Ecological Indicators 71 (2016) 567–576

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

Original articles

Ranking the indicators of building performance and the users' risk via Analytical Hierarchy Process (AHP): Case of Malaysia

Natasha Khalil[a,b], Syahrul Nizam Kamaruzzaman (Sr. Dr.) (Asoc. Prof.)[b,*], Mohamad Rizal Baharum (Dr.)[b]

[a] Department of Quantity Surveying, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA Perak, 32610 Seri Iskandar, Perak, Malaysia
[b] Department of Building Surveying, Faculty of Built Environment, Universiti Malaya, 50603 Kuala Lumpur, Malaysia

ARTICLE INFO

Article history:
Received 8 April 2016
Received in revised form 18 July 2016
Accepted 20 July 2016
Available online 3 August 2016

Keywords:
Building performance evaluation
Health and safety risk
Rating tool
Analytical Hierarchy Process
Higher educational buildings

ABSTRACT

The need to optimise the performance of buildings has increased consequently due to the expansive supply of facilities in higher education building (HEB). Hence, a proper performance assessment as a proactive measure may help university building in achieving performance optimization. However, the current maintenance programs or performance evaluation in the HEB is a systemic and cyclic process where maintenance is considered as an operational issue and not as opposed to a strategic issue. Hence, this paper proposed a Building Performance Risk Rating Tool (BPRT) as an improved measure for building performance evaluation by addressing the users' risk in health and safety aspects. The BPRT was developed from the result of a rating index using the Analytical Hierarchy Process (AHP) method. A total of 12 facilities management (FM) experts and practitioners were involved in the rating process. The subjective weightings were analysed by using the AHP computer software programme, the *Expert Choice 11*. The result of the AHP had successfully assigned weighting scores to all performance-risk indicators, with five indicators ranked as the most critical indicators; structural stability (14.9%), fire prevention services (9.1%), building-related illnesses (7.4%), emergency exits (6.8%), and electrical services (6.3%). The final indication to the assessed building using the BPRT provided a rating classification in terms of the following: "*Excellent*", "*Good*", "*Medium*", "*Low*", or "*Poor*", which suggested further actions to improve the performance of the building, as well as to mitigate the users' health and safety risks. Hence, the establishment of the BPRT was successfully employed as an aid of improvement towards the current performance assessment of HEB by emerging the concept of building performance and risk into a numerical strategic approach.

1. Introduction

The development of higher education buildings (HEB), including expanding facilities, is spirally a welcoming sign of the growth of tertiary educational programs. Unlike most land developers, university authorities need to have a long-term view of operations to ensure sustainability is achieved through performance optimization. However, building performance is not guaranteed as it depends on its lifespan, as well as the changes that take place in the physical requirement from the growing learning activities and students' populations. Hence, further issues, such as space inefficiency, ventilation discomfort, and inefficient of energy use, may decrease the performance of the buildings from time to time (Altan, 2010; Gillen et al., 2011; Hassanain, 2007; Sapri and Muhammad, 2010). Performance failure, nevertheless, does not only affect the sustainability of the building, but the users are also affected by the failure of building performance (Olanrewaju et al., 2010b). Hence, in order to optimise the performance of HEB, occupants, visitors, and passers-by should never be exposed to risks (Amaratunga and Baldry, 1999). This is because; several studies have shown that poor building performance presents vulnerability of risk towards the safety and health of building users (Almeida et al., 2010; Altan, 2010; Cole, 2000; Lützkendorf and Lorenz, 2007, 2006; Meacham, 2010; Wolski

* Corresponding author.
E-mail addresses: natashakhalil29@gmail.com (N. Khalil), syahrulnizam2013@yahoo.com (S.N. Kamaruzzaman), mrizal@um.edu.my (M.R. Baharum).

http://dx.doi.org/10.1016/j.ecolind.2016.07.032
1470-160X/

et al., 2000; Zalejska-Jonsson, 2012). This demonstrates the significance of addressing risk in the building performance evaluation.

HEBs constitute an important part of a university's facilities and considerable resources are committed to their design, construction and maintenance (Olanrewaju et al., 2010b). Human resources, materials and financial resources are devoted to the acquisition, operation and management of the facilities (Sapri and Muhammad, 2010). It is imperative for institutions to manage their facilities well by adopting good practices in various aspects of their operations. However, "sadly, the challenges and inspiration that can be sparked by commitments to a full suite of environmental performance variables have been missing in both education and practice" (Loftness et al., 2005). The focus in HEBs seems more narrowed to the university's policy and research in energy usage, maintenance management, and the students' learning efficiency. There is an absence of a holistic approach in the management of HEBs, that would be beneficial not only for the building itself but also for its users.

In revealing the crucial aspect of performance assessment, the Malaysian government, under the maintenance division, had issued the General Circular (No.1) dated 27th March 2009, which states holistic management of asset through all management should undertake a systematic approach to achieve building performance optimization. Furthermore, as described in the Guideline of Building Condition Assessment (BCA) to the existing government and public buildings (Public Works Department, 2013), the assessment for a building is essential not only for building repairs and improvement, but the assessment must also fit the aspect of safety and risk of building. Hence, employing a strategic approach via numerical building rating tool may resonate with the changing needs of HEB operations and expansive functions.

University buildings in Malaysia have been constructed since 1960. Nevertheless, all buildings deteriorate and decay with age as a result of various factors, including poor quality materials, bad workmanship, excessive usage, abuse, as well as inadequate and poor maintenance (Ali et al., 2010; Che-Ani et al., 2010). As buildings become larger and house more people, political and societal issues would have become more complex, which in turn, amplify the risks associated with occupying such buildings (Thompson and Bank, 2007). Hence, indicating a list of criteria towards a proper building performance assessment is definitely needed to mitigate hazards upon users.

2. Building performance and risk impact to the users

The basic concept of building performance evaluation (BPE) has been emerged on various issues, characteristics with various objectives. The performance concept involves recommendations for improvement and it is used for feedback and feed forward regarding the performance of similar buildings (Amaratunga and Baldry, 1998). It denotes the comparison of client's goals and performance criteria against actual building performance, measured both subjectively and objective. Building performance has been defined in BS 5240 as "behaviour of a product in use" (Almeida et al., 2010; Douglas, 1996). It is also described as a process of assessing progress towards achieving goods and services efficiency, quality of building outputs and effectiveness of building operations (Amaratunga and Baldry, 2003). This refers to the comprehensive features of a building, including structural, architectural, surroundings, environmental issues and building services. The performance measurement of a building is firstly summarised in terms of the background of the building and the scope of performance assessment (McDougall et al., 2002). Therefore, all relevant stakeholders need to understand the key performance factors in a building.

Building performance assessment is carried out in the context of the facilities management phase. Therefore Wong et al. (2011) stressed that its implementation is able to mitigate the potential loss of building data over the life cycle of the building. The ability of an emergency response team to attain information from such an assessment could substantially reduce risk to the responders, building occupants and the general public (Wong et al., 2011). This exemplifies the ability of a building performance assessment to reveal risk prevalence to be beneficial to its users at large. Consequently, risk can have a direct impact on end users, society and individuals or the whole building itself. Benchmarking the risk in building performance can be framed as a health risk, a safety risk, an environmental risk, an economic risk, a political risk or another type of risk (Almeida et al., 2010; Meacham, 2010).

The aspect that needs to be thoroughly assessed in building performance depends on the evaluation purposes. Risks are associated with the unintended consequences of building performance and the primary cause of these risks may be due to lack of measured performance data (Woods, 2008). Besides, the risk approach advocates principles on the level of building performance and predicts the impact on the society that is ultimately affected by the sources of risk. Therefore, to suit with the aspects of building performance in Malaysian HEBs, health risk and safety risk had been the main focus of this research. With that, the following provide the description of health risk and safety risk in the context of study for this research:

i) Health Risk

Impact towards human health effects; either direct or indirect exposure of building factors that can cause health risk (latent or patent); the effect in short-term or long-term health suffers.

ii) Safety Risk

The risks or hazards that create a tendency for injury, death, crime, theft, nuisance or burglary to the building users.

Since the risk frames are focussed towards health risk and safety risk, a list of performance elements or indicators needs to be constructed in prevailing the users' health and safety risks from elements of poor performance.

3. Initial development of the rating tool: the Performance-Risk Indicators (PRI)

The initial step in developing a new rating tool is to select the assessment areas that should be included; and next, determine the parameters, attributes or indicators that can be used to measure the selected aspects (Ali and Al, 2008; Malmqvist and Glaumann, 2009). In fact, a number of analyses upon previously established performance rating tools, such as Building Research Establishment's Environmental Assessment Method (BREEAM), Leadership in Energy and Environmental Design (LEED), Total Building Performance (TBP), Building Safety Condition Index (BSCI), Building Health Hygiene Index (BHHI), Malaysia's Green Building Index (GBI), and Building Rating Assessment System (BARIS) by the Public Works Department (PWD), had been carried out in the literature stage. The review is considered by far the most comprehensive method to develop a new rating scheme and to examine sustainability issues (Ali and Al, 2008).

Literatures by Lützkendorf and Lorenz (2007), as well as Preiser (2005), showed that the mandates or the criteria in building performance depend on the objectives of evaluation. The elements can be technical performance (heat insulation, fire), functional performance (functionality, applicability, adaptability), social performance (comfort, health, safety), economic performance (LCC, cash flow, market value) or environmental performance (energy use, materials use). Based on the review, functional performance, technical performance, and indoor environmental performance