. These architectural details will be designed to optimise human activities by providing the utmost level of comfort and satisfaction to user[4,6]. Without paying attention to users' preferences and needs, the assumed performances might result in fragility[19]. Charytonowicz (2007) stated that HFE in building design can facilitate the selection of the most suitable technologies to enhanced building function and thus, reduce waste and resources, increase cost saving and improve human comfort.

THE NEED FOR HUMAN FACTORS IN GREEN BUILDINGS

There are vast advantages of integrating HFE in green buildings. Even though there is a plethora of information about green buildings, very little has been written about HFE in green building development. In fact, HFE is still new and struggling to be integrated and recognised as a vital part of the green building design process. It

is crucial to show the practitioners how HFE can bring benefits and how this practice can enhance building quality and performance, and human productivity.

HFE could assist in resource saving such as energy and water[4,15]. Building users play a critical role in energy consumption as their behaviour affect approximately half of the energy use in buildings. They can influence the energy consumption by affecting the indoor surroundings such as opening windows, temperature control, lighting system, equipment and electric appliances. In such situations, the input of HFE in green building architecture can optimise the interaction between the occupants and buildings where those building features are designed to be well fitted to the occupant needs[9]. HFE can analyse, observe and understand the users' needs and expectancies in order to produce an interface which is compatible with them. If green buildings pay poor attention to the users' preferences and needs, this can cause poor energy performance during occupancy[19].

Occupant comfort and productivity are affected by the built environment that they occupy[4,15]. This can be improved by integrating HFE considering users' preference and needs in terms of physiology, psychology, behavioural, social and cultural senses. The HFE approach can contribute to focus on building inhabitants promoting the consideration of user's actual behaviour in a very early stage of the design of buildings, for a more comprehensive analysis of needs, demands and wishes, and a better articulation of energy performance targets of the built environment.

HFE could also assist in improving the functionality of building[4]. This is referred to the situation of a building whether its capacity could host occupant activities and the service or the function of the building are still met as planned. HFE can implement this issue in building design based on the analysis of building use and occupant needs and preference collecting through survey and observation[18].

CHALLENGES TO IMPLEMENT HUMAN FACTORS AND ERGONOMICS IN MALAYSIA

HFE was introduced in Malaysia few decades before[13,17,25-27] and at that time, this discipline is very new or not known. HFE is still in its infancy stage in Malaysia[1,24,26,27]. Malaysia has become one of the new Industrially Developing Countries (IDCs) and this has given the motivation to the development of local Small and Medium Industries (SMIs) and HFE has just started to be introduced in the industry.

However, most of the multinational companies in Malaysia put little importance on HFE due to the perception that HFE as expensive and oppressive[17,29] and is not a worthwhile investment. This was also due to the plenty of replaceable cheap labour and poor government regulation on labour health and safety issues. According to Shameem et al. (2001), the industrial workers experience less freedom and relaxation and work overtime during work. These workers were mostly not well educated and were oblivious of the work environmental standards. The knowledge and awareness of the discipline among Malaysian engineers and managers are low. An industrial survey conducted among the engineers by Ali et al. (2001) discovered that there was confusion between the words "ergonomics" and "economics among the engineers. The engineers thought that HFE is only related to product design and they had not taken HFE courses. Mustafa et al. (2009) discovered that only 35.6% of Malaysian manufacturing industries were aware of HFE awareness and only 33.3% of the manufacturing industries applied for HFE programmes. He also claimed that the main issues causing the lack of HFE awareness were the lack of info, education, training and no pressure from the top management to start HFE.

Poor education and training on HFE are also one of the reasons that contribute to the low HFE awareness in Malaysia. The effort has being done to solve these issues such as the establishment of the HFE division in the National Institute of Occupational Safety and Health (NIOSH) and the Human Factors & Ergonomics Society Malaysia (HFEM). The objectives of the societies are to promote professional interests in human factors, human-computer interaction and usability, to raise awareness as well as governing bodies in strengthening the implementation of HFE in private and government organisations. However, such efforts have barely raised the awareness among the industry.

CONCLUSION

Applying HFE in green building is intensely important in Malaysia. It is vital to endorse the HFE discipline and practice by disseminating their applications not only in occupational safety and health but also in green building development. This could make the designers be aware of the advantages of implementing HFE in order to create an atmosphere which is not only environmentally friendly and economically sustainable, but socially sustainable as well. However, HFE in Malaysia is developing at a slow pace. More effort and skills are required to promote proper attention and awareness on the

advantages of integrating HFE in green buildings among the practitioners.

ABBREVIATION

HFE- Human Factors and Ergonomics, GBI- Green Building Index, LEO- Low Energy Office

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