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DEVELOPING A 'GREEN BUILDING SUSTAINABILITY STRATEGY' FOR GREEN BUILDINGS IN THE COUNTRY OF INDIA.

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Abstract:
Although there has been extensive study on the position, drivers, and challenges of green buildings, there is a lack of an integrated plan to facilitate their growth. This research is a deliberate attempt in that regard. A 'Green Building Sustainability Model' was created after conducting a thorough study of literature, and structural equation modeling was used to validate the research framework. The research emphasizes that the commitment to sustaining environmentally friendly performance and embracing green practices must be present across all societal strata. The conceptual model proposes relationships among nine constructs: problems, challenges, government, corporate, developers, buyers, private bodies, strategic-mix, and sustainable development, and formulates twelve hypotheses. The data is gathered by a questionnaire survey approach. The study shows that cooperation between the government and various stakeholders is crucial in creating a strategic approach for sustainable development. The government, as a regulatory authority, has the most important role in shaping this strategic approach for a resource-efficient future. The paper's main contribution is the development of an innovative Green Building Sustainability Model to address a research gap. The concept has been designed and tested in India and might be further examined in green buildings in other developing or developed nations. The model is versatile and may undergo further testing for green building applications in both commercial and residential settings. The study findings are very relevant to academics, environmentalists, practitioners, policymakers, and will serve as a valuable reference for future research.

Keywords:
Green developing, Sustainable Development, Strategy Mix, Sustainability, and Green Architecture. Sustainability Framework

I.0 Introduction

1.1. Global Climate Change & Sustainable Buildings

The worldwide focus on climate change, global warming, and rising pollution has made it essential for policymakers worldwide to create environmentally friendly measures for a sustainable future. There has been a rise in ecological awareness, leading governments to implement eco-friendly measures to combat environmental damage (Hin Ho et al., 2013). Real estate has a significant role in contributing to global warming due to the pollution and waste generated by buildings (Centre for Science and Environment, 2011).A study conducted in the United States reveals that carbon dioxide emissions from the 'embodied energy' found in building products such as tiles, glass, and concrete surpass those from industry and transportation. These emissions make up roughly 40%-50% of energy intake, water usage, and raw material consumption. Additionally, they contribute to approximately 40%-50% of water pollution, air pollution, greenhouse gas emissions, and chlorofluorocarbons (CFCs) released into the environment (Green Rating for Integrated Habitat Assessment (GRIHA Manual, 2010)). Energy-efficient buildings decrease energy demand by 40%, lower associated costs, improve worker retention, enhance worker productivity and health, decrease risk, and provide benefits for developers, tenants, and owners. Research has shown that implementing energy-efficient practices may decrease greenhouse gas (GHG) emissions by 142 megatonnes (Mt) annually by 2020 and by 296 Mt annually by 2030 (Darko et al., 2013).

The worldwide recognition and significance of sustainability in the construction industry is increasing due to factors such as climate change, growing population, and fast urbanization, leading to a higher need for green buildings to promote sustainable development (Butera, 2010; Gou and Xie, 2016). The Energy and Resource Institute, a non-profit organization focused on sustainable development, defines green buildings as structures that are specifically planned, built, and operated to reduce overall environmental effects while improving user comfort and productivity (GRIHA Manual, 2010).The advantages of green buildings and their impact on sustainability are well recognized. Green buildings provide a variety of benefits such as waste reduction, pollution prevention, environmental protection, health promotion, increased productivity, resource conservation, asset value enhancement, higher rental revenue, risk mitigation, and lower life cycle costs (WorldGBC, 2013). Therefore, it is clear that the implementation of green buildings will support the sustainable growth of the construction sector (Darko and Chan, 2016).

Various obstacles and constraints, such as lack of public awareness, high costs, and regulations, hinder the widespread implementation of green buildings (Shafii and Othman, 2005). The primary obstacle to adopting environmentally friendly practices is the human factor, which requires being informed, educated, and motivated towards sustainability. Stakeholders are crucial in creating a necessary and well-crafted policy (Hong et al., 2007; Khera, 2011; Potbhare et al.2009).Countries have varying environmental requirements based on factors such as culture, climate, and building types. Different stakeholders in different countries play a crucial role in implementing green building policies based on the type of structure. For instance, new building developers may significantly decrease energy use by 20%-60%, while existing building occupants, owners, and stakeholders can lower it by 25%-50%. Implementing energy efficiency in new buildings is more cost-effective. Developing nations, such as India, where 60% of development is yet to occur, have a significant chance to integrate green building designs and decrease carbon footprints for the future (Hong et al., 2007). Hong et al. (2007) suggest that an effective 'policy-mix' should include government regulations to encourage action, together with non-regulatory market incentives to raise awareness and promote investment. Their study suggests an integrated strategy to produce a 'policy mix' that combines many policies to generate supply-side "push" and demand-side "pull" effects.

Ling et al. (2015) investigated how institutional variables affect green efforts in their research. The government's participation is recognized as a crucial institutional aspect in promoting green projects. Ling et al. (2015) reinforce the stakeholder theory proposed by Buysse and Verbeke (2003) by suggesting that stakeholders' pressure motivates organizations to implement green initiatives. Darko et al. (2017) provided a categorization system for green building drivers and suggested that various drivers would influence different stakeholders. The report presents several pieces of data to demonstrate that the government plays a crucial role as the primary driver, compelling other stakeholders to strive for sustainability.

1.2 Define Green Architecture.

The green construction sector is valued at over half a trillion dollars in the United States and over a trillion dollars globally. It has spurred the global adoption of green building and design, inspiring advancements in products, materials, and processes (World GBC, 2013).

Sustainability in buildings is a multifaceted notion, despite being a popular term. Several prominent definitions of sustainable buildings have been proposed. Kibert (2012) defines the result of using sustainable construction methods as high-performance green buildings, also known as green buildings. Today, we have structures known as "net zero buildings" or "zero energy buildings" that generate the same amount of energy as they need during a year. The concept of 'zero energy' refers to a situation where the energy generated on-site from renewable sources matches the energy used by the building over the course of a year, as shown by Torcellini et al. (2006) and UNEP (2009). Some notable worldwide net zero energy buildings are Green Acres in New York, Technische Universität Darmstadt in Germany, and Indira Paryavaran Bhawan in New Delhi, which is India's first net zero building (Press Information Bureau, 2014).

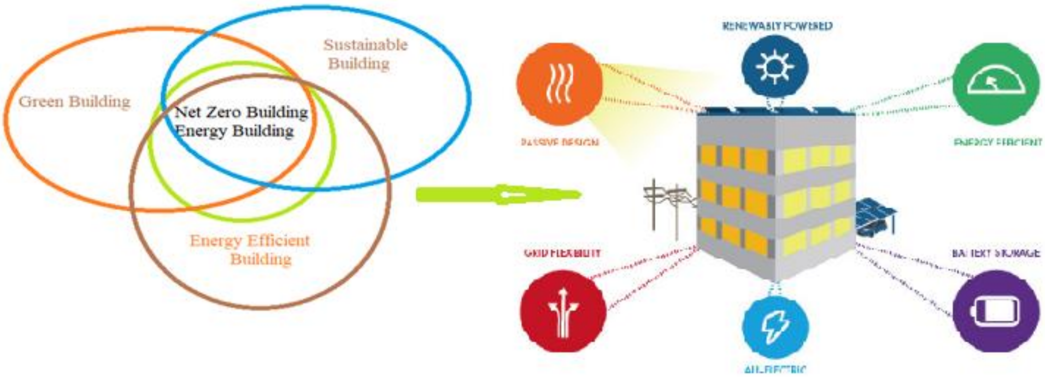

Figure 1: Net-Zero Structure

A building that is environmentally friendly is one whose conception and execution ensure the healthiest possible environment while making the most efficient and least destructive use of land, water, energy, and materials. After construction is complete, the best architectural choice is one that successfully emulates all of the natural processes and circumstances of that pre-developed environment.

Figure: 2 Flow diagram of Green Building

1.3 Sustainable Construction in India.

India's housing and building industry is seeing significant growth at a pace of 9%, surpassing the global average of 5.5%. This sector contributes an average of 6.5% to the GDP (GRIHA Manual, 2010). Urbanisation is rapidly rising, with projections indicating that two-thirds of the global population will reside in cities by 2050. According to a United Nations Report from 2013, India is projected to become the most populated nation by 2028, leading to a significant increase in energy consumption. The Green Building movement in India received a significant boost when the CII-Sohrabji Godrej Green Business Centre building in Hyderabad was awarded the first and prestigious Platinum rated green building certification outside of the US by the US Green Building Council. Since then, the movement has continued to progress. The government of India and key stakeholders are using a market-driven voluntary adoption strategy to boost the demand for green buildings. This approach has led to a decrease in costs, making it possible to construct a Certified Green Building at a comparable price to a standard one. India has made significant progress in green buildings, but there is still more work to be done. The government is acknowledging the environmental aspects of the construction sector by implementing various policy initiatives such as the National Building Code (NBC), Bureau of Energy

Efficiency (BEE), and voluntary green building rating systems like Green Rating Integrated Habitat Assessment (GRIHA) by The Energy and Resource Institute (TERI) and the Ministry of New and Renewable Energy, as well as Leadership in Energy and Environment Design (LEED) by the Indian Green Building Council (IGBC) The Indian Green Building Council (IGBC) provides grading systems for several types of buildings and environments, including residences, townships, special economic zones, industries, and landscapes. The majority of certified green buildings in India are owned by government entities or commercial corporations, with little residential interest (Darko et al., 2013). In 2011, the European Commission published a statement titled "Smart Cities & Communities," highlighting the need of balancing the economy and ecological. It stressed the importance of creating a connection between environmental preservation and the advancement of new technology. Prime Minister of India, Mr. Narendra Modi, emphasised the need of integrating the concepts of "smart city" and "green economy."India still has approximately 60% of building pending, which presents a significant opportunity for the country to make progress in sustainability.

2.0 Literature Review and assumptions

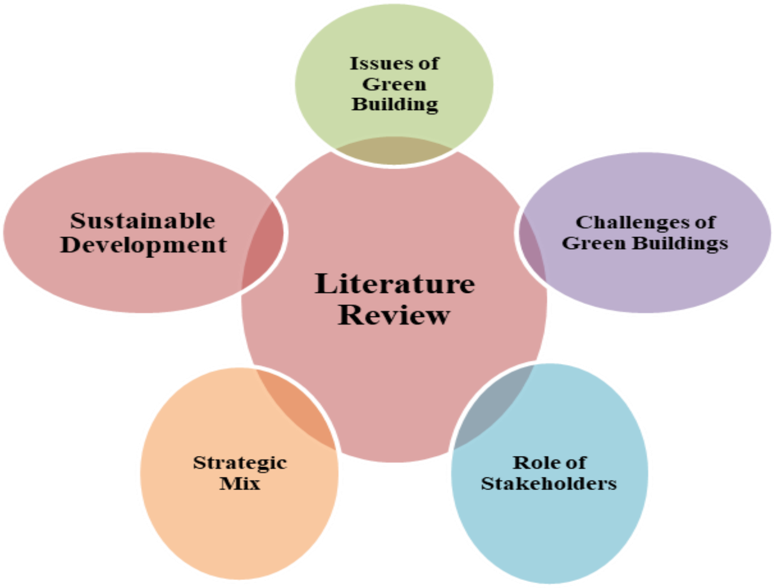

Figure: 3 schematic Diagram of Literature of review

2.1 Role of Stakeholders

Stakeholder have a significant impact on the adoption of environmentally friendly building techniques. Various stakeholders, including as government entities, programmers, commercial banks, and quantity surveying firms might be involved in the project (Darko et al., 2017). The participation of many stakeholders, such as private and public sector organisations, consumers, and suppliers, is crucial for determining the appropriate approach for adopting environmentally friendly practices (Arif et al., 2009; Zainul Abidin et al., 2013). The research examines the parties relevant to the Indian context, including government entities, corporations, builders, purchasers, and private organisations.

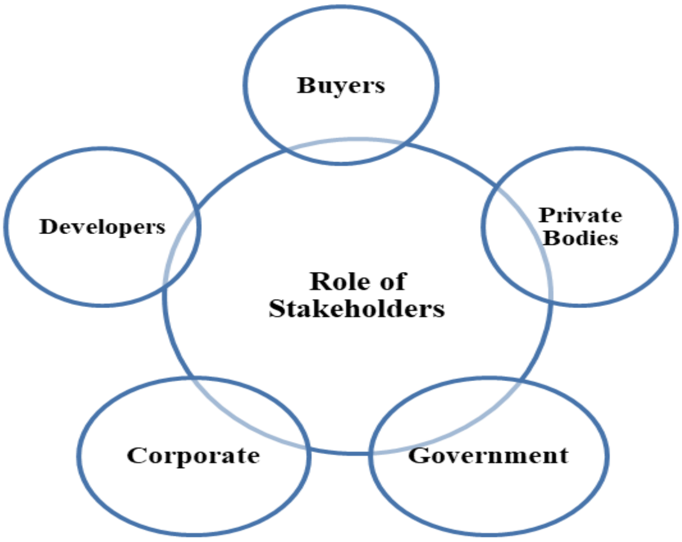

Figure: 4 flow diagram of Role of Stakeholders

3. Research Methodology

3.1. Data Gathering and Surveying Tool

This investigation used a method of quantitative investigation to confirm the hypotheses within the research methodology. Data collection was conducted using the questionnaire survey technique. The questionnaire used a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Previous research were used to create questionnaire items. The initial questionnaire had a total of 65 questions before undergoing pre-testing and pilot research. Pre-testing was conducted on 65 items by 7 professionals and 7 academics in the field of green construction to assess content validity (Malhotra, 2008). 5 things were removed based on received input. Content validity refers to how well the components of a tool represent the scope of the subject being studied (Talavera and Gloria, 2004). Changes have been implemented to the phrasing of the items to ensure content validity and consistency within the constructions in the Indian context. After ensuring the content validity by pre-testing and refining the questionnaire, a pilot research was carried out with 50 purchasers. The instrument's overall dependability was determined to be 0.84, which exceeds 0.7 and is deemed excellent according to Nunnally (1978) and Sekaran (2000). After examining the association between items, 3 items were removed from the scale, resulting in an improvement in total dependability to 0.89. The dependability data is shown in Table 2. The final questionnaire of 57 questions to assess nine structures, including two pure exogenous constructs (Issues and Challenges) and seven endogenous constructs (Corporate, Developers, Buyers, Private Bodies, Role of Government, Strategic Mix, and sustainable development). Table 1 presents an overview of constructions and objects. The target audience was chosen from four major cities in India, each representing a different geographical zone of the country: Delhi (Central India), Mumbai (Western India), Kolkata (Eastern India), and Bengaluru (Southern India). The developers were chosen by multistage random selection from the list of developers registered with CREDAI in Delhi, Mumbai, Bengaluru, and Kolkata. A random sample was selected by choosing every third developer from the list on the CREDAI website, and then selecting every fifth buyer from each developer until the desired sample size was achieved. Out of 1500 surveys sent to purchasers and 500 questionnaires sent to developers randomly, 932 from buyers and 289 from developers were returned. 800 valid surveys were gathered from purchasers (53.33%) and 200 from developers (40%) after incomplete questionnaires were discarded. The substantial sample size contributed to minimising sampling error (Zikmund, 2003). Kelloway (1998) recommends that a suitable sample size for structural equation modelling should consist of at least 200 observations. Among the 1000 respondents, 72.1% were men and 27.9% were females. 56.4% were salaried and

43.6% were self-employed. 65.7% were postgraduates, 21.5% were graduates, and the majority (60%) were over 36 years old. Most respondents' monthly income fell between Rs 2 lakhs and Rs 6 lakhs.

3.2 Some of the green materials

- Fly ash
- Green concret
- Blast furnace slag
- Coconut husk
- Marble dust
- Design efficient

4. Analysis of Data as well as Outcomes

The study utilised the technique of structural equation modelling (SEM) to validate the research model and hypotheses, and employed SPSS AMOS version 21 to derive empirical findings. Factor analysis was performed before moving on to structural equation modelling. Missing value analysis and purification were conducted by doing Little's MCAR test in SPSS, which yielded a non-significant result (chi-square= 253.811, df=278, Sig=0.620,ns). Subsequently, 11 erroneous instances were removed.

Figure:5 Green Building Project

4.1 Investigative factors analysis (IFA)

A IFA was performed to assess the one-dimensional nature of the components and uncover any latent dimensions (Ahire and Devaraj, 2001).The data's adequacy was assessed using Kaiser-Meyer-Olkin (KMO) statistics, which consistently above the threshold of 0.6, as recommended by Kaiser and Rice (1974). The Bartlett's test of sphericity yielded a significant result ($p < 0.01$), suggesting the existence of multicollinearity across variables. PCA with varimax rotation was used to extract the variables. Factor analysis used the MINEIGEN criterion, which requires that the Eigen values of all factors exceed 1.The total variation explained in all instances exceeded 65%.
Two elements from consumers, one from long-term viability one from headquarters, two from strategically mix, and one from private bodies dimension were excluded due to factor loadings below 0.5 (Hair et al., 2006). The Cronbach's alpha values vary from .791 to .891, suggesting that the data is credible and valid for further research.

4.2 Assessment of Confirmatory Factors

The purpose of confirmatory factor analysis (CFA) is to evaluate the dimensionality and suitability of measuring items that relate to related latent variables (Anderson and Gerbing, 1988).CFA examines the connection between the latent constructs that underlie the observable variables. (Byrne, 2001).The current work determined model fit indices, reliability and validity estimations, and a CFA-based assessment model by running it via Amos 21.

4.3 The suitability and Reliability of the Infrastructure

Confirmatory Factor Analysis was used to validate autonomous ideas and evaluate the complete model. Validity metrics are primarily categorised into Validity of Content and Construct Validity, which includes Convergent Validity and discriminate Validity.

4.3.1 Validity of Material

The instrument's content reliability was confirmed by collaboration with educational institutions and professional domain specialists (Lawshe, 1975; Rungtusanatham, 1998). Convergent and discriminant validities were developed to confirm concept validity. Convergent validity is the extent to which different measurement techniques of something provide consistent findings (O'Leary-Kelly and Vokurka, 1998).

4.3.2 Validity of Constructs

Concept validity (CR) refers to the degree to which a group of measured variables accurately represent the concept they are intended to assess (Hair et al., 2006). Construct validity was established by the assessment of convergent and discriminated validity. The requirements for ensuring convergent validity are: Composite Reliability (CR) should be more than 0.7, CR should be greater than the mean variance explained (AVE), while AVE should be greater than 0.5 (Hair et al., 2006).

All nine constructions have an Alpha value over 0.7. The average value of all the individual constructions exceeded 0.5. Moreover, for all nine unique constructs, the CR statistic was considerably higher than their corresponding AVE value. the individual constructs met the criteria for convergent validity. Differentiate validity refers to the extent to which the measurements of distinct implicit variables are distinct from each other. Discriminate validity is confirmed when a measure shows low correlation with other measures it is meant to be distinct from (O'Leary-Kelly and Vokurka, 1998). Discriminates validity is determined using the Average Variance Extracted (AVE) and Maximum Shared Variance (MSV). Discriminates validity criteria include MSV.

5. Discussion

The analysis of data and outcomes support the conclusion that the conceptual model, created from the literature study and established linkages, is important. The GFI, RMSEA, AGFI, TLI, and CFI values suggest that the Green Building Sustainability Model fits well. Twelve hypotheses derived from the conceptual model show good and substantial results.

The research found an adjusted regression weighting of 0.450, $p<0.05$ supporting the positive relationship between environmental concerns and the role of government (H1). Additionally, a regression weight of 0.321, $p<0.05$ supported the positive relationship between difficulties and the role of government (H2).The findings align with existing literature that highlights various environmental challenges such as urbanisation, population growth, and climate change. These challenges include factors like lack of consciousness, training, and schooling on sustainable design, as well as issues related to cost, materials, regulations, technology, and demand. The government plays a crucial role in initiating, controlling, and moderating strategies for green building development. The government is a crucial stakeholder that plays a significant role in policy formulation, building capacities, and setting an example (Hong et al., 2007). The government encourages developers by offering incentives such as tax refunds, cash awards, and soft loans. The government provides various incentives to boost demand for environmentally friendly housing, such as tax credits, favourable loans, free services, and reimbursement of registration fees to applicants. Additionally, it supports the development of private organisations like GRIHA, TERI, and IGBC to promote green building.The directive requires corporations to include environmental awareness into their Corporate Social Responsibility efforts and mandates the execution of green construction rules.

The most crucial factor is government, with a mean construct score of 4.11, based on research by Abidin and Powmya (2014), Centre for Science and Environment (2012), Samari et al. (2013), and The Energy and Resources Institute (2006). On the other hand, the least significant factor is the green purchasing purpose of purchasers, with a construct mean of 3.75. It is evident that customers do not want green houses. Either due to lack of awareness (Samari et al., 2013; Shafii and Othman, 2005) or because of their concentration on short-term perspectives (Hin Ho et al., 2013; The Energy and Resources Institute, 2006). Perhaps this is why green buildings have the lowest penetration in residential real estate. The government, as a regulatory authority, is essential in creating and enforcing legislations such as BREEAM (UK 1990), CASBEE (Japan 2001), and ECBC (India 2007) to promote the "Green Building Movement."

6. Conclusion

Energy efficiency policies in most Asian nations are not as advanced as those in industrialised countries. Green construction standards are widely recognised and rigorously implemented in Japan, Singapore, Taiwan, South Korea, Hong Kong, and China. Standards are established in India, yet there is a need to strengthen implementation strategies. The creation of the 'Green Building Sustainable Model' has significant theoretical and administrative significance in this context. Previous study has mostly focused on the factors influencing green buildings, obstacles to their implementation, and their current state in India and worldwide. However, there is a scarcity of empirical research on this topic. The study created a conceptual framework called the 'Green Building Sustainability Model' which examines the interaction among nine structures: issues, challenges, government, corporate, developers, buyers, private bodies, strategic mix, and sustainable development. The framework was empirically validated.

The research focuses on the current situation of green construction practices in India. It may examine green buildings in other nations and contrast them with the current findings. The research confirms the hypothesis by analysing cross-sectional data and does not include the influence of various phases of environmental laws, which may be examined using longitudinal data. The model may be evaluated individually for commercial and residential green buildings.

The report clearly outlines how a country's administration should collaborate with many stakeholders to build a strategic mix in order to promote sustainable growth amidst environmental difficulties. The study findings are very relevant to academics, environmentalists, practitioners, policymakers, and will serve as a valuable reference for future research. The research findings align effectively with Agenda 21, emphasising the importance of sustainability as a national priority. It advocates for collaboration between government and non-government stakeholders to promote green building principles for a healthier environment. Additionally, it supports the Indian strategy of integrating the "smart city" and "green economy" concepts. India must construct 60% of its building blocks by 2030 to establish sustainable smart cities and gain worldwide recognition.

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