

**STAKEHOLDER INVOLVEMENT IN
IMPLEMENTATION OF PUBLIC SECTOR GREEN
BUILDING PROJECTS**

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Degree of Master of Science in Project Management

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University of Moratuwa

Sri Lanka

December 2021

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Dissertation submitted in partial fulfilment of the requirement for the degree
Master of Science

Department of Building Economics

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December 2021

Declaration

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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Date

Abstract

Green buildings are gaining widespread acceptance in response to increasing environmental issues and global energy demands. Therefore governments across the world are taking key initiatives in implementing green buildings, which is also been adopted in Sri Lanka. However, it is observed that implementation of green building projects within public sector have many drawbacks with regard to building industry stakeholders. Therefore, intention of this study is to investigate stakeholder involvement in implementation of public sector green buildings projects in Sri Lanka.

This research aims to develop a framework that effectively overcome barriers in stakeholder involvement in the life cycle of implementing green buildings in public sector green building projects. Findings from literature survey supported by three case studies on an actual public sector building projects addressing green building life cycle were analysed to ascertain the barriers, causes involved in stakeholder involvement in implementation of green building projects in public sector. Barriers including key aspects barriers and stakeholder involvement were then verified through a questionnaire survey. The results were analysed using Relative Important Index and incorporated into a framework. The proposed framework is expected to direct effective implementation of public sector green building projects.

Keywords: Green Building projects, Public Sector, Stakeholder Involvement, Barriers

Dedication

This dissertation dedicated to my family members who have never failed to give me endless support not only throughout this task but also throughout my life.

Acknowledgement

This dissertation would not have been possible without the assistance, encouragement and dedication of numerous individuals and organizations who contributed in many ways. Therefore, I take this opportunity to extend my gratitude to all of them.

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LIST OF ABBREVIATIONS

| Abbreviation | Description |
|---------------------|--|
| BREEAM | Building Research Establishment Environmental Assessment Method |
| CASBEE | Comprehensive Assessment System for Building Environmental Efficiency |
| CoC | Certificate of Conformity |
| DGNB | Deutsche Gesellschaft für Nachhaltiges Bauen (German Sustainable Building Council) |
| GBCA | Green Building Council of Australia |
| GBCSL | Green Building Council Sri Lanka |
| HK BEAM | Hong Kong Building Environmental Assessment Method |
| LCA | Life Cycle Assessment |
| LEED | Leadership in Energy and Environmental Design |
| PPC | Preliminary Planning Clearance |
| UDA | Urban Development Authority |
| US EPA | United States Environmental Protection Agency |
| USGBC | United States Green Building Council |

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1 INTRODUCTION

1.1 Background

During the past decade sustainability in building construction has a significant growth in the building sector. Emissions of greenhouse gases, depletion of natural resources, high energy consumption and increased costs on building materials are among reasons leading the green buildings to forefront. With public awareness of such issues and constant improvement of industrial practices, green buildings are likely to play a significant role in shaping the future.

The building industry accounts for a significant percentage of energy-related carbon emissions across the world (Siva, Hoppe, & Jain, 2017). According to Nobel (2012), the public sector in USA is responsible for approximately one-third of the country's construction expenditure. As such the green movement across the world has placed green buildings in a significant position so that building demand can be met mitigating the negative impacts of building industry (Nguyen & Gray, 2016). In response to the global green movement, the building industries from many countries have taken these 'green measures' in their developments, setting strong accent on green building construction (Hwang and Tan, 2012). The growing awareness of green buildings creating positive impact on environmental issues is pushing green building to the forward. In keeping up with this movement, Sri Lanka has also considered in constructing green buildings a key national priority.

State owned public buildings not only provide space for public activities but they also serve as symbols of the country's ideals and priorities. These buildings and their sites have significant impacts on environment, economy, worker productivity and health. Consequently the governments representing the public sector are rethinking how it builds today to enhance the future.

However, researchers indicate that the concept of green buildings is still relatively new in the South and South East Asian region as many important stakeholders involved in the building industry are not aware of the green building concepts and its application (Nguyen & Gray, 2016).

The approach to green building projects brings several professional disciplines such as investors, regulators, consultants, project managers, suppliers and contractors together. From the inception of the building project it is vital to work collaboratively to ensure green building concept central to the project is met as a whole, rather than fulfilling add-on requirements as afterthought. This is for the reason that stakeholder interests and influences vary throughout phase of the project lifecycle (Aaltonen & Kujala, 2010). Siva et al. (2017) state temporary involvement between the stakeholders working on a single building project may lead to a failure. If not strategically managed, different stakeholders coming in at different phases of the green building project often lead to sub-optimal design. Siva et al. (2017) further elaborate that it is due to the absence of integrative involvement of stakeholders in the project. As a result, project goals become diluted due to the temporal involvement of project stakeholders.

1.2 Research Gap

There are many studies that have been done related to stakeholder management and green buildings. The need for integrative approach in stakeholder management in building projects has been raised in previous research (Chinyio & Akintoye, 2008). Often these studies focussed on identification, analysis, classification, and predictions on how to manage the stakeholders. Also stakeholders in green building projects and their interactions had been under the discussion (Yang, Zou, & Keating, 2013). However there is very little research done analysing stakeholder involvement in implementation of public sector green buildings projects.

This research intends to fill the gap by identifying possible barriers in stakeholder involvement in implementation of public sector green buildings projects. A research in this regard is current need as there are many drawbacks in adopting green building implementation within the current set of norms and practices in the public building sector.

1.3 Research Problem

The important role of stakeholders and their involvement in development and implementation of public sector green buildings projects is increasingly obvious. The barriers to the widespread adoption of green buildings interact with the stakeholders that are involved in (Yang, Zou, & Keating, 2013). The efforts in implementation are often trap at various phases of project life cycle by various stakeholders due to these interrelations. It is observed that the complexity of the construction sector and the even greater complexity of the social-ecological system within green building projects are implemented limit the outcome (Yang & Zou, 2014).

Current framed policies, regulations, rating schemes, financing mechanisms make stakeholder involvement in the green building project implementation complex especially in public sector. Under such circumstances, how to effectively involve stakeholders in implementing public sector green building projects? is the key question that need to be answered through this study.

1.4 Aim and Objectives

1.4.1 Aim of the study

Aim of this study is to develop a framework that effectively addresses the barriers in stakeholder involvement in the life cycle of public sector green buildings projects.

1.4.2 Research Objectives

This study mainly focused on developing the following research objectives;

1. To explore the stakeholder involvement in implementation of public sector green building projects.
2. To identify possible barriers of stakeholder involvement and causes that occurs in the life cycle of implementation of public sector green building projects.
3. To suggest solutions for the barriers in the stakeholder involvement in the implementation of public sector green building projects.

1.5 Methodology

The research was divided into three phases as preliminary study phase, data collection phase and data analysis phase. In the preliminary study phase, a literature survey was conducted to identify application of green building concepts worldwide, their adaptation to promote public sector constructions, their success and failures and the involvement of stakeholders.

In the data collection phase, a semi-structured interview with predetermined open questions was conducted among stakeholders in three identified public sector building projects in Sri Lanka as case studies to identify facts. Then it was evaluated upon the literature findings in relation to context of local building industry. A questionnaire survey based on above was then distributed among stakeholders involved in public sector green projects.

In the last phase, the data obtained from the case study and questionnaire survey were analysed to present the result. Therefore this research adopts mixed research methods to achieve the objectives.

1.6 Scope and Limitations

This research focuses only on barriers of stakeholder involvement in implementation of public sector green building projects. Present research does not study stakeholder management in implementation of public sector green building projects.

2 LITERATURE REVIEW

2.1 Introduction

Literature review is an approach to the research enables a better understanding about the theoretical stand point of the research problem. This chapter discusses about the green buildings, project management and stakeholder involvement in implementation of in green buildings public sector. The objective of this chapter is to explore the stakeholder involvement in implementing green building projects in public sector. An overview and analyse of barriers that have encountered in implementing of green buildings globally in both private and public sector are also discussed.

2.2 Sustainable Development and Green Building

2.2.1 Sustainable Development

Notion of sustainable development grew out from various environmental movements in earlier decades. The modern concept of sustainable development has been derived from the 1987 Brundtland Report defining, “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, 1987, p.54). Since then the concept of sustainable development has developed beyond its initial framework and is often present as divided into the economic, social and environment aspects. In the essence, the main principle of sustainable development is the incorporation of environmental, social, and economic aspects into all decision-making.

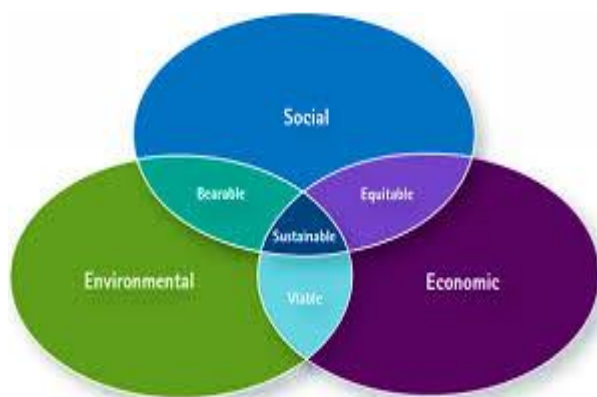


Figure 2-1. Scheme of sustainable development

Source: (<https://www.sustainable-environment.org.uk>, 2019)

One of the key policies observed in many governments worldwide is sustainable development in construction sector. This is in view of the fact that whenever construction come about construction industry alone has an enormous impact on the natural environment (Patil, 2012). In the present day construction industry offer high economic value as well as social significance to needs such as housing, workspace, utilities, transport, infrastructure and (Sev, 2009).

As it is observed, the relationship between sustainable development and construction industry has become obvious due to high economic significance, social impacts and strong environmental concerns. It makes construction industry an unusual case that endures lasting impacts comparing to other industries. Truly sustainable construction project should achieve the right balance between economic, social and environmental issues in the whole project life cycle of planning, construction and demolition stages with the aim of providing an environmentally conscious, accessible and affordable building (Sev, 2009).

According to Kibert (2008), sustainable construction centres on the context of environmental, social and economic issues of a building. Sustainable construction is the future of building industry and green building is actual tool in achieving sustainability (Akinshipe & Aigbavboa, 2018). Accordingly, green building is a stepping stone towards sustainable development.

2.2.2 Green Building

Green building refers to new approaches in planning, designing and constructing buildings in a way that reduces environmental impacts and occupant well-being in mind (Keysar & Pearce, 2015). United States Environment Protection Agency (US EPA) (2019) defines Green building as the practice of creating and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice counterpart with the conventional building design concerns of utility, economy, comfort, and durability. The Green Building Council of South Africa (GBCSA) defines a green building as a “resource-efficient, energy-

efficient and environmentally responsible building that reduces its direct and indirect impact on the environment throughout its life, from the beginning of construction, during occupancy, and when it is later demolished” (Abimbola, 2014). Robichaud & Anantatmula (2011) define the green building as a practice to reduce negative impacts on the environment, enhance people wellbeing, improve economic growth and propose public prosperity.

| Agency | Nature of Practice |
|---------------|---------------------------|
| US EPA | Building Lifecycle |
| GBCSA | Building Life |

Table 2-1. Promoting Agencies of Green Building Practice

Regardless of having multiple definitions, a green building accommodates sustainability concept by integrating environment, the social and economic value while preserving human wellbeing for the very future (Table 2.1). Essentially, green buildings set out to solve assessable problems associated with conventional buildings to create healthy facilities in a resource-efficient manner using environmentally based principles (Kibert, 2013).

However, researchers indicate that the concept of green building is still relatively new in the South and South East Asia region, that many key stakeholders in the building industry are not aware of the Green Building concepts (Nguyen & Gray, 2016). The uses of green concepts in building projects create new awareness among the stakeholders as movement of green in the industry. As a result, governments are taking key initiatives to promote and encourage green buildings worldwide.

2.2.3 Green Building and Project Management

In green building projects, a holistic and integrated design is being used right at the inception as green buildings have many distinctive design features that typically not found in conventional building which require deep integration (Kibert, 2008).

Therefore, Green building designs can be more complicated than conventional buildings as consideration must be given to alternative materials and systems by the design team (Glavinich, 2008). Therefore, reducing the impact of the construction practices on the environment must be planned and managed (Glavinich, 2008). Figure 2.2 shows participation of number of stakeholders in green building projects against conventional hierarchical arrangement in traditional buildings.

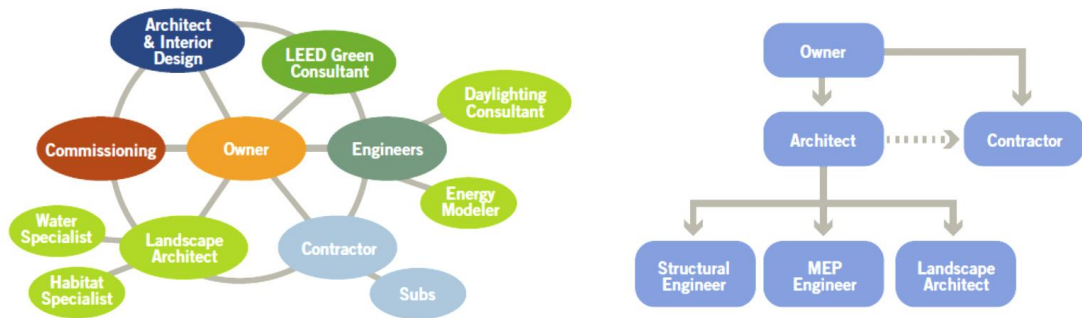


Figure 2-2. Stakeholder participation in Green building project vs. Traditional building project

Source: How- to guide to LEED certification for New Mexico Buildings (as cited in USGBC,

In a survey conducted by Hwang & Tan (2012) common challenges that project managers come across while managing green building projects are escalation of project cost, upfront costs of green practices, lack of communication, lack of credible research on benefits of green buildings and lack of interest from stakeholders. These challenges were interrelated resulting overall high cost premium for green buildings at the end (Hwang & Tan, 2012). The respondents in the study indicated that the escalation of total project costs in green construction projects are due to relative new green technologies and systems required to fulfil the anticipated performances of the buildings.

In implementation of green building projects specialized consultants in green technologies are required to be hired in order to assess and validate (Kibert C. J., 2013). This is an additional project cost. Also the knowledge and consultation provided by green consultants must be clearly communicated to project team members who may not possess knowledge with specific areas (Hwang & Tan, 2012).

If not done properly it will create complexity-of communication among project team members in turn causing miscommunication and interruption of information flow.

During construction, project managers and contractors have to pay attention to sustainable practices like waste management, minimum pollution to environment, minimum disturbance to the environment, which often neglected in traditional construction (Hwang & Tan, 2012). Often the reasons for this negligence are lack of awareness in green construction practices among contractors and project managers (Hewamanage, 2012).

Differentiating from conventional building project, commissioning and closing out of a green building project can be more complex (Glavinich, 2008). It is often the case when the developer wishes to obtain third party green certification. Different types of green certification and assessment tools have been developed worldwide to rate and monitor green buildings (Siva et al., 2017), such as LEED (US), BREEAM (UK), GBCA (Australia), Green Mark (Singapore), DGNB (Germany), CASBEE (Japan), and Pearl Rating System (Abu Dhabi). Developed by local green building councils, these schemes are voluntary and have been accredited by appointed professionals (Siva et al., 2017). Connecting these organisations as an international network the World Green Building Council was established to globally communicate the knowledge of green buildings to end users, tenants to maintain sustainability. Initiated as a third party verification that measures how well a building or community performs; the applicability of said standards are in question in relation to local contexts. As a result, different countries adopt their own developed standards for green building rating system (Table 2-2).

| Rating System | Promoting Agency |
|----------------------|--------------------------|
| LEED | United States of America |
| BREEAM | United Kingdom |
| Green Mark | Singapore |
| DGNB | Germany |
| GBCA | Australia |

| | |
|---------------------|-----------|
| CASBEE | Japan |
| Pearl Rating System | Abu Dhabi |

Table 2-2. Green Building Rating Systems Worldwide

Consequently, first to implement in Sri Lanka was GREEN^{SL}[®] Rating of Buildings by Green Building Council Sri Lanka (GBCSL) with affiliation of World Green Building Council in 2009. As of the annual report 2019/2020 GBCSL, Sri Lanka has 51 green buildings certified by GBCSL accounting for 6.0 million square feet and on-going 26 projects (Table 2-3.). Recognizing the importance of state intervention in implementation of green buildings in public sector, another initiative was initiated in 2017 by Urban Development Authority (UDA) in Sri Lanka making it mandatory to achieve green rating system for Government and semi government buildings (Blue Green Sri Lanka, 2017).

| No. of certified Buildings | Total Floor Area | No. of on-going projects |
|-----------------------------------|-------------------------|---------------------------------|
| 51 | 6.0 Mn sqft | 26 |

Table 2-3. Status of GBCSL certified green building construction in Sri Lanka

Source: Annual Report 2019/2020 GBCSL

Tight work plans of construction projects often leave out project team members taking inadequate time to understand green requirements (Hasan & Zhang, 2016). As such green requirements could be overlooked affecting the project negatively. Also green technologies could be costly to implement and investments in implementing green practices may not have their return on investment if they are not properly managed. Project team members require training and education in green building concepts until they acquire a certain level of performance on new technology and systems adopted in green building projects (Chan et al., 2017).

2.2.4 Green Building development cycle and general barriers in green building implementation

Green building projects call for an whole building life cycle assessment approach (LCA) that cater for all impacts on environment, social wellbeing and economy through four phases of (1) Plan and design (2) Construction (3) Operation and maintenance (4) Reuse or demolish (Deng, Yang, Tang, & Tang, 2016). Figure 2.3 below summarise the development ecosystem of green building.

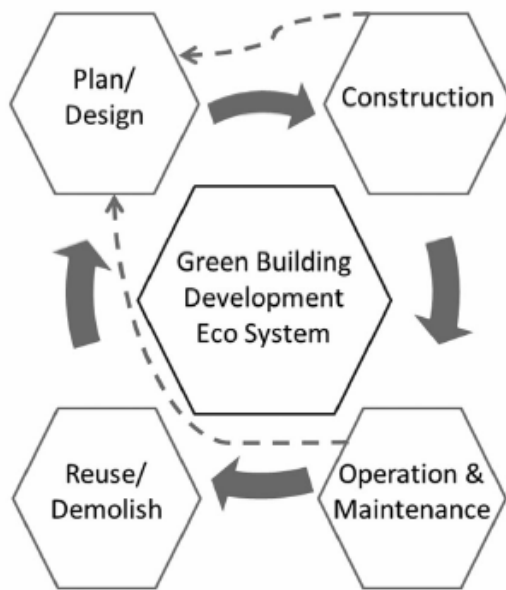


Figure 2-3. Green building development ecosystem
Source: (Deng et al., 2016)

2.2.4.1 Plan and Design

The whole building life cycle assessment approach is essential to successfully design, construct, and operate green building projects. By engaging many stakeholders as possible from early in the design process of green buildings enable to incorporate environmentally, economically, aesthetically, and functionally feasible solutions (Menassa & Baer, 2014). The variety of opinions, values, perspectives and expectations among stakeholders is considered valuable at this stage. This will make green building projects to be properly managed and avoid turning it from a liability into an asset (Hwang & Tan, 2012). Menassa & Baer (2014) further suggest that four E's (everybody, engaging, everything, early) can address each team member's

objectives, aspirations and values from early on in the project design. This will achieve an alignment among the team members before getting into a more detailed work.

The green building projects require effective collaboration of constant communication and design-making in an integrative and holistic means (Hwang & Tan, 2012). Key stakeholders in this phase consist of investors, developers, and clients, public authorities, green building rating agencies, design professionals, green building consultants. According to Deng et al., (2016), barriers recognized during this phase include; high financial risks, absence of market recognition, technological challenges, scarcity of qualified professionals, insufficient access to relevant knowledge and technologies, inadequate communication, lack of leadership, cost of green building products, lack of progressive policies and favourable incentives.

Abimbola (2014) identifies the professional team including many key players from distinct trades in architectural, electrical and mechanical are the most influential in the green building projects. This is for the reason that building envelope, energy efficiency and selection of materials mainly affects the built environment. Limited involvement of other industry stakeholders in the plan and design phase can negatively influence the performance of green building projects (Robichaud & Anantatmula, 2011). As such contractor's involvement in the plan and design phase is often limited. Abimbola (2014) argues that integrated procurement systems (e.g., turnkey, design and build, engineer- procure -construct (EPC)) would, permit more active participation of contractors in green building plan and design phase.

2.2.4.2 Construction

Unlike the conventional building construction which is a sequential process; green building construction is an integrated interactive process (Robichaud & Anantatmula, 2011). It makes use of the knowledge and skills of contractors and suppliers effectively in the green building projects facilitating effective decision-making and efficient communication. Accordingly, key stakeholders at construction phase are green building consultants, contractors, sub-contractors, developers, suppliers of

equipment material. According to Deng et al., (2016), barriers associated in this phase are costly green building products and systems, insufficient green construction industrialisation level, traditional linear procurement process, first mover risk, inadequate platforms to publicize and demonstrate new technologies, lack of knowledge, and inadequate coordination among stakeholders in between different phases.

In research conducted by Alkilani & Jupp (2012) Jordanian construction industry found that, substitutes to the existing two-stage procurement systems should be adopted across public sector due to design complexity. It is also highlighted that public sector should avoid practice of avoiding to the lowest bidder rather than to substantially responsive bid as it ‘disincentives’ contractors to invest in sustainable procurement practices (Alkilani & Jupp, 2012). In the Singapore building industry, projects awarded based on the lowest tender price suffered project cost related issues and can be are very sensitive to all stakeholders especially in green building projects (Hwang & Tan, 2012).

According to the research by Alkilani & Jupp (2012), participants stated lack of expertise and leadership within the public sector of Jordan. Participants reported critical decision-making relating to green building implementation were often assigned to public sector employees who do not have the sufficient knowledge and expertise in green building construction issues. As a suggestion, employing qualified professionals and consultants to advice on green building procurement processes and construction practices has been brought forward. Also the carrying out facility management strategies in green building operation needed to be taken on (Yang & Zou, 2014).

2.2.4.3 Operation and maintenance

Following stakeholders need brought together to work collaboratively for anticipated green performance during operation and maintenance phase of Green building projects. Building occupants, building owners, operators, facilities managers, green building consultants, contractors, community, green building systems suppliers and

installers, are all stakeholders who ought to involve in helping to solve the performance gap between design intentions and operational outcomes (Deng et al., 2016). Further inadequate exposure to relevant knowledge and technologies; lack of incentives and market recognition; insufficient knowledge and skills training; scarcity of qualified professionals in facility management and no mandate regulations on commissioning are to be the main barriers for achieving expected green building performance in the building operational and maintenance phase (Au-Yong, Myeda, & Azmi, 2021). Initial high investment of green buildings could be 'paid back' during proper operation and maintenance phase if project is properly executed and it will benefit occupant comfort and wellbeing while reducing environmental impacts.

2.2.4.4 Reuse/demolishing

There are several possibilities to extend the life of a building or ensure its disposal, i.e. re-use refurbishment, recycle and final disposal (Deng et al., 2016). Recycle, reuse and disposal measures can distinctly vary depending on the specific construction materials used like metal, concrete, glass, timber, plastics, etc. Hence cradle-to-cradle approach demands green thinking in advance for green building projects (Berawi, Miraj, Windrayani, & Berawi, 2019). As such policy makers, design professionals, contractors and suppliers are the main stakeholders involved in this reuse and demolish phase of a building life cycle. Current barriers in this phase include inadequate incentive mechanism, poor industrial standard systems, drawbacks in market recognition, insufficient access to relevant knowledge and technologies, non-availability of platforms to promote industry leaders and best practice (Deng et al., 2016).

The whole building life cycle approach (LCA) simplifies effective communication and quick decision-making by sharing stakeholders each other experiences, knowledge and expertise (Aaltonen & Kujala, 2010). Utilising this with integrated design and management supposed to overcome existing barriers in this phase.

| Project Life Cycle phase | Barriers |
|---------------------------------|---|
| Plan and Design | 1 lack of market recognition |
| | 2 absence of policies and incentives |
| | 3 high financial risk |
| | 4 technological challenges |
| | 5 absence of qualified professionals |
| | 6 insufficient access to relevant technologies and knowledge |
| | 7 poor communication and leadership |
| | 8 expensive green building product |
| Construction | 1 inadequate green construction industrial development |
| | 2 first mover risk |
| | 3 inadequate demonstrations on new technologies |
| | 4 expensive green building systems and products |
| | 5 traditional procurement process |
| | 6 poor coordination among stakeholders and in between different phases |
| | 7 poor of knowledge and trust |
| Operation and maintenance | 1 insufficient incentives and market recognition |
| | 2 insufficient access to related technologies and knowledge |
| | 3 inadequate knowledge and skills training |
| | 4 Shortage of qualified professional |
| | 5 inadequate platforms to showcase technologies and operational templates |
| | 6 no proper approval regulations on commissioning |
| Reuse/ Demolishing | 1 Poor industrial standard systems |
| | 2 inadequate incentive mechanism |
| | 3 Drawbacks in market recognition |
| | 4 insufficient access to related technologies and knowledge |
| | 5 non-availability of platforms to promote industry leaders and best practice |

Table 2-4 General barriers identified in green building project life cycle

(Source: Deng et al; 2016)

2.3 Stakeholder involvement in green building projects

Shift towards green building paradigm require a substantial move from the current architectural practice and building technologies (Deng et al., 2016). Such shift is not a mere technological transcendence but a social and technical transition that involves changes within national standards, policies, technologies, professional norms, and consumption behaviours. To increase the efficiency and effectiveness of the decisions made during the whole building life cycle, project managers require to develop comprehensive stakeholder involvement (Heravi et al., 2014). As stakeholders in building projects are numerous and different, the concept of stakeholder involvement take on a level of complexity (Aaltonen & Kujala, 2010). This becomes even greater with reference to green building projects.

2.3.1 Stakeholders in green building projects

Following Freeman's Stakeholder theory, definition for project stakeholders are defined as individuals and organizations that are actively involved in the project or whose interest may be affected as a result of project execution or project completion (Aaltonen & Kujala, 2010). According to the Project Management Institute (PMI), the term project stakeholder refers to, "an individual, group, or organization, who may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project" (Project Management Institute, 2013). Every project has stakeholders who are impacted or can impact the project in a positive or negative way (Project Management Institute, 2017). Certain stakeholders might have limited capacity to influence the project or outcomes; and some may have substantial influence on the project and its outcomes. Incorporating the various interests of stakeholders should be extremely important in implementing Green Buildings.

The central roles of stakeholders for the implementation of green buildings are progressively more obvious in the present. The difficulties to the widespread acceptance of green building practices network in ways that reinforce each other to create a formidable net within (Wallbaum, et al., 2010). Nevertheless, the complexity of the building construction sector, and the greater complexity of the social-

ecological system within it operates limits the effect of regulations, policies, rating schemes, preferential financing mechanisms put forward as incentives to change.

The incompatibilities of interests among stakeholders cause conflicts and disputes in construction (Lam, Chan, Poon, Chau, & Chun, 2010). Regardless of the rising interest of stakeholders in green building projects, effective stakeholder involvement is complex, challenging and often underestimated (Waligo, Clarke, & Hawkins, 2013). Collaboration is difficult due to the numerous and various stakeholders often having dissimilar viewpoints. However, the contribution of all stakeholder groups is necessary for the continual execution of a project.

According to Olander (2006), there are two basic categories of stakeholders: internal stakeholders who are actively involved in project execution and external stakeholders who are passively involved and affected by the project. Achterkamp & Vos (2008) elaborate Freeman's definition; the actively involved as "can affect" stakeholders and the passively involved as "affected" parties.

2.3.1.1 Internal Stakeholders

Also known as primary stakeholders, internal stakeholders are those who are the participants of the project (Olander, 2003). They know all the inputs and outputs of the project, its performance, and make significant decisions of the project. Each internal stakeholder plays a different role in the project interacting with each other. Over the total lifecycle of a typical building project the internal stakeholders are owner, investors, architects, developers, engineers, contractors, suppliers, workers, and end user (Yang & Zou, 2014).

As of study conducted by Yang et al. (2013), internal stakeholders play more significant roles in green buildings compared to external stakeholders. As Achterkamp & Vos (2008) they are otherwise elaborated as, "can affect" stakeholders or involved stakeholders within the project. Hence, is often considered as the key stakeholders of a project.

| | KEY-STAKEHOLDERS | MAIN CONCERNS |
|--|--------------------------------|---|
| INTERNAL-STRATEGIC STAKEHOLDERS | Investor | Return of investment; Economic feasibility |
| | Manufacturer / Supplier | Energy supply; Availability of natural resources |
| | Banks / Financial Institutions | Return of investment |
| | Contractors | Materials and Energy supply; Workforce |
| | Planners/designers | Knowledge; Creative and efficient application of technologies |
| | End User / Owner | Well being; Economic feasibility; Life style |
| | Public Authorities | Regulations and Control |
| EXTERNAL, NORMATIVE STAKEHOLDERS | NGO & Civil Society | Social equity; Access to information |
| | Research & Education | Technology and knowledge |
| | Media | Democratic share of information |

Table 2-5 Key stakeholders and their concerns in the building life cycle

Source: (Wallbaum et al., 2010)

2.3.1.2 External Stakeholders

External stakeholders are those affected by the project in a significant way (Wallbaum, et al., 2010). They have a variety of individual interests. Olander, (2003) suggest that public is an important external stakeholder when it comes to public sector financed building projects. Maintaining the public image of a project is crucial as well as managing their physical creation since poor public perception can damage or end a project implementation. Olander, (2003) further states that the need to address the interest of external stakeholders, the public in particular, and that the management of external stakeholders must be considered as an essential cost element in the implementation of any major public sector project. Apart from general public, external stakeholders like media, competitors, NGOs and certain communities can influence and cause complications in implementing green building projects (Yang & Zou, 2014).

2.3.2 Stakeholder Involvement

Active involvement and participation with stakeholders is important for projects experiencing a high degree of change. In a building construction project stakeholders are abundant and contrasting, which presents a level of complexity to the stakeholder

involvement (Heravi, Coffey, & Trigunarsyah, 2014). Menassa & Baer (2014) highlight that frequent communication at every level is must to incorporate each stakeholder's values so each stakeholder can understand how their values relate to each other. Stakeholder involvement encompasses creating and maintaining relationships that actively support and guarantee of the people to the implement change through green project delivery.

Satisfaction of the stakeholders should be identified and managed as a project objective (Project Management Institute, 2017). The importance of identifying the roles and concerns of the stakeholders should advocate the holistic inclusion of different interests from stakeholders. Siva et al. (2017) states in their study cooperation between stakeholders were considered as poor by the interviewees. This was mainly due to the absence of an integrative design approach in the projects. Various stakeholders involving at different stages of green building projects often lead to substandard design. As a result project goals may become diluted attributing to temporal involvement of stakeholders. Yang & Zou, (2014) point out that in stakeholder environs of green building projects, multiple and interdependent interactions simultaneously exist. So in green building projects, vital questions would be who associates whom and in what ways these stakeholders depend on each other for green project related decision making and execution.

To enable idelivering successful project outcomes, effective stakeholder involvement without a doubt is becoming a part of professional practice. According to the Project Management Institute (2017) project success relies on the principles of golden triangle of time, cost, quality; project stakeholder satisfaction and their incorporation to the project. Similarly project success and failure depends on the capability of the project manager and team on how properly they identify and engage all stakeholders. In order to increase the chances of success the stakeholder identification and involvement should initiate right after when project charter has been approved.

The key to effective stakeholder involvement is continuous communication with all stakeholders, understanding their needs and expectations, managing conflicting interests, and fostering appropriate stakeholder involvement in project decision

making and execution (Project Management Institute, 2017). Accordingly, activities of identification, prioritization, and involvement should be reviewed and updated in regular basis at least at the following:

1. When the project passes through different phases in its life cycle,
2. When present stakeholders are not involved in the current work or when new stakeholders become members of the project's stakeholder community
3. When there are noteworthy changes in the project organization or the wider stakeholder community.

The stakeholder literature is really weak on the stakeholder involvement. Bunn, Savage, & Holloway (2002) present six generic stakeholder involvement approaches to fit within the context of multi-sector innovation; and thus the essence of approaches redefined to project environment.

1. **Lead** – Leadership is the capability to lead a team and motivate people to do their work well. A successful project need strong leadership and is essential through all phases of the project life cycle to communicate the vision and inspire the project team to achieve the required performance. Top-level or management level support is essential for effective stakeholder involvement.

2. **Collaborate** – The project stakeholders may enter into strategic alliances or partnerships with suppliers, competitors, or customers in effectively delivering the project. This encourages collaborative problem solving and decision making.

3. **Involve** – Continue involvement of the key stakeholders throughout the project lifecycle in decision making and execution is important leveraging their relationship. Good relationships among project stakeholders create positive project outcomes. So it ensures that all stakeholders stay in the involvement process.

4. **Defend** – Technological advances and project complexities contribute to project task uncertainty and are in turn associated with project execution outcomes (Tatikonda & Rosenthal, 2000). If the project teams fail to defend these risks the

project success could not happen. Therefore assessing risks and defending the changes keep stakeholders involved in the long run.

5. **Educate** – Wider range of activities need to be accommodated through education and awareness to enhance communication and to engage influence over important stakeholders.

6. **Monitor** – With regard to stakeholders, information must be gathered and observed continuously for better stakeholder involvement.

The choices among these approaches depend on numerous factors including the project's relationship with the involved stakeholders.

2.4 Stakeholder involvement in implementation in public sector green building projects

Generally, when government seeks to implement new policies national wide it is first implemented through the public sector. Often these policies challenge professionals involved in public sector by adding new demands restricted by budget limits, multiple objectives, and shorter time frames (Keysar & Pearce, 2015).

Public sector building projects in Sri Lanka require following numerous procedures and regulations unlike private sector building projects. The main reason is that these projects utilise public money which the public sector is mainly accountable for. Hence stakeholders involved have higher stake in their involvement.

2.4.1 Implementation of Public Sector Green Building projects

Why Build Green in the Public Sector? The building sector itself is accountable for a noteworthy percentage of energy-related carbon emissions around the world (Siva et al., 2017). According to Nobel (2012), the public sector in USA is accountable for approximately one-third of the state's construction expenditure. Therefore the governments worldwide hold substantial influence over the movement towards green buildings.

Building sector is an interesting area to investigate the government's ability to implement green building strategy (Hall & Purchase, 2006). A country's government is often considered as the sole principal customer within a country which can possibly use acquiring power to influence the behaviour of private sector organizations (Walker & Brammer, 2009). In the due course findings show that the government's influence can promote a central role in implementation of green buildings. Hence government's involvement is expected one of the important and effective ways in promoting green buildings (Deng et al., 2016).

United States Green Building Council-USGBC (2011) identifies four factors that pursue public sector to promote green buildings.

1. Leading by Example – use best practices in construction, operation and maintenance of public sector buildings to promote local market transformation.
2. Reduction of operational and maintenance costs throughout building lifetime - water and energy efficiency combined with green operations practices to reduce operational and maintenance costs throughout building lifetime.
3. Extend infrastructure capacity - demands on infrastructure reduced through waste and storm water management in green buildings.
4. Decrease staff-related overhead costs – attaining worker satisfaction and productivity by improving indoor air quality, natural light and flexible design in green buildings

As governments encounter increasing utility bills, high demand for services and infrastructure, numerous public sector institutions in the United States and overseas are adopting policies to make sure that their facilities are designed to harness green strategies. Many of these guidelines are based on the U.S. Green Building Council's LEED (Leadership in Energy and Environmental Design) standard (Office of the Federal Environmental Executive, 2008).

Green building implementation does not only depend on the 'green' supply, but also on considerable market demands. According to Deng et al. (2016) public awareness

is an effective way for promoting green buildings for the reason that the public attitude can be transformed into demand conditions. This is may influence corporate business behaviour as well as increase in the supply in quality and quantity.

2.4.2 Involvement of stakeholders in public sector green building projects

Government departments and agencies representing public sector have many stakeholders contesting for resources and have different control over interactions with their customers and suppliers (Walker & Brammer, 2009). They are highly different, have multiple interests and play diverse roles (Wallbaum, et al., 2010). However, in green building projects, there is tendency of various stakeholders getting involved in different stages of the building life cycle.

Numerous studies have developed green building associated stakeholder lists for potential use in practice. Also, the role of stakeholders in green building project implementation has been given emphasis in several of researches. According to Yang et al. (2013) possible roles of stakeholders vary from providing of financial sources (investor), regulating activities (government), knowledge gaining (research), management (owner, developer, regulator, tenant), consultant (architect, engineer), construction (contractor, supplier, manufacturer), marketing, and occupant to the evaluation of a design and construction process (regulator, professional association, public, media). The addition of the stakeholders green building projects in public sector also involves new roles like setting up physical resources and strategies, value addition, application and mitigation of political or civic pressure.

As applying to current topic most part of the internal stakeholder comprises of government agencies and bodies in public sector. So unlike general green building project, it is vital to analyse the behaviour of the stakeholders in implementing green building projects in public sector within the set framework of governance and provision.

Public sector in definition by itself being part of an economy that is controlled by the state, the provision of financial sources (investor) is borne wholly or partly by the state. This brings about those regulating activities all fall into the strict condition of

government regulations in utilizing public money. Hence the developer, owner, commercial tenant, and regulator become the client. Often in Sri Lankan context consultation of many of these projects are undertaken by consultation firms in government sector or semi government sector in the objective in strict utilization of public funds, ease in fund transfer auditing and quality management. As of that in the two out of three main roles in client, consultant and contractor triangle is undertaken by the public sector.

Apart from that since 2017, it has made mandatory by the Sri Lankan government to acquire Green certification to all newly constructed buildings in public sector in response to the green movement globally. Recognizing the importance of government intervention to regulate policy and regulatory reform an initiative was initiated by Urban Development Authority (UDA) in Sri Lanka as competitor to GREEN^{SL}® Rating of Buildings by Green Building Council Sri Lanka (GBCSL) (Rathgamage, 2019).

2.4.3 Barriers in involvement of stakeholder in public sector green building projects

In implementing green building projects in public sector, stakeholders undertake risks in time, cost, quality, organizational /management issues, technical issues, policy and standard related issues, safety, ethics, reputation, and issues related to environment (Yang and Zou 2014). Uncertainty and risk related to novel green technology is common. Also the risks connected to the reliability and effectiveness of a novel product averts many experts from specifying green building materials (Lam et al., 2010). So understanding the environmental impacts, green practices, material selection and the effects of energy in construction are vital for the successful planning of a Green Building.

The various concerns, the barriers to overcome and the tools that implement green building can be approached from key stakeholders' perspective at different phases of building life cycle such as plan/ design, tender, construction, renovation, refurbishment, demolition (Wallbaum, et al., 2010). Certain conflicting of interests,

lack of information, different professional approaches, and poor strategies management make it problematic to bring together the diverse stakeholders into a single process. The innovations brought out by novel necessities of green buildings create additional challenges for the conventional practices and standards for decision-making by stakeholders at all phases of the building life cycle (Wallbaum, et al., 2010).

In order for better stakeholder involvement, the planning of green building should carry out by consultants with participation of key stakeholders (Project Management Institute, 2017). The approach of an integrated design team is necessary to all green building projects to achieve required project outcomes. It synchronises the project planning, promotes cooperation between disciplines and generates interactions between stakeholders. The approach brings together range of professional disciplines such as architects, engineers, project managers, and contractors work collaboratively from early on. This ensures green building performance goals are met from its inception rather than later add-on requirements.

Another analysis regarding the institutional barriers for implementation of green buildings revealed that main difficulties to green building development are the lack of interaction and cooperation among different stakeholders as well as the unequal distribution of costs and benefits amongst them (Xiaolu, 2014).

In a study conducted on investigating challenges of green building implementation in mainland China categorizes the key barriers of green building construction into four major aspects: management, technology, economics, and awareness (Hasan & Zhang, 2016).

1) Economics

Cost as well as time has been considered as economics where in implementation of green building is considered to add extra cost. With the use of green techniques it is often observed that capital cost is increased. Since stakeholders consider time as the main objective of projects, it goes in line with the cost as well.

2) Technology

Technical difficulties during design and construction of green buildings are widely discussed by studies regarding green building development.

3). Awareness

Lack of awareness in green initiative among the stakeholders is another drawback. The consultants, suppliers and contractors must have interaction from the early phases of construction as they will share mutual knowledge related environmental issues, technologies and building materials (Hasan & Zhang, 2016).

4).Management

Circo (2008) states without government initiation on green buildings, green building objectives would not be considered and would be overlooked. This demonstrate the important effect of regulatory and policy requirements on green building development. Hasan & Zhang, (2016) in fact stress that only if the top management in an oraganisation is committed to the environmental issues, will the organization employees at lower hierarchies will able to influence due to their limited power.

Considering above, how to deal with the barriers that occurs in implementing green buildings in public sector Sri Lanka is worthwhile to study.

2.5 Public sector Administration

Since the current research study implementation of public sector green building projects it is important discuss process and procedures in the public sector. Therefore, some key elements in public administration are described here.

The public sector officials today are not mere passive executor of public policy; its initiator and formulator at large (Bhagawan & Bhushan, 2009). They are responsible for appropriate authorities. As such, implementing green buildings in public sector require authority among the involved stakeholders.

2.5.1 Control over Administration

The bureaucracy of public sector has its vast discretionary powers. If such a powerful bureaucracy is left uncontrolled, it may turn irresponsible and tyrannical and thereby jeopardise the rights and liberties of the people. It is the very reason that every democratic government provides for a number of controls over administration. The purpose of control is to make sure that the bureaucracy exercises its powers within the limits of laws and established rules of procedures. There are definite controls on how administrative responsibility is enforced. Generally, there are two controls, namely external and internal controls.

2.5.1.1 External Controls

The external controls over the administration operate from the outside. According to Bhagawan & Bhushan (2009), external control over public administration is considered from four standpoints – of the executive, of the legislature, of the judiciary and of the community, respectively. These aspects influence decision and actions of public administrations. Some major persuasive facets that come through these aspects are as follows.

2.5.1.1.1 Political Direction

In public administration, public officers are answerable to administrative superiors namely Ministers representing Parliamentary Government (Bhagawan & Bhushan, 2009). The Minister of the line ministry has the power of direction, control and supervision over the laid down the policies and looks to their implementation. As experts, advisors and executioners of the decisions public officers exercise significant influence on the Ministers in making policies and their implementation.

However, the degree of administrative control of a minister over his ministry and departments relies on his political position.

If the appointee minister has full confidence of the head of the government that is Prime Minister and has a strong political backing, he may deal successfully with bureaucracy (Bhagawan & Bhushan, 2009). On the other way round if his political

base is weak, his control over administration may be non-assertive. In fact, a minister's control over administration is influenced not only by the constitutional system of the country but also from his political forte.

2.5.1.1.2 Budgeting System

The parliament passes the budget annually and authorises expenditure. Without proper authorization from the legislature, no money can spend by the administration. With its control over the consolidated fund, the legislature outlines closely the activities, which the ministries and departments may undertake (Financial Regulations of the Government of the Democratic Socialist Republic of Sri Lanka, 1992).

The Public officers have to work within the budgetary allocation. The money has to spend according to the financial rules and not a single rupee can be without the proper approval from the higher authorities. Therefore, accurate accounts are to maintain which are subject to audit.

In a parliamentary system, the legislature is unable to turn down the Executive's request for grants so long as the Executive has majority in the House (Bhagawan & Bhushan, 2009). However, the budget provides an opportunity for the Parliament to review, scrutinize, examine, criticize and influence the functioning of public administration. To be an effective budgetary system, constant control shall be under the Executive Legislature.

2.5.1.2 Internal Controls

Internal controls operate within the public sector administrative mechanism automatically and spontaneously. These operate from top to bottom designed hierarchically, in which one controls the work of the other. The superiors in the administrative organization may control the subordinates by directing, advising, regulating and supervising them (Bhagawan & Bhushan, 2009). They may exercise the control by charging penalties for those who are responsible for the lapses as well as providing incentives to the loyal and efficient officials (Bhagawan & Bhushan,

2009). Since the administrative machine has today become a complex structure, it is necessary to supplement the external controls by internal controls in order to make the machine work efficiently.

2.6 Summary

This chapter presented the outcome of literature review on stakeholder involvement in implementation of public sector green building projects. Implementations of Green buildings require a whole building life cycle approach including phases of (1) Plan and design (2) Construction (3) Operation /maintenance (4) Reuse/demolishing. Throughout these phases, involvement of numerous and different stakeholders in green building projects take on a level of complexity unlike in conventional building projects. This becomes even greater in implementing green buildings in public sector. The review identified main barriers of effective stakeholder involvement for green building implementation in public sector into four fundamental aspects: Management, Technology, Economics, and Awareness.

Green building projects undergoing high degree of changes need active involvement and participation with project stakeholders. The review on stakeholder involvement revealed six generic approaches to fit within the context of green project implementation in public sector. They are Lead, Collaborate, Involve, Defend, Educate and Monitor. The means to overcome the barriers in involving stakeholders effectively in implementing public sector green building projects will be underlined in these approaches. Findings of the review presented in this chapter will be the basis of the study. The next chapter presents the research methodology adopted for the overall study presented in this thesis.

3 RESEARCH METHODOLOGY

3.1 Introduction

The procedural framework that undertake on how research is conducted is called the research methodology (Amaratunga, Baldry, Newton, & Sarshar, 2002). According to Leavy (2017), two questions have to consider in research design: What do we want to achieve? and How do we execute that goal? This is the process of building a methodology. This chapter discusses the research methodology adapted for the research under three phases. Each phase according to their related application in the research design is discussed separately. The main phases of this chapter are Research Approach, Data Collection and Data Analysis.

3.2 Research Approach

Research design is the plan and the process of spanning the research decisions from broad assumptions to detailed methods of data collection and analysis (Creswell, 2009). A design is used to structure the research; hence it can be utilized to demonstrate how all the main components of the research project work together to address the fundamental research questions. After clarifying the issue and suggested outcome of research subject matter, this study required to; comprehend what data is required, whom to interview, how many to interview, what to interview and accordingly construct an appropriate interview with a choice of questions, order of questions and a choice between conversation or the structure type.

Research Approach allow researchers to choose the research design applicable in the research in terms of data to be collected, sources of data, data collecting techniques and data analyse. It also guides researchers on selecting a suitable research strategy for the study. Research approach can be categorized into Qualitative approach, Quantitative approach and Mixed Method Approach.

3.2.1 Qualitative Approach

Qualitative approach seeks understanding social phenomena from the viewpoints of participants. It is subjective in nature that uses research strategies like ethnography, grounded theory, content analysis, case studies and phenomenological data. The process of research includes collecting data from participant's background, analysing data forming from facts to general themes and making interpretations from the collected data. This form of approach helps to have a better view angle at research that accomplishes an inductive style and rendering the complexity of a situation (Creswell, 2009).

3.2.2 Quantitative Approach

In quantitative approach factual data is collected to establish and validate relationships, then contributing to the development of theories. By examining the relationship among variables quantitative approach seek to establish objective theories. These variables can be measured typically on instruments and numerical data can be analysed using statistical techniques (Creswell, 2009). It employs research strategies like experiments and surveys, and collects data using pre-set tools that yield statistical data.

Similar in qualitative approach, researchers engaged in this form of inquiry have assumptions about testing theories. They deductively build in defences against bias controlling for alternate explanations, generalise and replicate the findings (Creswell, 2009).

3.2.3 Mixed Method Approach

Mixed Method Approach provides an opportunity to examine combining or associating both qualitative and quantitative forms in a single study. Thus, this approach is more than merely collecting and analysing both kinds of data. This approach encompasses both approaches so that overall strength of a research is greater than either qualitative or quantitative research alone (Creswell, 2009).

3.2.4 Justification of the Research Approach

As the purpose of this research is to figure out the basis of what identified in the literature survey and how it applies in the real world scenario, it requires the in depth understanding of the research problem. According to Creswell (2009) qualitative research can provide a distinct advantage when comprehensive information is required. In view of that qualitative research approach allows the researcher to accomplish the objectives of the research by answering the questions of “what is happening at the moment”, “how and why it is happening”, “how would propose framework affect current practices and outcomes” and “what are the things that has to be improved”. As a result, qualitative research approach was selected for the research study. The other part of the research is approached with quantitative methods. Thus the current research adopts mixed research method.

The aim of this study is to develop a framework that effectively involves stakeholders in the life cycle of implementing green buildings in public sector. As of it the literature review was conducted to identify of implementation barriers in green buildings and means of promoting stakeholder involvement to address the barriers in the public sector. Subsequently, case study analysis was conducted addressing life cycle in green buildings and key administrative procedures and practice adopted in current Sri Lankan public sector. Identified barriers including key aspects barriers and stakeholder involvement were then verified through a questionnaire survey. Findings were incorporated to a framework for implementation of green building projects in public sector. Following diagram summarises the research design.

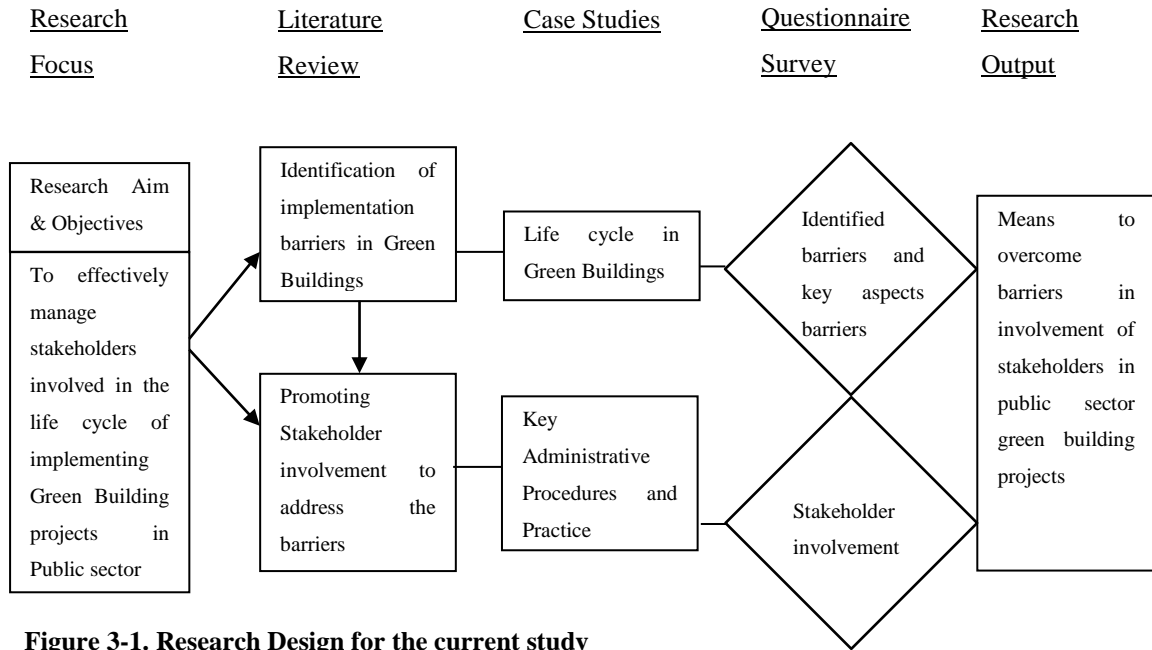


Figure 3-1. Research Design for the current study

Following the mixed research method the current study goes through the above research process to achieve the stated objectives,

3.3 Data Collection

Qualitative data consist of well grounded, descriptive data that explain procedures in identifiable local contexts. With qualitative data, it is expected to maintain the sequential flow, understand exactly which events led to which consequences and derive successful explanations (Asgedom, 2004). Qualitative research may conduct in dozens of ways such as field methods; interview, case study, participant observation, naturalistic methods and responsive evaluation (Amaratunga et al., 2002).

3.3.1 Literature Review

In order to achieve the objectives of this study, a comprehensive literature review on green building projects, involvement of its stakeholders and barriers in implementing green buildings in public sector was carried out. The aim of the literature review is to discover the differences between conventional and green building projects throughout building lifecycle of design, construction, and commissioning phases; challenges faced in green building project implementation and stakeholder

involvement in public sector. The findings were incorporated into the questionnaire survey along with the findings from the case studies to verify the basis of the research problem.

3.3.2 Case Study

A case study seeks to investigate a current phenomenon within its actual context, particularly when the phenomenon's boundaries and context are not obvious (Yin, 2009). In this study three case studies were conducted to capture the potential barriers met in implementing green building projects in Public Sector which are not reflected in the literature review. As such, the first case study discusses the involvement of stakeholders at Planning and Design stage, second at construction stage and the third at post construction covering the stages of Operation /Maintenance and Reuse/Demolish. Case study analysis of selected projects under different project phases also helped to determine questions and background studies. Semi Structured Interviews with pre-determined questions and open-ended questions (Appendix 2) were used to collect data from the respective selected stakeholder representative from each project as the data collection technique.

The significant facet of the case study method is the emphasis on understanding processes as they happen in their context (Amaratunga et al., 2002). A case study may consist of a single case or multiple case studies base on the situation. A single – case may be carried out instead of multiple-cases if the single case can represent the critical assessment of a significant concept or phenomena. It may also be possible that the investigator has gained access to a situation where a case was previously not accessible to any systematic explanations. A case study is hence worth conducting for the descriptive information that will be indicative.

3.3.3 Questionnaire Survey

A survey questionnaire based on insights drawn from the literature review and the interviews of the case studies was carried out as the data collection technique. It was distributed to capture a specific set of challenges encountered in implementing green building projects in public sector Sri Lanka. All the causes identified through the

literature review and case study analysis were considered in developing the base for questionnaire. The questionnaire was then circulated among the respondents to get the agreement level for each factor. The questionnaire survey consists of three parts, namely the first section – respondent's profile containing questions with regard to respondent's background and involvement in implementing of green buildings in public sector. The second section asks the respondents to rate challenges met during the implementation of green buildings in public sector, and the last section require the respondents to select and suggest possible solutions to overcome those challenges during involvement in implementing of green buildings in public sector.

The questionnaire made in Google Forms in English was among stakeholders involved in green building projects in public sector via emails. The utmost care was taken in the selection of stakeholders in terms of their exposure and relevancy to the field. The sample selection was made using purposive sampling adhering to the selected case studies.

Second section of the questionnaire consists of 17 barriers in implementing green buildings in public sector; which were identified from the literature survey and case studies. These factors were grouped into four different categories: i) Economics; ii) Technology; iii) Awareness; iv) Management related; and in the analysis scored on a 5-point Likert scale of Strongly disagree, Disagree, Neutral, Agree, Strongly agree.

Third section of the questionnaire consists of 10 possible solutions that stakeholders see as that can promote involvement to overcome above barriers. Each identified from the literature survey and in case study interviews. These factors were clustered into six different categories: i) leadership; ii) collaborate; iii) involve; iv) defend; v) educate and vi) monitor in the analysis as scored on a 5-point Likert scale of Strongly disagree, Disagree, Neutral, Agree, Strongly agree.

3.3.4 Sample Selection

The questionnaire was circulated via e-mail to key stakeholders selected through purposive sampling technique. These stakeholders must represent the public sector building industry and comprise of clients, developers, consultants, contractors,

suppliers, and officials in government organizations in Sri Lanka. Therefore, the target population which the sample was selected was based on their recent involvement in implementation on green buildings in public sector, type of organization they belong to and level of experience they have in public sector building industry. It was assumed that with their involvement in planning, procurement, construction and commissioning of green building projects are able to provide comprehensive accounts of the barriers encountered during the management of such building projects. The setting of data collection is in Sri Lankan Public sector building industry.

3.4 Data Analysis

After data collection, the next phase is data analysis. Collected data require categorisation, presentation and interpretation. Since the research focus on stakeholder involvement in implementation of green building projects in the public sector Sri Lanka, the collection of views from the stakeholders engaged in the public sector green building projects were collected in form questionnaire survey.

The questionnaire responses were then analysed using Microsoft Excel application. Based on the content of the questionnaire, the analysis was divided into two sections as demographic analysis and relative importance index analysis.

Demographic Analysis

Demographic analysis is used to measure the dimensions and dynamics of population sample and set a foreground to which the rest of the analysis is set. This utilises the first section of the questionnaire to discuss green building construction in the public sector.

Relative Importance Index Analysis

Using the Relative index analysis factors were ranked according to relative importance. Below formula was used to determine the relative index (RII)

$$RII = \text{Sum of weights } (W_1 + W_2 + W_3 + \dots + W_n) / A \times N$$

Where **W** is the weight given by each respondent on a scale of one to five with one denoting the least and five the highest, **A** is the highest weight and **N** is the total number in the sample.

Based on the ranking (R) of relative indices (RI), the weighted average for the four categories will be decided.

RI values are then broke down into ranking levels: high (H) ($0.8 \leq RI \leq 1$), high medium (H-M) ($0.6 \leq RI < 0.8$), medium (M) ($0.4 \leq RI < 0.6$), medium-low (M-L) ($0.2 \leq RI < 0.4$) and low (L) ($0 \leq RI < 0.2$) to determine the most affected Barrier/ causes and solutions.

3.5 Summary

This chapter mainly discussed about the Research Approach, Data Collection and Data Analysis used in this research. Mixed research approach was selected as the research approach. Case study and questionnaire survey were used as the data collection methods. The data analysis methods adopted for the study were Demographic Analysis and Relative Importance Index Analysis. In next chapter findings and data analysis will be discussed.

4 RESEARCH FINDINGS & DATA ANALYSIS

4.1 Introduction

This chapter intends to discuss the research findings through the case study and Questionnaire survey. The first part presents the case study analysis, which represent four stages of green building lifecycle; Plan/ Design, Construction, Operation & Maintenance and Reuse/ Demolish, latter two stages presented and discussed in conjunction in the third case. The second part analyse the data collected through questionnaire survey. All the data recorded been carefully analysed and the summary of the analysis is used to derive conclusions.

4.2 Case Study Analysis

A case study is used in numerous circumstances as a research method. The case study often used to explore individuals, organisations and communities; to examine applied research mechanisms and procedures and to explore a phenomenon in context with help of variety of data sources. The distinctive need for a case study arises due to the desire that requires understanding a complex social phenomenon (Abimbola, 2014). Additionally, a case study lets investigators to recollect a complete and expressive feature of realistic proceedings.

In this research, three case studies have been chosen to analyse the stakeholder involvement throughout the four stage life cycle of green building implementation in the government sector. Case study One discusses Plan/ Design stage, Case study Two on construction stage, Case study Three on operation/ maintenance and reuse/ demolition stages.

| Green Building Case | Represented phase of green building lifecycle | Client | Consultant | Contractor |
|---------------------------------------|--|---------------------------------------|---------------------------------------|----------------------------------|
| Case Study 1 (Office Building) | Plan/ Design | Government Department (Public Sector) | Government Department (Public Sector) | CIDA registered (Private Sector) |
| Case Study 2 | Construction | Government | Government | CIDA registered |

| | | | | |
|---------------------------------------|---|--|--|-------------------------------------|
| (Bank Building) | | Department (Public Sector) | Department (Public Sector) | (Private Sector) |
| Case Study 3 (Office Building) | Operation & Maintenance and Reuse/ Demolish | Government Department (Public Sector) | Government Department (Public Sector) | CIDA registered (Private Sector) |

Table 4-1. Introduction to Green Building Cases

In the respective case studies key involved stakeholders were interviewed (Table 4.2).

| Green Building Case | Green Building Life cycle phase | Interviewed Stakeholder | |
|---------------------------------------|---|---|---|
| Case Study 1 (Office Building) | Plan/ Design | Client Consultant Green rating agency | Assistant Director Architect Project Engineer Chief Engineer- Estimates UDA officer |
| Case Study 2 (Bank Building) | Construction | Client Consultant Contractor (Previous) | Assistant Manager Architect Project Engineer Green Consultant Site Engineer |
| Case Study 3 (Office Building) | Operation & Maintenance and Reuse/ Demolish | Client Consultant Contractor | Divisional Secretariat Architect Project Engineer Site Engineer |

Table 4-2 Interviewers profile of the case studies

4.2.1 Case Study 01 – Plan/ Design

Construction of Office Building at Nuwaraeliya was a project programmed to be implemented by a government department. It was funded by the Government Treasury through the respective line Ministry. The proposed building was to be designed as a regional centre, providing facilities in registering persons in the District of Nuwaraeliya. The client organization of this project was a Department and public organization that comes under the Central Government.

The consultant was also a government department, a key state sector organization responsible for the design and construction of public buildings in Sri Lanka that has the capacity to offer consortium services for the project; including Architectural, Structural, Quantity Surveying, Electrical and Mechanical consultancy with the specialist consultants with their supervisions.

The initial approach to the project was as traditional building project because at the time client organization was unaware of the green building concepts as of at 2019. Since it has made mandatory by government of Sri Lanka to make public buildings green since 2017, the Architect had to inform and make aware of it to the client representative. Hence they agreed to proceed accordingly. Due to the fact of client's unawareness certain design strategies adapted to the building apart from traditional building planning had to be justified to client; so that more time had to be spent by design and planning team to convince the client.

Eventually the planned building of 1180 sq.m consisting G+ 3 floors cost Rs. 130.6 million. In comparison with earlier preliminary estimates of traditional building construction, an added cost had to be borne by the client to get certification from the relevant authority UDA, which was 1% at approximately Rs. 1.3million in this case. This had to be justified to client, as client had not foreseen which came as an additional cost. On the consultant's part, it was criticized that this particular amount of money is not meaningful. It was because the green building approving agency (UDA in this particular case) has set up guidelines to score up the rating to which consultant have to prepare a detailed report justifying the design. The consultant

team has put huge time-consuming effort apart from normal routine to prepare this document at no additional cost for consultancy quoting only 5% of management fee. At 1% charging fee UDA has only checked the document and returned to resubmit as the score was not at passable level of 40 marks. In the interview project architect explained UDA could have at least recommended possible solutions and alternatives of improvements to the deducted scores when they charge such high fee to this approval process. It was also in consultant opinion that there are no proper consultation fee standards in the industry, which can be applicable for green buildings.

Consultant Department has vast experience to provide design consortium services, and project management for many types of building projects for more than 40 years. Usually the working procedure was somewhat late and formal in the government departments due to the 8 hour working day and the strictly adherence to the Administrative and Financial Regulations imposed by the government. Even though all the consultants were in one department, the Architects, Engineers and Quantity surveyors were in separate divisions. Due to the lack of coordination between the divisions, integration of flow of information required for green building design was mismanaged. Green building design is not a linear process and the whole team has to work together achieve the final outcome. This was specially observed in compiling the green report to be submitted to the UDA. This Green report has to be prepared addressing all the aspects of the building concerning architecture, structural, electrical, mechanical, water supply and construction management. Therefore all the consultants had to work together to achieve the required score in a preconstruction stage. If one consultant failed to comply in his part, it will not lead to a successful score. According to the project architect all the consultants had to have idea of green building application prior to construction.

In this specific case study the consultants lack proper training or exposure to green building construction; it was observed that some innovative and cost saving solutions had not opted for. In consultants' view if they have gone through proper training in their respective field with regard to green building applications it would have been

better because all they were applying right now is the knowledge they acquired through self-study.

Generally, the common practice is that Architect handles the total project from the inception to the completion, as he is the person who has created the design and therefore has the ability to manage various resources in order to realize his creation. However, due to the management system of the consultant organization, the project engineer who executed the project may not have the exact picture of the project as it was. Therefore, there was a great tendency to lose the required quality of the end product.

It was also observed that there was a lack of awareness of the public sector officers who represent procurement committees and of lack of participation of green consultants at technical evaluation during the bidding stage. As stated by the “Procurement Guidelines “on Government Tender Procedure, there are established systems and procedures when Government Projects are carried out to prevent any mal practices, bribery and corruption and to create standardization. Client’s department procurement committee undertook this particular project. According to the procurement guideline, the purpose of the bid evaluation is to determine the lowest evaluated substantially responsive bid out of the bids received. To select lowest evaluated substantially responsive bid the TEC would consider many facts like prequalification, experience similar projects, financial stability etc. It has been observed that procurement committee has depended on traditional approach in evaluating the bid disregarding the green approach of the building. This could have caused by the lack of awareness on green building concepts by the public sector officials representing the procurement committee and technical evaluation committee.

In the above case study following points are observed in summary

1. Lack of awareness of green building project implementation among the public sector officers and clientele.
2. Lack of incentive mechanism for green building implementation.

3. Inadequate training and exposure to green building construction among consultants.
4. Lack of motivation among team members and no proper leadership to lead green building project.
5. Inadequate communication and coordination among key stakeholders involved at this phase
6. Lack of awareness and motivation of client and consultants are shown when they attain a marginal pass to green certification.

4.2.2 Case Study 02 – Construction

The client organization of this project was a government-owned major commercial bank in Sri Lanka. The project scope was construction of Bank Office branch at Wadduwa. The consultant to this project was selected through bidding process. The request for proposals had been called from government and semi government sector consultancy firms. In the client's request for proposals, it was clearly indicated the requirement of green consultant apart from the architect and other consultants, where they have included points in their marking criteria. In this case the client was knowledgeable and very particular in getting green certification as a part of their corporate plan. At the initiation of this project the aim is to obtain a Green Building Council Sri Lanka (GBCSL) Gold certification.

The consultant was government department, same as the above case study having the capacity to offer in house consortium services for the project; including the service of Green Building Council Sri Lanka qualified green professionals. This was a plus point in the getting the project as many of the competitors for the project have outsourced the green consultant.

From early stage on the client had shown keen interest and knowledge in green building implementation. Also had had active participation with architect and the green consultant who was also an architect. The design team along with other consultant have constantly shared ideas and contributed to the design. It is observed that client's motivation to construct a green building encouraged great involvement

during the design stage. The relationship between client and consultant was in a satisfactory level. Even in design stage the client's participation and knowledge regarding green concepts is adequate level. However the problem seems to have been that relevant concept has been missed during bid documentation.

It was observed that decisions made at earlier stages are very important to the success of project. Though we might not see the immediate effect, they may have consequences that cannot be restored later. So it is vital green concepts are considered from early stage in design.

In this particular project procurement had been carried out by the client organization. The total project cost estimated was Rs. 53 million and consist floor area of approx. 600 sq.m. of two storey building. It was observed that technical evaluation committee had not been keen on green construction ability of the contractor and had taken a traditional building approach during the bidding stage. All the contractors who were from private sector had been registered in the Construction Industry Development Authority (CIDA) Sri Lanka. Since prequalification did not require contractor's knowledge, professional approach in green buildings the selected contractor's experience in green building construction was at very low level. It is noteworthy the successful contractor had been selected on basis not the lowest but the substantially responsive to the bid.

As seen on the bidding stage, the contractor took the same traditional building approach in construction as well. The contractor clearly showed lack of motivation to see the project as a green building project. Although consultant had made available a copy of the green report to the construction site, it had been observed that contractor did not read it in conjunction with drawing and details. Also a failure had been noted on consultant part; is that resident engineer had also not compelled the contractor to do so.

Half way along the construction process the project suffered poor quality, contractor delays and very poor performance that client along with consultant instruction decided to terminate the contractor. At only Rs. 20 million worth works done, the

project had been again called for bid. The total project cost had been raised from estimates Rs. 53 million to Rs. 60 million. It was observed that contractor's lack of experience in green building construction, cost of material, technical knowhow and lack of qualified technicians lead project to suffer midway of the construction from time, quality and cost.

On the contractor's view point, incomplete technical specifications on green building materials as huge draw back. When project engineer was interviewed, he also had a same view that Bill of Quantities should have more comprehensive approach in specifying green building materials.

As CIDA was considered as an organization established by the Government of Sri Lanka to promote and develop the domestic Construction Industry, it is vital that that such organizations should set up Performance Specification for green buildings so that registered contractors be aware of green buildings construction.

In the above case study, following points are observed in summary during this phase.

1. Client's motivation and awareness in public sector green building implementation has been an acceptable level.
2. Deficiencies in specification and costing in design phase lead to failures in construction phase.
3. Contractor's lack of awareness and technical knowhow in green building construction.
4. Lack of coordination and communication among stakeholders and between in different stages of green project lifecycle.
5. Lack of competition among green building material products.

4.2.3 Case Study 03 – Operation & Maintenance and Reuse/ Demolish

Construction of Office Building at Mahiyanganaya was a project programmed to be implemented by another government department. It was funded by the Government Treasury through its respective line Ministry. This particular type of building already has a building prototype developed by a public sector consultant department; hence the client's request was to implement the same prototype to this particular site.

Hence consent to preliminary estimate and design was given without considering the green aspects. As a result green aspects had to be adopted as a mere after thought only to fulfil the marginal requirement of the UDA green certification. Among the proposals were solar panels for the roof. However due to the budget restrictions the client has overlooked the installation of solar panels which in return UDA has denied issuing the Certificate of Conformity (COC) for the building. Also an added cost to preliminary estimate had to be borne by the client to get certification from the relevant authority UDA which is 1% which was not in the preliminary estimate. This is precise example about cost escalation comparison among traditional building versus same building with accommodated green aspects. However it was also noteworthy that since this building was not originally designed as green building, that mere after thoughts of green aspects to traditional building can over run costs. It was also worth mentioning that since green building implementation as commonly known to be expensive, it rewards back at that the time of building operation.

In public sector building construction it is common practice of consultants to consider that buildings require being less in maintenance. This is often because once it is handed over to public usage there is no proper authority taken by clients to maintain especially in the context in Sri Lanka. This being the case for normal traditional buildings, green buildings with more complex green solutions can easily be left to deteriorate. So it is duty of consultants to re-evaluate the return of investment of public money to overpriced green building solutions in the public sector buildings before implementation.

As discussed above another aspect of green certification commonly overlooked is the maintenance. Often green certification criteria call upon trained maintenance staff and specific allocated space/room which can be easily accommodated in design stage. However at operating and maintenance stage client cut down this staff to save expenses as well as use maintenance room for other purposes like drivers rest etc. This mainly due to lack of awareness and motivation of clients and users during operation period on overall green building concepts where they see green building only as an object rather than as a practice or process.

In the above case study following points are observed during this phase as results of subsequent phases in summary.

1. As discussed in this case study green building concepts cannot be mere after thought, it should incorporate to design from early stage as inception thus ultimately can turn into failure or heavy burden.
2. High maintenance cost of green aspects in public buildings is not feasible.
3. Lack of awareness by users during maintenance phase.
4. Disregard operation stage maintenance in green buildings.

As observed in these case studies barriers that affect stakeholder involvement do not affect independently, rather they are more interconnecting through the phases linking the stakeholders.

In the presentation of above analysis following are observed as summary.

| Green Building Case | Green Building Life cycle phase | Reported Barriers found in the relevant phase |
|---------------------------------------|--|--|
| Case Study 1 (Office Building) | Plan/ Design | <ul style="list-style-type: none"> • Inadequate budget for client • Inadequate training & exposure for consultants • Lack of awareness of the client/ clientele • Lack of client's motivation and leadership. • Inadequate communication & coordination among consultants |
| Case Study 2 (Bank Building) | Construction | <ul style="list-style-type: none"> • High cost for products and installations • Inadequate training & exposure for consultants. • Inadequate training & exposure for contractor • Deficiencies in specification and costing. • Inadequate competition among green building material products • Lack of contractor's awareness • Client's motivation and leadership. |

| | | |
|---------------------------------------|---|--|
| | | <ul style="list-style-type: none"> Inadequate communication & coordination among consultant and contractor |
| Case Study 3 (Office Building) | Operation & Maintenance and Reuse/ Demolish | <ul style="list-style-type: none"> Inadequate maintenance budget for end user/client Inadequate training for end users Lack of client / end user awareness Lack of client's motivation |

Table 4-3. Summary of reported barriers found in the selected cases.

Categorisation of reported barriers found in the selected cases affecting stakeholder involvement in implementation of public sector green building projects are presented below.

| Fundamental Aspects of Barriers | Case Study 1 | Case Study 2 | Case Study 3 |
|--|--|--|---|
| Economics | <ul style="list-style-type: none"> Inadequate budget for client | <ul style="list-style-type: none"> High cost for products and installations | <ul style="list-style-type: none"> Inadequate maintenance budget for end user/client |
| Technology | <ul style="list-style-type: none"> Inadequate training & exposure for consultants | <ul style="list-style-type: none"> Inadequate training for & exposure consultants. Inadequate training & exposure for contractor | <ul style="list-style-type: none"> Inadequate training for end users |
| Awareness | <ul style="list-style-type: none"> Lack of client's awareness | <ul style="list-style-type: none"> Client's awareness and leadership is significant. Lack of contractor's awareness | <ul style="list-style-type: none"> Lack of client / end user awareness |
| Management | <ul style="list-style-type: none"> Lack of client's motivation and leadership. Inadequate communication & coordination among consultants | <ul style="list-style-type: none"> Client's motivation and leadership. Inadequate communication & coordination among consultant and contractor | <ul style="list-style-type: none"> Lack of client's motivation |

Table 4-4. Comparison of results of the cases in terms of fundamental barriers

4.3 Questionnaire analysis and Findings

The target population, from which the sample selected, was based on their role in the project, level of experience, and type of organization (related to Public sector projects) they belong to. The questionnaire contained of a sections that captured the profile of respondents, section asking the respondents to rate barriers and challenges encountered during implementation of green buildings in public sector, and last section requiring the respondents to choose solutions to overcome those barriers and challenges. Out of the 50 questionnaires distributed, 32 completed sets were received.

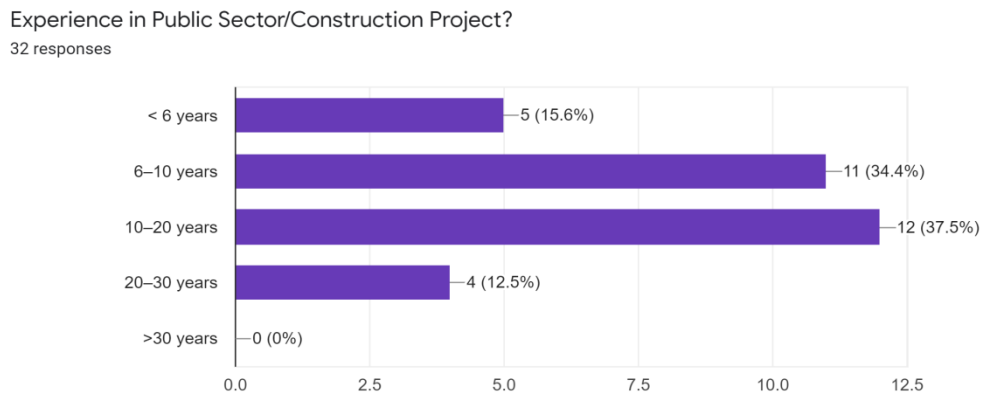


Figure 4-1. Respondents' Experience

The 84.4% of participants have more than 6 years of experience in public sector/construction projects.

According to the responses 62.5% of them are directly involved while the rest of 40.6% are indirectly involved in implementing green buildings as of their current job position.

Are you involved in the implementation of green buildings related works at present as per your current appointment ?

32 responses

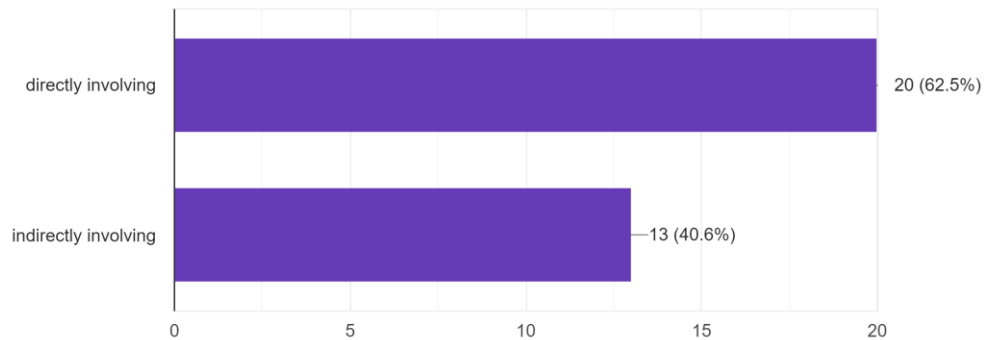


Figure 4-2. Respondents' nature of involvement in the project.

Out of the received responses 15.6% represent the client, 62.5% the consultants, 6.3% implementers of green building rating system. 18.8% contractors and suppliers, 3.1% of end users.

Your current role in the public sector green building project/s?

32 responses

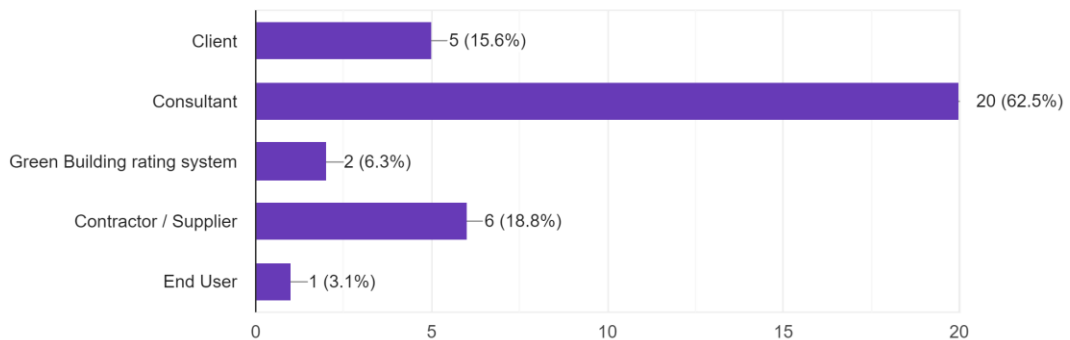


Figure 4-3. Respondents' role in Green Building Project

As for the Building Life Cycle phase of public sector green building project/s they are involved in; 62.5% are engaged in Plan/ Design, 4.3% in construction. 9.4% in operation and maintenance, 6.3% at reuse/ demolition and 9.4% have their involvement throughout total building lifecycle.

Building Life Cycle phase your involvement to the public sector green building project/s engaged in?

32 responses

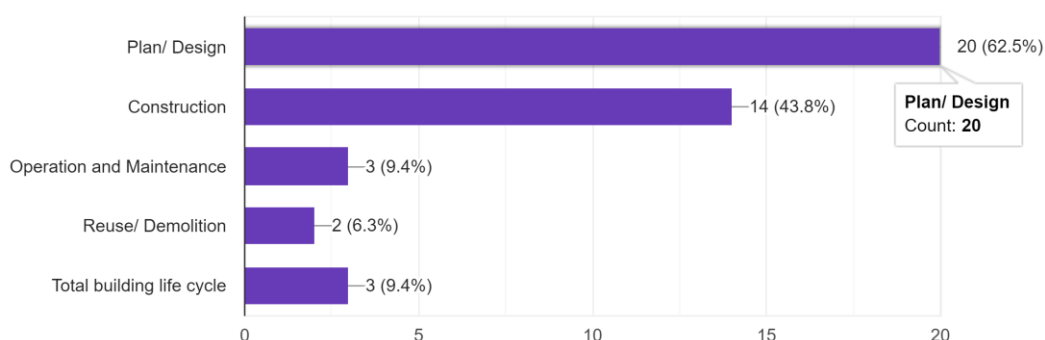


Figure 4-4. Respondents involvement throughout total building lifecycle

4.3.1 Barriers that affect stakeholder involvement in implementation of public sector green building projects in Sri Lanka.

In section 02, 17 barriers and causes put into rating to find out which affect the smooth functioning of implementation of green buildings in public sector Sri Lanka given in the perspective of key stakeholders to evaluate them. The barriers and causes are further clustered under four major themes.

| | Criteria – Barriers and Causes | Category |
|---|---|-------------------|
| 1 | Inadequate incentive mechanism by Government to implement Green Buildings in Public Sector | Management |
| 2 | Dependence on promotion by government and lack of motivation by key project stakeholders | Management |
| 3 | Lack of communication and participation at brief formulation among building project Stakeholders (e.g. no early contractor participation, end user involvement) | Management |
| 4 | Lack of support from Senior management (May it be client/ consultant/ contractor) | Management |
| 5 | Lack of coordination among project Stakeholders between different stages of green building project | Management |
| 6 | Inadequate responsibility for green building maintenance in public sector. | Management |

| | | |
|----|--|------------|
| 7 | Lack of communication and interest required among project team member and stakeholders | Management |
| 8 | Higher costs caused by green construction practice and green materials. | Economic |
| 9 | Lengthy planning and approval process for new green technologies and recycled materials | Economic |
| 10 | More time required to implement green construction practice onsite. | Economic |
| 11 | Inadequate access to relevant knowledge and technologies | Awareness |
| 12 | Lack of qualified professional in implementing Green Building in Public sector | Awareness |
| 13 | Limited availability of green suppliers and information | Awareness |
| 14 | Lack of competition among green building material products, producers and suppliers | Technology |
| 15 | Imperfect and uncertainty in green technological specifications and performance. | Technology |
| 16 | Unfamiliarity with green technologies/ materials and understanding green technological operations. | Technology |
| 17 | High and complex maintenance of green buildings in public sector. | Technology |

Table 4-5. Clustered configuration of barriers that affect stakeholder involvement in implementation of public sector green building projects

4.3.2 Relative ranking of the barriers and causes criteria

Out of 17 barriers and causes, 7 fall under Management, 3 in Economic, 3 in Awareness and 4 in Technology. Relative Importance Index analysis was used to determine the relative ranking of the criteria. **Table 4-4** shows the ranking results for each **category** based on these ranking results. The rankings allowed to cross-compare the relative importance of the criteria as perceived by respondents.

| Criteria | RII | Category | Criteria Rank |
|---|------------|-----------------|----------------------|
| 7. Lack of communication and interest required among project team member and stakeholders | 0.84 | M | H |

| | | | |
|--|------|----------|----|
| 5. Lack of coordination among project Stakeholders between different stages of green building project | 0.82 | M | H |
| 3. Lack of communication and participation at brief formulation among building project Stakeholders (e.g. no early contractor participation, end user involvement) | 0.81 | M | H |
| 8. Higher costs caused by green construction practice and green materials. | 0.80 | E | HM |
| 9. Lengthy planning and approval process for new green technologies and recycled materials | 0.79 | E | HM |
| 1. Inadequate incentive mechanism by Government to implement Green Buildings in Public Sector | 0.78 | M | HM |
| 13. Limited availability of green suppliers and information | 0.78 | A | HM |
| 6. Inadequate responsibility for green building maintenance in public sector. | 0.78 | M | HM |
| 16. Unfamiliarity with green technologies/ materials and understanding green technological operations. | 0.77 | T | HM |
| 12. Lack of qualified professional in implementing Green Building in Public sector | 0.76 | A | HM |
| 2. Dependence on promotion by government and lack of motivation by key project stakeholders | 0.74 | M | HM |
| 15. Imperfect and uncertainty in green technological specifications and performance. | 0.73 | T | HM |
| 4. Lack of support from Senior management (May it be client/ consultant/ contractor) | 0.73 | M | HM |
| 14. Lack of competition among green building material products, producers and suppliers | 0.73 | T | HM |
| 11. Inadequate access to relevant knowledge and technologies | 0.70 | A | HM |
| 10. More time required to implement green construction practice onsite. | 0.65 | E | M |
| 17. Complex maintenance of green buildings in public sector. | 0.55 | T | M |

Table 4-6. Ranking results according to RII values

Based on overall ranking, most of the criteria are under Management (3 out of 7) are H-Highest and it shows that respondents agreed more management criteria affect the implementation of green building projects in public sector. Lack of communication and interest; Lack of coordination; Lack of communication and participation among project Stakeholders and in between different phases of the project are in the highlights of the above criteria.

Among the next are H-M – High-Medium range which are led by 2 out of 3 economic criteria. The high initial cost on material and technology in implementation; lengthy planning approval process and subsequent lengthy period on return of investment are seen as the most significant barriers with economic concerns.

Followed by another 02 management criteria - Inadequate incentive mechanism by Government to implement Green Buildings in Public Sector; Inadequate responsibility for green building maintenance in public sector and also Limited availability of green suppliers and information of Awareness criteria.

Owing to lack of experience in green building project implementation in Sri Lanka, there is **16.Unfamiliarity with green technologies/ materials and green technological operations** as whole affecting the construction industry. The understanding of these technologies is also variable depending on projects and this is been reflected in by this Technological criteria. This is also backed by the next Awareness criteria of **12. Lack of qualified professionals in implementing Green Building in Public sector**. It is observed that out of the sample respondents has far more involvement at concept stage than at construction.

2. Dependence on promotion by government and lack of motivation by key project stakeholders Depends on the client and in this research majority of the clientele represented by the government/ public sector. As of Sri Lanka, from 2017 onwards it has made mandatory by the Sri Lankan government to acquire Green certification to all newly constructed buildings in public sector. Otherwise, there is no other motivation driven by the public sector clients, consultants or contractors in

adopting Green Buildings. As such among the respondents getting a score 0.74 means they are aware of this Green Building initiative by 2020 at time of this research about the green building implementation in public sector but not adequate motivation is there. Hence project initiators like Architects must highlight the importance of green buildings to other project stakeholders.

15. Imperfect and uncertainty in green technological specifications and performance. At a score of 0.73 it is observable how much this particular aspect affects. In procurement of public sector projects, open competitive bidding is adopted. Therefore most of the time clear specification is required. Due to lack of availability in green technological specifications and performance consultants as well as contractors face difficulties in carrying out construction. Hence variations in construction stage are unavoidable in return occurring loss to client.

4. Lack of support from senior management (May it be client/ consultant/ contractor). This goes par along with No. 2 Dependence on promotion by government and lack of motivation by key project stakeholders. Unless main stakeholders (May it be client/ consultant/ contractor) are not motivated their whole management structure is not driven in one vision. Sri Lankan public sector is service orient sector and do not depend on profit. Still lack of motivation in green concept is not been deeply rooted among these stakeholders. With the score of 0.73 it highlights that proper management should lead implementation of green buildings in public sector.

14. Lack of competition among green building material products, producers and suppliers for green building material show that there still are not much green technological advances in the local construction industry.

The respondents seem to believe that ignorance related to green buildings is a problem and that further education and of experiences are required. Hence, **11. Inadequate access to relevant knowledge and technologies** under Awareness plays a significant role.

Placing at **10- More time required to implement green construction practice**

onsite at 0.65 suggest that respondents care less economy of time in implementing construction onsite. This score could be the result that only 43.8% of the respondents engage at construction stage.

17. Complex maintenance of green buildings in public sector. Respondents have participated in the questionnaire have less or not at all experience at maintaining phase of green buildings. According to UDA sources out of 200 building registered for Green building only 01 have been completed and been awarded the certificate since 2017. As a matter of fact respondents do not seem to have experience in maintenance and operation phase. This might have been one reason to place this aspect at last position.

4.3.3 Possible means to overcome barriers in stakeholder involvement in public sector Green buildings implementation

In section 03, 10 possible solutions to overcome above barriers and engage stakeholders in implementing Green Buildings in the Public Sector were given to respondents to evaluate them. These solutions are further clustered under six generic stakeholder involvement aspects.

| | Criteria – Possible Solutions | Category |
|---|--|--------------------|
| 1 | Evaluation of the benefits and advantages about Green Building by the client/ clientele in the Public Sector building projects | Lead |
| 2 | Maintain contractor/sub-contractors / supplier data base in the field of green building construction projects | Involve |
| 3 | Maintain material manufactures and suppliers data base in the field of green building construction projects | Involve |
| 4 | Annually update above contractor/ supplier databases and use as qualification during the bidding | Involve |
| 5 | Every key stakeholder shall be made aware about the project Goals, Objectives and performance specification of green building construction by a project charter. | Collaborate |
| 6 | Allocating of sufficient budget for Green building construction projects | Defend |
| 7 | Change Technical Know- how and promote innovative techniques available in local context safeguarding long-term benefit to the building industry. | Defend |

| | | |
|----|---|---------|
| 8 | Conduct the Green Building training/promotion and education programs for key stakeholders of the project (including client, project team and end users) | Educate |
| 9 | Conduct Green Building technical and management training programs for the project team | Educate |
| 10 | Obtain the client and end user feedback on quality in Green Building Projects | Monitor |

Table 4-7. Clustered Configuration of Possible Solutions

4.3.4 Relative ranking of the solution criteria

It is note while that all of the 10 solutions were rated in High Range between 0.8 to 1.0 and is in a significant low variant range (0.88-0.81). It indicates that respondents have been seeking solutions to overcome barriers caused during implementation of green buildings in public sector.

| Criteria | RII | Category | Criteria Rank |
|---|------|----------|---------------|
| 6. Allocating of sufficient budget for Green building construction projects | 0.88 | D | H |
| 5. Every key stakeholder shall be made aware about the project Goals, Objectives and performance specification of green building construction by a project charter. | 0.88 | CO | H |
| 8. Conduct the Green Building training/promotion and education programs for key stakeholders of the project (including client, project team and end users) | 0.87 | E | H |
| 10. Obtain the client and end user feedback on quality in Green Building Projects | 0.87 | M | H |
| 3. Maintain material manufactures and suppliers data base in the field of green building construction projects | 0.86 | I | H |
| 9. Conduct Green Building technical and management training programs for the project team | 0.86 | E | H |
| 2. Maintain contractor/sub-contractors / supplier data base in the field of green building construction projects | 0.83 | I | H |

| | | | |
|---|------|---|---|
| 7. Change Technical Know- how and promote innovative techniques available in local context safeguarding long-term benefit to the building industry. | 0.83 | D | H |
| 4. Annually update above contractor/ supplier databases and use as qualification during the bidding | 0.82 | I | H |
| 1. Evaluation of the benefits and advantages about Green Building by the client/ clientele in the Public Sector building projects | 0.81 | L | H |

Table 4-8. Ranking results according to RII values

Based on the overall criteria ranking, **no. 6. Allocating of sufficient budget for Green building construction projects** leads. This clearly shows that sufficient budget is not allocated at implementation stage. This is mainly owing to the fact that benefits of green building during the total life cycle are not considered during implementation. In common notion green buildings have high implementation cost compared to traditional buildings but on the long run it reduces the operational costs compared to traditional buildings giving back the return on investment. As such green building implementation is still at early stages in the Sri Lankan Public sector clients are yet to experience the virtue in the long run. In fact proper allocation of budget is good strategic defence to get stakeholders engage resourcefully.

At the second, **no.5. Every key stakeholder shall be made aware about the project Goals, Objectives and performance specification of green building construction by a project charter**, in respondents opinion most of the stakeholders are unaware of their roles in green building project implementation in public sector. If the project team and stakeholders to collaborate into one objective, they all must share one vision and mission throughout the whole life cycle. Stakeholders are expected to have adequate competence, abilities and accumulated knowledge to set out green objective in the project delivery process. Hence by incorporating a project charter at the very beginning will let all stakeholders joining and leaving at different phases of the project life cycle to share collaborate effort to one objective. Hence it enables to achieve a collaborative decision making and execution process that harnesses the talents and energies of all key stakeholders involved.

Another drawback observed among barriers was the unawareness of the green buildings among stakeholders. Education is the key. As a result, **8. Conduct the Green Building training/promotion and education programs for key stakeholders of the project** is good form to educate key stakeholders.

Next in the ranking is **10. Obtain the client and end user feedback on quality in Green Building Projects** which fall under Monitor aspect. It shows that respondents are also concerned about monitoring aspect and lessons learned in implementation of green buildings. This also include that if building achieved green certification it should be maintained by update. According to expert interviews of officials in GBCSL many of the buildings granted with green certification have not updated their certification and thereby have disqualified as green buildings.

3. Maintain material manufactures and supplier data base in the field of green building construction projects is next in ranking. This shows that it is important to get involve manufactures and suppliers that exist in a niche market in Sri Lankan construction industry.

As stated before in no 8, education is the key. Hence **9. Conduct Green Building technical and management training programs for the project team** must be continuous addressing the whole project life cycle addressing at different phases time to time. Education enables solve most of the barriers causing under **Awareness** and **Technology** criteria previously discussed and to enable effective involvement of stakeholders.

2. Maintain contractor/sub-contractors / supplier data base in the field of green building construction projects enable to have a recognized record in green building construction that also raises the performance level of contractors. These specialized contractors can be prequalified to participate in bidding. When selecting a contractor for green building project clients have to make decisions where selection is not made only on the lowest bid but based on their experience, technical capability, financial capability, and sufficient manpower to execute a green building project. Also main contractors should involve experienced and reputed subcontractors.

Respondents have mentioned in their comment section that Green building rating system adopted in Sri Lanka (May it be UDA blue green Sri Lanka or GBCSL) lacks contextual references to Sri Lanka and are based on European or foreign criteria. Hence no. **7. Change Technical Know- how and promote innovative techniques available in local context safeguarding long-term benefit to the building industry** should be considered. This could **Defend** the local stakeholders to adopt more viable green building solutions and engage stakeholders in more cost effective and feasible ways.

As mentioned before in involvement of manufactures, suppliers and contractor/sub-contractors it note while that created databases are up to date. So **4. Annually update above contractor/ supplier databases and use as qualification during the bidding** is in the next ranking.

Sri Lankan Public sector projects in general are largely determined by the client, the project brief and budget constraints rather than the public needs they address. Hence leading stakeholder involvement towards implementation of green buildings should **2. Evaluation of the benefits and advantages about Green Building by the client/ clientele in the Public Sector building projects.** Management and leaders in public/ government organizations (Client, Consultant, Contractors, suppliers and approval agencies like Green building rating organisations) can adopt stakeholder involvement as an prospect to inspire and influence other organizations and create policies and processes to support the vision and mission of sustainability.

4.4 Summary

This chapter analysed the findings from the case study analysis and the data collected from the questionnaire survey. The findings of case study analysis were used to formulate the questionnaire combined with the findings from the Literature Review in Chapter 2. Focusing on key objectives of the study, the data collected from questionnaire were analysed to identify possible barriers to stakeholder involvement in implementation of public sector green buildings and means to overcome the barriers. The conclusions reached from the results discussed in this chapter will be presented in next chapter.

5 CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter presents derived conclusion of the research from findings in the preceding chapter. Furthermore, this chapter explains the summary of the research, enabling arriving at the outcome. Henceforth, conclusion includes revisiting the objectives where they are persisted through the research findings. This aim of this study is to develop a framework that effectively addresses the barriers in stakeholder involvement in the life cycle of public sector green buildings projects.. Focusing towards this aim, objectives were established to explore the stakeholder involvement in implementation of public sector green building projects, to identify possible barriers of stakeholder involvement and causes that occurs in the life cycle of implementation of public sector green building projects and to suggest solutions for the barriers in the stakeholder involvement in the implementation of public sector green building projects. The conclusion compiles the accomplishment of each objective together with research findings leading to recommendations.

5.2 Revisiting the Objectives

Objective 1 - To explore the stakeholder involvement in implementation of public sector green building projects

Objective 1 of the research is achieved mainly through the literature Review in Chapter 2. This chapter discusses about Green Buildings, how construction differ from the traditional buildings and accordingly how stakeholders and conventional processes change throughout green building project life cycle. Unlike in private sector, construction industry in public sector Sri Lanka lay down mandatory procedures and regulations in achieving the construction projects. This is due to maintaining transparency in spending public money over the execution and delivery of public projects. Moreover, Green Building implementation in public sector becomes more challenging with above, especially with their technical, environmental and economic concerns. With its expanding requirements foregoing a traditional building, green building attracts many stakeholders to work with at different lifecycle

stages.

These findings are also brought to discussion in Chapter 4 case study analysis which was carried out in different stages of projects' lifecycle. Although in Sri Lankan Public Sector, most of the stakeholders represent government bodies from client, consultant, user and statutory bodies; design and construction process of building is very fragmented. The manner stakeholders are involved in project decisions making and execution are not always streamlined to achieve project success.

Objective 2 - To identify possible barriers of stakeholder involvement and causes that occurs in the life cycle of implementation of public sector green building projects.

From the Literature Review and the subsequent case study analysis 17 possible barriers of stakeholder involvement were identified that affects decision making and project execution of public sector green buildings. It is observed that these 17 can be further categorised to four fundamental aspects: Management, Technology, Economics, and Awareness. These 17 barriers are then included in the questionnaire in form of Likert scale to rate by the stakeholders involved in public sector green building projects.

Management

The unique nature of green buildings requires alterations to conventional project management practices in order to minimise risks and increase the possibilities of successful project delivery. Design and construction process of a green building project is not a linear procedure. Throughout total project life cycle of a project number of stakeholders influence from a diverse range of backgrounds. The most major challenge in delivering a successful green building project is coordination and communication through a multidisciplinary group of stakeholders. Hence management of stakeholder involvement play a critical role in implementing public sector green building projects.

Economics

If all decisions ‘come down to cost’ increase in capital cost is the biggest barrier in implementing green building projects. Even though most of the green buildings focus on their positive impacts on environmental, study shows public sector clientele decisions to go green remains deep-rooted in their financial viability. In the case study analysis it is observed that addressing green issues by relevant stakeholders early in the project life cycle than to work them in during project implementation is indeed less expensive. Indeed timely decisions can seriously impact the rate of return on short-term construction costs as well as long term operating costs especially in the public sector. So it is not mere terms in monetary value but also in the economy of time. In general, the results suggest stakeholder decisions in public sector are driven more by economics than environmental or social aspects.

Technology

Green building projects vary from conventional building project implementation in terms design, materials and the technologies used. Technology in construction is always a fragmented approach in developing countries like Sri Lanka. However Green building implementations in public sector require a holistic approach from project inception to completion and maintenance more than just looking into few green alternatives. Therefore an overview guide is essential to maintain that links to all stakeholders involved in the decision making process in technological terms.

Awareness

The very notion of green buildings is not yet implanted in the Sri Lankan building industry or in public sector projects. Once when deeply rooted only will stakeholders take initiatives to adopt green building in the public sector. To do so, they need to be more educated and have a greater understanding on qualitative and quantitative facets like whole building life cycle, economic concerns, environmental and social impacts of implementing green building projects in public sector Sri Lanka.

Objective 3 - To suggest solutions for the barriers in the stakeholder involvement in the implementation of public sector green building projects.

The analyses of the responses from case study interviews suggest solutions to overcome above barriers. Thus they were the basis of forming the proposed framework stakeholder involvement. They were listed under the six generic stakeholder involvement approaches Lead, Collaborate, Involve, Defend, Educate, Monitor and were included in the questionnaire in form of Likert scale to rate the responses from the stakeholders in implementing green buildings in the public sector Sri Lanka.

Lead

Effective stakeholder involvement relies on effective leadership. As such key stakeholders attached to public sector like policy makers and clients need to take leadership in promoting public sector green building projects evaluating the benefits and advantages. This would make other stakeholders involved in public sector green building projects to be motivated and result in effective involvement in implementation of public sector green building projects.

Collaborate

Public sector green building projects implementation requires capability and willingness among various stakeholders to involve with each other, and to communicate and collaborate effectively. Therefore it needs clear vision and mission that can be lead to project success. This can be governed by a project charter and making key stakeholders aware of it. Decision making and execution by key stakeholder groups can then be streamlined to an outcome-oriented process, safeguarding that there will be resources and commitment to follow-up on resultant actions. Only then will stakeholders make ‘holistic’ approaches to decision making.

Involve

Inclusive decision-making strengthen stakeholder networks, accountability, and a sense of empowerment. By maintaining and updating contractors, sub-contractors,

manufacturers and suppliers in the field on green building construction is very valid fact, especially in niche market environment like Green Buildings.

Defend

Accountability is a serious problem within the building industry as stakeholders naturally have resistance to change. This is observed in the recent efforts in adopting green building implementations in public sector. In a developing country like Sri Lanka the real challenge is not obtaining or the affordability of materials and technology but incorporating locally sourced materials with innovative green technology to deliver novel solutions to meet the demand. Hence research and development in green materials and technologies must yield more reliable research on the benefits of green building. Therefore the government must seek of means in providing necessary funding for the establishment of green technology research institutes and centres.

Educate

Stakeholders need to be more educated and aware to use ‘holistic’ approaches in decision making and execution. These approaches must base on a better understanding of qualitative and quantitative aspects in terms of long term economic concerns, environmental and social impacts of implementation of green buildings in Public sector. Therefore continuous training and awareness programs for key stakeholders and project team make effective stakeholder involvement throughout project life cycle.

Monitor

The overall assessment of the green building performance is a complex task. The main reason for this is much construction, energy and environmental aspects have to be considered. Only a more involved client presumably building’s main tenant or user, must more likely to assess the performance outcomes. Nevertheless, for this to become regular practice and implication, it either has to be established in the major environmental schemes, national building codes or as in part of the contract between

the client and contractor.

By means of overcoming barriers of stakeholder involvement through Lead, Collaborate, Involve, Defend, Educate and Monitor, public sector green building projects are expected to deliver project success. This study contributes some important insights into limited literature on stakeholder involvement in implementing green building projects in public sector. It also gives details on how the key stakeholder groups can develop successful involvement in implementing public sector green building projects.

5.3 Proposed Framework

The overall aim of this study was to develop a framework that effectively addresses the barriers in stakeholder involvement in the life cycle of public sector green buildings projects. This aim was pursued by addressing the following specific research objectives:

1. To explore the stakeholder involvement in implementation of public sector green building projects.
2. To identify possible barriers of stakeholder involvement and causes that occurs in the life cycle of implementation of public sector green building projects.
3. To suggest solutions for the barriers in the stakeholder involvement in the implementation of public sector green building projects.

The overall framework provides a comprehensive outlook on the stakeholder involvement in implementation of green buildings in public sector (Refer Appendix 1).

Sri Lankan public sector is still in the early stages adoption of Green Buildings. Therefore support and guidance are essential for successful adoption of green buildings not only in public sector but as well as in private sector. A commonly seen problem in green building implementation is that they place too much emphasis at the design phase, rather than the practical reality of their management and use. Hence

the building projects suffer failure rather than embracing change for success.

The shift from conventional buildings to green buildings requires altering the background in which buildings are designed, developed and operated. Especially in the public sector, the role that numerous stakeholders play is vital given on the overall context they operate and due to governmental procedures distinct to public sector projects. Moreover motivating green buildings in public sector requires shared vision, shared ownership and shared responsibility.

The outcomes of this research are very important in the present-day and offer noteworthy contribution for project decision-making and project execution related to implementation of public sector green buildings projects. It will not only contribute to knowledge mitigating barriers in implementation of green building projects in public sector Sri Lanka, but also offer valuable reference in assisting policy makers and stakeholders to take appropriate measures to promote green buildings implementation in public sector. The findings deem valuable information to the stakeholders as well as professionals to deliver successful projects. This study will generate greater awareness among key stakeholders in the public sector building industry on the importance of having useful stakeholder involvement framework for successful implementation of Green Buildings in Sri Lanka.

5.4 Recommendations

There is a large amount of literature on green buildings, but only few studies have focused on the implementation of public sector green building projects and its stakeholders. A key issue in furthering green building practice in public sector centres on what identifies as the need to develop and existing public institutional mechanisms, public policies and contracts need to adopt the on-going change. Through the proposed framework, the public sector building industry is expected to make its stakeholders willing on adopting green building construction instead of conventional construction in the future.

Findings of this research provide a basis for further development of framework that aims to improve and enhance the involvement of stakeholders in implementation of

public sector green building projects. It has revealed from this research that serious consideration must be given to facilitate more effective incorporation of different project stakeholders throughout the project life cycle.

As compared with traditional building projects managing green building projects have to be more detailed and allow greater communication and participation between all stakeholders involved. Although there are many studies about the performance and cost of green building projects, there are limited case studies about the stakeholder involvement in the public sector green building projects.

It is recommended to carry out further studies on how to improve and strengthen stakeholder involvement addressing government policies and regulations to be tailored towards implementing public sector green buildings projects. Also, need to address the demand for public sector green buildings through with public awareness of environmental issues and advantages of green buildings. As previously stated in this study, government must take lead in promoting green buildings by setting an example.

5.5 Limitations of the Study

The conclusion of this study was reached depending on the answers provided by stakeholders involved in public sector green building projects in Sri Lanka. Since Green Building construction in public sector is still a novel approach vastly adhering to UDA regulations implemented in 2017, not many projects have been completed. Hence the study lacks feedback from stakeholders involved in Project Life Cycle phases of Operation / Maintenance and Reuse/ Demolish.

The generalisation of the findings in this study is limited to the Sri Lankan public sector construction industry. Moreover, the results of similar study in different countries may differ subject to government policies and regulation, procurement routes and contract conditions regarding green buildings.

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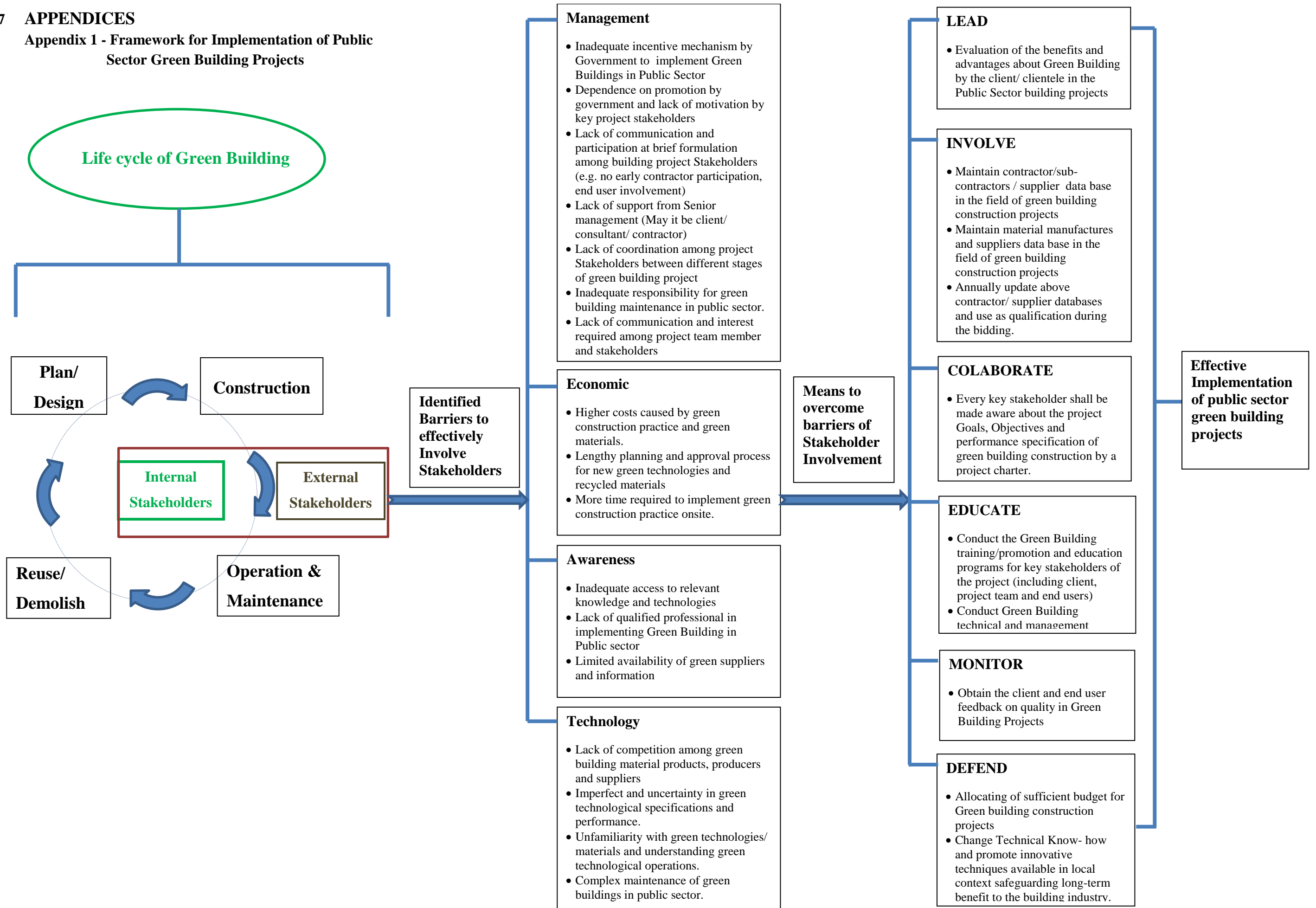
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7 APPENDICES

7 APPENDICES

Appendix 1 - Framework for Implementation of Public Sector Green Building Projects



Appendix 2

CASE STUDY INTERVIEW QUESTIONNAIRE

Part One;

1. Green Building Life cycle phase of the building - Plan/ Design
2. Stakeholder category - eg. Client
3. Employed Organisation - eg Department of registration
4. Current position in public sector - eg Assistant Director
5. Experience in public sector building projects-

The aim of this part is to categories the stakeholders based on their involvement in the building project.

Part Two;

1. Briefly explain your role in the selected green building project as per your current appointment.
2. Can you explain the problems encountered in implementing the selected green building project in this phase compared to tradition building implementation?
3. In your point of view how do you think involved stakeholders at this phase could have handled these problems?
4. Any suggestions on how effective stakeholder involvement could resolve successful implementation of green building projects in public sector in future?

Part Three;

Remarks;

Researchers' remarks after the questionnaire based interview.

Appendix 3
QUESTIONNAIRE

**Stakeholder Involvement in
Implementation of Public Sector Green
Building Projects**

RESPONDENT'S PROFILE

1. Name

2. Designation

3. Organization

4. Date

Example: January 7, 2019

Kindly indicate your answer by highlighting using "tick" or "x" in your worksheet and relevant space provided along with the questions.

5. Gender ?

Check all that apply.

- Male
 Female

6. Age?

Check all that apply.

- Below 30
- 31-40
- 41-50
- 51-65
- Above 65

7. Experience in Public Sector/Construction Project?

Check all that apply.

- < 6 years
- 6–10 years
- 10–20 years
- 20–30 years
- >30 years

8. Are you involved in the implementation of green buildings related works at present as per your current appointment ?

Check all that apply.

- directly involving
- indirectly involving

9. Your current role in the public sector green building project/s?

Check all that apply.

- Client
- Consultant
- Green Building rating system
- Contractor / Supplier
- End User

10. Briefly explain your involvement to the public sector green building related works as per your current appointment

11. Building Life Cycle phase your involvement to the public sector green building project/s engaged in?

Check all that apply.

- Plan/ Design
- Construction
- Operation and Maintenance
- Reuse/ Demolition
- Total building life cycle

Barriers that affect stakeholder involvement in implementation of public sector green building projects in Sri Lanka

SECTION
2

1. Inadequate incentive mechanism by Government to implement Green Buildings in Public Sector

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

2. Dependence on promotion by government and lack of motivation by key project stakeholders

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

3. Lack of communication and participation at brief formulation among building project Stakeholders (e.g. no early contractor participation, end user engagement)

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

4. Lack of support from Senior management (May it be client/ consultant/ contractor)

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

5. Lack of coordination among project Stakeholders between different stages of green building project

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

6. Additional responsibility for green building maintenance in public sector.

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

7. Lack of communication and interest required among project team member and stakeholders

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

8. Higher costs caused by green construction practice and green materials.

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

9. Lengthy planning and approval process for new green technologies and recycled materials

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

10. More time required to implement green construction practice onsite.

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

11. Inadequate access to relevant knowledge and technologies

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

12. Lack of qualified professional in implementing Green Building in Public sector

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

13. Limited availability of green suppliers and information

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

14. Lack of competition among green building material products, producers and suppliers

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

15. Imperfect and uncertainty in green technological specifications and performance.

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

16. Unfamiliarity with green technologies/ materials and understanding green technological operations .

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

17. Complex maintenance of green buildings in public sector.

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

Possible solutions to overcome above barriers in implementing Green Buildings in the Public Sector

SECTION
3

1. Evaluation of the benefits and advantages about Green Building by the client/ clientele in the Public Sector building projects

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

2. Maintain contractor/sub-contractors / supplier data base in the field of green building construction projects

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

3. Maintain material manufactures and suppliers data base in the field of green building construction projects

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

4. Annually update above contractor/ supplier databases and use as qualification during the bidding

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

5. Every key stakeholders shall be made aware about the project Goals, Objectives and performance specification of green building construction by a project charter.

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

6. Allocating of sufficient budget for Green building construction projects

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

7. Change Technical Know- how and promote innovative techniques available in local context safeguarding long-term benefit to the building industry.

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

8. Conduct the Green Building training/promotion and education programs for key stakeholders of the project (including client, project team and end users)

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

9. Conduct Green Building technical and management training programs for the project team

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

10. Obtain the client and end user feedback on quality in Green Building Projects

Check all that apply.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

Any other Suggestions?
