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A FRAMEWORK TO IMPLEMENT DESIGN AND BUILT PRACTICES FOR GREEN AND ADAPTIVE REUSE OF EXISTING BUILDINGS

WIJESIRI W.M.M.[1], DEVAPRIYA K.A.K.[2] & RATHNASIRI H.W.T.P.[3]
[1,2,3]Department of Building Economics, University of Moratuwa, Katubedda, Sri Lanka
[1]Madhuranga.wijesiri.wm@gmail.com, [2]kakdevapriya@uom.lk, [3]Stprathnasiri@gmail.com

Abstract

Adaptive Reuse is the process to improve environmental, social and financial performance of buildings. Reuse of existing buildings, especially as a result of performance upgrades has been identified with a significant impact on the sustainability of built environment. Application of adaptive reuse with green building concept is known as difficult and lacks attention in the field of research. Further, the potential to implement Green Adaptive Reuse has become uncertain as the way of implementing specific design, build practices for green buildings is still unknown. Thus, this research is aimed at developing a framework to implement design and built practices for green adaptive reuse of existing buildings. A qualitative research approach was followed for this research with semi-structured nterviews involving nine (09) local expert professionals and one (01) international expert professional. The findings were analyzed using content analysis method. Physical, Economics, Functional, Technological, Social, Legal and Political were identified as major design criteria, which related to green building practices. Further, the findings included with barriers and strategies for the implementation of green adaptive reuse for existing buildings. Considering the Sri Lankan context, this study developed a framework as a guide for the implementation of green adaptive reuse for existing buildings. Moreover, government involvement, conducting social awareness programmes, developing skilled professionals, empowering the regulations, provisions of tax concessions through government intervention were highlighted as strategies to mitigate barriers of green adaptive reuse. Finally, a framework was developed for the implementation of green adaptive reuse concept for existing buildings.

Keywords: *Adaptive Reuse- Green- Existing Buildings- Design and Built Practices-Barriers and Strategies*

1. Introduction

Reuse can be described as something special, unique and often expensive, and adaptation can mean rehabilitation, refurbishment or repair work, not necessarily involving the use of changes (Holyoake & Watt, 2002). Therefore, it can be reasonably justified that adaptation is a way to extend the life of a building and thus extend its sustainability through a combination of improvement and conversion (Lowe, 2004). Adaptive reuse can be identified as a process that improve the environmental, social and economic performance of any building (Langston, et al., 2008). Adaptive reuse the process of converting an obsolete or invalid project into a new project that can be used for different purposes, and it is the bypasses the wasteful demolition and reconstruction process (Department of Environment and Heritage [DEH], 2004). JL Architects (2015) points out that the key advantage of adaptive reuse is the opportunity to create a sustainable and uniquely designed structure that nods in history and current purposes.

The new building construction consumes many raw materials, energy and produces high carbon emissions. Buildings are more than 40% of global energy each year, producing one-third of global greenhouse gas emissions (GGE) (United Nations Environmental Programm [UNEP], 2009). Reuse of existing building stocks, especially due to performance upgrades, has been identified as having a significant impact on the sustainability of the built environment (Bromley, et al., 2005). According to Reed and Wilkinson (2008), there have been developments in the building design and construction phase that can reduce energy waste and reduce carbon dioxide (CO^2) emissions, however, there are major problems with existing building stocks.

Most of existing stocks are in poor condition and operating efficiency is very low, such as high-energy consumption (Ma, et al., 2012). The adaptability of a building depends on its design, materials, form

and extent to which the building is suitable for its purpose (Remoy & Wilkinson, 2012). In the past decade, the concept of building adaptive reuse has become important, as work in public and private organizations requires more creative and flexible workplace design changes (Douglas, 2006).

According to the Myers and Wyatt (2004), Sustainable development raises the importance of buildings as economic, social and cultural capital and should not be wasted. As described by Getty Conservation Institute, Current research efforts are advocate the integration of green environmental design into the adaptive reuse of existing buildings (Getty Conservation Institute [GCI], 2011). Only a few places have been mentioned for about green adaptive reuse of buildings and their green design and built practices. Due to the limited research published on green adaptive reuse in existing buildings, particularly in terms of sustainability, the proposed review is expected to provide the basis for future research in this contemporary and controversial area.

The aim of this research was to implement design and built practices for green adaptive reuse of existing buildings in built environment. The objectives were identified as, (i) To identify the design and built practices for green adaptive reuse of existing buildings, (ii) To determine the barriers of design and built practices for green adaptive reuse of existing buildings, (iii) To investigate the strategies to implement design and built practices for the green adaptive reuse of existing buildings and (iv) Develop a framework to implement design and built practices for the green adaptive reuse of existing buildings.

2. Literature findings

2.1 CONCEPT GREEN ADAPTIVE REUSE OF EXISTING BUILDINGS

In an age of climate change, adaptive reuse is important to future because must maximize wealth and utility to minimize resources and environmental impacts (Gorgolewski, 2008). "Green adaptive reuse" is an effective way to extend the life of the facility and reduce the carbon footprint while helping to protect the value of important heritage that defining cultural development. The concepts of "Green Adaptation and Reuse", including the principles of green renovation of historic buildings and technology to improve performance while preserving heritage and cultural values (Langston , 2010). Through green adaptive reuse process of building, sustainability and climate change can be promoted by reducing CO2 emissions (Bullen, 2007). However, this is an important strategy for adaptive reuse. Practitioners increasingly combine sustainable design with adaptive reuse of existing buildings to create a green adaptive reuse area (Thomsen & Van der Flier, 2006). Furthermore, further research and advocacy are needed to develop guideline and strategies increasing the green adaptive reuse of buildings.

2.2 DESIGN AND BUILT PRACTICES FOR GREEN ADAPTIVE REUSE OF EXISTING BUILDINGS

The architectural and structural integrity of the building must be maintained while adding modern features (Loonen, et al., 2001). In addition, it is necessary to check the settlement of the foundation and the adequacy of was carried new load conditions. The structural properties of building materials, including soil, must be tested. Retrofitting modern pipelines, HVAC systems, and electrical and communication systems requires sophisticated surgery on existing skin and skeletons in historic buildings (UNEP, 2009). Meeting modern regulatory requirements such as fire safety, safety and disability to reduce the historical appearance of buildings is a major challenge (Wilkinson, et al., 2012). The removal and safe disposal of toxic substances is a strict requirement. All of these barriers are best handled by the careful planning of architects, engineers and builders before beginning the implementation of adaptive reuse projects (Hein & Houck, 2008). Designing a building for adaptability can reduce the generation of significant construction waste during building renovation (Adeyemi, et al., 2014).

2.3 BARRIERS OF GREEN ADAPTIVE REUSE OF EXISTING BUILDINGS

One challenge that architects and engineers face when designing for adaptive reuse is designing a high performance building while maintaining the independence of the systems and features that enhance adaptability, such as redundancy, robustness, and ease of access, repair and replacement (Saleh & Chini, 2009). Shipley, Utz, & Parson (2006) suggested that this technical challenge requires a wide range of renovation and refurbishment technologies. In addition, they are almost always accompanied

by higher cost challenges. The exhibits harmoniously restored all the structures of the building and restored them to their original freshness (Mathieu, 1999). Furthermore, Table 1 is presented three (03) main barriers according to the Haritos & Lam (2010).

Table 1 - Main Barriers

Main Barriers	Description
Cost	Construction elements and materials are usually not designed to facilitate their complete removal, which makes them difficult and costly to salvage
Safety issues	They are not been considered easy to remove in their design to get main elements, especially by trying to remove the tertiary and secondary elements and then disconnecting them often leads to high risk
Integrity issues	The fitness for purpose (or reuse) of construction elements and materials may be questioned as their strength and integrity may have been compromised from adverse loading effects, during their history of operation, or as a result of the removal process itself.

Source (adapted from Haritos &Lam, 2010)

3. Research methodology

According to the Taylor (2005), the advantages of qualitative approach as could focus on specific set of people, in depth study on broad topics, offer greater latitude in selecting topics and representing the views and perspectives of the people. Therefore, qualitative approach was selected to explore the concept vigorously. Because of the lack of applicability of the green adaptive reuse concept in Sri Lankan build environment, drawing a large sample of respondents for data collection was constrained. Hence, qualitative approach was undertake for this research. Within the research in concern, expert interviews were taken as the data collection sources (Kothari, 2004). Semi-structured interviews were select for this research because it elicits more elaborate and purposeful answers from the respond to the research questions. There expert interviews were used to accomplished set whole objectives of this research. In Sri Lankan green adaptive reuse of building context, expert professionals with both practical and theoretical knowledge were limited. Ten (10) professionals, who were experience of adaptive reuse, green building concept and design and built practices in construction industry.

Content analysis is the procedure for the categorization of verbal or behavioral data for the purpose of classification, summarization and tabulation (Creswell & Creswell, 2018). This refers to compiling and interpreting of collected data based on the research techniques used and form of data collected. For that, study was carried out by conducting the semi-structured interviews. Therefore, this research, content analysis was taken as the data analysis technique. The QSR NVivo 12 software is to be used for the data analysis process.

4. Research findings and analysis

4.1 DESIGN AND BUILT PRACTICES FOR GREEN ADAPTIVE REUSE OF EXISTING BUILDING

Design and built practices for Green Adaptive Reuse of existing buildings are discussed, while reviewing seven (07) design criteria, which were identified from literature. In literature review, Design criteria have to be applied on the reused projects, thus could be implemented several points (Naguib, 2015). Those are, Long Life (Physical), Location (Economics), Loose Fit (Functional), Low Energy (Technical), Sense of Place (Social), Quality Standard (Legal) and Context (Political). The design and built practices identified under each design criteria was structured and supported by “NVivo 12” data analysis software.

Table 2 - Design and Built practices in green adaptive reuse of existing buildings

Design and Built practices in green adaptive reuse of existing buildings
1. Long Life (Physical)
Consider Easy to maintenance
Consider the various geometries of the building before doing the design and innovation
Define building capabilities to save operational resources
Identified the structural integrity of the building (Purpose identified, brief identified, volume and safety identified)
Identify the climate changes

Identify the differential settlement and substrata movements
Indigenous workmen and quality craftsmanship
Look building's history for inspiration
Preserve the structure of historic building
Resuscitating the structural masonry shell and infusing it with a modern core
Reuse the existing materials
Select the durable materials and assets
Using eco-friendly materials
Using green resources and materials (Eg: Green Roof, Walls)
Using recyclable materials
2. Location (Economics)
Consider the built area, spatial proportion and enclosure, site access, parking and other facilities
Consider the location and distance of the urban or major city
Consider the planning constraints
Consider the transport and other infrastructure facilities in area
Design the plot size according to the landscape
Land in use highest and best
Minimum damage to the tree
Using Geothermal heating and cooling
Walkable distance to many public uses or services (Centrality)
3. Loose Fit (Functional)
Design the building as a flexibility
Design the space, as a divisibility, elasticity, multi functionality
Design the structural grid as the ideal and economic limit of the span and fully interchangeable
Design the vertical circulation
Space capabilities are changed according to the new requirements
Using multifunctional furniture
4. Low Energy (Technical)
Design the indoor and outdoor courtyard – open area, gardens
Design the thermal mass, sunshades and automated blinds
Dismantled to open the building to allow it to naturally daylight and improve air circulation
Ensure cross ventilation
Equitable green space allocation
Increase the ambient air intake
Installation the BMS system for the building services
Solar installation for getting the energy
The rainwater retention system collects and stores as much rainwater as possible
Using external stone paving
Using the double screen windows for western side
Using the glazing for sunlight glare control and regulate internal temperature.
Using the unique cooling system
When the light is too high or too low, automatic control and artificial lighting are ready to enter
5. Sense of Place (Social)
Design the building , according to the local and social communities
Design the building according to the human scale, then consider the anthropometrics.
Indigenous materials to conserve authenticity
Networking parks
Preservation of natural landmarks (Eg; large trees, sacred trees, rocks)
Prevent social and cultural attributes and value
Protect the historical aesthetic appearance of the buildings
Provides comfort and convenient facilities
Using the reusable materials with original appearance of the historic building
Visual coherence and organization of the built environment using the landscape
6. Quality Standard (Legal)
Check the air quality
Design hygiene and a clean environment
EMP's (Environmental Management Practices) implemented during the project based on significant environmental impact anticipated
Green building Comprehensive Assessment System for Built Environment Efficiency (CASBEE), SL – Green building Council , UK - LEEDS
Provision for high standard workmanship
Provisions for fire safety
To control the noise level, using the sound insulation materials
Using safety regulations
Using the environmental performance measures
Using the hazard and risk management plan
Using the non-hazardous materials

7. Context (Political)
Consider the Ecological Footprint
Follow the government and archaeological department Guidelines , principles and legislation
Get the community interest and participation
Green zoning (Environment conservation and protection zones)
Want the urban master plan.

4.2 BARRIERS OF GREEN ADAPTIVE REUSE OF EXISTING BUILDINGS

The converting Adaptive Reuse Buildings with Green Building Status is seem as a difficult task and can be identified as an area that lacks attention because their common barriers. According to the interviewees, such barriers can be identified in Green Adaptive Reuse of Existing Buildings. In the literature review, three (3) barriers were mainly identified including, cost, safety issues and integrity issues. In addition, interviewees discussed the barriers of Design and Built Practices for Green Adaptive Reuse of Existing Building in seven (7) categories. The Figure 4.9 illustrated the barriers of the design and built practices for Green Adaptive Reuse of Existing Buildings under each design criteria, which were structured and supported by "NVivo 12" data analysis software.

Table 3 - Barriers of Green Adaptive Reuse of Existing Buildings

Barriers of Green Adaptive Reuse of Existing Buildings
1. Long Life (Physical)
Cannot easy to disassembly
Lack of awareness
Lack of flagship project
Lack of motivation to adapt green
Lack of old materials (Eg: tiles or brick)
Over structures
Termite breakage
The facility has significant embedded physical life (or residual value) and structural integrity
The frame of doors and windows cannot be find in market
Time allocation problems
2. Location (Economics)
Financial risk
High opportunity cost
High repair and maintenance cost
3. Loose Fit (Functional)
Fault building design
No side or back yard
Outdated of equipment
Poorly arranged floor plan
Raised the leaks , Damage the building (Eg: with plant growth and water seepage)
4. Low Energy (Technological)
Inadequate space available to accommodate modern building services.
Inflexibility to accommodate new information technology
Limited local technical – know- how
No structural drawings and mechanical and electrical drawings
5. Sense of Place (Social)
An expensive building in a neighborhood where a new uses for the industrial plant which cause a loss in property values because no one wants to in that building
Lack of knowledge about the GARB concept
The communities against changing the heritage and culture of the property
The existing function or purpose of the facility has become inappropriate due to changing social expectations and/or market needs
6. Quality Standard (Legal)
Over protected
Regulation barriers
Unpredictable and difficult to predict due to lack of information about the future development and confidentiality of government policies
7. Context (political)
Archeological building protected
High control over historical – building reuse (modification)
National building protected

4.3 STRATEGIES TO IMPLEMENT DESIGN AND BUILT PRACTICES FOR GREEN ADAPTIVE REUSE OF EXISTING BUILDINGS

Barriers faced by the Green Adaptive Reuse projects throughout the design criteria (Physical, Economics, Functional, Technological, Social, Legal and political) were identified via the semi structured interviews conducted with the experts of Adaptive Reuse Buildings (Refer Section 4.2). Strategies adopted to overcome each barrier of design and built practices of green adaptive reuse of existing buildings were elicited from the experts during the interviews and literature review.

Table 4 - Barriers and Strategies

Barriers	Strategies
Lack of old materials	• Proper management system
Lack of awareness	• Conducting social awareness programmes • Developing skilled professionals • Provided training programme for the workers
Time allocation problems	• Implementation the time action plan • Implementation the time line
Lack of flagship project	• Management support and commitment • Conducting workshop
Lack of motivation to adapt green	• Conducting the awareness programme • Provided training programme
Financial risk	• Create a policy and use it consistency
High repair and maintenance cost	• Simplify the procedure • Optimize the equipment • Review training practices • Prepared maintenance schedule • Right technology and get warranties and insurance
Fault building design	• Assigned professional with proper skills and experience about Green Adaptive Reuse Building concept
Over protected	• Government involvement • Provisions of tax concessions through government intervention • Empowering the regulations
Limited local technical – know-how	• Using new technology

Among the identified barriers, this considers critical barriers such as barriers which are repeated in different design criteria and highlighted the barriers by experts. Table 4 presents the critical barriers of Green Adaptive Reuse Building projects along with the strategies. Strategies adopted to overcome the critical barriers faced by Green Adaptive Reuse Building projects.

5. Conclusion

The research findings and their entire outcomes can be achieved research objectives and finally research aim. The findings of the research, indicate a new concept to the Sri Lanka construction industry and society. The less awareness of the community and less government involvement is the major problems because of the undeveloped the GARB concept in the construction industry. Overcome the barriers of the GARB concept would be making the proper design and built practices for Green

Adaptive Reuse of Existing Buildings. Further, the findings included with barriers and strategies for the implementation of green adaptive reuse for existing buildings. Considering the Sri Lankan context, this study developed a framework (Refer Annexure I) as a guide for the implementation of green adaptive reuse for existing buildings.

6. Recommendations

In this research identified Design and Built Practices for Green Adaptive Reuse of Existing Buildings. In Sri Lankan construction industry, have not the framework for Adaptive Reuse or Green Adaptive Reuse. Professional in construction industry wants to proper framework for an adapted green concept for the adaptive reuse of existing buildings. Through the research, it was recommended to consider suggestion strategies. Government involvement, conducting social awareness programmes, developing skilled professionals, empowering the regulations, provisions of tax concessions through government intervention were highlighted as recommended to green adaptive reuse of existing buildings.

The research exposed scenarios pertaining to the Green Adaptive Reuse of existing buildings within design and built practices. Nevertheless, the Green Adaptive Reuse is a subject, which is developed with the time, and there are immense of scenarios yet to be discussed and exposed. These proposals are recommended as ideal proposals for further researches on Green Adaptive Reuse of existing buildings can be performed with the necessary adjustments.

- Test the validity of the Design and Built Practices for Green Adaptive Reuse of existing building developed framework to Construction industry in Sri Lanka
- Cost Benefit Analysis (CBA) of significant Green Adaptively Reused of existing building projects
- Implementing the assessment process for Green Adaptive Reuse of existing buildings
- Facilities Management (FM) role in Green Adaptive Reuse of existing buildings

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Annexure I - Framework for Design and Built Practices for Green Adaptive Reuse of existing buildings