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A Conceptual Framework for Accelerating Green Concept Implementation in the Sri Lankan Construction Industry

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Abstract- The construction sector has a great impact on global economic growth, and at the same time, it has led to a high rate of environmental degradation, as it consumes about a quarter of the world's energy and nearly a third of the emissions of greenhouse gases. Although there is an ever-growing global concern regarding sustainability and green building technologies (GBTs), the use of GBTs is still unsustainable and incoherent. This study builds upon a well-developed conceptual framework to expedite the application of the green building concepts in the Sri Lankan construction industry by determining and incorporating key barriers, drivers, and enablers. The study will use a sequential exploratory design, which involves using qualitative data such as semi-structured interviews and focus group discussions, and then quantifying the data using structured questionnaires given to 150-200 construction industry practitioners. The study has been conducted with reference to four main aims, namely determining the barriers to the adoption of GBT, studying the driving forces and enablers, working out the integrated conceptual framework, and strategic policy, technology, and stakeholder engagement recommendations. The results indicate that barriers to adoption are high initial costs, poor technical knowledge, poor regulatory compliance, and poor stakeholder coordination, whereas the enablers are: financial incentives, capacity building programs, technological readiness, and enabling policy environments. The suggested framework provides a systematic guide to decision-makers, construction professionals, and regulators to address issues of implementation and to achieve national development objectives in accordance with international climate obligations.

Keywords: Green Building Technologies, Sustainable Construction, Conceptual Framework, Construction Industry, Sri Lanka.

I. INTRODUCTION

Background of the Study

The building sector is taking the forefront in the economic growth of the globe, in addition to environmental degradation. It not only contributes significantly to the GDPs of the nations, but also consumes nearly a quarter of the global energy and emits about a third of the greenhouse gases (UNEP, 2023). In response to it, the international sustainability demands, such as the United Nations Sustainable Development Goals (SDGs), SDG 9 (Industry, Innovation and Infrastructure), SDG 11 (Sustainable Cities and Communities), and SDG 13 (Climate Action), have given plausible grounds for why more sustainable, green construction should be implemented. The targets have countries go to a low-carbon and resource-efficient built-in environment, in which technology, sustainable materials, and the circular economy move (Mannamarakkalage, 2024; Siriwardena et al., 2024).

The concept of environmental sustainability (such as energy efficiency, water conservation, waste reduction, and reduction of carbon footprint) has evolved into the green building principle that has become one of the principles of sustainable building (Fernando and Perera, 2023). The green building technologies (GBTs) have been adopted at the global level to ensure that the resources are optimally utilized without having to sacrifice the comforts of its users and the environment (Jayasinghe et al., 2024). These innovations not only help to reduce the embodied energy but also enhance better long-term cost-efficiency, which is consistent with environmental changes on the global scale of carbon neutrality (Gunasekara, 2024; Wijesinghe, 2023). Table 1 was an overview of the sustainability

imperatives that are driving the transition of the world to green construction.

Table 1: Green Construction Core Sustainability Imperatives

#	Green Construction Core Sustainability Imperatives
1	Mitigation of climate change by designing energy-efficient buildings and the use of low-carbon materials
2	Efficiency of the resources through reduced usage of water, energy, and raw materials
3	Reduction of wastes and recycling
4	The green building standards improve human health, well-being, and productivity
5	Conformity to international sustainability systems (SDGs, Paris Agreement)

Sri Lankan Context

The construction industry is among the most significant economic sectors in the country, and it produces approximately 670000 to 700000 of the national GDP, and hundreds of thousands of people (both formal and informal employees) work in the construction industry (Mannamarakkalage, 2024). The sector plays an active role in the development of the infrastructure, residential development, and industrial development. However, it is also among the most resource-intensive industries of the country, which is energy-intensive, experiences a poor material management system, and creates a high degree of construction waste (Liyanage et al., 2024). It is also demonstrated that construction activities in Sri Lanka consume approximately 30 percent of the overall national energy and produce up to 20 percent of solid waste annually, which is a significant challenge to the environmental sustainability of the country (Rajapaksha, 2024).

These issues have been addressed through institutional and policy mechanisms. In 2009, the Green Building Council of Sri Lanka (GBCSL) introduced the GreenSL Rating System, which is a locally adapted certification system on the LEED and BREEAM models. There are such complementary policies as the National Policy on Sustainable Consumption and Production (2019), which is aimed at resource efficiency and environmental responsibility in industries (Fernando and Perera, 2023). Nevertheless, despite such structures, the green building theories are hardly present in the practical implementation of the large-scale construction works. It has been found that the number of large-scale projects in Sri Lanka that are fully adopting GBTs or a green rating system is a small percentage (Mendis, 2024; Seneviratne et al., 2024).

Research Gap

Even though interest among professionals and policy makers in Sri Lanka has been raised concerning the need to apply and understand the concepts of green construction, green building practices are still applied in fragments. According to surveys, the construction industry is characterized by many structural and systemic problems, which prevent the implementation of Green Building Technologies (GBTs) from becoming the norm. One of the biggest barriers is the unavailability of technological competence in the industry. Many firms, particularly the small and medium-sized enterprises (SMEs), lack the technical skills to design, install, and support green building systems effectively (Wijesinghe, 2023). This lack of consideration reduces confidence in the adoption of the new solutions and introduces a predisposition to adopt the old construction methods, in which the price is of more significance than the sustainability.

The second great drawback is the high initial price of the green technologies. Whereas long-term savings of operations and environmental implications are well-established, first-time investments in energy-efficient systems, sustainable materials, and renewable energy are very restrictive, particularly to SME with low financial resources (GBCSL, 2024). The existence of inefficient application of the offered green policies promotes further decrease in interest in the use of these technologies. The standards and guidelines are in place through models such as the GreenSL Rating System, but practice is impeded by the impossibility of control and punishment in case of non-conformity (Mendis, 2024).

Moreover, there is poor stakeholder coordination where the developers, contractors, architects, and the regulatory bodies are typically weak, and hence they cause fragmentation of project management

and also delay the introduction of sustainable practices. The absence of coordinated systems and pathways of planning reduces the efficiency and effectiveness of green movements (Siriwardena et al., 2024). Finally, but not least, the problems are only complicated by the presence of SMEs in the Sri Lankan construction sector, as smaller companies tend to be unable to invest in research, innovation, and training of GBTs (Silva et al., 2024). These challenges collectively lead to the need to have a context-sensitive model managed by a systematic strategy that dwells on the technological, financial, regulatory, and collaborative barriers to enable the adoption of green construction in Sri Lanka.

Purpose of the Study

Because the impediments towards the adoption of green constructions have remained a factor in Sri Lanka, the proposed study aims at developing a conceptual framework that would be effective in integrating the primary drivers, obstacles, and enablers that would aid in speeding up the process of adoption of sustainable building practices. The framework will focus on providing a coherent framework according to which the complexity of relations between the technological preparedness, financial incentives, policy support, and partnership between the parties can be examined, synthesizing both theoretical perspectives and empirical evidence of the latest studies (Jayasinghe et al., 2024; Mannamarakkalage, 2024; Fernando and Perera, 2023). In particular, it highlights the importance of joint actions taken by the developers, contractors, regulatory bodies, and professional associations to ensure the absence of issues such as fragmented practices, as well as to make sure that the green policies were successfully transferred into the working outcomes.

The proposed framework also includes the capacity building and dissemination of knowledge since the deficiency in technical expertise and knowledge is also considered to be one of the key impediments to the adoption. The study will serve to bridge the gap that exists between awareness and real practice, and provide valuable suggestions to the policy makers, industry practitioners, and researchers through the delivery of a systematic approach. Ultimately, this theoretical framework is seen to enable the principles of a sustainable and competitive construction industry in Sri Lanka and to harmonize the national development objectives with the global environmental obligations, though it is part of the broader objective of sustainable urbanization and climate resiliency.

II. PROBLEM JUSTIFICATION

The construction industry has been universally accepted as a means of both economic development and one of the largest contributors to environmental degradation. As much as the green building structures and technologies are rapidly spreading around the globe, their application has not been uniform, particularly in the less developed economies such as Sri Lanka. There are increasingly numerous questions about the construction industry in the country in terms of its effects on the environment and specifically excessive energy use, wastage of materials, and greenhouse gas emissions (Gunasekara, 2024; Fernando and Perera, 2023). The exacerbation of such issues is the high degree of urbanization, population expansion, and industrialization, which increases resource consumption and ecological pressure. The problem is that the absence of sustainability programs is not a key issue since the implementation of green building technologies (GBTs) and practices is sluggish and haphazard in the face of the heightened awareness and policy support (Jayasinghe et al., 2024).

Incorrect Adaptation and Inefficient Adoption of Green Practices.

Although the Sri Lankan Government has made positive steps through the Green Building Council of Sri Lanka (GBCSL) and the development of the GreenSL Rating System, this practice is superficial and restricted to a small number of projects (Mendis, 2024). The findings of the research by Siriwardena et al. (2024) and Liyanage et al. (2024) show that many contractors and developers lack a deeper understanding of GBTs but believe that sustainability is a type of compliance. In addition, the prohibitive character of the initial cost of green technologies and the unavailability of green financing do not

presuppose a private investment in sustainable building (Wijesinghe, 2023). The difference between policy aspiration and the practice on the ground suggests that there is a structural malfunction in the mechanism of translating cognitive ideas into measurable outcomes.

The unprovability of demonstration projects, the inadequate coordination of the stakeholders, and the lack of technical skills to comprehend the obstacles to GBT implementation turned out to be the most important limitations in their research on the subject, according to Jayasinghe et al. (2024). Similarly, a study by Mannamarakkalage (2024) on the problem of green procurement has shown that a lack of a standardized assessment structure and little communication with the suppliers is an obstacle to the rigid implementation of environmentally-friendly materials and processes. These findings highlight the importance of the fact that the existence of the policies is insufficient without other similar capacity-building mechanisms, the cooperation of the stakeholders, and economic incentives.

Institutional and Regulatory Constraints.

Weaknesses at the other level of the problem are institutional and policy-level weaknesses. Although the government policies, such as the National Policy on Sustainable Consumption and Production (2019) and other policies, promote green practices, the strategies for enforcement are weak and inconsistent at the ministries and agencies. In the process, the coordination among the Central Environmental Authority (CEA), Urban Development Authority (UDA), and GBCSL is low, which causes overlaps in the policies and ineffective allocation of resources (Fernando & Perera, 2023). Some construction works, especially in the private sector, are not done with a comprehensive environmental analysis or research, according to the findings of the research by Rajapaksha (2024) and Seneviratne et al. (2024).

The large-scale projects are not obliged to undergo the obligatory green certification, which further disheartens the industry in complying with the sustainability requirements. Some countries, such as Singapore, Malaysia, and India, have developed green certification in their building regulations and government procurement policies, but Sri Lanka continues with voluntary guidelines (Jayasinghe et al., 2024). This loophole in regulation serves as an addition to the soft policy environment where words promote sustainability but lack legal enforceability.

Technological and Financial Barrier.

The Sri Lankan construction industry is still at a low level of technological preparedness as compared to the world standards. The articles by Seneviratne et al. (2024) and Mendis (2024) indicate that the companies lack access to better design and simulation software to ensure the implementation of green buildings, such as Building Information Modelling (BIM), Life Cycle Assessment (LCA), and renewable energy integration technologies. Also, the quantity of environmentally friendly materials produced on location is limited, and most goods with green certifications are imported, raising the prices and logistic issues (Liyanage et al., 2024).

Green building projects are more expensive to start up but higher in the long-term economic payoff due to energy savings and operational efficiency (Mannamarakkalage, 2024). However, Sri Lankan financial institutions are yet to possess dedicated green financing instruments such as concessional loans and green bonds, as well as tax incentives on sustainable projects. Developers, in turn, can consider green construction as a viable choice that would be less profitable in the short term as well as in the conditions of financial risk (Wijesinghe, 2023; Siriwardena et al., 2024).

Knowledge Inefficiencies and Socio-Cultural.

Another factor that contributes to a slow process of transition towards sustainability is the socio-cultural attitudes, other than the institutional and economic constraints. In one of the studies by Fernando and Perera (2023), the authors found that most professionals and clients associate green buildings with high costs and aesthetics. Moreover, the population, as a rule, does not know about the long-term advantages of sustainable construction, which decreases the demand for green-certified buildings (Gunasekara, 2024). The systems used to educate and train engineers, architects, and quantity surveyors are also obsolete and more geared

towards traditional construction management rather than sustainability-oriented competencies (Jayasinghe et al., 2024).

Requirement of Conceptual Framework.

In light of these multidimensional issues, such as failures in policies, to socio-technical constraints, the necessity to implement an integrated conceptual approach that can accelerate the implementation of green concepts in the construction sector in Sri Lanka is imminent. Based on the existing body of research, it is possible to say that the introduction of green practices can be successful only with the assistance of facilitating governance and financial innovation and cultural change in addition to technological capability (Mendis, 2024; Seneviratne et al., 2024; Mannamarakkalage, 2024). The conceptual model can be created to identify and interconnect the drivers (e.g., policy, innovation, education), barriers (e.g., cost, awareness, regulation), and enablers (e.g., collaboration, digital tools, incentives) to scale up sustainable construction in the sector.

In conclusion, it cannot be said that this problem is the lack of knowledge of sustainability, but the absence of a unified mechanism that can bridge the gap between the policy framework, technology capabilities, and the actions of the stakeholders. The conceptual framework to this question is thus playing a vital role in making sure that the Sri Lankan construction industry has a significant role in ensuring that the national sustainability targets and international climate commitments are achieved.

III. RESEARCH AIM, OBJECTIVES, AND QUESTIONS

Research Aim

The overall goal of the research is to find a comprehensive conceptual framework for accelerating the uptake of green building concepts and sustainable construction practices in the Sri Lankan construction industry. Even though the concept of sustainability is gradually entering the consciousness of the global community, the three pillars of sustainability, including energy efficiency, resource optimization, and carbon reduction, are becoming a reality, and it is still debatable in Sri Lanka due to economic, technical, institutional, and socio-cultural reasons (Jayasinghe et al., 2024; Mendis, 2024). The proposed research will seek to synthesize evidence on the subject, theoretical insights to establish what matters, obstacles, or enabling factors that would give the concept of green adoption consideration, and to develop a systematic model upon which the concerned parties can embrace the concept without difficulties.

The decision-makers, construction practitioners, and regulators will streamline the process of planning and implementation of sustainable construction projects by aligning the policies, preparing them using technology, ensuring financial viability, and coordinating among the stakeholders in the project. The second contribution made by the study is that it helps to bridge the awareness-action gap needed to make Sri Lanka fulfil the national sustainability targets and global climate commitments (Fernando and Perera, 2023; Siriwardena et al., 2024).

Research Objectives

To operationalize this goal, four objectives are set in the paper:

1. To identify the primary barriers to the adoption of green building technologies (GBTs) in the Sri Lankan construction industry and categorize them. Previous research claimed that the primary barriers are high initial costs, insufficient technical competence, ad hoc compliance with regulations, and incompetence in the collaboration of interested parties (Wijesinghe, 2023; Jayasinghe et al., 2024). The research will provide a rationale for certain interventions and policy updates, as it will map these obstacles in a systematic way.
2. To investigate the forces and enabling factors that facilitate the implementation of the green concepts. It has been established that government incentive schemes, regulatory conditions, digital solutions, sustainable procurement, and capacity building can drive the adoption in other developing countries of a similar nature (Mannamarakkalage, 2024; Seneviratne et al., 2024). These factors will be identified and prioritized, which will facilitate the framework to provide practical avenues to the stakeholders.

3. To create a conceptual framework that entails the incorporation of barriers, drivers, and enablers as a holistic model in accelerating green adoption. This objective is meant to bridge the gap between theory and practice. As it comprises the knowledge obtained in literature and by means of empirical observation, the framework will be employed as a strategic tool for planning the project, policy-making, and development of capacity within the industry in general (Rajapaksha, 2024; Liyanage et al., 2024).
4. To provide policy, technology, and stakeholder engagement strategy advice on how the adoption of the green concept can be enhanced in Sri Lanka. International best practices should be used in an advisory manner, but have to be adapted according to the country because each country has its own legal, financial, and even socio-cultural background. The study will have the capacity to take the abstract research into tangible recommendations that can be applied by the decision-makers and the practitioners (Fernando and Perera, 2023; Gunasekara, 2024).

Research Questions

The research questions of the study are four to achieve the aforementioned objectives:
1. What are the critical barriers to the adoption of green building technologies in the construction industry in Sri Lanka, and how can they be overcome? What are the effects of the critical barriers on the project implementation?
2. What are the technological, financial, regulatory, or socio-cultural drivers or enablers to embrace the green concepts, and how can this be maximized?
3. So, what do you think such an integrated conceptual framework can be to realize a lean-out endeavor to integrate the stakeholders, policies, and technological interventions on acceleration of the green implementation efforts?
4. The strategic ideas that can be inferred using the framework are what can make adoption of green buildings more practical, particularly in large and public sector buildings.

The research suggests a response to these questions in such a manner, and, therefore, it is both a theoretical and a practical contribution to the study. It is assumed that the framework will provide a systematic information on how to cope with the adoption barriers present in the findings of previous researches (Jayasinghe et al., 2024; Mannamarakkalage, 2024) but on the other hand introduce to the fore, the enabling mechanisms in which implementation of the green building concepts can be practically foured, at scale and in a sustainable manner within the Sri Lankan context.

IV. LITERATURE REVIEW

The body of literature that has been made concerning the adoption and sustainable development of green buildings in Sri Lanka demonstrates that the multi-faceted array of technology, financial, institutional, and socio-cultural aspects is at play. Previous studies have intermittently indicated the most prominent hindrances, drivers, and enablers that define the use of green building technologies (GBTs) and environmentally friendly practices. These are factors that should be comprehended to be able to create a conceptual framework that will shorten the process of implementing the green concept in the construction industry in Sri Lanka.

Green Building Technologies and International Worldviews

Concept of green construction within the international arena has assumed a niche sustainability experiment to mass activities in the light of the regulatory forces, firm social responsibility, in addition to action on climate demands. Energy efficiency, optimization, and low-carbon design became the major concentration of green building standards such as LEED, BREEAM, and EDGE (Gunasekara, 2024). The use of technologies that comprise Building Information Modelling (BIM), Life Cycle Assessment (LCA), integration of renewable sources, and smart construction systems is part of the technology that has contributed to the enhanced capacity to plan, monitor, and optimize sustainable practices in real time (Fernando and Perera, 2023).

The global literature is devoted to the concept that implementation must be successful not only because of the presence of various technologies, but also integration of policy, financial procedures, and

human capacity (Siriwardena et al., 2024). According to Asian studies, regulatory policies, such as expeditious approvals of certified projects, and monetary policies, such as concessional lending and tax exemptions, are significant in green uptake (Jayasinghe et al., 2024).

Sri Lankan Environment of Green Building.

Green building in Sri Lanka has not yet taken off. Fragmentation of the regulatory enforcement, high start-up cost of investment, and deficiency of technical expertise are the key obstacles to implementation (Jayasinghe et al., 2024). The sustainable building certification is done in the Green Building Council of Sri Lanka (GBCSL) and the GreenSL Rating System, yet the adoption remains low, as it has predominantly been applied to large and high-profile buildings (Mendis, 2024; Liyanage et al., 2024).

Sri Lanka is experiencing particular environmental problems, such as the largest amount of construction waste, buildings that consume a large amount of power, and minimal consumption of renewable products. The research on non-domestic structures revealed that quite a small portion of the projects had reached material green certification rates, which signifies a group of cost-sensitivity, absence of technology, and low participation rates of stakeholders (Liyanage et al., 2024). It has been suggested in literature that the system mechanisms are necessary in addition to awareness to apply policy and knowledge awareness into the working practice (Wijesinghe, 2023; Rajapaksa, 2024).

Green building technology barriers to implementation.

The barriers of some of the studies are categorized as financial, technological, institutional, and socio-cultural. The financial obstacles will include the perception of intensive start-up costs and the unavailability of green financing tools (Mannamarakkalage, 2024). Among the technological barriers, a lack of environmentally friendly and sustainable materials in the country, a lack of knowledge related to the use of BIM and LCA programs, and a lack of technical competence of professionals may be distinguished (Seneviratne et al., 2024).

The strong change obstacles in the Sri Lanka case context are the institutional ones. Simultaneously, the lack of a strong implementation of the policies, duplication of the mandate of the regulatory authorities, and the voluntary nature of the certification schemes can be enumerated among the obstacles (Fernando and Perera, 2023). Social and cultural factors that undermine the motivation to embrace the use of green practices are the absence of customer requirements in line with sustainable buildings and misconceptions about aesthetic and financial compromise (Gunasekara, 2024; Siriwardena et al., 2024). Table 1 presents the key barriers identified in the recent studies.

Table 2: Barriers of Green Building Adoption: Sri Lanka

Category	Barriers to Green Building Adoption: Sri Lanka
Technological	Poor understanding, poor use of BIM/LCA, poor access to green materials
Institutional/Policy	Decent enforcement, optional certification, piecemeal governance
Socio-Cultural	Lack of awareness, resistance by clients, wrong beliefs about beauty and affordability

Green Implementation Driving Forces and Enablers

Despite the presence of barriers, which hamper adoption, drivers and enabling factors to adopt green concepts have been highlighted in the literature. Such tools as tax reductions and expedited certifications on certified plans of construction are literal incentives given by the regulatory authorities to the developers (Mendis, 2024). Institutional support can be given to provide technical preparedness concerning professionals in terms of training programs, capacity-building actions, and demonstration projects (Jayasinghe et al., 2024).

Financial mechanisms that are considered necessary facilitators are concessional loans, green bonds, and project-level subsidies; specifically, SMEs that dominate in the Sri Lankan construction industry

(Mannamarakkalage, 2024; Wijesinghe, 2023). Social and cultural enablers, such as increasing client demand for a sustainable office and residence, media, and pro-best-practice networks, also drive adaptation (Gunasekara, 2024).

Another role is played by the technology enablers. The conjunction of BIM, energy modeling, and LCA allows one to optimize the design at the initial design phase and reduce the amount of waste of materials and energy consumption (Fernando and Perera, 2023). Renewable materials and modular approaches in construction and integrated systems that allow efficient energy management can be used to make the projects greener (Rajapaksea, 2024).

Green retrofitting and sustainable procurement involve creating a green space and productive procurement, which must be environmentally friendly at each phase (Green Supply Chains 2012). The idea of retrofitting old buildings with greenery is a new trend in the literature. As Seneviratne et al. (2024) put it, retrofitting represents a more cost-effective option which may allow reducing the embodied energy, making it more energy-saving, and reach the desired sustainability without the necessity to establish a large-scale object. The purchasing operations, like certified sustainable materials priorities and supplier engagement, have also been termed as the determining switches to improve sustainability (Mannamarakkalage, 2024; Liyanage et al., 2024).

Research Gaps and the need to possess a conceptual framework

The barriers and drivers are getting more and more learned; however, studies done on the situation in Sri Lanka show that there are no integrated models that would take into account the technological, financial, institutional, and socio-cultural factors holistically. Recent research is usually fragmented, since it merely touches upon the individual sides of the problem as compared to the holistic approach that is required to accelerate the adoption (Jayasinghe et al., 2024; Fernando and Perera, 2023). Moreover, the scanty empirical information on such interaction in the field remains to be found primarily in SMEs and in those projects by the state.

A broad conceptual framework that incorporates the multidimensional drivers, barriers, and enablers can provide a sequential version of acceleration of the green building adoption. This type of framework can provide a working guide to the developers, policymakers, and industry players through mapping the relationships between policy, technology, and stakeholder behavior (Siriwardena et al., 2024).

Lastly, the literature confirms the fact that despite the success that Sri Lanka has made in the areas of policy and institutional interventions in building sustainably, the practice has not been adopted yet because of financial, technical, regulatory, and cultural barriers. Simultaneously, the avenues to the rapid implementation are the motivators, institutional reinforcement, and technological advances. Development and implementation of a synthesized conceptual system is therefore crucial and propitious, and provides a foundation for planned intervention and scalable green building processes.

V. METHODOLOGY

The critical research methodology of this study shall be applied by researching the drivers and obstacles that influence the adoption of the green concept in the Sri Lankan construction industry and emerge with a conceptual framework that will enhance the implementation process. The research problem is multidimensional, which is why the research method is selected as a mixed-method one, and the qualitative and quantitative data collection and analysis will help to cover in-depth context and empirical validity (Creswell, 2014). This approach will allow triangulation and make the results stronger, as well as allow for the development of a theory and a practically applicable framework.

Research Design

It will also be a sequential exploratory study, since the first is the qualitative exploration of the perception and experience of the stakeholders, and then, as the survey progresses, the validity of the identified factors will be determined. The qualitative aspect is the semi-structured interviews and focus group discussions of the key stakeholders, who

include the architects, engineers, quantity surveyors, contractors, and developers, the policymakers, as well as the other members of the Green Building Council of Sri Lanka (GBCSL). The stage will aim to provoke the contextual nuances, attitudes, and perceptions of the green building adoption that will provide informative insights into the socio-cultural, institutional, and technological dimensions (Jayasinghe et al., 2024; Mannamarakkalage, 2024).

Quantitative phase involves surveys and structured questionnaires, which are provided to more practitioners in the industry. The aim is to statistically validate the obstacles, motivation, and facilitators that were identified during the qualitative stage, enabling ranking them according to the level of importance and frequency. The provided sequential methodology ensures that the conception framework is grounded, not only on the insights of the experience, but also on the empirical research.

Population and Sampling

The review will be addressing mega-projects in building in Sri Lanka, in the business sector, as well as in the government sector. It comprises industry players in the field of planning, designing, and developing construction works with regard to sustainability.

During the qualityative stage, a sample of 25-30 participants will be chosen purposively, who will be of different positions in the company and expertise. This ensures that they exhaust a range of opinions and enhances the trustworthiness of the findings (Fernando & Perera, 2023). The stratified random sampling method will be used to choose about 150-200 respondents, that is, certified green projects, professional networks, and industry associations, in the case of the quantitative phase. The stratification is made based on the size of the project, the industry (both the public and the private), and occupational status, so as to ensure that the findings can be generalized to the remaining industry.

Data Collection Methods

- **Qualitative Data Collection**

The semi-structured interviews will be conducted under the guidance of the interview guide that will be informed by the review of the literature (Jayasinghe et al., 2024; Seneviratne et al., 2024). Questions explore the perception of barriers, motivators, institutional support, technological readiness, and monetary motivators. The interviews are audio-taped and transcribed word-for-word, which makes the analysis possible.

It is also conducted in the form of a focus group discussion with 6-8 participants to share knowledge and to validate preliminary findings of the interview. The method allows the stakeholders to collectively deliberate the issues, concerns, and potential solutions of a problem that would provide them with a wider knowledge of group dynamics and perceptions.

The quantitative data acquired will be quantitative since it is the quantification of variables and facts.

Quantitative Data Collection

The quantitative data will be quantitative in the sense that it will involve the techniques of quantifying variables and facts.

A questionnaire is created on a structured form, just like qualitative outcomes and current literature (Mendis, 2024; Siriwardena et al., 2024). A Likert scale is used in the questionnaire to establish the significance of the barriers, drivers, and the availability of enablers and prioritization of questions. The data would have been obtained by the use of online questionnaires and face-to-face interviews where the participants can be accessed.

Data Analysis

- **Qualitative Analysis**

Qualitative data is analyzed using thematic analysis (Braun and Clarke, 2006). The objective of inductive coding of transcripts is to identify common themes and patterns of barriers, drivers, and enablers. Qualitative analysis is designed with the help of NVivo or some other qualitative analysis software that enables the creation of categories and the discovery of relationships between variables. Thematic analysis allows for the development of a meaning that would never have been detected within structured surveys, and it further ensures that the conceptual scheme reflects the actual experience

and current issues that are being experienced by the stakeholders.

Quantitative Analysis

Quantitative data are analyzed using descriptive and inferential statistics. Descriptive statistics (mean, SD, and frequencies) are used to summarize the factors' perception and importance among the stakeholders. Factor analysis is employed to group similar barriers, drivers, and enablers into similar dimensions. It may also be conducted by use of regression analysis to determine the influence of some drivers in determining the potentiality of adopting green practices (Siriwardena et al., 2024).

Conceptual Framework Development.

The conceptual framework will be progressively built, which will include qualitative observations and quantitative testing, as well as the literature evidence. The framework categorizes the factors under three fundamental dimensions, namely barriers, drivers, and enablers. It illustrates the relationship between the three dimensions with one another in a manner that provides a guide on how to impel the green adoption in the context of Sri Lanka.

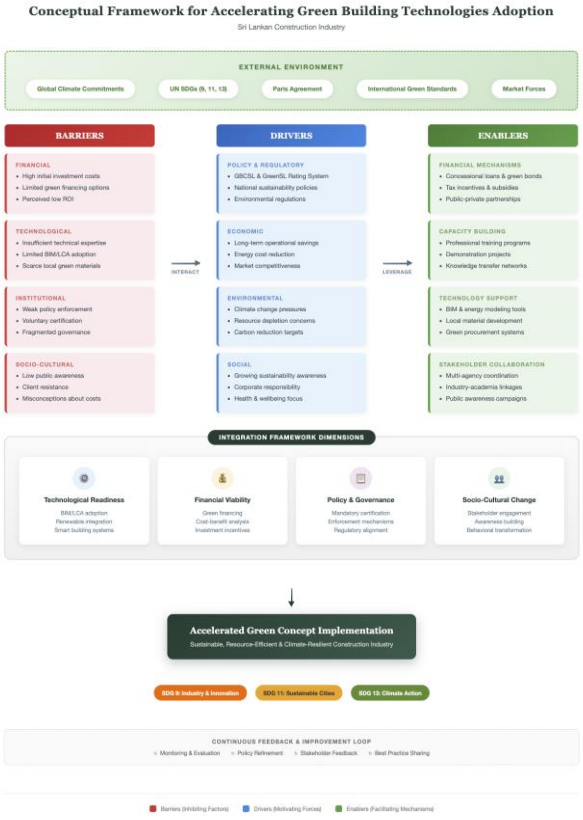

Figure 1: Conceptual Framework for Accelerating Green Building Technologies (GBTs) Adoption in the Sri Lankan Construction Industry

To identify which factors are applied to adopt green buildings, a graphical representation is drawn to depict the interaction between institutional support and financial incentives, technological readiness, stakeholder collaboration, and socio-cultural awareness. The framework also demonstrates the intervention strategic points that can be utilized by policymakers, industry players, and financiers in the fight against the barriers and in exploiting the enabling factors.

Ethical Considerations

It receives the ethical approval of the relevant institutional review board. All the participants of the study are informed about the aim of the study, their right to withdraw at any time, and their privacy. Every interview, focus group, and involvement in a surgery survey is informed. To guarantee the privacy of the data utilized, as well as to ensure that the ethical norms are kept, the data are anonymized and kept in a safe place.

Limitations of Methodology

Despite the fact that the mixed methods design is a comprehensive design, limitations are likely to be experienced in the study. A purposive and stratified sampling method can also cause the development of selection bias, and the findings may not be fully applicable to all construction projects in Sri Lanka, particularly the small ones. Besides, the self-reported data may include a social desirability bias, where the subjects overestimate their commitment to sustainability. However, the qualitative and quantitative data triangulation assists in overcoming these restrictions, as they contribute to the legitimacy and power of findings.

VI. SIGNIFICANCE OF THE STUDY

In addition to the multidimensional aspects that define the uptake of green building technology (GBT), the study supplements the literature on green sustainable buildings. Though earlier studies in Sri Lanka have pointed to the financial, technical, and

regulatory barriers, a holistic system of analyzing the interdependence between technological, financial, institutional, and socio-cultural factors was absent. The presented framework gives researchers an opportunity to continue with the empirical testing, revisions, and comparative research on green retrofitting, sustainable procurement, and resource optimization not only in Sri Lanka but also in other developing countries.

Practical Implications

The framework provides practical advice to developers, contractors, architects, engineers, regulators, and policymakers. It identifies certain interventions in response to the obstacles, including high initial costs, accessibility to green materials, and a detached stakeholder coalition, and gives some directions on accelerating the uptake process by offering financial incentives, capacity-building mechanisms, and regulatory support.

Policy Implications

The results can guide the government bodies and the regulatory authorities on effective intervention that encourages green construction. The framework assists in the development of incentive programs, certification programs, and regulatory implementation instruments that are specific to the Sri Lankan construction sector and focus on stakeholder cooperation in order to increase the efficiency and viability of the projects.

Industry Competitiveness

Green building minimizes the use of energy, emissions of carbon, and waste materials, which are in line with national environmental policies and corporate social responsibility. This research project makes the Sri Lankan construction industry competitive in the international market, where green certification and sustainable design have gained popularity.

The awareness-implementation gap addressed by this research in the end is based on an elaborate conceptual framework that enhances theoretical knowledge and also offers a specific roadmap towards the rapid adoption of sustainable construction in Sri Lanka. Its input has the potential to change the policy, practice, and research, and make the construction industry sustainable and resilient.

VII. LIMITATIONS

Even though the study will also seek to outline a detailed conceptualization of accelerating the implementation of the green concept in the Sri Lankan construction industry, it is essential to mention the inherent limitations that can influence the interpolation, extrapolation, and application of the research findings. Such awareness of the limitations will make it possible to generate a subtle interpretation of the research findings, as well as result in future research.

Among the key limitations is the geographical and contextual specificity of the study. The research examines the Sri Lankan construction industry, where the study has narrowed down to the mega projects, both within the state and in the private sector. Even though such a narrow focus is possible to explore specific contextual barriers, drivers, and enablers of green building technology adoption in detail, this study cannot be directly generalized to other developing countries or regions with dissimilar regulations and cultural trends (Fernando and Perera, 2023; Jayasinghe et al., 2024). In this way, it is necessary to approach the notion of generalization with some caution, and perhaps we will have to adjust the application of the conceptual framework to different national or regional contexts.

The other weakness is associated with the methodology. The study uses a mixed-method research design, which entails the application of qualitative interviews, focus group discussions, and quantitative surveys to gather data from stakeholders of interest. Despite the attempts to triangulate findings and enhance validity, the data are inherently based on self-reporting, which may permit the entry of biases, including social desirability and recall bias. Respondents will be prone to exaggerating or underreporting the problems concerning green practices or challenges due to organizational pressure or due to the perceived reputational problems (Siriwardena et al.,

2024). Even though the study has rigorous data validation procedures, they cannot be eliminated.

Besides, the studies are largely focused on large construction businesses, and may not be entirely representative of small and medium-sized enterprises (SMEs), as a large portion of the construction sector in Sri Lanka. The SMEs also have certain issues, such as financial limitations, inappropriate access to sustainable resources, and a lack of technical expertise, which are not common among larger entities (Mannamarakkalage, 2024). The conceptual framework, in its turn, may require further expansion to achieve an ideal reflection of the limitations and opportunities related to smaller companies.

The relevance of the study is also influenced by time limitations. The technologies, the policies, and the standards of sustainability of a green building are evolving at an extremely high speed, and that is why the barriers and the facilitating factors, as they were at the time the research was being conducted, could be different. The conceptual framework is, therefore, considered the dynamic model, which should be empirically tested, constantly and periodically revised to remain relevant and useful in practice (Gunasekara, 2024; Rajapaksa, 2024).

Finally, although the study has had a very broad spectrum of the dimensions that could have influenced the green building adoption, like the technological, financial, regulatory, and socio-cultural, it lacks in the all-encompassing exploration of all the possible factors that may influence the adoption of the green building including the climate-specific design of the buildings or the study of the lifecycle cost of all building typologies. Other variables can be included in the scope in future research.

Despite these weaknesses, the research provides a solid foundation for the understanding and promotion of the implementation of green buildings in Sri Lanka. It gives a lot of information to the policy makers, the stakeholders of the industry, and the researchers by clearly pointing out the limitations and challenges, and offering new chances to consider and enhance the situation.

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