

POST OCCUPANCY EVALUATION FOR SUSTAINABILITY ASSESSMENT
FRAMEWORK OF RETROFITTING COMMERCIAL OFFICE BUILDING

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requirements for the award of the degree of
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Specially dedicated to my parents (*Late Alhaji Aliyu Mohammed Shika & Hajiya Halima Aliyu Shika*), my beloved wife, (*Khadijah Shuaibu*) and my children (*Aliyu, Abdullah, Mohammad and Hajarah*)

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ABSTRACT

The researchers in Facilities Management (FM) have emphasized the need to prioritise customer insight towards organisational success. Post Occupancy Evaluation (POE) is widely used for different environments and facilities: for instance, to investigate the added value of FM, workplace management, performance management and sustainability. The commercial office building has been identified as having key potential in addressing occupants performance. Evidence from POE suggests that retrofitted buildings often fall short on the expectation of occupants. This suggests that there is clear gap between the benefits of retrofitted buildings and user expectations. The aim of this research is to develop sustainability assessment framework for retrofitting commercial office buildings. The objectives include: exploring experts' view of sustainability criteria and parameters for retrofitting commercial office buildings, determining the important sustainability criteria and parameters for improving occupants productivity, developing framework for retrofitting commercial office buildings that improves occupants' productivity and validating the indicators assessment. A sequential mixed method research approach consisting of in-depth interview and questionnaire survey was adopted. Data from the interview were analysed by thematic content analysis using Nvivo 8 software. Thirteen sustainability criteria and thirty-one parameters were identified which forms the basis for questionnaire survey. The structured questionnaires were distributed to occupants in four selected commercial office buildings within Kuala Lumpur, Malaysia. Descriptive statistics and important index analysis were used to identify the important criteria and parameters that influence the productivity of occupants, and the data was further subjected to testing for statistical significance using one-sample t-test analysis. The results led to the extraction of sustainability criteria and parameters that serve as the basis for developing the framework. Validation of the framework was carried out using commercial office building to test the indicators. The result shows an overall score of 75.06% for the case study building, indicating that the framework is suitable for sustainability assessment of retrofitting commercial office buildings for occupants' productivity. The findings of this research can greatly benefit the construction industry particularly facilities managers as guideline for sustainable upgrading of commercial office building. The framework can be use to assess the criteria of thermal and physical comfort, functionality, space planning, safety, security and accessibility. Assessment score of 50% and above for the criteria indicate that the building meets the sustainability requirement and below 50% indicates need for retrofitting.

ABSTRAK

Para penyelidik dalam pengurusan fasiliti (FM) telah menekankan keperluan mengutamakan pandangan pelanggan ke arah kejayaan sesebuah organisasi. Penilaian selepas penghunian (POE) telah diguna secara meluas untuk persekitaran dan fasiliti yang berbeza: misalnya, untuk menyasat nilai tambah FM, pengurusan tempat kerja, pengurusan prestasi dan kelestarian. Bangunan pejabat komersial telah dikenalpasti sebagai bangunan yang berpotensi besar untuk menyelesaikan prestasi penghuni. Pembuktian dari POE menegaskan bahawa bangunan yang diubahsuai seringkali tidak memenuhi jangkaan penghuni. Ini menunjukkan terdapat jurang yang jelas antara manfaat bangunan yang diubahsuai dengan jangkaan penghuni. Matlamat kajian ini adalah untuk membangunkan sebuah rangka kerja penilaian kelestarian bagi pengubahsuaian bangunan pejabat komersial. Objektif yang terlibat: meneroka pandangan pakar terhadap kriteria dan parameter kelestarian untuk pengubahsuaian bangunan pejabat komersial, menentukan kriteria dan parameter kelestarian yang penting untuk meningkatkan produktiviti penghuni, membangunkan rangkakerja untuk pengubahsuaian bangunan pejabat komersial dalam meningkatkan produktiviti penghuni dan mengesahkan indikator penilaian. Pendekatan kaedah campuran berurutan yang terdiri daripada temubual secara mendalam dan kajian soal selidik telah digunakan. Data yang diperolehi dari temubual telah dianalisis melalui analisis kandungan tematik menggunakan perisian Nvivo 8. Tiga belas kriteria dan tiga puluh satu parameter kelestarian yang dikenalpasti telah menjadi asas kepada kajian soal selidik. Soal selidik berstruktur telah diedarkan kepada pengguna empat bangunan pejabat komersial yang terpilih di Kuala Lumpur, Malaysia. Statistik deskriptif dan indeks analisis telah digunakan untuk mengenal pasti kriteria yang penting dan parameter yang mempengaruhi produktiviti penghuni, dan seterusnya ujian statistik ketara dijalankan menggunakan analisis ujian-t satu sampel yang membawa kepada pemilihan kriteria dan parameter kelestarian yang digunakan sebagai asas dalam membangunkan rangka kerja. Pengesahan rangka kerja telah dijalankan menggunakan bangunan pejabat komersial bagi menguji indikator. Dapatan kajian menunjukkan markah keseluruhan sebanyak 75.06% bagi bangunan kajian kes, menunjukkan bahawa rangka kerja ini sesuai untuk penilaian kelestarian pengubahsuaian bangunan pejabat komersial untuk produktiviti penghuni. Hasil kajian ini boleh memberi manfaat kepada industri pembinaan terutamanya pengurus fasiliti sebagai garis panduan untuk naik taraf kelestarian sesebuah bangunan pejabat komersial. Rangka kerja ini boleh digunakan untuk menilai kriteria keselesaan terma dan fizikal, fungsi, perancangan ruang, keselamatan, sekuriti dan kemudahsampaian. Skor penilaian 50% dan ke atas bagi kriteria menunjukkan bahawa bangunan itu memenuhi keperluan kelestarian dan di bawah 50% menunjukkan bahawa ia memerlukan pengubahsuaian.

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LIST OF ABBREVIATION

ASHRAE	-	American Society of Heating, Refrigerating and Air Conditioning Engineers
BAS	-	Building Assessment System
BEPAC	-	Building Environmental Performance Assessment Criteria
BIFM	-	British Institute of Facilities Management
BMS	-	Building Management System
BPRU	-	Building Performance Research Unit
BREEAM	-	Building Research Establishment Environmental Assessment Method
BQA	-	Building Quality Assessment
CBD	-	Central Business District
CCTV	-	Closed-Circuit Television
CFM	-	Centre of Facilities Management
CIDB	-	Construction Industry Development Board, Malaysia
CIQ	-	Customs, Immigration and Quarantine
EDRA	-	Environmental Design Research Association
EPA	-	Environmental Protection Agency
FM	-	Facilities Management
FSA	-	Functional Suitability Analysis
GBI	-	Green Building Index
HID	-	High Intensity Discharge
HK-BEAM	-	Hong Kong Building Environmental assessment method
HVAC	-	Heating, Ventilation, and Air Conditioning
IAQ	-	Indoor Air Quality
IBC	-	International Building Code

ICT	-	Information and Communication Technologies
IFMA	-	International Facilities Management Association
LEED	-	Leadership in energy and environmental design
NAFAM	-	National Asset and Facilities Management
NFPA	-	National Fire Protection Agency
O&M	-	Operations and Maintenance
PEA	-	Property Efficiency Appraisal
POE	-	Post Occupancy Evaluation
REN	-	Real Estate Norm
SAP	-	Systems, Applications and Products in Data Processing
SBS	-	Sick Building Syndrome
ST&M	-	Serviceability Tools and Methods
UBC	-	Unified Building Code
WBDG	-	Whole Building Design Guide
WELS	-	Water Efficiency Labelling and Standards
WHO	-	World Health Organisation
WSHC	-	Workplace Safety and Health Council

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CHAPTER 1

INTRODUCTION

1.1 Background

The concept of sustainable buildings continues to attract international attention in the wake of growing environmental demands. A great deal of the focus has been on the accommodation of sustainable principles in building design and the incorporation of retrofit solutions in the subsequent building life cycle. A fixation with technological remedies can, nevertheless, look out on the fundamental role of the facilities management team in ensuring the continued rectification and improvement of a building's performance. The idea of a sustainable retrofitting of buildings should be subject to continuous improvement throughout the building life and influence on the occupants need and expectation. Much has been discussed about the failure of many 'retrofitted' commercial office buildings to realize their potential in improving the occupants' needs. This failure in cognitive process may turn out over time as a general impairment in performance. In achieving the goal of sustainability in buildings, facilities management (FM) plays an indispensable role, tackling the complexities of people, process, and stead. The layered concept of building systems and the associated concepts of passive and active systems highlight the staged involvement of the facilities management team.

McKibben (2007) described sustainability as a quiet revolution that goes round the consensus that what we demand is 'more'. Sustainable strategies aim to regulate one-sided approaches regarding economic, social or environmental dimensions to deliver a balanced outcome. The new scheme of sustainable buildings evolves from the incorporation of the concept 'sustainable development' into the real estate and construction industry that offers

an integrated access to environmental, social, and economic proportions. The World Commission on Environment and Development (WCED) popularised this concept in the Brundtland Report in 1987, indicating that it ‘meets the demands of the present without compromising the ability of future generations to satisfy their own needs’. However, Kielstra (2008) proposes that companies are at an early stage in gaining such an understanding of sustainability and addressing the attending opportunities and risks has become a ‘sustainable challenge’. Sustainability as a concept can become devalued if occupants’ engagements with buildings are not acceptable.

By conceptualizing phenomena and highlighting trends, sustainability simplifies, quantify, analyse and put across the complex and complicated information (Best and Purdey, 2012; Zuo and Zhao, 2014). In this regards occupants’ attitudes towards a building’s ‘green’ identity interacted with the building’s operation and the occupants’ overall satisfaction of the building can impact on the buildings’ sustainable performance.

Research in the field of ‘green building’ focused on the assessment of environmental and (to some extent) health-associated properties of buildings. The further development towards the ‘sustainable building’ approach led to the inclusion of economic and social aspects that resulted in a substantially widened scope of assessment criteria. Concerning ‘sustainable buildings’, the description of functional building performance is thus a precondition for safeguarding the comparability of building concepts, and for validating the fulfilment of building users’ needs (Lutzkendorf and Lorenz, 2007).

Therefore, this can be accomplished by merging both approaches of sustainable and green building and by the growth of an overall scheme for the description and assessment of a building’s features and attributes, so this research focus on acquiring a concept of POE assessment criteria concept in retrofitting process for the fulfilment of building user's need towards performance-based sustainability.

In commercial office settings, such as the workplace, where needs, incentives, responsibilities and the means for users to interact with building systems differ from the residential context, feedback mechanisms and their power to change behaviour are less easily understood. How much and what kind of information is valuable to occupants, and how this information should be surrendered, are important questions to be addressed (Cole et al., 2008). Feedback in both conventional and retrofitted commercial office buildings is particularly important, not only to support the transition of users and operators to new indoor environments, technologies, and expectations around comfort, but also to motivate environmentally responsible behavior. Retrofitted buildings may offer an opportunity to teach lessons about sustainability, linking individual actions to larger social and ecological issues, through demonstration (e.g. Signs and exhibitions), direct experience and reflection, and active participation.

Commercial office buildings have a key function to play in facilities management (FM). Most people work and live within buildings, hence, they are considered as the backbone of the workplace. With the emergence of FM, buildings were being seen to a greater extent as an enabler to the leading business to sustain the creation of expected performance towards productivity (Douglas 1996). Expectations, standards and requirements of building residents have increased owing to improvements in engineering science and alterations in economic conditions. Facilities managers therefore have to continually strive to identify the needs of residents in order to fulfil their expectations. This would go to more satisfied and productive workplace occupant.

A sustainability assessment framework for retrofitting commercial office buildings that reflect the views of occupants (POE) is rattling essential for assessment of retrofitted and conventional commercial office buildings. In this research, the focus is for this framework to be used as an initial planning tool for retrofitting conventional commercial office buildings and improve the already retrofitted commercial office buildings to determine problems and other focus areas in the building for sustainable retrofits to ensure that all stakeholder requirements are met in the process. This will offer an opportunity to

achieve social benefits of retrofit in addition to its known economic and environmental benefits for the productivity of occupants.

1.2 Research Gap

The research works on retrofitting buildings appears to confirm a positive connection between green workplaces and worker expectation for retrofitting commercial office buildings (e.g., Heerwagen 2000; Kibert, 2007). According to research released by The Royal Institution of Chartered Surveyors in 2005, the most significant impacts of retrofitted buildings on occupants include increased occupant satisfaction, exceeding even the projected environmental benefits. Similarly, Office Tenant Survey by Colliers International showed that major corporations perceived retrofitted buildings to extend not merely cost savings through reduced energy expenditure but also benefits such as comfort, satisfaction, increased employee turnover, less sick leave and better morale.

Numerous studies have proven that retrofitting commercial office buildings can provide a better overall environment for their occupants (Ati Rosemary Mohd Ariffin, 2014). The returns of retrofitting buildings are often important justifications for a firm's shift to a green workplace. Heerwagen (2000) described some of the common technical features of retrofitted buildings that may contribute to workplace productivity. These include: improved ventilation systems to increase airflow and reduce airborne infection, selection of less toxic building materials and furnishings, Reduced energy use and improved interior illumination through day-lighting, Use of high quality, energy efficient lighting to reduce computer glare, Increased use of natural light to create a natural environment and Improved maintenance to reduce build-up of microbial contamination. A study by Haynes (2008a) in an office building also proved that employees feel that the workplace influences their output. Enhancing the workplace also has the potential for minimising complaints and absenteeism.

The above discussion focuses only on the satisfaction of the occupants with the building not on their expectations of sustainable retrofit features that will improve on their productivity. This suggests that there is a clear gap between the benefits of retrofitted commercial office buildings to its occupants in terms of improving productivity, on that point are also gaps between user expectations and their real perceptions of certain faces of such constructions, yet there is little evidence in literature of facilities management fields that specifically concentrate on sustainability criteria and parameters for the productivity of occupants.

This clearly shows the importance of conducting this research as it explores post occupancy evaluation as a concept in facilities management. This research builds upon the earlier work of researchers, addressing the expectation of the occupants in commercial office building of retrofitting as its influence on the occupant productivity.

1.3 Statement of Research Problem

Sustainable building performance and its assessment have earned increased attention in recent years, especially with respect to retrofitting buildings. Retrofitting the commercial office building has been identified as having a key potential in addressing improvement of the building green features, less concern is given for occupants expectation of sustainability in the process of retrofitting to enhance their productivity (Gou et al., 2012; Zhang and Altan, 2011; Frontczak et al., 2012; Danatzko et al., 2013). It, however, became imperative that improved productivity and accountability in building performance become significant to ensure that commercial office buildings produce significantly the much needed enhancement towards the occupants' needs and prospects.

Commercial office buildings are one of the facility where administrative work and business-related services are achieved, rendered, and expended and have the potential to create a substantial impact on its occupants' performance (Danatzko et al., 2013). The primary role of an office environment is to support its residents in performing their task.

In this regard, retrofitting commercial office buildings for sustainability need to be carried out based on the prospects of the occupants' socially sustainable mindset in society to better their overall productivity. A retrofitted commercial office building in the perspective of this study is delimited as a building that continually meets the users' needs and expectations with respect to defending the core purposes of workplace and working environment primarily for administrative, business and managerial functions. The inability of retrofitted commercial office buildings to attain the needs and expectations of occupants may reduce productivity of the occupants. This has the implication of hampering the occupants' achievement and this would likely impact on the turnover for the company and the overall performance of the occupants.

1.4 Research Question

- Q1. What are the relevant performance criteria and parameters for measuring sustainability of existing commercial office buildings?

- Q2. How is the commercial office building currently being assessed for sustainability?

- Q3. What are the most significant measures for assessing commercial office buildings for the productivity of occupants?

- Q4. How will the survey data reveal the relevant configuration for the assessment framework?

1.5 Research Aim and Objectives

The research aim is to develop a post occupancy evaluation sustainability assessment Framework for retrofitting commercial office buildings.

The following objectives were set for the research:

- i. To explore experts' view of relevant sustainability criteria and parameters for retrofitting of commercial office buildings
- ii. To determine important sustainability criteria and parameters related to occupants' productivity in commercial office buildings
- iii. To develop a sustainability assessment framework for retrofitting commercial office buildings that improves occupants' productivity
- iv. To validate the applicability of the sustainability parameters on a case study building.

1.6 Scope of the Research

The framework developed in this research serves as a measurement tool for determining the extent to which sustainability in commercial office buildings will impact on the occupants towards increasing their productivity. The developed framework is specifically applicable to retrofitting commercial office buildings. The application of the developed framework is limited to buildings that have already been occupied. While the framework developed may serve as a guide at earlier phases of commercial office building retrofitting development, its use for assessment purpose is only applicable at the occupancy phase. Thus, assessment using this framework may be regarded as a form of post occupancy evaluation.

1.7 Significance of the Research

Facilities managers are responsible for the management of services and procedures that underpin the core clientele of an organization. They ensure that an organisation has the most suitable working environment for its employees and their activities. The outcome

of this research would be useful to FM within commercial office buildings in achieving this responsibility with regard proper operation of all aspects of a building to create an optimal, safe and cost effective environment for the occupants to function in the buildings. Specifically, the framework could serve as a tool for assessing the retrofitting with regards to the extent to which the commercial office buildings meet the expectation of occupants. It is provided as a mechanism for identifying aspects of commercial office buildings that need to be improved for enhanced productivity of the occupants. This has implication on the ability of the buildings to enhance the objectives of its occupants, thereby contributing to the overall performance.

1.8 Overview of Research Process

The overview of the process of this study is briefly outlined below:

i. **Literature Review:** This stage involves review of literature related to the study. It provided the basis for articulating the problem statement and research objectives and the theoretical framework based on the theory of the most well-known descendant of the discrepancy theory ‘expectancy disconfirmation paradigm’, which states that, if performance exceeds expectations, individuals will be positively disconfirmed (increase in productivity). On the other hand, if performance fails to meet expectations, individuals will be negatively disconfirmed (decrease productivity)

ii. **In-depth Interview:** This was used to explore aspects of sustainability criteria and parameters for retrofitting commercial office buildings. Seven experts of the green building accredited facilitators participated in the exercise. The outcome of this stage helped in achieving the first objective of the study. It also provides input for developing survey instrument used in the next stage of the study.

iii. **Questionnaire Survey:** This was used to determine the important criteria and parameters with regard to occupants’ expectation of sustainability in retrofitted and conventional commercial office buildings that improves productivity. Responses were collected from 352 occupants from four selected commercial office buildings. Descriptive

statistics and Important Index analysis were used to analyse the data. Results from this stage were used to achieve the second objective.

iv. **Framework Development:** This stage involves development of an assessment framework. A scoring system for respective criteria and parameters was determined. This achieved the third objective.

v. **Framework Validation:** A sustainable commercial office building was selected and assessed to validate the framework. This achieved the fourth objective of the study.

1.9 Thesis Outline

The thesis is reported in eight chapters.

Chapter 1 highlighted an overview into the whole study. It provides the background, problem statement, objectives and scope of the study, brief overview of research methodology and organisation of chapters.

Chapter 2 provides the review of literature. It discussed relevant topics such as user needs and preferences in the workplace; influence of workplace needs and preference on user satisfaction and productivity; impact of customer focus in facilities management; factors that influence workplace satisfaction and productivity; and impact of facilities on occupants satisfaction and productivity; sustainability in the context of built environment and how it promotes more satisfied and productive occupants; the function of commercial office buildings; the concept of retrofitted office building and its link to meeting occupants expectations.

Chapter 3 presents the performance evaluation systems and rating tools used in assessing sustainability of buildings which are mostly used in assessing performance of the building from different countries; it describes the different existing assessment tools.

Chapter 4 describes the research methodology adopted in the study. It describes various aspects of the study such as philosophy, research design, data collection and data analysis methods.

Chapter 5 shows the results and discussion of the in-depth interview. The purpose of conducting the interview was to explore experts view relating to criteria and parameters for retrofitting commercial office buildings.

Chapter 6 displays the results and discussion of the questionnaire survey. The chapter consists of two parts. In part one, the data was subjected to descriptive analysis. The results helped in identifying the important criteria and parameters which are relevant to occupant's expectation of sustainability in commercial office buildings. The second part deals with determining relative importance of each criteria and parameter for retrofitting commercial office building, which was used to develop the assessment framework.

Chapters 7 describes the process of developing the framework of criteria and parameters for retrofitting commercial office building and discusses the proposed scoring system and the weightings for the criteria and parameters

Chapter 8 presents the validation of the assessment framework using a selected commercial office building. Detailed outcome of the assessment exercise were reported.

Chapter 9 concludes the write up and gives a brief summary of the whole study, major findings, contributions, and limitations of the study. Recommendations for further study were also suggested.

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