

Exploring Barriers and Opportunities for Sustainable Construction Practices in the Modern Construction Industry

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Abstract- Sustainable practices are crucial since the building sector contributes considerably to global carbon emissions. This study examines opportunities and barriers in sustainable building using the Relative Importance Index (RII) method. Budgetary restrictions, complicated approval processes, and a lack of financial incentives are identified as the main obstacles. Improved indoor environmental quality, less environmental impact, and effective resource use are important potential. Sustainable building practices improve tenant comfort and health while increasing building value. It provides significant economic and environmental advantages despite current obstacles. In order to promote the adoption of sustainable construction techniques, the study emphasizes the necessity of regulatory support, technical improvements, and awareness campaigns.

Keyword- Sustainable Construction, Barriers, Opportunities, Relative Important Index Method- (RII).

1. Introduction

The construction industry is a major contributor to global resource consumption, environmental degradation and carbon emissions [1]. Sustainability has become an important factor in the construction sector, and it is being more and more integrated into the phases of design, planning, construction, and operation [2]. Beyond that, the construction industry play a crucial role to a country's economic success [3], and this significance is particularly evident in India, where rapid growth is expected to lead to a GDP of around 4 trillion US dollars and a population of nearly 1.5 billion by 2030 [4]. However, the building industry is a major contributor to energy consumption, resource depletion, and carbon emissions, this fast development has also heightened environmental concerns. Estimation suggest that construction and demolition activities account for approximately 40% of the total solid waste generated worldwide [5]. By

encouraging effective resource use, cutting waste, and improving overall project performance, sustainable building techniques have arisen as a crucial strategy to strike a balance between economic growth and environmental conservation.

In addition, it is estimated that construction and demolition (C&D) waste in India accounts for about 10- 12 million tons annually [6].

2. Research objective

The objectives of the study is given below;

1. To determine key barriers affecting sustainable construction
2. To examine major opportunities in sustainable construction
3. To apply the RII method for ranking factors

3. Literature Review

3.1 Definition of Sustainable Construction

The term “sustainable development” emerged in the 1970s to describe a future in which the demand of future generations is not compromised by the existing generation [7]. The process of planning, designing, building, operating, maintaining, and ultimately demolishing infrastructure and buildings in a way that minimizes adverse environmental effects while optimizing economic efficiency and social well-being throughout the building's life cycle is known as sustainable construction. Many scholars claim that the construction industry is slow in terms of the adoption of sustainability [8].

3.2 Principal of Sustainable Construction

There are seven principles of Sustainable Construction and their role are shown in table-1;

Table 1: Principles of Sustainable Construction

Principal	Role
Resource Efficiency	Makes effective use of energy, water, and materials to minimizes waste and protects the environment.
Energy Efficiency [9]	Lowers operating costs and emissions by reducing energy consumption through effective design, insulation, and utilization of renewable energy sources.
Sustainable Design	Reduces land degradation, protects natural habitats, and chooses suitable areas to minimize environmental effect.
Water Conservation	Encourages water conservation through recycling, rainwater collection, and waste reduction.
Waste Management [10]	Focuses on using recycling, reuse, and appropriate disposal techniques to cut down on construction waste.

Durability	Ensures long-lasting constructions made of durable materials. lowers the need for resources and maintenance.
Indoor Air Quality	Use non-toxic materials, enough ventilation, and natural lighting to create healthy indoor environments that enhance occupant well-being.

3.3 Barriers identified in Previous studied

3.3.1 Technical Barriers

The effect of technical barriers on the success of sustainable construction was reported and Cost is the main obstacle most often identified in the adoption of green building materials [11]. Many researchers have identified some of the major barriers to the implementation of sustainable construction which includes lack of environmentally sustainable materials, lack of sustainability measurement tools, lack of demonstration project, lack of easily accessible guidance, lack of technical know-how, persistent skills and labour shortages [12]. Furthermore, the adoption of new technologies is slowed down by their complexity and hazards.

3.3.2 Financial Barriers

Sustainable building is both benefited and hindered by financial considerations. Tax credits and deductions are among the most effective financial incentives to promote sustainable construction [13]. They are intended to lessen the tax burden on people and businesses who make investments in environmentally friendly building methods and technology. While, high initial investment, long payback periods are the problem to cause the sustainable construction practice in construction industry.

3.3.3 Knowledge and Awareness Barriers

The term "knowledge and awareness barriers" describes stakeholders including engineers, contractors, and clients who lack knowledge, information, and education on sustainable construction procedures. These obstacles result from inadequate training, inadequate exposure to new technology, and inadequate best practice distribution. Awareness among construction professionals is a key determinant of adoption [14], as a lack of information frequently causes reluctance to embrace sustainable practices, which slows the uptake and decreases the efficacy of ecologically friendly building solutions.

3.3.4 Regulatory and Policy Barriers

Government regulations, legislation, and administrative processes that prevent the implementation of sustainable building methods are referred to as regulatory and policy hurdles. Participants in this study highlighted the lack of clear government policies, incentives, and guidelines as a key obstacle to promoting sustainable building materials [15]. These difficulties lead to uncertainty, raise expenses, and deter stakeholders from implementing creative and environmentally responsible building solutions.

3.4 Opportunities Identified in Previous Studied

3.4.1 Environmental Opportunities

Environmental sustainability has become a critical aspect of the global agenda, particularly in the construction sector, which is one of the most resource-intensive industries worldwide [16]. In this regard, using recyclable materials, electricity-efficient designs, power from renewable sources, and efficient waste management techniques are the main environmental opportunities in construction. In addition to increasing long-term economic gains, these strategies lessen their

negative effects on the environment, preserve natural resources, cut carbon emissions, and enhance overall sustainability.

3.4.2 Innovation and Technological Opportunities

In order to increase productivity, sustainability, and overall project performance, innovation and technical opportunities in construction concentrate on using new techniques, materials, and digital tools. Innovative materials play a crucial role in sustainable construction practices by offering more environmentally friendly and energy-efficient alternatives to traditional building materials [17]. Furthermore, improvements in planning, real-time monitoring, cost reduction, and project delivery speed are made possible by innovations like Building Information Modeling (BIM), artificial intelligence, IoT, and prefabrication techniques. When taken as a whole, these developments greatly help to make the building industry more efficient, sustainable, and prepared for the future.

3.4.3 Economic Opportunities

India is one of the worlds fasting-growing economies faces significant challenges in balancing economic development with environmental sustainability [18]. It is essential in this situation since it promotes sustainable practices and opens doors for employment, revenue production, and business expansion. Economic prospects may promote development without endangering natural resources via investments in green technology, infrastructure, and innovation, ultimately leading to long-term growth and enhanced quality of life.

4. Relative Important Index Method (RII)

A comprehensive literature review on barriers and opportunities to sustainable construction were carried out, and pre-survey questionnaire was developed. The respondents were asked to rate the extent to which each of the barrier affects sustainable construction using a 5-point Likert scale [19]. Out of 100 questionnaires sent out, 70 sets of completed survey questionnaires were received and analysed. The response rate was relatively low because those that were not completed or properly answered were rejected. In addition, only response from respondents who had experience and had clear understanding of sustainable construction were used.

A. Response Rate

The following figure-1 show the types of profession who participate in survey are as follow;

- Twenty (20) respondents representing 29% of the sample size were consultant.
- Eighteen (18) respondents representing 26% of the sample size were project manager.
- Fifteen (15) respondents representing 21% of the sample size were contractor.
- Twelve (12) respondents representing 17% of the sample size were site engineer.
- Five (5) respondents representing 7% of the sample size were other (such as developer, billing and civil engineer).

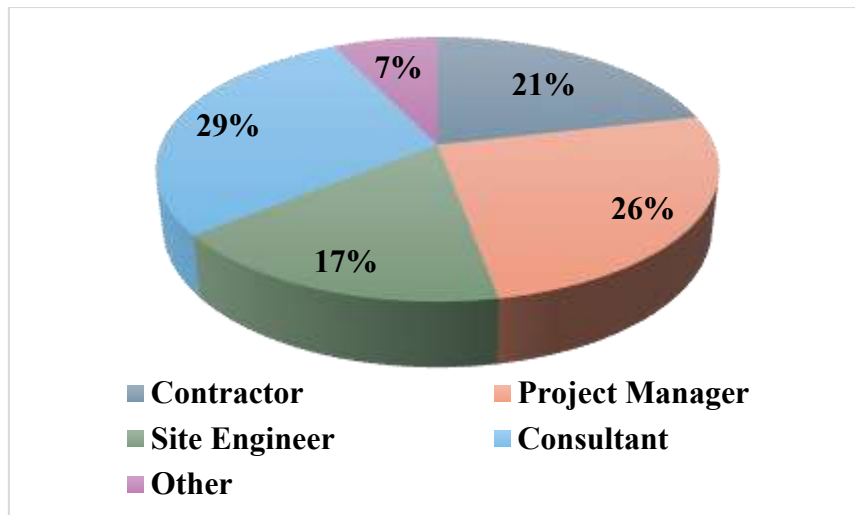


Figure 1: Type of Profession

B. City Wise Respondent Rate

The Table-2 and figure-2 show the data and percentage from respondents from city-wise;

Table 2: City-Wise Response Rate

City	Ahmedabad	Gandhinagar
Targeted Sample Size	55	25
Response Received	49	21
No Response	6	5

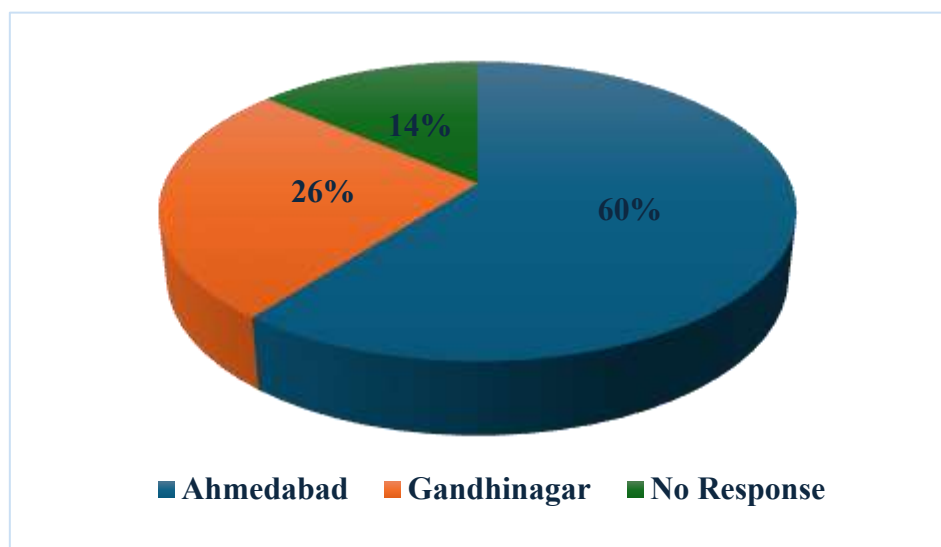


Figure 2: Location of Work

C. Work Experience

The figure-3 shows that Percentages of the total number of responses having work experience;

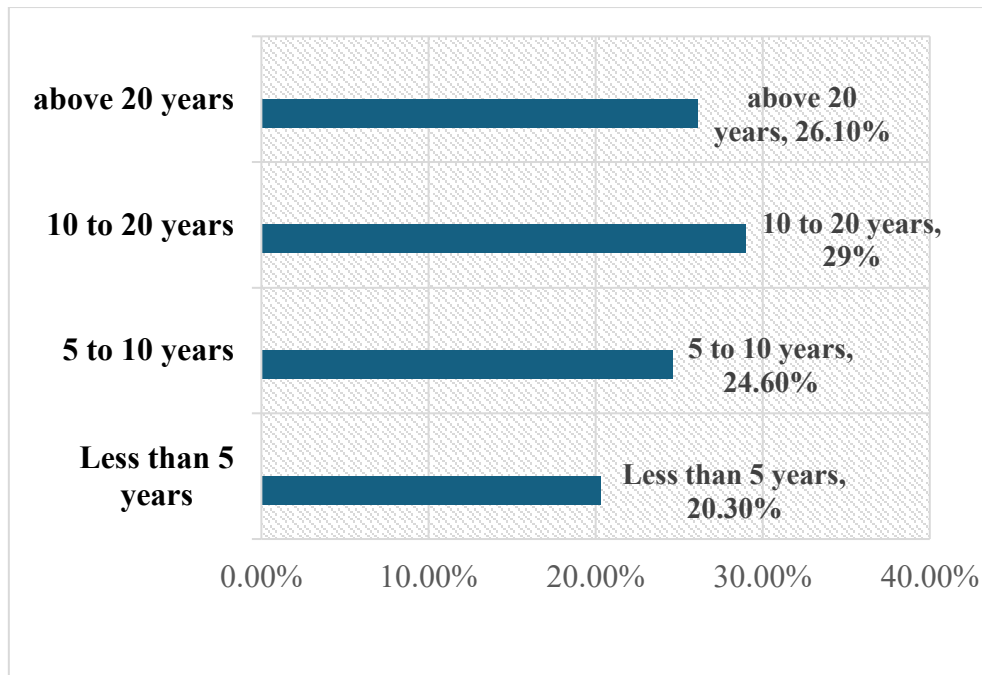


Figure 3: Experience in Industry

4.1 Data Analysis Using RII Method

The data provided by the respondents in the questionnaire form. Later, The Relative Importance Index (RII) technique in Microsoft Excel was used to analyse this data [20]. This method was also used to rank barriers and opportunities affecting the implementation of sustainable construction industry.

$$\text{Relative Important Index} = \frac{5n_1 + 4n_2 + 3n_3 + 2n_4 + n_5}{5(n_1 + n_2 + n_3 + n_4 + n_5)} \quad \text{----- (Equation-1)}$$

Where, n_1 = number of respondents who answered "Critical effect."

n_2 = number of respondents who answered "High effect."

n_3 = number of respondents who answered "Medium effect."

n_4 = number of respondents who answered "Low effect."

n_5 = number of respondents who answered "No effect."

5. Result and Discussion

The data was physically analysed by the RII method, which resulted in a decimal figure for each variable known as its Relative Importance Index [21]. The variables are ranked using this strategy.

The top 10 key barriers of sustainable construction are classified using RII method in table-3;

Table 3: Top 10 Key Barriers

Sr. No.	Barriers to sustainable construction	RII	Rank
A4	Budget constraints in construction projects	0.808	1st

D3	Complex approval & certification procedures	0.750	2nd
A2	Lack of financial incentives	0.728	3rd
D1	Weak enforcement of environmental regulations	0.722	4th
E1	Resistance to change in organizations	0.706	5th
E2	Lack of top management commitment	0.703	6th
A1	High initial cost of sustainable materials	0.700	7th
B3	Incompatibility with conventional methods	0.694	8th
C1	Lack of awareness among professionals	0.683	9th
A3	Long payback period of investments	0.681	10th

According to the RII method, budgetary restrictions and a lack of incentives have a big impact on project choices, making financial limits the biggest barriers to sustainable development. This suggests that because conventional building methods have lower upfront costs and faster returns, stakeholders tend to support them. Adoption of sustainable practices is discouraged and delays are caused by regulatory concerns, particularly complex certification and approval procedures. Furthermore, the sector's compliance and accountability are decreased by lax enforcement of environmental rules. Organizational challenges, such as senior management's lack of commitment and opposition to change, highlight how important leadership is in advancing sustainability. Additionally, there are technical and financial obstacles due to the high initial cost of sustainable materials and their incompatibility with traditional processes. The use of sustainable solutions is further hampered by experts' lack of understanding. Additionally, developers find such investments less appealing due to lengthier payback periods. All things considered, these results emphasize how crucial it is to provide funding, streamline laws, and raise awareness in order to promote sustainable building methods.

The top 10 key opportunities of sustainable construction are classified using RII method in table-4;

Table 4: Top 10 Key Opportunities

Sr. No.	Opportunities to sustainable construction	RII	Rank
I2	Efficient use of natural resources	0.800	1st

I1	Reduction in environmental impacts	0.797	2nd
M1	Improved indoor environmental quality	0.747	3rd
L2	Improved overall project performance	0.739	4th
J2	Use of digital tools (BIM, smart systems)	0.731	5th
N1	Increasing market demand for green buildings	0.731	6th
M3	Public awareness & social responsibility	0.728	7th
K2	Green building rating systems (GRIHA, LEED, IGBC)	0.719	8th
J1	Adoption of green construction technologies	0.711	9th
J3	Development of low-carbon materials	0.708	10th

The most important advantage of sustainable building, according to the RII method of possibilities, is the effective use of natural resources, underscoring its significance in attaining long-term sustainability. The necessity to reduce pollution and carbon emissions in the construction industry is reflected in the high ranking for the mitigation of environmental consequences. The benefits to occupant comfort and health are demonstrated by improved indoor environmental quality. Furthermore, improved overall project performance demonstrates how sustainable methods lead to increased cost, time, and quality efficiency. Planning and execution are greatly enhanced by the use of digital tools like BIM and smart technologies. Adoption of sustainable methods is further encouraged by the growing market demand for green buildings. The transition to environmentally friendly building is also aided by social responsibility and public awareness. Additionally, green building grading systems aid in promoting and standardizing sustainable practices. Lastly, the advancement of low-carbon materials and green technology keeps bolstering the prospects for sustainable building.

6. Conclusion

The following are the conclusion of the research work as given below;

1. The most significant obstacle to the adoption of sustainable building is budget constraints, which are caused by project financial limitations.
2. Project execution is greatly delayed by complicated approval processes, which deters stakeholders from using sustainable practices.
3. Developers become less motivated when there are no financial incentives, which lowers the economic appeal of sustainable development.
4. The biggest potential is provided by the effective use of natural resources, which guarantees long-term sustainability and construction cost reductions.

5. Minimizing pollution and resource depletion is the main advantage of sustainable building, as evidenced by the reduction of environmental consequences.
6. The value of green buildings is increased by improved indoor environmental quality, which also improves tenant comfort and health.

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