HINDRANCES IN CONSTRUCTING GREEN BUILDINGS IN BANGLADESH: A COMPREHENSIVE STUDY

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ABSTRACT

Bangladesh, a developing country in Southeast Asia, having comparatively smaller contribution to the appalling rates of Climate change is regrettably susceptible to the brunt of its adversities. Being on an economical, geographical, and technical backfoot, numerous challenges arise when a combative approach like constructing green buildings is taken. This study presents a comprehensive analysis of such predicaments. Given that existing research is still in its infancy in Bangladesh, the goal of this study is to shed further light on this front. The research included both qualitative and quantitative methods. There were 160 sets of questionnaires distributed to both the experts and the general public, and 87 responses were obtained. The collected data was then analyzed using the AHP method. The data shows that several factors are hindering the construction of green buildings in Bangladesh. Among them, the awareness of people, the incapability of the masses to cover the high initial cost, and the lack of both individual as well as organizational initiative are noteworthy. This study aims to provide recommendations for reforming the current and developing structures, given that most of the major infrastructural decisions are made by policymakers in Bangladesh. By understanding the limitations, Bangladesh can advance towards a sustainable environment in the construction industry by ensuring collaboration between stakeholders, organizations, and government.

Keywords: *Green Building, Bangladesh, Sustainable development, Climate Change, Hindrances*

1. INTRODUCTION

A green building refers to a structure designed, constructed, and operated to minimize its negative environmental impact, conserve resources, enhance sustainability, and promote the health and well-being of its occupants. This approach integrates various eco-friendly practices and technologies to reduce energy consumption, water usage, waste generation, and overall environmental footprint throughout its lifecycle. Even without considering worst-case climate responses, the current trajectory puts the world on track for a temperature rise between 2.1°C and 3.9°C by 2100 (Kemp et al. 2022, Liu & Raftery, 2021). The construction industry consumes up to 40% of the total energy and accounts for up to 30% of the total annual greenhouse gas emissions at the global level (United Nations Environment Program (Chan et al., 2018, UNEP, 2011). Commercial and Residential buildings consume almost 40% of the primary energy in the United States or Europe, nearly 30% in China and approximately 32% in Bangladesh (Jamal et al. 2018, Deng et al. 2014). Residential and commercial buildings account for nearly 40% of global energy consumption (Amaral et al.2020). In a country like Bangladesh with incessant population growth, carbon emission is an alarming issue. Coupled with the low standards of living and the prices of commodities, managing electric bills while maintaining a certain living standard is getting increasingly difficult. Implementing the green building solution directly into the heart of this bustling city, the negative impact of rapid urbanization can be staved off somewhat. Yet the inclusion of this seemingly simple solution has its share of difficulties. The barriers are widely ranged, explored in this paper with a view to identifying the most effective way to go about allocating our resources and manpower if we want to revolutionize our building industry. In recent years, there has been a growing awareness and inclination towards green building practices within the construction sector in Bangladesh. However, despite this interest, the widespread adoption of green building principles faces multifaceted obstacles and hindrances. The developers who want to go for green buildings are applying for LEED Certification from US Green Building Council (USGBC) which is an America-based organization. (Jamal et al. 2018, The Daily Star, 2014). Although a number of researchers worldwide have conducted research on the Green Building; however, there is no specific guideline and work on the Green Building in the context of Bangladesh. (Jamal et al. 2018). GB risks differ from risks in conventional projects, which leads to a limited understanding of how these risks affect GB projects (Nguyen & Macchion, 2022, Guan et al., 2020). This study delves into the numerous challenges that impede the construction of green buildings in Bangladesh. By scrutinizing various factors such as ownership of residence, satisfaction level, indifference, willingness to convert, overall expense, government involvement, and technical difficulties, this research aims to provide a better understanding of the barriers preventing the widespread implementation of sustainable building practices in the context of Bangladesh. Green building (GB) emerged from the green movement around 1970s-1980s as a solution to meet building demand while reducing the construction industry's energy consumption (Nguyen et al., 2017, Retzlaff, 2010). Studies have shown that the greening technologies and design applied in GB can increase the efficiency of buildings by up to ten times in terms of resource utilization (Nguyen et al., 2017, Green building: project planning & cost estimating, 2011). Compared to average conventional buildings, certified GBs in Australia and New Zealand emit only 1/3 greenhouse gases, consume 1/3 electricity and ½ potable water, and recycle almost 96% of demolition waste (Nguyen et al., 2017, BCI Economics, 2014). The barriers as seen in this paper do not have similar impact and consequences, using Analytical Hierarchy Process, plugging in the responses received from a wide range of general public, the barriers themselves can be ranked in terms of impact. Analytical Hierarchy Process is one of the most inclusive system is considered to make decisions with multiple criteria because this method gives to formulate the problem as a hierarchical and believe a mixture of quantitative and qualitative criteria as well. The first step is to create a hierarchy of the problem. The second step is to give a nominal value to each level of the hierarchy and create a matrix of pairwise comparison judgment (Taherdoost, 2017). The aim of this research lies in its potential to illuminate the path towards a more sustainable built environment in Bangladesh. By addressing the challenges hindering the construction of green buildings, this study aspires to contribute valuable insights that can inform policymakers, industry stakeholders, and practitioners, ultimately fostering a more sustainable future for the nation.

2. METHODOLOGY

2.1.1 Data Collection

A questionnaire was set including 10 questions dealing with the consensus of general people regarding green buildings. The questions included different factors ranging from basic knowledge to technical aspects on adopting green buildings. The questions posed to the general public were as follows:

1. Is your current residence owned by you?
2. Are you aware of the impacts of climate change on our country?
3. Are you satisfied with your expenses in electricity, gas and water bills?
4. What is your stance on green buildings?
5. Which aspect of a sustainable structure attracts you the most?
6. Since a green building gives you a sustainable structure, are you willing to spend slightly higher initial expenses?
7. Are you willing to convert your current residence to a green building?
8. If not, which incentive will most likely change your mind?
9. Why do you think there are so few green buildings in Bangladesh?
10. Is the socio-economic infrastructure of Bangladesh suitable for the construction of green building?

The questionnaire was created using Google forms and distributed using social media. A total of 87 responses were received and analysed.

2.1.2 Data Analysis

The data received through the forms was analysed using Analytic Hierarchy Process (AHP). These ten questions and their responses were sorted into seven different criteria and plugged into an online AHP calculation software. A sample hierarchical tree is illustrated in figure 1.

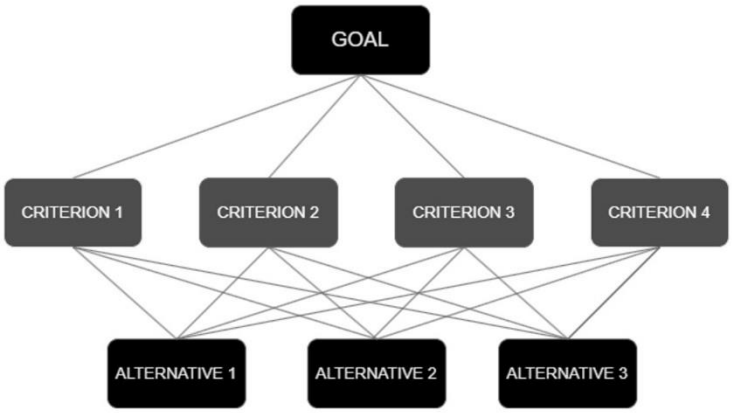

Figure 1: Sample Hierarchical Tree

2.1.2.1 Stepwise Procedure

The criteria were compared pair-wise regarding thier impact over each other on a scale of 1 to 9. These values of relative importance were assessed from the volume of responses and the weight of each factors were determined. A pairwise comparison matrix A was constructed from the responses collected and the normalized weight vector n was calculated from the equation (1).

$$W = \lim_{k\to\infty} \frac{A^k \cdot e}{e^T \cdot A^k \cdot e} \quad (1)$$

Where, e^T= (1,1,1……..,1)

If $a^{ik}.a^{kj} = a^{ij}$ is not confirmed for all *k, j, and i* for the matrix A, the Eigenvector method is selected (Jalaliyoon, et al., 2012). To achieve a meaningful data set from the random answers, the process was repeated a number of times using equation (2).

$$\lambda_{max} = \frac{\sum a_j w_j - n}{w_i} \quad (2)$$

$A=\{a^{ij}\}$ with $a^{ij}=1/a^{ij}$
A: pair wise comparison
w: normalized weight vector
λ_{max}: maximum eigen value of matrix A
aij: numerical comparison between the values i and j

To validate the results, the consistency ratio (CR) was calculated using equation (3), in which the consistency index (CI) was determined using equation (4). The AHP calculation was done on AHP-OS, an online software (Goepel, K.D., 2018).

$$CR = CI/RI \quad (3)$$

$$CI = \frac{\lambda max - n}{n-1} \quad (4)$$

3. ILLUSTRATION

3.1 Figures and Graphs

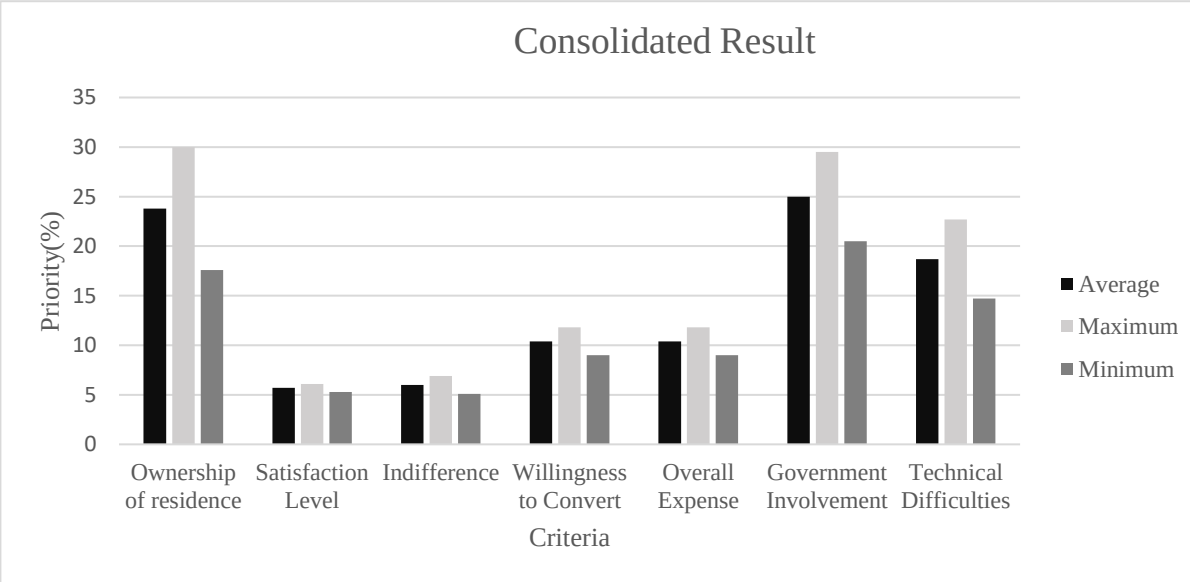

Figure 2: Consolidated Results of criteria weights based on pairwise comparisons

3.2 Tables

Table 1: Resulting weights for criteria based on pairwise comparisons

Sl. NO.	Criteria	Priority	Rank	Maximum	Minimum
1	Ownership of residence	23.8%	2	30%	17.6%
2	Satisfaction Level	5.7%	7	6.1%	5.3%
3	Indifference	6%	6	6.9%	5.1%
4	Willingness to Convert	10.4%	4	11.8%	9.0%
5	Overall Expense	10.4%	4	11.8%	9.0%
6	Government Involvement	25%	1	29.5%	20.5%
7	Technical Difficulties	18.7%	3	22.7%	14.7%

4. RESULTS AND DISCUSSIONS

The collected data through the survey carried 87 responses in total. Analysing these data indicated that among all the criteria, the lack of involvement of government plays the biggest role for hindering the construction of green building in this country. Moreover, a large portion of people do not have their own residence, they rent houses. Hence, for them to construct or convert a building into a green one is difficult. This is also one of the major reasons hindering this matter. Furthermore, not enough manpower expert in this source is available. This also comes with the scarcity of materials and hence, increased cost. Although not many are satisfied with the amount of bills they have to pay for electricity, gas or water, the high investment in this relatively new sector seemed risky to many respondents. The analysed data is tabulated in table 1 which shows the resulting weights of criteria based on pairwise comparison. The bar chart in figure 2 shows the variation of average priority with the maximum and minimum values. The ownership of residence criteria showed the highest variation in the AHP method. The satisfaction level showed the minimum variation among the seven criteria that were used.
From the AHP method, the principle eigen value, λ_{max} was 7.087 while the consistency ratio (CR) was found out to be 0.011. It should be noted that consistency ratio lower than 0.10 verifies that the results of comparison are acceptable. (Taherdoost, 2017). As the consistency ratio (CR) found from AHP online OS is lower than the maximum allowable value, the weighted rankings were correct.

5. CONCLUSIONS

In light of the results, the ranking by which these criteria impact the construction of green buildings is clear. These rankings should determine the hierarchy of tasks that should be undertaken to overcome the hindrances faced. The following steps can be taken to combat these issues most efficiently:

- New legislations can be introduced to implement green practices in new construction projects including sustainable energy.
- Government should provide certifications to developers who are willing to implement green practices.
- Government led yearly awareness programs and loans to homeowners could be very impactful. Co-operating with private organisations could further accelerate this process.
- To overcome the technical difficulties and material scarcity, both individual and organisational initiative is necessary. Green practices in construction should be included in vocational education to develop skilled manpower. Engineering institutions should encourage and incentivise research on green construction practices.

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