Bridging the Knowledge Gap in Sustainable Construction: A Study of Stakeholder Perspectives in Hyderabad Real Estate Sector

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Abstract

As our population continues to grow, the strain on non-renewable resources makes sustainability—especially in construction—more important than ever. However, in India, sustainable building practices are still not widely adopted, despite their global significance. The construction sector, being one of the most polluting, often talks about sustainability but struggles with proper implementation. While other countries have looked at consumer perspectives on sustainable construction, India, particularly cities like Hyderabad, hasn't been studied in-depth. To bridge this gap, we conducted an online survey with key stakeholders in Hyderabad, including developers and consumers, to understand how well sustainability is understood and applied in real estate purchases. Our findings show that, while consumers acknowledge the importance of sustainability, many lack detailed knowledge about the processes and certifications needed to make a project truly sustainable. These knowledge gaps present real obstacles to adopting sustainable practices, and our study highlights the need for better education and awareness to drive real change in the construction industry.

Keywords: Sustainability, Sustainable Architecture, Construction industry, Consumer Preference, Sustainable Construction,

1. Introduction

With the global increase in population, the world has experienced a shortage of non-renewable resources, due to pollution, overconsumption and wastage (Magdoff, 2013). In such a scenario the idea of sustainability has become a very important point of discussion locally, nationally, and globally.

The word “sustainability” is derived from the Latin word “sustinere”, which means to hold up. To sustain means to maintain, support, uphold or endure resources in a manner in which they are optimally used (*Cambridge Dictionary*, 2024). In recent times, the term “sustainability” has become increasingly popular, due to continued efforts from various organizations, governments and individuals around the globe. The most widely accepted interpretation of sustainability comes from the 1987 United Nations Brundtland Commission, (*Brundtland*, 1987) defines it as:

> “Meeting the needs of the present without compromising the ability of future generations to meet their own needs.” (*Brundtland*, 1987, p. 42)

In the era characterized by global climate change, the depletion of natural resources, and the emergence of "failing states" incapable of fulfilling their citizens' fundamental needs, the concept of sustainability has been tasked with formidable responsibilities of "rescuing civilization" and "preserving the planet."

The acquisition of skills necessary for sustainable living and working is arguably the most significant challenge facing humanity today (Thiele, 2024).

In lieu of sustainability, the 2030 Agenda for Sustainable Development, with 17 Sustainable Development Goals (SDGs) at its core, was adopted by all 191 United nations member states (*United Nations*, n.d). These SDGs have been described by the UN as:

> "As a blueprint for sustainable development that improves health and education, reduces inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests." (*Sustainable development goal*, n.d. , para 1).

Today, sustainability has been widely adopted in some form or manner in almost all aspects of social, economic, and public life, ranging from agriculture, to industries to service sectors like healthcare. On the global scale, 196 countries are making changes within the parameters of the Paris Agreement, a significant global agreement reached at the 2015 United Nations Climate Change Conference (COP21) to restrict the effects of greenhouse gas emissions (*Transforming our world: The 2030 agenda for sustainable development*, n.d). At the grassroots level, by concentrating on addressing the underlying causes and advocating for systemic changes rather than merely treating the symptoms, these organizations heighten awareness regarding the current unsustainability. Furthermore, by developing and showcasing viable alternatives, these initiatives, which emerge from civil society, are paving the way for new avenues towards sustainable production and consumption (*The Paris agreement*, 2015). In India specifically, a study by Jain et al. (2016) found:

> "Overall the corporate social responsibility/ sustainability climate in India is showing signs of positive reform." (Jain, R., & Winner, L., 2016)

As per latest reports, India lags behind in terms of sustainability; India achieved a total SDG score of 60.32 out of 100, placing significantly lower compared to other countries. Specifically, certain sectors lag far behind in terms of sustainability and climate transition plans (Dutta, R, 2022 ; *CDP Worldwide*, 2023). One such industry is the construction and architecture industry. According to The World Benchmarking Alliance (n.d.) and *CDP Worldwide* (2023):

> "Most property developers, managers, and construction companies don't have both emissions targets and climate transition plans in place." (The World Benchmarking Alliance, n.d.; CDP Worldwide, 2023)

This inaction is particularly concerning given that, as per the latest edition of the World Status Report on Buildings and Construction, buildings account for 34% of worldwide energy consumption and 37% of the energy and process-related carbon dioxide (CO2) emissions (*United Nations Environment Programme, & Global Alliance for Buildings and Construction,* (2023).The Buildings Benchmark illustrates a scenario where the industry is drifting towards a future where harmful emissions are embedded in the construction and operation of numerous buildings, underscoring the necessity for prompt measures throughout the entire sector. Half of the companies evaluated lacked a climate change strategy, while 44% did not have any objectives to decrease their emissions (The World Benchmarking Alliance, n.d.; *CDP Worldwide* 2023; *United Nations Environment Programme, & Global Alliance for Buildings and Construction,* 2023). Nevertheless, sustainable construction and green practices are being actively explored, although they are

still not widely accepted (Backes et al., 2023; Anupam et al., 2022; Suer et al., 2022). Terms like "sustainable architecture" and "green construction" are increasingly becoming popular in the construction sector in India(Baweja, 2017). As a concept, sustainable architecture is defined as, :

> "A revised conceptualization of architecture in response toa myriad of contemporary concerns about the effects of human activity."(Williamson et al., 2002, p.2)

Green construction practices aim to mitigate the economic, environmental, and social impacts of the construction industry (SIIL, n.d.). As a sector, construction industry involves several key stakeholders, namely, the builders, architects and other employees as well as the end-consumer. Each individual is equally important in influencing the decisions taken by the builders, who eventually decide whether or not to incorporate certain features (Ruiz-Zafra & Noguera, 2023). However, there is a lack of understanding of sustainability in the global scale and, more specifically India. According to Thiele (2024):

> "Owing to the frequency and looseness of its usage, sustainability has been called 'one of the least meaningful and most overused words in the English language." (Thiele, 2024, p. 2)

Subsequently some essential sustainable development targets have been overlooked, resulting in an undue focus on particular objectives, such as climate change, causing a lack of a holistic understanding of sustainability in the consumer's mind (Lynch, 2021). In order to explore sustainability, its interpretation, relevance and prevalence this paper specifically focuses on the construction industry.

When taking a look at the construction industry in India, Hyderabad is recognized as one of the country's premier real estate hubs, witnessing a 49% year-on-year (YoY) increase in housing sales (*PropTige*r, 2023). AsHyderabad is a major player in India's real estate landscape, and analyzing the understanding, prevalence and implementation of sustainable architecture and related practices, helps paint a larger picture of consumer perception, economic viability and producer mentality towards sustainable construction in India. With the help of a structured questionnaire administered online, this paper seeks to examine the attitude and knowledge of all stakeholders towards sustainable building practices on both the production (i.e. architects, builders, engineers, and etc.) and the consumption, (i.e. consumers) side. The findings of this study suggests that there are several fundamental knowledge gaps among consumers, who for example, mention the relevance of sustainability, but on further probing lack the knowledge of the processes, permits and designs that would make a project sustainable, among other things. Further, it is observed that while architects and builders support the idea of sustainability in principle, in practice the decision is completely dependent on consumer's demand, and rarely do producers nudge buyers to adopt sustainable construction decisions. The findings of this study are useful to identify the factors that together hinder the adoption of sustainability in the construction sector and can be used for the development of .

Lastly, the study hopes to understand and develop guidelines for effectively integrating sustainability practices into the building and construction sector in India.

2.1 Understanding Sustainable Development Goals

The mission statement of the United Nations Sustainable Development Goals (SDGs) states that the SDGs are:

> "A shared blueprint for peace and prosperity for people and the planet, now and into the future ."(*United Nations,* 2024)

A total of seventeen17 SDGs Sustainable Development goals together set by the UN aim to tackle global issues like No poverty (SDG 1), Zero hunger (SDG 2), Good health and well-being (SDG 3), Quality education (SDG 4), Gender equality (SDG 5), Clean water and sanitation (SDG 6), Affordable and clean energy (SDG 7), Decent work and economic growth (SDG 8), Industry, innovation and infrastructure (SDG 9), Reduced inequalities (SDG 10), Sustainable cities and communities (SDG 11), Responsible consumption and production (SDG 12), Climate action (SDG 13), Life below water (SDG 14), Life on land (SDG 15), Peace, justice, and strong institutions (SDG 16), and Partnerships for the goals (SDG 17) (*United Nations,* 2024).

In practice, Nonetheless, the implementation of the SDGs faces a multitude of significant challenges in its implementation, which include difficulties in . These include aligning the SDGs with national planning processes, which often leads to a disconnect between global objectives and local priorities. Prioritizing among the 17 SDGs can be complex due to competing interests and limited resources. The lack of effective intra-governmental and intergovernmental coordination can result in fragmented efforts and inefficiencies. Furthermore, deficiencies in management and leadership undermine the strength of institutional frameworks and oversight. Adequate financing and resources are also critical, yet many countries struggle with mobilizing sufficient funds and implementing innovative financing mechanisms. Addressing these challenges requires strengthened institutional capacities, improved policy coherence, and enhanced multi-stakeholder collaboration (Mostaque & Lam-ya, 2016).

Around the globe these SDG's have been incorporated by governments, companies and individuals. Despite the inclusion of the SDGs at all levels, there remains a significant gap between the initiatives taken and those that are truly needed.

A study assessing the engagement of the Fortune Global Top 500 corporations with the SDGs, using data from November 1, 2019, to February 15, 2020. Of the 500, 304 had relevant content on their websites, but 32.6% simply aligned existing business practices with SDGs rather than initiating new efforts. Only 22.8% developed specific strategies, and just 0.2% created tools to evaluate progress. European companies lead in SDG engagement, while U.S. and Chinese firms lag behind. SDG 8 (Decent Work) and SDG 13 (Climate Action) are the most addressed, while SDG 2 (Zero Hunger) and SDG 14 (Life Below Water) are the least. Engagement also varies by sector, with Information & Technology leading and Health Care showing the least interest (Song, Lan, et al 2022).

On the individual level, understanding public attitudes toward the SDGs is essential for effective communication, as the successful implementation of these goals requires broad individual support and strong public consensus . Without a clear grasp of public sentiment, efforts to mobilize action and secure backing for SDG-related initiatives may prove insufficient. Therefore, engaging the public in a meaningful and informed dialogue, while fostering their commitment to these goals, is imperative for achieving the SDGs (Guan and Zhang, 2023; Mostaque & Lam-ya, 2016).

It is widely recognized that the successful attainment of the 17 Sustainable Development Goals (SDGs) relies on effective governance structures(Glass et al., 2019). Since their advent, these goals have been adopted by all 191 UN member states. However several countries still lag far behind, while some perform much better, Reverte (2022) writes:

> "The Scandinavian countries (Denmark, Sweden, and Finland) have the highest SDG index values, which reflects their ingrained culture in sustainability and defense of the environment and social rights. Our study shows that the countries that are best placed to achieve the SDGs are those with higher levels of governance where there is greater government effectiveness and political stability, greater freedom of expression and association, stronger rule of law and greater control of corruption [31]."

Looking at the adoption of these goals in India, we can see that, according to Prabhakar et al (2015).

> "Significant progress has been made in the field of basic universal education, gender equality in education, and global economic growth."(p.12)

But, when looking at mortality, morbidity and the environment, India lags behind. Hence, India ranks far lower compared to other countries, both in Asia and world-wide.

2.2 Sustainability in Construction

After the Brundtland declaration in 1987, several scholars and decision makers examined the fundamental concepts of sustainable development. Khalfan (2002) emphasized that sustainable construction typically refers to the integration of sustainable development principles in the construction sector.

From the available scholarship, While looking at several research papers, reports and studies, one outline of sustainability emerges as the most prominent, namely – the triple line approach (Mohamed et al., 2010; Weniger et al., 2023; Al-Kodmany & Kheir, 2022; Goel et al., 2019), which . In accordance with this concept, sustainability includes three aspects: economic, environmental, and social:

- Environmental Sustainability in Construction: Implementing strategies to minimize waste, reduce energy consumption, and conserve water is essential for preventing harmful and potentially irreversible effects on the environment. These measures ensure the moderate use of natural resources and contribute to the long-term preservation of our natural basis of life.
- Social Sustainability in Construction: Addressing the needs of individuals involved in the construction process, from commissioning to demolition, is imperative to ensure their well-being and satisfaction. This inclusive approach fosters a supportive and equitable environment, enhancing trust and strengthening relationships with all stakeholders.
- Economic Sustainability in Construction: Increasing profitability by optimizing the use of resources, including labor, materials, water, and energy, is a key aspect of economic sustainability. Ensuring the preservation of economic capital for future generations emphasizes long-term economic stability and resilience, safeguarding the economic basis of life.

Sustainability in the construction sector began in 1993, with the establishment of the US Green Building Council (USGBC), a critical step toward promoting sustainable buildings in the United States and globally

(*U.S. Green Building Council,* n.d.). Subsequently, in 1998, the USGBC developed the Leadership in Energy and Environmental (LEED) Certification, also referred to as green building rating systems, which evaluate and acknowledged buildings that achieve specific sustainability criteria or standards. These certifications reward companies and organizations that construct and manage more environmentally friendly buildings, motivating them to enhance their sustainability efforts. By establishing benchmarks, these certifications stimulated the market, leading to higher aspirations in government building codes, workforce training, and corporate strategies (*World Green Building Council,* n.d.). In 2002, the World Green Building Council was officially formed, with Green Building Councils in: Australia, Brazil, Canada, India, Japan, Mexico, Spain, and the US.

Specifically, in India, in 2004, the Indian Green Building Council (IGBC) was formed to promote green building practices across the country. It introduced green building certifications, aligning with international systems like LEED but focusing on India-specific sustainability needs, such as water conservation, energy efficiency, and eco-friendly materials (*Indian Green Building Council,* n.d.). At present,

Today, the World Green Building Council also administers 61 sustainable building certifications, which include but are not limited to Building Research Establishment Environmental Assessment Methodology (BREEAM), Indian Green Building Council(IGBC), (*World Green Building Council,* n.d.).

In the current era, sustainable construction and sustainability are gaining traction in many sectors, far and wide. A study by *Deloitte* (2023) finds:

> "75% of CxOs said their organizations have increased their sustainability investments over the past year." (*Deloitte,* 2023, para 1.)

Additionally, the construction industry is experiencing a major shift towards the use of green building materials and sustainable techniques (Mittal, 2023).. In 2023, the global Sustainable Construction market generated USD 476.19 billion in revenue and is forecasted to expand at a compound annual growth rate (CAGR) of 9.64% from 2024 to 2033, with expectations to reach USD 1,195.28 billion by 2033. Europe led the global sustainable construction market in 2023, capturing a 39.61% share of the market's revenue (*The Brainy Insights,* 2023).

Despite these efforts, construction and manufacturing remain the third most polluting industry in the world, coming in after the fuel and agriculture industry (Howell, 2024). Research by the The World Benchmarking Alliance (n.d) and *CDP Worldwide* (2023) revealed:

> "Building companies don't have low carbon strategies in place, but neither are they thinking about people. Only a few companies within the Buildings Benchmark are engaged with topics that are necessary for a just transition. Only five (16%) of the 32 companies with significant development or construction activities (Ayala, Gecina, Hyundai E&C, Lendlease and Prologis) have a net-zero target that includes the in-use emissions of delivered buildings. However, none have a time-bound roadmap of how they will deliver solely zero carbon-ready buildings by their target year." (The World Benchmarking Alliance, n.d.; *CDP Worldwide,* 2023)

Similarly, sustainable construction faces numerous challenges. The primary obstacles include increasing costs, a lack of environmental awareness, insufficient education and training in both technical and managerial fields, the need for effective change management, a limited availability of eco-friendly

materials and components, poor understanding of environmental legislation, inadequate communication, and a lack of commitment (Baloi & Daniel, 2003).

2.3 The role of consumers in promoting sustainability in construction

Several key stakeholders influence the promotion of sustainability. While the government establishes policies, organizations, including builders and licensing authorities, implement them. Consumers, who drive demand and are willing to pay for sustainable options, as stakeholders play a crucial role in promoting sustainability . Sustainable lifestyles cannot be achieved without significant changes in consumer attitudes and behavior (Ölander & Thøgersen, 1995). CHowever, these changes in consumer attitudes and needs must then also be recognized and addressed by the industry with appropriate In the building industry, understanding consumer needs and desires is particularly vital.. According to Othman (2014):

> "Achieving customer satisfaction has been identified as an important element for measuring project's success and sustaining competitive advantage. Traditionally, customers were expelled from the product development process. Little effort was done, in the past, to identify the factors that lead to customer satisfaction and hence, use them for product improvement. Organizations that adopted that approach, encountered the risk of losing their customers." (Othman, 2014)

There is generally a lack of consumer understanding regarding sustainability. A study by Deloitte 2023 found that:

> "The main reasons for not adopting a more sustainable lifestyle remain these relate to cost (62%), a lack of interest in sustainability (58%), and not having enough information (50%)." (*Deloitte,* n.d.)

Understanding consumer behavior in sustainable building is vital for effective communication of product benefits. Consumer preferences and awareness around sustainability are often subjective and varied, complicating efforts to present products as eco-friendly (Lee et al., 2020). Similarly, Consumer education plays a significant role in fostering sustainable development, affecting both customer choices and producer practices (McDonald et al., 2012).

To address this, a written survey was conducted to evaluate consumer knowledge and motivations in the building sector, helping companies better tailor their sustainability messaging and engagement strategies.

2.4 The Indian Government and its role in promoting sustainability

The word "sustainability" became relevant after the release of the 1987 Brundtland Commision Report, laying the groundwork for industries, including construction, to consider long-term environmental, economic, and social impacts of their activities (*Brundtland*, 1987). Since 1987, governments and organizations around the have been taking measures to promote sustainability around the world.

In 1992, Rio Earth Summit, held in Rio de Janeiro, brought global attention to environmental issues, resulting in several landmark agreements, including Agenda 21, which called for future strategies for achieving comprehensive sustainable development in the 21st century (*United Nations*, 1992). Soon after,

in the 2000's came the Millennium Development Goals, signed by 189 countries and established by the UN, aiming to tackle global poverty, hunger, education, gender equality, child mortality, and environmental sustainability by 2015 (*United Nations*, n.d.).

The Indian government's journey into promoting sustainability began in 2008, when they launched the National Action Plan on Climate Change (NAPCC). The (NAPCC) outlined eight key goals: boost solar energy capacity, promote energy efficiency across sectors, encourage sustainable urban planning, ensure water conservation, protect the Himalayan ecosystem, increase forest cover, support climate-resilient agriculture, and enhance scientific research on climate change for informed decision-making and innovation (*Department of Science and Technology, Government of India*, n.d.). Still, Kothari (2013) finds that India faces significant challenges when moving towards a comprehensive framework of sustainability, along with human security and equity. These challenges encompass knowledge, capacity and expertise gaps; political apathy and hostility; and public ignorance and attitudes (Kothari, 2013).

On the global scale, in 2015, 196 countries signed the Paris Agreement, a significant global agreement reached at the United Nations Climate Change Conference (COP21) to restrict the effects of greenhouse gas emissions, and are making changes within the parameters o to restrict the effects of greenhouse gas emissions (United Nations, n.d.).

In 2024, when looking specifically at India incorporated the idea of , sustainability is being incorporated both at the governmental and corporate level (Rizwan, 2024). According to Rizwan (2024):

> "The adoption of corporate sustainability practices in India is becoming more nuanced and integrated into corporate strategies, driven by both local regulations and global sustainability trends. Indian corporations are increasingly aligning their operations with ESG considerations, demonstrating a commitment to not only meeting compliance requirements but also to making a meaningful impact on society and the environment." (Rizwan, 2024)

In the past few years, Similarly, the Indian Government has taken several steps to embrace sustainability;, its dedication to the Sustainable Development Goals (SDGs) is evident in its alignment with the national development agenda. The SDG India Index, which assesses progress at the subnational level, showcases the country's strong SDG localization model focused on adoption, implementation, and monitoring at the state and district levels (*Sustainable Development Goals*, n.d.). Additionally, India undertook several campaigns to specifically target and promote and incorporate SDG's, such as Swachh Bharat (Clean and Healthy India), Sabal Bharat (Empowered and Resilient India), and Sanatan Bharat (Sustainable India) (*Sustainable Development Goals*, n.d.). Still, India still lags behind in sustainability, as Subrahmanyam et al. (2023) argues that, finds:

> "India is not On-Target for 19 of the 33 SDGs indicators. The critical Off-Target indicators include Access to Basic Services, Wasting and Overweight Children, Anaemia, Child Marriage, Partner Violence, Tobacco Use, and Modern Contraceptive Use." (Subrahmanyam et al., 2023)

A survey by Leiserowitz et al. (2024) on climate change in the Indian mind, found :

> "When it comes to global warming risk perceptions, a large majority believe it will harm flora and fauna (83 per cent), people in India (82 per cent), future generations (81 per cent), people in their own community (78 per cent), and themselves and their own family (74 per cent). According to 78 percent of Indians, the Indian government should be doing more to address global warming. Only 10 per cent believe the government is doing enough to combat global warming." (Leiserowitz et al., 2024)

This statistic highlights the need for a better understanding of sustainability in all sectors, including the construction industry, a big contributor to pollution and overall environmental harm. When looking at sustainable development, Hyderabad in Telangana, comes into picture.

Amongst the ten fastest growing cities in the world, Hyderabad has experienced a construction boom, witnessing a 49% year-on-year (YoY) increase in housing sales (*PropTige*r, 2023; *Knight Frank*, 2024. Hyderabad's government in Hyderabad has been working to promote sustainability in several sectors, encompassing green energy, waste management and organic farming (*Invest Telangana*, n.d.; *MCR HRDI*, n.d.). The major initiatives include farmer's investment scheme, piped and treated drinking water to every household, support to minorities, welfare schemes, etc However, despite these initiatives Hyderabad's state Telangana was ranked 11th in Niti Aayog's Sustainable Development Goals (SDG) India Index for 2023-24 (*NITI Aayog*, 2024*)*. Due to Hyderabad's lack of progress in sustainability, in spite of rapid urban development, and expansion, sustainability in its construction and architecture sector was chosen as a field of study.

3.1 Research Objectives

This paper tries to critically explore the following research objectives:

1. To map the understanding of sustainability among the different stakeholders in Hyderabad, Telangana.
2. To analyse the extent to which consumers consider sustainability as a factor when purchasing real estate.
3. To identify knowledge gaps between stakeholders, including builders, architects, engineers, and consumers.

3.2 Methodology:

It became clear throughout the Literature review, that all stakeholders involved, including builders, engineers, architects and other industry professionals, along with the consumers are pivotal in developing an attitude towards sustainability and its integration in the construction sector. Accordingly, the research aimed to map out the understanding, implementation, and employment of sustainability among all stakeholders involved in the sustainability process.

To answer the intended research questions, a structured survey was administered online to two group of respondents, namely to buyers of construction, and to builders and architects to map the relative understanding of key stakeholders. This specific approach was selected because other methods, such as

observation and literature review, were deemed inadequate to address the research question of whether consumers in the construction industry consider sustainability when choosing building products. A structured questionnaire was particularly advantageous, offering a higher degree of structure and being cost-effective. Additionally, this type of survey also offered anonymity and confidentiality to respondents, and encouraged them to provide more honest and thoughtful responses to the questions.

Since all stakeholders needed to be studied, two distinct sample groups were studied: the production side, consisting of builders, architects, engineers, and employees at real estate firms; and the consumption side, comprising consumers over the age of 18 residing in Hyderabad. Two separate questionnaires were then developed, tailored to the expertise of both producers and consumers. The developer's questionnaire, designed for the production side, included an additional section to assess what producers believe about consumers' understanding of sustainability. These findings were later compared with the consumers' responses to identify knowledge gaps between producers and consumers.

Both the questionnaires were organized into multiple thematic sections to provide participants with a clear and structured flow. It opened with a concise explanation of key information and instructions, including contact details for any questions or feedback, followed by key demographic questions inquiring, name, age, gender, educational qualification and occupation. They were then followed by questions about their experience in the construction sector, their understanding of sustainability, its implementation and preferred marketing techniques.

The questions (See Table 1 Below), were designed after examining several studies [ ] and questionnaires. Respondents were reached through various social media platforms and the authors' personal network. The platforms utilized included Telegram, WhatsApp, and LinkedIn.

4.1 Findings - Consumer Survey

After closing the two surveys at the end of August 2024, a total of 46 respondents took part in the consumers survey belonging to a wide range of age groups. In total, 59.6% of respondents were females, and 40.4% were males. Of these, the majority, 63% were from the ages of 41 to 60, 28.5% were above the age of 60, 6.1% were between the ages of 28 to 40, and 2.04% were between the ages of 18-27. Individuals under the age of 18 were excluded from the data and subsequent analyses, as they are not legally able to make business decisions and are therefore not directly relevant to the construction industry. In total, 43% of respondents had an undergraduate degree, 39% obtained a postgraduate degree, 12% were high school graduates, and 6% studied above post-graduation.

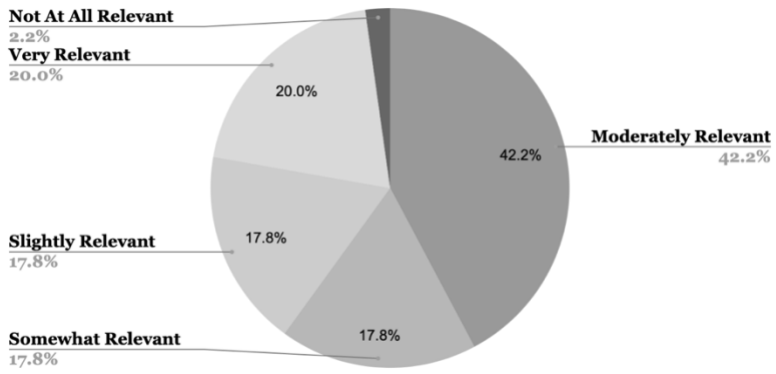

Figure 2: Distribution of how significant sustainability is in the personal lives of the respondents.

A Chi-square test was conducted to evaluate potential correlations between age group, gender, and educational background, and the relevance of sustainability in the respondents' personal lives. The results indicated no significant associations between these variables. On similar lines, consumers were asked about the relevance of sustainability when purchasing a piece of real estate. In order to eliminate consumer bias, two questions were placed in the questionnaire, at different intervals. Figure 3 demonstrates the results of these questions.

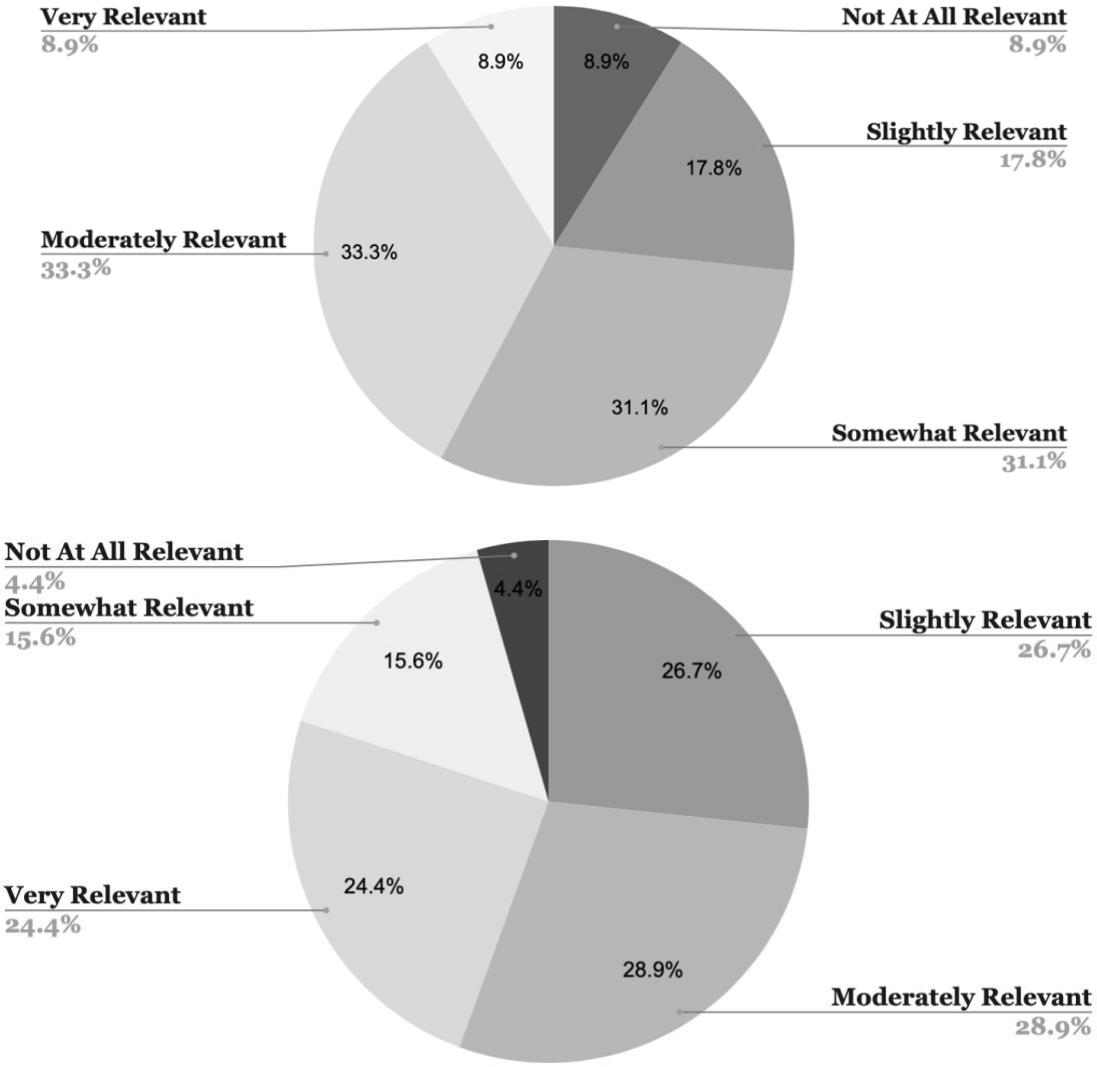

Figure 3: Relevance of Sustainability in when purchasing a piece of real estate

Consumers were also asked to rate how well-informed they were about sustainability, using a scale from “Highly Aware" to "Not at All Aware.". 6.7% indicated they were Highly Aware, 28.9% were Somewhat Aware, 37.8% were Moderately Aware, 22.2% were Slightly Aware, and 4.4% were Not at All Aware.

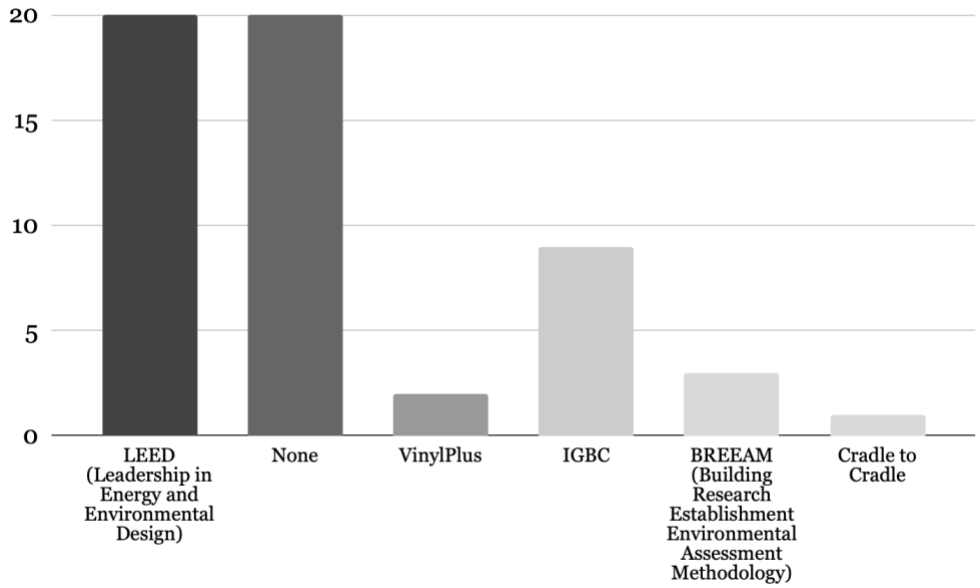

Figure 4: Consumers knowledge of common green building certifications

To evaluate the importance of purchasing criteria for real estate consumers, they were asked to rank the relevance of location, price, sustainability and facilities when purchasing a piece of real estate. The results are presented in Figure 5 below, with a scale ranging from 1 being "Very Relevant," to 5 being "Not at All Relevant."

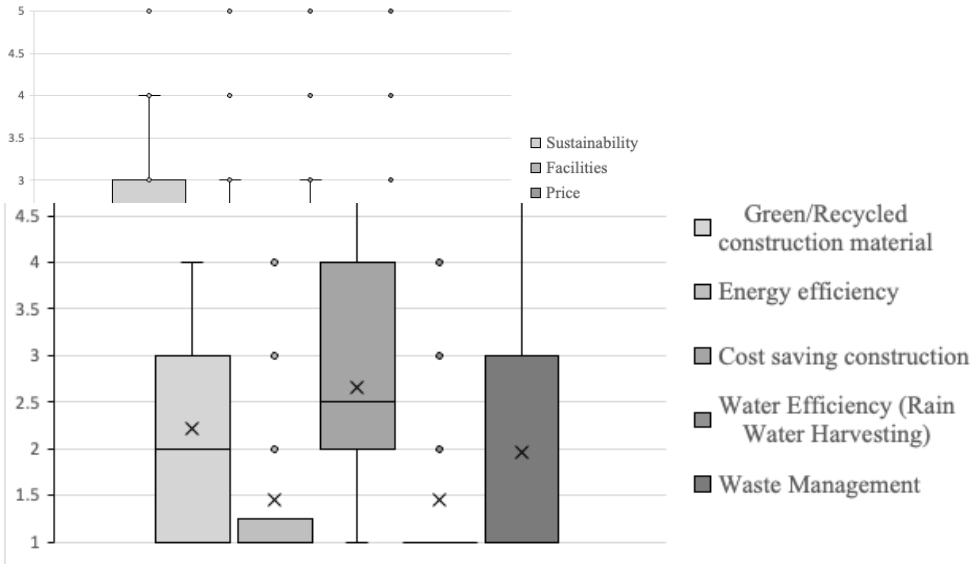

Figure 5: Consumers' preferred criteria for real estate purchases

To further assess consumers' understanding of sustainable construction, they were asked to rank the relevance of five specific criteria in relation to the term "Sustainable Real Estate". The five criteria were: Green/Recycled Construction Material, Cost Saving Construction, Waste Management, Water Efficiency(Rainwater Harvesting), and Energy Efficiency. The results are indicated in Figure 6 below, with 1 being "Very Relevant" and 5 being "Not at All Relevant".

Figure 6: Consumers' Understanding of Sustainable Real Estate

To examine consumers' understanding of sustainable construction, their knowledge of water management and energy efficiency was evaluated. Figure 7 portrays consumers' association with water management with 1 being "Very Relevant" and 5 being "Not at All Relevant".

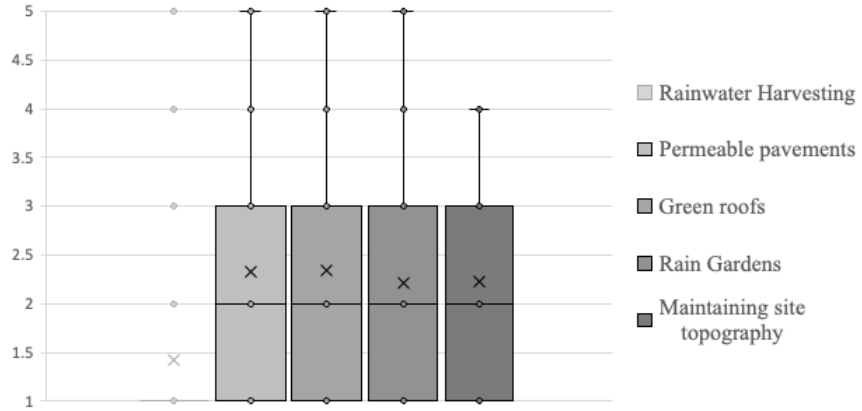

Figure 7: Consumers' Associations with Water Management

Figure 8 portrays consumers' association with Energy Saving with 1 being "Very Relevant" and 5 being "Not at All Relevant".

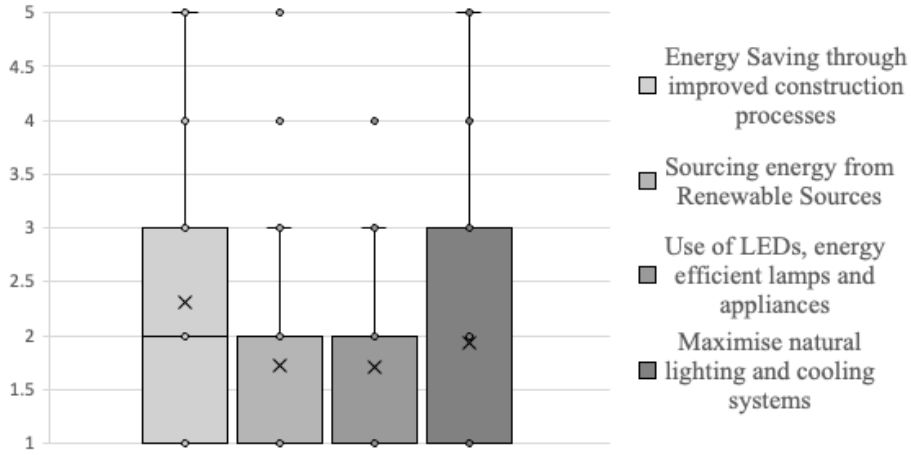

Figure 8: Consumers' Associations with Energy Saving

When assessing consumers' marketing preferences, respondents indicated the highest confidence in the fulfillment of sustainability criteria through "Certificates/Labels" (40.8%), followed by "Detailed Product Information" (34.7%), and "Building Design" (24.5%).

Similarly, consumers indicated their preferred marketing tools, the results of which are indicated in Figure 9 below.

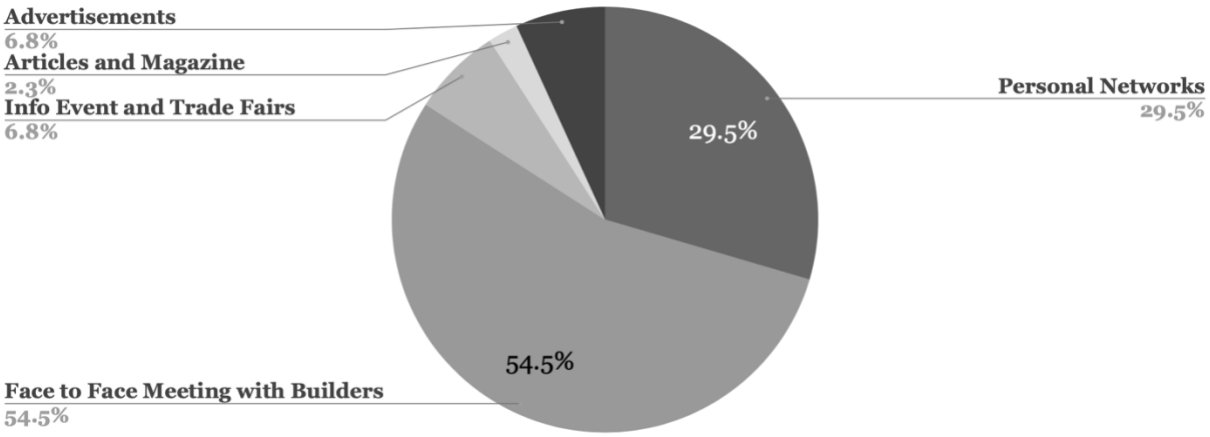

Figure 9: Preferred Marketing Tools by Consumers.

Consumer opinions about green buildings promote economic growth were examined. The responses showed that none 45.5% Strongly Agree, 36.4% Agreed, 13.6% were Neutral, 4.5% Disagree, and none Strongly Disagree.

4.2 Findings - Developers Survey

A total of 38 participants completed the consumer survey. Among these, only 5.3% were female while 94.7% were male. The majority, 63.2%, were aged between 41 and 60 years, 5.3% were over 60 and 31.6% were aged between 28 and 40 years. Individuals under 18 were excluded from the analysis as they are not legally permitted to make business decisions and are therefore not relevant to the construction industry. Regarding educational qualifications, 57.9% of respondents held an undergraduate degree, 36.8% had a postgraduate degree and 5.3% had education beyond postgraduate level.

To gain a deeper understanding into the demographics of the developers their experience in the construction industry was examined. 89.5% of respondents had spent over 10+ years, 5.3% between 4 to 6 years and 5.3% between 0-3 years. 68.4% of these people had built both residential as well as commercial complexes, whereas 31.6% had only focused on residential properties. Over 47.4% had experience in the field of sustainable architecture and construction through their profession directly, whereas, 5.3% had done so, only through private engagement. In contrast, 42.1% had no experience in sustainable architecture, while only 5.3% had learnt about it while pursuing their higher education degree.

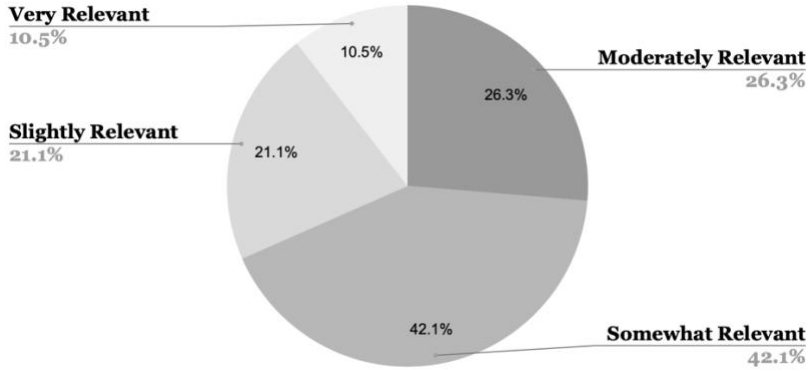

Figure 10: Significance of Sustainability in the personal lives of the Respondents.

A Chi-square test was performed to assess potential correlations between age group, gender, educational background, and the importance of sustainability in developers'' personal lives. The results showed no significant associations between these variables.

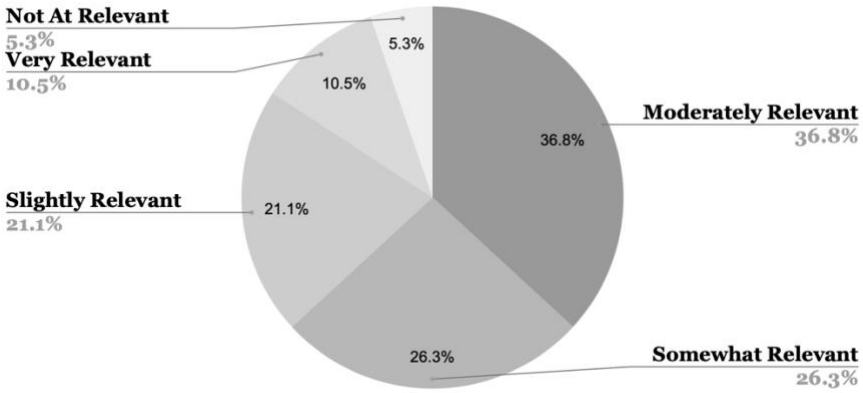

Figure 11: Relevance of Sustainability to Developers

Developers were also surveyed about their familiarity with common green building certifications.

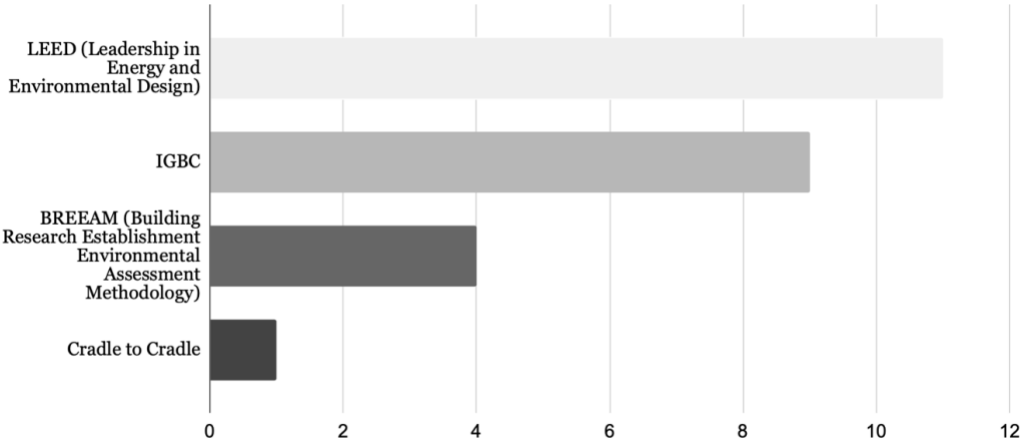

Figure 12: Developers Awareness of Green Building Certifications

To assess the significance of various sustainability criteria during the construction process for real estate developers, they were asked to rank the importance of the usage of green material, energy efficiency, cost saving methods, water efficiency and waste management during the construction process. The results, shown in Figure 13 below, use a scale where 1 represents "Very Relevant" and 5 represents "Not at All Relevant."

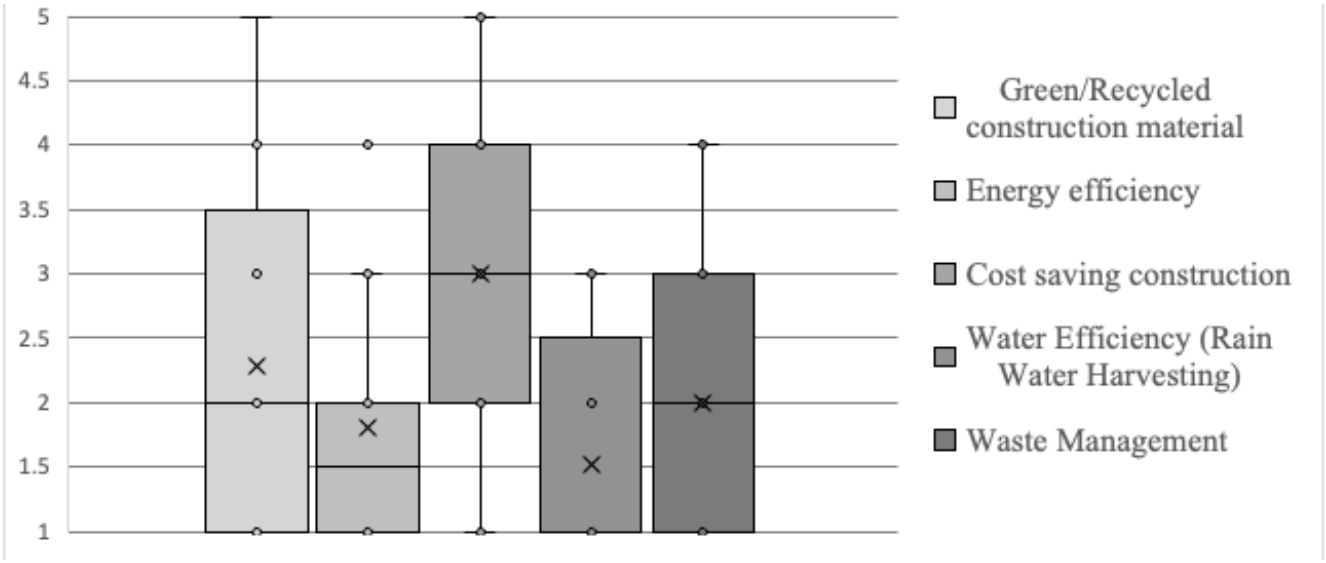

Figure 13: Developers understanding of the term 'Sustainable Real Estate"

To gain deeper insights into developers' understanding of energy saving, they were asked to rank the importance of four specific criteria associated with the term "Energy Saving". These criteria included Energy Saving through improved construction processes, sourcing energy from renewable sources, use of LEDs and energy efficient lamps and maximising natural cooling and lighting methods . The results are displayed in Figure 14 below, with 1 signifying "Very Relevant" and 5 signifying "Not at All Relevant."

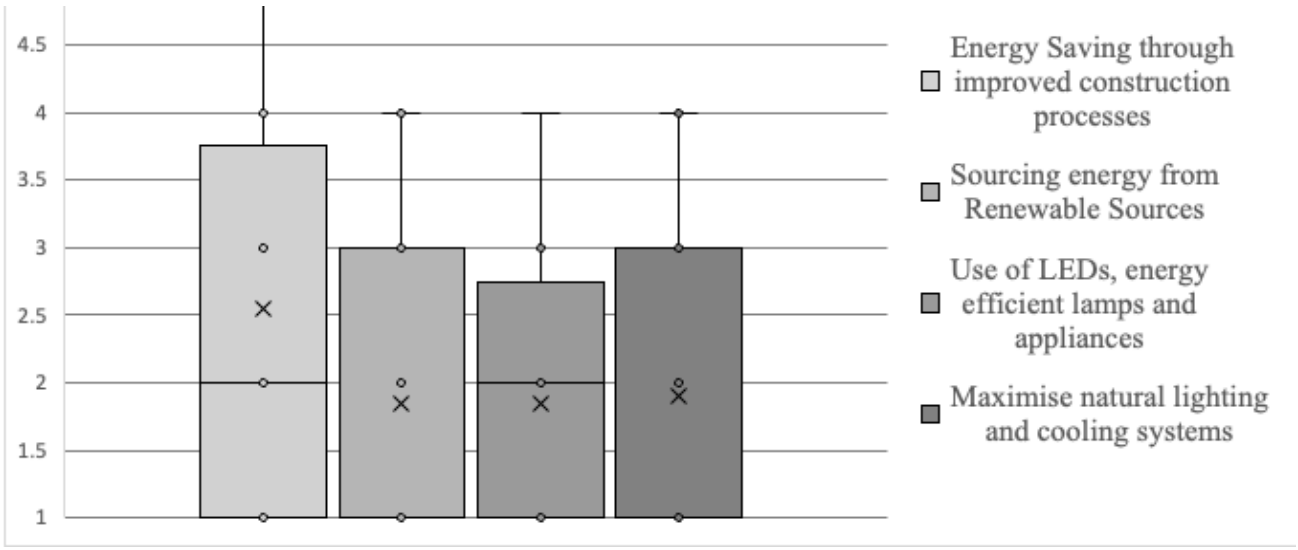

Figure 14: Developers Associations with Energy Saving

To assess developers' understanding of water management, a deeper analysis was undertaken. Figure 15 illustrates developers' perceptions of water management, with 1 representing "Very Relevant" and 5 representing "Not at All Relevant."

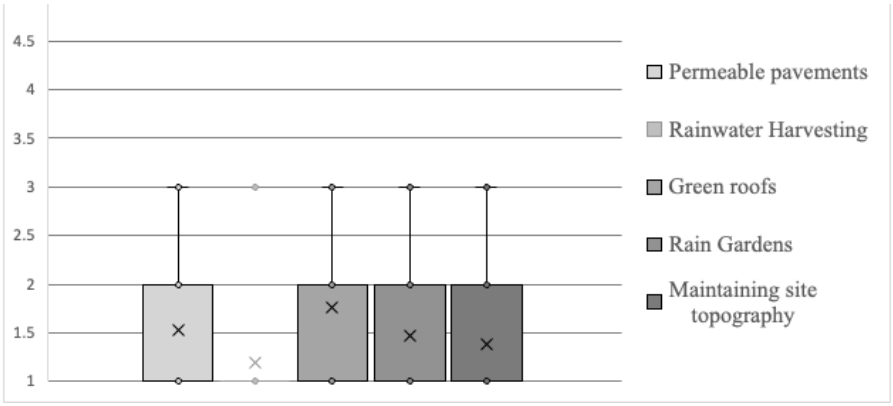

Figure 15: Developers Associations with Water Management

To assess the importance of various criteria for real estate developers, they were asked to rank the relevance of location, price, sustainability, and facilities when constructing a property. The results, shown in Figure 16 below, are based on a scale where 1 indicates "Very Relevant" and 5 indicates "Not at All Relevant."

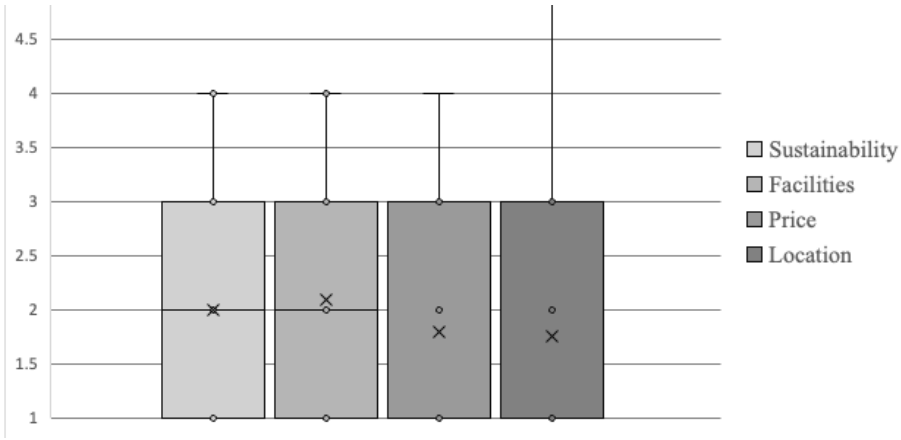

Figure 16 : Developers Preferred Criteria for Real Estate Development

To study the gaps in knowledge between developers and consumers, developers' opinions about market demand were analyzed. Figure 17 highlights the perspectives of developers on the consumer considerations of sustainability

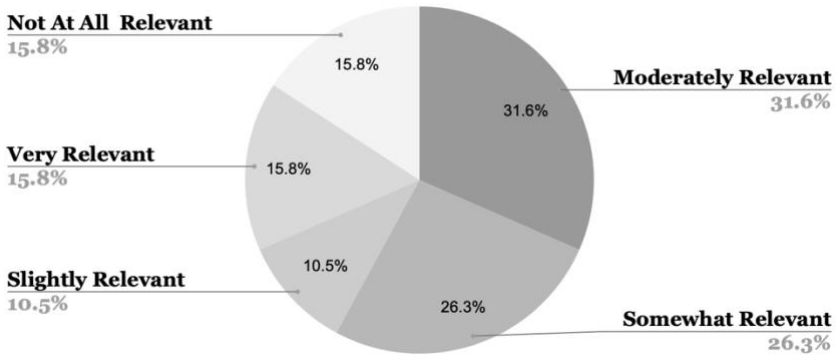

Figure 17: Developers opinions on consumer consideration of sustainability

Additionally, developer's opinions on consumer awareness were also examined. Figure 18 highlights developers' opinions on consumers awareness of sustainability.

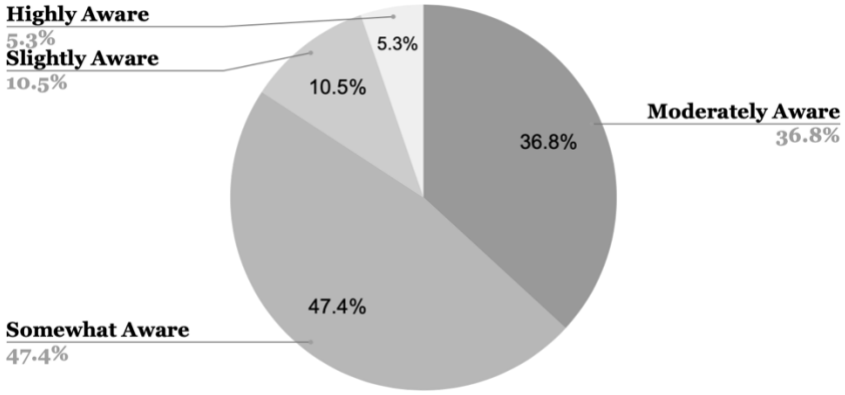

Figure 18: Developers opinions on consumers awareness of sustainability

Figure 19 highlights developers' perspectives on the percentage of consumers looking for sustainability when purchasing real estate.

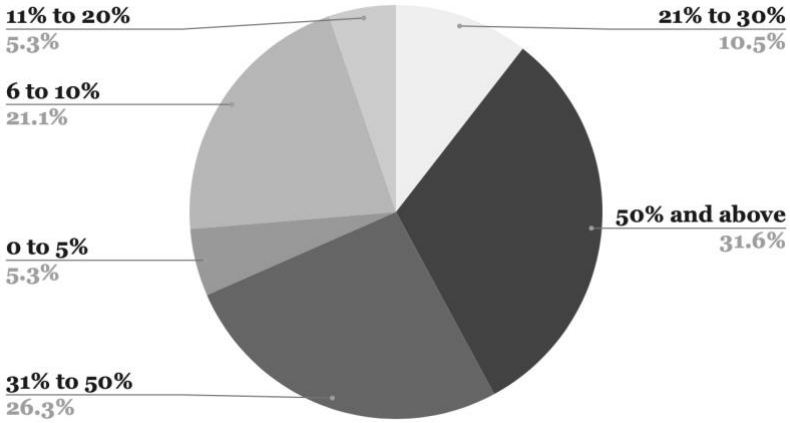

Figure 19: Perspectives of developers on the percentage of consumers looking for sustainability when purchasing real estate.

When assessing developers' marketing preferences, respondents indicated the highest confidence in the fulfillment of sustainability criteria through "Certificates/Labels" (40.8%), followed by "Detailed Product Information" (34.7%), and "Building Design" (24.5%).

5. Discussion

A mapping of the perception of sustainability of stakeholders of the city of Hyderabad, such as consumers and real estate developers, will be given by this study. Well indicated is the knowledge and perception gap and also inconsistency with some literature but inconsistency with others. The majority of the respondents have more than 10 years of experience with the construction industry, amounting to

about 90 percent of the respondents. Such depth in terms of experience contributes to making the collected data more reliable since it further strengthens the conclusions of the study.

A critical finding is that consumers' self-reported awareness of sustainability differs significantly from their knowledge, especially that related to green building certifications. This, along with 73.4% of consumers claiming to be moderately to highly aware, reveals a serious shortfall as 43.5% were unaware of basic certifications such as LEED and IGBC, which are staple certifications for the sustainable construction market. This is consistent with previous research that suggested a dichotomy between consumer perceptions and actual knowledge of sustainability. Meanwhile, all developers surveyed were familiar with at least one green building certification, thus paying testament to their industry knowledge.

This division of knowledge between consumers and developers is frightening because it reflects little regulation and well-informed decision-making on the part of the construction sector. A comparison with the understanding of stakeholders about the term "sustainable real estate" will reveal a similar response from consumers and developers toward five criteria: Green/Recycled Construction Material, Cost Saving Construction, Waste Management, Water Efficiency, and Energy Efficiency. This promising result indicates that there is a shared understanding of the great role that these factors play in sustainable real estate.

However, while customers rated these criteria within a claimed margin of error of 0.5 percent, their general understanding is shallow compared to what respondents of the developer category manifest.

The gap was more evident with the research on water management. Consumers rated rainwater harvesting of very high relevance; however, they demonstrated a little understanding of complementary methods such as maintenance of site topography and permeable pavements. Such gaps illustrate the literature's assertion that consumer knowledge usually lags behind industrial standards. Both consumers and developers showed comparable levels of comprehension regarding energy efficiency, with little difference in their views on how crucial this is. Therefore, on the whole, there is a plus sign regarding the awareness of energy-saving issues in property development among both parties. The real power of developers' deep market understanding is pronounced once they assess consumer preferences, with special attention to consumers' consciousness and concern for sustainability. They emphasized the low level of consumer awareness and relatively lower priority given to sustainability in decision-making.

Regarding marketing preferences, the consumers proved to have the highest level of confidence with "Certificates/Labels" concerning the fulfillment of sustainability at 40.8%, "Detailed Product Information" with 34.7%. This assumption, as a matter of fact, goes well with the literature stating that sustainability in marketing is indeed very much influential in terms of building consumer trust and affecting buying decisions.

Inversely, consumption of the certificates means that the consumers do not really know how sustainability details work, and therefore, they need assurance through a paper that bears an implied trust in the institution issuing it rather than believing its content. On the other hand, developers ranked the "Detailed Product Information" at the topmost at 57.9% thus, showing gaps on the understanding of the market. Thus, in sum, the investigation revealed the disparity in comprehension as well as cognizance between consumers and stakeholders of the construction industry. The developers have a better insight into how sustainable practice works, while the consumers do not. Developers are fully aware of what

sustainability acts are, while the consumers do not know that. That situation may result in uninformed purchasing decisions, which are contrary to the sustainability attribute.

Another key point through which claims for sustainability would be justified and above-board would be establishing regulations on the marketing practices of the construction industry. The stakeholders by filling these gaps will, therefore, provide a well-informed customer base that would create more demand for the sustainable construction process, thereby ensuring a further more sustainable future for urban development in Hyderabad and beyond.

For that reason, there is a need to explore the knowledge gap that emerges between consumers and developers of Hyderabad's construction industry. Based on the literature at hand, it can be anticipated that pragmatic consumers are going to demand sustainable practices followed by the increased demand for green buildings. From the current affairs, however, the opportunity has been missed as the developers haven't capitalized on consumer interest in sustainability.

Of course, the two teams, theoretically, know that sustainability is of the essence but with vast discrepancies on the level of knowledge. There is this gap that jeopardizes the success of marketing strategy and also poses a challenge to the broader usage of sustainable practice in the industry. The developers will be aware of industry standards and certifications that facilitate them to use sustainable practices while keeping the consumers in the dark about specifics that could influence their purchasing decision.

This presents an opportunity risk to the developers, under the consideration that consumer awareness relates to that of the developer. This mismatches marketing messages and product offerings. Developers may state broad terms of sustainability without covering the knowledge barriers existing for consumers. A later feeling of reprobation or disinterest from the consumers toward those green buildings is developed, which would prove harmful to the growth of the markets.

This should be done by engaging in targeted educative efforts. These kinds of programs would be beneficial for raising the awareness through rationally explaining sustainability practices and value to the consumer, and through a green building. This could be achieved by community workshops, webinars online, or partnerships through developers and educational institutions in developing accessible content around living sustainably and construction. Along with targeted education efforts for the consumer base, developers must be proactive in the provision of information on sustainability features that their projects encapsulate.

Besides education, frameworks of regulation should be improved to make such marketing claims about sustainability credible, clear and informative. In this respect, there would be standards and guidelines about the sustainability communication in the marketing materials, especially if they would show if sustainability claims are valid, and therefore clear for the consumers. For this reason, one could have a system of labeling green buildings which would make it easy to decide at a glance and hence promote transparency in the market. Knowledge of consumers and other stakeholders in the construction sector would therefore find their way to supplement each other in the long term in aiding to enhance consumer confidence and further cultural change toward sustainability in urban development.

Consumers would then enlighten and become militant; they would, hence force developers to become sustainable. Thus, via collaboration and knowledge sharing and mutual support, consumers may team up with the developers toward the greener tomorrow of Hyderabad's real estate landscape.

6. Conclusion

The paper is based on the perception and cognition of stakeholders who diversified in the real estate industry of Hyderabad regarding sustainability focusing on the construction sector. The research identifies knowledge gaps between consumers and developers pertaining to the sustainable practices in building and accreditations while assessing how knowledge gaps about such practices impact decision-making in real estate buying and development.

To this end, the quantitative questionnaire was administered to two major stakeholder groups: consumers and developers. The questions ranged from awareness about sustainability certifications such as LEED and IGBC to perceived relevance of sustainability criteria, ranging from energy efficiency, water management, and use of recycled construction materials. Among these two groups, the study attempted to assess whether and how there is a difference in perceptions in terms of understanding the sustainability factor between the two groups.

Some of the key findings include that there was a substantial gap between consumers' knowledge and awareness of sustainability and developers' awareness and knowledge of sustainability. While 73.4% of consumers said they had moderate to high awareness of sustainability, many respondents showed little to no knowledge of key certifications. More so, developers were heavily equipped with the knowledge on how to go about the sustainability practices and were known to be familiar with sustainability methods. In addition, results portrayed an understanding of whether consumers and developers both agreed to consider water and energy efficiency, but the developers showed better understanding in the technical considerations involved in those areas.

However, the study also has disadvantages. The sample size is relatively small at least for the developers, which had only 19 cases and might not fully represent the general population. Furthermore, the approach of only employing a questionnaire restricted the depth and richness of perception studies among consumers. With in-depth interviews, much more would have been known about attitudes of consumers toward sustainability and even on potential predispositions toward behavioral changes in sustainability. Lastly, in this research, there is only one aspect of sustainability used-understood as built environment. Sustainability may even not be behind the construction of this building but rather behind current consumption practices and constant maintenance of the buildings.

Despite the above limitations, this study would be very relevant because it points out the knowledge gap and understanding towards sustainability between developers and consumers in construction. The study not only calls for more effective consumer education but also better communication from developers to fill the gap. The conclusion calls for a much stronger role of policy measures in promoting the adoption of green building practices and sustainability becoming integral to decision-making in the real estate sector. It thus provides a very worthwhile basis for future research and policy interventions that are going to lead towards sustainable development in this real estate sector.

References

Al-Kodmany, Kheir. "Sustainable High-Rise Buildings: Toward Resilient Built Environment." Journal of Urban Technology, vol. 25, no. 1, 2018, pp. 1-21.

Anupam, B. R., Chandrappa, A. K., and Sahoo, U. C. "Sustainable Pavements for Low-Impact Developments." Materials Today: Proceedings, vol. 37, 2021, pp. 1308-1313. DOI: 10.1016/j.matpr.2020.06.172.

Backes, J. G., Traverso, M., and Horvath, A. "Environmental Assessment of a Disruptive Innovation: The Case of Prefabricated Buildings." Building and Environment, vol. 229, 2023, p. 109833. DOI: 10.1016/j.buildenv.2023.109833.

Baloi, Daniel. "Sustainable Construction: Challenges and Opportunities." Journal of Cleaner Production, vol. 16, no. 1, 2008, pp. 47-60. DOI: 10.1016/j.jclepro.2007.01.020.

Bennetts, H., Radford, A., and Williamson, T. "Understanding Sustainable Architecture: Beyond the Building." RICS Research Paper Series, vol. 4, no. 9, 2002, pp. 1-10.

Cambridge University Press. "Sustainability." Cambridge University Press, 2023. Accessed July 30, 2024. https://dictionary.cambridge.org/dictionary/english/sustainability

CDP Worldwide. "Research Reveals Building Sector is Dangerously Behind on Climate Progress." CDP, 2023. Accessed July 18, 2024. www.cdp.net/en/articles/media/research-reveals-building-sector-is-dangerously-behind-on-climate-progress-and-planning-for-net-zero

Climate Change Programme. Department of Science and Technology, Government of India. "Climate Change Programme." Government of India, 2024. Accessed July 30, 2024. https://dst.gov.in/climate-change-programme.

Deloitte. "New Deloitte Research on Sustainability Investments." Deloitte Insights, 2023. Accessed July 18, 2024. https://www.deloitte.com/global/en/about/press-room/new-deloitte-research-on-sustainability-investments.html.

Department of Science and Technology, Government of India. "Climate Change Programme." Government of India, 2024. Accessed July 30, 2024. https://dst.gov.in/climate-change-programme

Dutta, R. "Sustainability and India - A Primordial Review." Journal of Sustainable Development, vol. 15, no. 2, 2022, pp. 1-11. DOI: 10.5539/jsd.v15n2p1.

"Eco Technologies in Telangana." *Invest Telangana*, [Accessed August 8 2024], https://invest.telangana.gov.in/ecotechnologies/#:~:text=Telangana%20has%20a%20total%20installed,from%20other%20renewable%20energy%20sources.&text=%236%20Ranked%20state%20in%20India,44mn%20st%20built%20up%20area.

Glass, Lisa-Maria, and Jens Newig. "Governance for Achieving the Sustainable Development Goals." Sustainability Science, vol. 14, no. 4, 2019, pp. 877-888. DOI: 10.1007/s11625-019-00767-7.

Goel, A., Ganesh, L. S., and Kaur, A. "Sustainability Assessment of Construction Practices in India." Sustainable Cities and Society, vol. 62, 2020, p. 102378. DOI: 10.1016/j.scs.2020.102378.

Guan, and Zhang. "Sustainability and Environmental Research: Public Health." Environmental Science and Policy, vol. 87, 2018, pp. 1-9. DOI: 10.1016/j.envsci.2018.05.003.

Gutberlet, J. "Grassroots Waste Picker Organizations Addressing the UN Sustainable Development Goals." Waste Management & Research, vol. 39, no. 8, 2021, pp. 945-949. DOI: 10.1177/0734242X211019550.

Howell, "Top 7 Most Polluting Industries." *The Eco Experts*, [Accessed July 14 2024], 2024, https://www.theecoexperts.co.uk/blog/top-7-most-polluting-industries.

"Indian Green Building Council." *Indian Green Building Council*, [Accessed July 15 2024], https://igbc.in/.

Jarvie, M. E. "Brundtland Report." World Commission on Environment and Development, 1987. Accessed August 1, 2024. https://www.britannica.com/topic/Brundtland-Report

Jain, R., and Winner, L. "CSR and Sustainability Reporting Practices of Top Companies in India." Indian Journal of Corporate Governance, vol. 9, no. 1, 2016, pp. 1-22. DOI: 10.1177/0974686216642551.

Kothari, Ashish. "Development and Ecological Sustainability in India." Journal of Sustainable Development, vol. 12, no. 2, 2019, pp. 1-8. DOI: 10.5539/jsd.v12n2p1.

Knight Frank. "India Real Estate Office and Residential Market: Jan-Mar 2024." Knight Frank Research, 2024. Accessed July 29, 2024. Link.

Leiserowitz, Thaker, Verner, Goddard, Carman, Rosenthal, Modala, Talwar, Deshmukh, Shukla, Marlon, Ballew, and Goldberg. "Climate Change in the Indian Mind, 2023." Yale Program on Climate Change Communication, 2023. Accessed July 5, 2024. https://climatecommunication.yale.edu/wp-content/uploads/2014/05/climate-change-indian-mind-2023.pdf

Lynch, S. (2021, August 25). The construction industry is getting greener: Why, how, and what's changing. *Forbes*. https://www.forbes.com/sites/sap/2021/08/25/the-construction-industry-is-getting-greener-why-how-and-whats-changing.

Magdoff, F. "The Depletion of the World's Natural Resources: Is Population the Problem?" Monthly Review, vol. 65, no. 4, 2013, pp. 1-17. DOI: 10.14452/MR-065-04-2013-01_1.

Millennium Development Goals. United Nations. "Millennium Development Goals Report 2015." United Nations, 2015. Accessed July 2, 2024. https://www.un.org/millenniumgoals/.

Mostaque, Lam-ya. *Moving Forward with the SDGs: Implementation Challenges in Developing Countries*. 2016, https://doi.org/10.13140/RG.2.2.26189.69609.

Mittal,"How Sustainability Will Shape India's Construction Industry." *Economic Times*, [Accessed July 5 2024], 2023, https://economictimes.indiatimes.com/small-biz/sustainability/how-sustainability-will-shape-indias-construction-industry/articleshow/106042273.cms?from=mdr#.

NITI Aayog. "Social Sector Indices." NITI Aayog, 2023. Accessed July 10, 2024. https://www.niti.gov.in/social-sector-indices.

Prabhakar, M. Christopher David. "Sustainable Development Goals (SDGs) - Challenges for India." Indian Journal of Public Administration, vol. 66, no. 4, 2020, pp. 623-637. DOI: 10.1177/0019556120960545.

PropTiger. "New Home Sales Record 33% YoY Growth in 2023." PropTiger.com, 2023. Accessed July 29, 2024. https://www.proptiger.com/guide/post/new-home-sales-record-33-yoy-growth-in-2023-proptiger-com-report

Rizwan, Mirza. "Corporate Sustainability Practices in India: The Way Forward." International Journal of Business and Management, vol. 15, no. 2, 2020, pp. 1-10. DOI: 10.5539/ijbm.v15n2p1.

Ruiz-Zafra, N., and Noguera, A. "Construction Process." Journal of Cleaner Production, vol. 142, 2017, pp. 134-145. DOI: 10.1016/j.jclepro.2016.11.034.

Salama, Mohamed, and Rika Hana. "Green Buildings and Sustainable Construction in the United Arab Emirates." International Journal of Sustainability in Higher Education, vol. 21, no. 6, 2020, pp. 1259-1275. DOI: 10.1108/IJSHE-03-2019-0076.

Song, Lan, et al. "How Much Are Global Business Sectors Contributing to Sustainable Development Goals?" Sustainable Development, vol. 30, no. 5, 2022, pp. 901-912. DOI: 10.1002/sd.2202

Sushil, and Soni, S. "Circular Economy in Construction: Innovations, Benefits, and Challenges." Journal of Cleaner Production, vol. 248, 2020, p. 119224. DOI: 10.1016/j.jclepro.2019.119224.

"Sustainable Development Goals." *United Nations*, [Accessed July 19 2024], www.un.org/sustainabledevelopment/sustainable-development-goals/. Accessed 10 Aug. 2024.

The World Bank. "Climate Change Overview." The World Bank, 2023. Accessed July 25, 2024. https://www.worldbank.org/en/topic/climatechange/overview

Thormark, C. "A Low Energy Building in a Life Cycle Perspective." Building and Environment, vol. 39, no. 3, 2004, pp. 315-320. DOI: 10.1016/j.buildenv.2003.10.002.

UN Environment Programme. "The Emissions Gap Report 2022." UN Environment Programme, 2022. Accessed July 15, 2024. Link.

UN-Habitat. "Sustainable Urban Development." UN-Habitat, 2024. Accessed July 12, 2024. https://unhabitat.org

United Nations. "Transforming Our World: The 2030 Agenda for Sustainable Development." United Nations, 2015. Accessed July 1, 2024. https://sdgs.un.org/2030agenda

Van Der Meer, A. "Sustainability in Construction: The Impact of the Construction Industry on Climate Change." Sustainability, vol. 12, no. 1, 2020, p. 300. DOI: 10.3390/su12010300.

Whelan, T. "The Future of Sustainable Architecture." Harvard Business Review, 2021. Accessed August 1, 2024. https://hbr.org/2021/03/the-future-of-sustainable-architecture

Williams, S. "Sustainable Construction: How the Industry is Adapting." Building Magazine, 2023. Accessed July 20, 2024. https://www.building.co.uk

World Green Building Council. "The Future of Sustainable Construction." World Green Building Council, 2023. Accessed July 15, 2024. https://worldgbc.org

Zain, R., et al. "The Role of Green Building in Sustainable Development: A Case Study in India." Journal of Sustainable Development, vol. 11, no. 4, 2018, pp. 1-10. DOI: 10.5539/jsd.v11n4p1.

Zawadzki, A. "Circular Economy in the Construction Sector: A Review." Resources, Conservation and Recycling, vol. 145, 2019, pp. 141-152. DOI: 10.1016/j.resconrec.2018.07.026.

Zhai, J., and Wong, S. "Environmental and Economic Benefits of Prefabricated Buildings." Journal of Cleaner Production, vol. 197, 2018, pp. 32-39. DOI: 10.1016/j.jclepro.2018.06.221.

Zhao, Y., et al. "The Role of Big Data in Sustainable Urban Development." Journal of Urban Technology, vol. 26, no. 1, 2019, pp. 1-21. DOI: 10.1080/10630732.2018.1533506.

Zhou, Y., and Wu, J. "Integrating Sustainability into Building Design." Building Research & Information, vol. 50, no. 4, 2022, pp. 393-404. DOI: 10.1080/09613218.2022.2066148.