



# Consumer Adoption Behaviour of Smart, Green, and Sustainable Building Materials for Future Cities and Environment: Extension of UTAUT 2 Model

TECHNICAL ARTICLE

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## ABSTRACT

This study explores various factors that influence the consumer's intention to adopt smart, green, and sustainable building materials in Bangalore city, Karnataka, India. The purpose of this study is to evaluate how consumers' actual adoption behaviour of smart, green, and sustainable building materials is influenced by their behavioural intentions. A standardized questionnaire was utilized to collect data from 382 homebuilders in Bangalore as part of a descriptive research study. A simple random sampling technique was used along with Structural equation modelling (SEM) was employed to test hypotheses framed. Findings indicate that availability and accessibility, awareness, epistemic values, and technology adoption propensity all positively affect subjective norms. Subjective norms positively impact behavioural intention and adoption behaviour. However, challenges in adoption influenced subjective norms negatively, thus hindering consumer adoption. Awareness had the greatest influence on subjective norms, emphasizing the need for increasing consumer awareness. Subjective norms successfully mediated the relationship between independent factors impacting behavioural intention and adoption behaviour. Significant indirect effects of awareness via subjective norms on Behavioural intention were observed. This study highlights the need of increasing social awareness and cultivating a positive view of social expectations in order to promote the widespread use of smart, green, and sustainable building materials, which will eventually result in long-term sustainable cities and surroundings.

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## KEYWORDS:

UTAUT; subjective norm; adoption Behaviour; smart building material; future cities and environment

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## INTRODUCTION

“The more clearly we can focus our attention on the wonders and realities of the universe about us, the less taste we shall have for destruction” (Carson, 1962).

In light of the urgent need to find a sustainable way forward in urban development, this research examines on consumer adoption Behaviour in embracing emerging smart, green, and sustainable materials. It encourages the principles of smart, energy-efficient, resource-efficient, and environmentally friendly building materials, aiming to provide guidance for future cities and sustainable environments. The motivation behind this study is to assess the nature of influence that Behavioural intention has on consumers' actual adoption Behaviour regarding smart, green, and sustainable building materials acceptance. Additionally, it aims to understand the mediating effects of subjective norms and Behavioural intentions on consumers' adoption Behaviour of smart, green, and sustainable building materials SGSBM, and also to identify the influence of various factors on subjective norms. Bangalore, an Indian location, serves as the focal point for all these objectives. Since Bangalore's middle class has expanded, the city's focus on eco-friendly practices has increased (Anantharaman, 2016). Consumers' inclination towards sustainability is vital to achieving extensive adoption of SGSBM. The role of these building materials has grown in today's world as a result of the intense global concern for the preservation of the environment. However, the various consumer factors pose challenges for their widespread adoption. Scientific research has advanced environmentally conscious construction materials. However, consumer Behaviour, environmental, economic and marketing factors that affect acceptance and adoption of these products must be acknowledged and addressed for their adoption. The building sector has been known to exploit natural resources with little regard for environmental hazards to extract building materials. Cement and concrete usage and production are major contributors to environmental damage in the construction sector, including greenhouse gas emissions and water depletion (Habert et al., 2020). Furthermore, projections indicate that cement production could increase by as much as 23% by 2050 due to population growth (Chelsea Harvey, 2018). Accordingly, pollution remains a significant concern, particularly in Bangalore, where the construction sector has a disproportionately large environmental impact. The escalating concerns about global warming and climate change have led to a heightened awareness of the necessity to embrace sustainable techniques in the building and construction sectors. Smart, sustainable, and green building materials play a crucial role in managing construction pollution due to their innovative and eco-friendly nature. One such smart, green and sustainable building material is self-healing concrete. “Self-healing concrete” is a building material with the ability to

cure cracks on its own. Self-healing concrete reduces maintenance costs, extends the life of the structure, and helps the environment and customers by reducing repair costs. The global self-healing concrete market is expected to reach \$1,375,088 thousand by 2025, up from \$216,720 thousand in 2017, at a CAGR of 26.4% (Vivek B, 2019). As per the 2030 agenda objectives put forward by the United Nations' Sustainable Development, it is imperative to enhance the development of cities that are both sustainable and resilient (*Transforming our world: the 2030 Agenda for Sustainable Development | Department of Economic and Social Affairs, no date*). Thus, the unified theory of acceptance and use theory UTAUT2 framework, which has been widely used in research studies to investigate technology adoption Behaviour can serve as a strong foundation to understand individual consumption Behaviour of SGSBM. In these conditions, the purpose of this study is to expand the boundaries of the UTAUT2 framework to examine consumer adoption Behaviour of SGSBM in Karnataka state, India. This article focuses on consumer Behavioural factors affecting the Behavioural intention and consumer adoption Behaviour of SGSBM in the construction sector of Bangalore, India, as, the growing middle class population in Bangalore leads to a shift towards sustainable lifestyle and a sustainable and smart future cities.

## LITERATURE REVIEW AND BACKGROUND

Rising environmental awareness, together with a growing global urban population, has led to a growing emphasis on sustainable urban development, which requires the use of smart, green and sustainable construction materials to offset environmental deterioration and ensure urban sustainability over the longer term, as cities constantly expand. The study categorizes select materials as smart, green and sustainable building materials. Although awareness of smart, green, and sustainable construction materials has been gradually increasing in Bangalore in recent years, there is a need to examine consumers' intention in embracing them. Approximately 77.4% of professionals and specialists in the built environment sector, such as those in Kenya, are unaware of the criteria for selecting sustainable building materials, leading to their limited adoption (Sangori et al., 2020). This is very similar to the scenario in Bangalore, a developing Indian city. Emerging countries encounter challenges like new contemporary building material adoption due to low technology adoption propensity. These kinds of cutting-edge construction materials are more likely to be adopted by people who feel comfortable picking up new technology (Ratchford and Barnhart, 2012). In addition to the technical considerations surrounding smart, green, and sustainable construction materials, there are a

host of consumer Behavioural, and marketing-related factors that aid in widespread adoption. About 71% of Indians have moderate to low knowledge of sustainable construction according to the survey (Shaker et al., 2022). The solution to this is raising awareness and establishing the best laws and policies for promoting the use of sustainable and green building materials through research. Subjective norm exhibit a mediating effect in influencing Behaviour (Martínez-Climent, 2020). In addition, research studies have not included the full spectrum of consumer Behavioural aspects that impact the adoption Behaviour of SGSBM, such as Behavioural intention (BI), subjective norms (SN), Challenges in adoption (CIA), awareness (AW), availability and accessibility (AA) and technology adoption propensity (TAP). Figures 1 and 2 show the actual photos captured by the authors at Medley and Malhar green building construction projects by Good Earth Construction Company, located in Bangalore city, Karnataka state, India. Good Earth Construction Company specializes in building houses made of smart, green, and sustainable building materials, such as stabilized mud bricks, with the goal of building sustainable communities and future cities that are truly sustainable for generations to come. These are the types of eco-conscious initiatives by construction companies setting the path to a sustainable future cities and sustainable environment.

### SMART, GREEN, AND SUSTAINABLE CONSTRUCTION MATERIALS CONSIDERED IN THIS STUDY

Stabilized mud blocks (SMB): The qualities and durability of stabilized soil blocks (SSBs), a low-embodied carbon, energy-efficient substitute for structural masonry, are

determined by the ideal soil grade, block density, and stabilizers vvv(Venkatarama Reddy, 2012).

Self-Healing Concrete: Self-healing microbiological bio-concrete repaired cracks efficiently, and organisms created minerals through bio-mineralization (Tebo et al., 2005). Self-healing concrete reduced pollution and lasted longer in harsh environments. Thus it saves on repair cost and results in greater saving for consumers.

Bamboo: Bamboo is the most environmentally friendly building material for affordable homes (Kumar and Vasugi, 2020). In India, South America, Africa, and some parts of Asia, bamboo became the most unusual construction material due to its elasticity, wooden-like strength, elegance, and lightness (Rathour et al., 2022).

Rammed Earth: Rammed earth building had a high compressive strength and was more energy efficient than brick and cement, although it was hardly controlled with regard to standards (Canivell et al., 2020; Khadka, 2020; Ávila, Puertas and Gallego, 2022).

### THEORETICAL ADAPTATION OF FACTORS INFLUENCING ADOPTION BEHAVIOUR OF SGSBM

This study employs a combination of diverse and robust theories, well-established for understanding the adoption of new technology. Specifically, it integrates the Theory of Planned Behaviour (with adapted variables: TAP, SN, BI), Diffusion of Innovation (with adapted variables: AW, AA), Technology Adoption Model (with adapted variables: CIA, AB), and Elaboration Likelihood Model (with adapted variables: EV) in a holistic manner. The aim is to develop an adapted conceptual model, as demonstrated in Figure 3.



**Figure 1** Row houses construction using stabilized mud bricks, Solar PV's and earthen materials at goodearth medley project, Bangalore, India.

Source: Authors captured real photographic image of the building with permission.

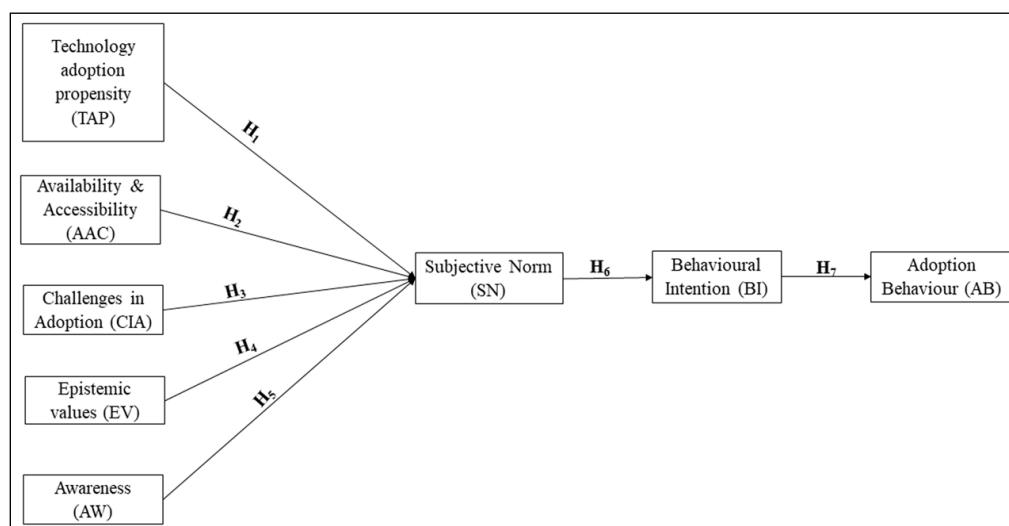
Courtesy: Good earth medley project Bangalore, India.



**Figure 2** Villa construction using combination of stabilized mud bricks and earthen materials at goodearth malhar project.

Source: Authors captured real photographic image of the building with permission.

Courtesy: Goodearth medley projects, Bangalore, India.



**Figure 3** Conceptual model of SGSBM adoption.

Source: Authors own creation.

As Table 1 presents, the detailed connections between factors influencing subjective norms (SN) and how those relationships affect Behavioural intention (BI), which in turn shapes how smart and sustainable materials are used in the construction sector.

### DEVELOPING A THEORETICAL FRAMEWORK, ADAPTED QUESTIONNAIRES AND HYPOTHESES

The aim of this research was to examine the variables that affect customers' adoption of SGSBM in the context of construction or renovation projects. Variables included in the Figure 3's adaptation model are main constructs which are based on 5-point Likert scale based questionnaires with statements ranging from (not at all aware to very much aware and Strongly Disagree to strongly agree) to measure the latent constructs and their sub variables or items:

In the conceptual model as depicted in Figure 3, the authors have significantly adapted variables of similar nature that could potentially affect subjective norm and Behavioural intention of consumers and in turn lead to adoption Behaviour and finally actual adoption of SGSBM. The latent constructs and their corresponding items, adapted from various literatures, are presented in Table 2. This table details the specific questionnaires (adapted Items/statements) used in the study, providing a comprehensive overview of the measurement instruments employed for each construct.

**Research gap:** The authors of the paper notes that while the usage of sustainable building materials is increasing, there has been relatively little research on how Bangalore, India's consumers react to smart, green, and sustainable building materials. Since, the existing body of research has primarily focused on developed



| FACTORS                                                                             | SUMMARY DESCRIPTION                                                                                                                                                                                                                                                                                                                  | AUTHORS                                              |
|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|
| Technology Adoption Propensity (TAP)                                                | A measure of people's propensity to accept technology has been created and validated known as Technology Adoption Propensity (TAP) index. This indicator has been used to evaluate the willingness of different groups to accept technological advancements and business students in Hungary.                                        | (Ratchford and Barnhart, 2012; Berenyi et al., 2021) |
| Awareness (AW)                                                                      | Environmental education may be seen as a facilitator for the uptake of green products. Factors affecting adoption or factors affecting adoption Behaviour are Lack of awareness, government incentives, and technical skills necessitates stakeholder engagement and communication to achieve sustainable development in the nation. | (Saleh and Al-Swidi, 2019; Liu et al., 2022)         |
| Availability and accessibility of smart and sustainable construction materials (AA) | Availability, affordability and accessibility played the main role as a driver of sustainable material adoption and that lead to green consumption.                                                                                                                                                                                  | (John et al., 2021)                                  |
| Subjective Norm (SN)                                                                | Subjective norms have been shown to have a mediating effect on user intention, suggesting that these norms have a substantial impact on intentions.                                                                                                                                                                                  | (Rochelle and Ng, 2022)                              |
| Challenges in Adoption (CIA)                                                        | Most important challenges in adoption are the high price, insufficient incentives, the lack of awareness among stakeholders, and the absence of laws and regulations.                                                                                                                                                                | (Kuppusamy et al., 2019)                             |
| Epistemic Value (EV)                                                                | The importance of knowledge and understanding in making decisions is the value of epistemic Value. Both the desire to adopt and the actual adoption Behaviour was influenced from epistemic value.                                                                                                                                   | (Đai et al., 2021)                                   |
| Behavioural Intention (BI)                                                          | Positive intentions to use sustainable construction materials and methods are more likely to arise in people who have a strong feeling of environmental responsibility.                                                                                                                                                              | (Devine and McCollum, 2019; Omopariola et al., 2022) |
| Adoption Behaviour (AB)                                                             | Consumers that have a strong Behavioural intention toward green technology are more likely to be influenced by peer and community expectations as well as social pressure, which eventually results in greater adoption rates.                                                                                                       | (Chen and Tung, 2014; Shahzad et al., 2022)          |

**Table 1** Consumer Behavioural factors used in the conceptual path model with literature summary.

| ADAPTED REFERENCES                                                                            | LATENT CONSTRUCT                                                    | ITEMS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------------------------------------------------------------------------|---------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (Ratchford and Barnhart, 2012)                                                                | Technology Adoption Propensity (TAP)                                | <p>(i) I find it easier than others to integrate and utilize smart, green, and sustainable building materials in construction projects?</p> <p>(ii) Adopting these innovative SGSBM gives me more control over the environmental impact of my construction projects?</p> <p>(iii) Choosing SGSBM helps me make necessary changes in my construction practices to align with eco-friendly standards?</p> <p>(iv) SGSBM allow me to more easily incorporate sustainable features into my construction projects at times when I want to implement them?</p> <p>(v) Utilizing new smart, green, and sustainable building materials makes my construction practices more eco-friendly and resource-efficient?</p> |
| (Zainul Abidin Nazirah, 2010)                                                                 | Awareness on "smart, green and sustainable building materials" (AW) | <p>(i) Awareness on Hazardous effects of traditional construction materials.</p> <p>(ii) Awareness on SGSBM.</p> <p>(iii) Awareness on Environmental benefits of using these contemporary building materials.</p> <p>(iv) Awareness on certifications of these innovative building materials.</p> <p>(v) Awareness on these construction materials are valuable as it creates environmentally friendly process.</p>                                                                                                                                                                                                                                                                                          |
| (Darko et al., 2018; Tran and Huang, 2021)                                                    | Challenges in Adoption (CIA)                                        | <p>(i) It is difficult to understand how to implement SGSBM into the building.</p> <p>(ii) SGSBM are not properly marketed and promoted.</p> <p>(iii) Smart, green and sustainable building materials are expensive.</p> <p>(iv) There is lack of confidence among stakeholders in the performance of SGSBM.</p> <p>(v) The benefits of these building materials are not educated properly.</p> <p>(vi) Lack of insurance for these building materials and its constructed projects.</p>                                                                                                                                                                                                                     |
| (Khan and Mohsin, 2017; Ali et al., 2019; Muhamed et al., 2019; Kasilingam and Krishna, 2022) | Epistemic values (EV)                                               | <p>(i) I prefer checking eco-labels and certifications for SGSBM before making a purchase?</p> <p>(ii) I would prefer to gather complete information on SGSBM before deciding to adopt them in my construction?</p> <p>(iii) I want to have a deeper understanding into the features, manufacturing processes, and environmental impacts of SGSBM before considering their adoption?</p> <p>(iv) I like to search for what is new and different in the category of SGSBM?</p> <p>(v) I like to know origin of SGSBM?</p> <p>(vi) I like to adopt SGSBM so as to test these contemporary building materials</p>                                                                                               |

(Contd.)

| ADAPTED REFERENCES                                                                               | LATENT CONSTRUCT                     | ITEMS                                                                                                                                                                                                                                                                                                   |
|--------------------------------------------------------------------------------------------------|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (De Carvalho, De Fátima Salgueiro and Rita, 2016)                                                | Availability and Accessibility (AAC) | <p>(i) SGSBM were available and accessible closer to location of construction/building.</p> <p>(ii) SGSBM were available and accessible in local market</p> <p>(iii) SGSBM offered more trial opportunities</p>                                                                                         |
| (Belanche, Guinaliu and Albás, 2022)                                                             | Subjective Norm (SN)                 | <p>(i) People whose opinions I trust believe that I should opt for SGSBM?</p> <p>(ii) Individuals important to me advocate for the adoption of SGSBM in construction projects?</p> <p>(iii) Those who have influence over my choices and actions express a preference for the utilization of SGSBM?</p> |
| (Han, Hsu and Lee, 2009; Ko, Hwang and Kim, 2013; Yadav, Kumar Dokania and Swaroop Pathak, 2016) | Behavioural Intention (BI)           | <p>(i) I am determined to pay more for SGSBM.</p> <p>(ii) I would prefer to reside in a home constructed with SGSBM rather than a conventional one.</p> <p>(iii) I am open to recommending SGSBM to my friends and relatives for their future residences.</p>                                           |
| (Davis, 1989; Dilotsotlhe and Duh, 2021)                                                         | Adoption Behaviour (AB)              | <p>(i) I make special effort to use of SGSBM building materials?</p> <p>(ii) Whenever I buy/adapt SGSBM I check whether they are less harmful to the environment?</p> <p>(iii) Adopting SGSBM materials would result in overall productivity enhancement in my life?</p>                                |

**Table 2** Latent constructs and its corresponding items (questionnaires) used in the study an adaptation of questionnaires from different literatures.

economies, there is minimal emphasis on the unique challenges and consumer dynamics prevalent in emerging markets like India. Furthermore, consumer psychological Behaviour, managerial issues, and marketing challenges hinder adoption. Previous research has concentrated on technological, engineering, and cost-related issues but lacked a strong focus on core consumer psychological and Behavioural aspects to encourage adoption. The broader consumer Behavioural aspects, such as subjective norms, technology adoption propensity, availability and accessibility, epistemic values, Challenges in adoption, and their effects on Behaviour intention and consumers actual adoption Behaviour, with regards to SGSBM adoption have been studied. This study explores the mediating influence of subjective norms and Behavioural intention on adoption Behaviour, considering various independent consumer factors such as TAP, AA, CIA, AW, and EV. This study fills in these knowledge gaps by providing information that will help formulate strategies for easier adoption. These initiatives may raise awareness, reduce adoption barriers, and promote smart, green, and sustainable building materials in Bangalore's construction industry.

### HYPOTHESIS FRAMING

H1: Technology adoption propensity of SGSBM positively influences subjective norms of consumers.

H2: Availability & Accessibility of SGSBM positively influences subjective norms of consumers.

H3: Challenges in adoption negatively influences consumer's subjective norms regarding the adoption of SGSBM.

H4: Epistemic values positively influence consumers' subjective norms regarding the adoption of SGSBM.

H5: Awareness of SGSBM positively influences consumer's subjective norm.

H6: Subjective norm positively influences the Behavioural intention of consumers regarding the adoption of SGSBM.

H7: Behavioural intention of consumers positively influences consumers' adoption Behaviour regarding the adoption of SGSBM.

## RESEARCH METHODOLOGY

### SAMPLE FRAME

This study used a descriptive research methodology to examine consumer Behaviour and trends surrounding the use of SGSBM in Bangalore, India. The study's target population comprises individuals who have recently built new residential properties or are involved in renovation projects in Bangalore, India, and have actively participated in the decision-making process regarding the procurement of construction materials. The sampling frame for this study was derived from select builders and real estate agent companies in Bangalore. A total of 13,708 consumers, who were involved in construction and renovation projects during 2022 and 2023, constituted the initial data pool. The authors employed a random number generation method to select the sample respondents for the study. Bangalore's multicultural and cosmopolitan environment, which attracts individuals from diverse backgrounds, renders it an ideal location for conducting research on consumer Behaviour. Bangalore city is ideal for generalizing consumer studies that can be applied universally due to its cultural diversity, which comprises a miniature of the global population, and the significant increase in multinational and conglomerate corporations. Since January 2023, the new houses constructed in 2022 in Bangalore have been 49,196 units (The Economic Times, 2023).

## SAMPLING TECHNIQUE

To select participants for data collection, this research employed a simple random sampling technique, ensuring a fair representation of individuals who recently constructed new residential homes in Bangalore, India, and actively participated in decisions regarding the purchase of building materials. The choice of simple random sampling was motivated by its ability to minimize selection bias by providing every member of the target population an equal chance of inclusion. This approach was deemed appropriate for generalizing results to the broader population of interest. Bangalore was recognized for its heterogeneous population.

## SAMPLE SIZE CALCULATOR

To determine the required sample size, the authors used the following Cochran formula for simple random sampling:

$$n = \frac{(Z^2 * p * (1-p))}{E^2} \quad (1)$$

Where:

n = required sample size

Z = Z-score (standardized value) that corresponds to the required degree of confidence (taking a 95% confidence level into consideration, Z = 1.96).

p = calculated the proportion of the population that demonstrates the desired trait (with a cautious estimate of 0.50 for the range of variability)

E = margin of error (considering a 5% margin of error, E = 0.05)

By inputting the values in to the simple random calculation formula one will get:

$$n = ((1.962 * 0.50 * (1-0.50))) / (0.052)$$

$$n = (3.8416 * 0.25) / 0.0025$$

$$n = 0.9604 / 0.0025$$

$$n \approx 384.16$$

Upon rounding to the nearest ~384.16, the final sample size is 384.

## SAMPLE UNIT, DATA COLLECTION AND TOOLS USED

Selections of recently constructed residential areas were made for the sample units. From these units, 384 respondents were chosen randomly using a random number generator. To mitigate biases such as non-response and location bias, every part of Bangalore was thoroughly covered. The representativeness of the sample was confirmed through the comparison of census data with demographic features. The use of a simple random sample approach aimed to enhance the validity and generalizability of research results on factors

influencing Bangalore consumers' adoption Behaviour of SGSBM. IBM SPSS AMOS 22 was used for analyzing the data. Reaching out to the selected respondents involved both offline and online methods in the data gathering process. Offline surveys were conducted face-to-face, while online questionnaires were distributed via email and social media platforms. To ensure an adequate number of responses, the data collection period was extended by sixteen weeks, from December 1st, 2023, to March 23rd, 2024. However, after rigorous data cleaning procedures, only 382 responses were considered for the final sample size.

## QUESTIONNAIRE DESIGN

This study's data were gathered using a structured questionnaires that covers questions on demographics, knowledge of smart, green and sustainable building materials, use patterns, technology adoption propensity, motivating factors, and epistemic principles associated with using such materials. On a 5-point Likert scale, respondents were asked to score the traits (1 = strongly disagree to 5 = strongly agree). Since the all the questionnaire in the dataset are adapted from previously published and validated research papers there is no need to perform any exploratory factor analysis to reduce dimension.

## ETHICAL CONSIDERATIONS

For primary data, ethical considerations included obtaining informed consent from participants, ensuring data confidentiality, anonymity, and voluntary participation in the study. Ethical concerns for secondary data encompassed proper citation and adherence to copyright regulations, acknowledging the sources used in the research.

## RESULTS AND FINDINGS

### DEMOGRAPHIC DETAILS

The demographic analysis of the population in [table 3](#) under investigation revealed important trends. According to the gender distribution, there were more males (61.0%) than women (39.0%). In terms of age distribution, those under 30 made up the largest share of the population—45.0% of all respondents. Those in the age range of 31 to 40, who made up 29.6% of the population, came next. When it came to education, the majority of people had either a Master's or Post Graduate degree (68.6%), a Ph.D. degree (10.7%) and a High School education (5.8%). Regarding the economy, a lower percentage of participants fell into higher income groups, with the bulk of respondents (77.2%) reporting annual incomes below 9,00,000.

| GENDER                 |           |            |
|------------------------|-----------|------------|
| PARAMETER              | FREQUENCY | PERCENTAGE |
| Male                   | 233       | 61.0%      |
| Female                 | 149       | 39.0%      |
| Total                  | 382       | 100%       |
| AGE                    |           |            |
| PARAMETER              | FREQUENCY | PERCENTAGE |
| <30                    | 172       | 45.0%      |
| 31–40                  | 113       | 29.6%      |
| 41–50                  | 61        | 16.0%      |
| 51–60                  | 18        | 4.7%       |
| >60                    | 18        | 4.7%       |
| Total                  | 382       | 100%       |
| EDUCATION              |           |            |
| PARAMETER              | FREQUENCY | PERCENTAGE |
| High School            | 22        | 5.8%       |
| Diploma                | 16        | 4.2%       |
| Under Graduate         | 41        | 10.7%      |
| Master's/Post Graduate | 262       | 68.6%      |
| Ph.D.                  | 41        | 10.7%      |
| Total                  | 382       | 100%       |
| ANNUAL INCOME          |           |            |
| PARAMETER              | FREQUENCY | PERCENTAGE |
| Below 9,00,000         | 295       | 77.2%      |
| 9,00,001–15,00,000     | 32        | 8.4%       |
| 15,00,001–20,00,000    | 18        | 4.7%       |
| 20,00,001–25,00,000    | 23        | 6.0%       |
| >25,00,000             | 14        | 3.7%       |
| Total                  | 382       | 100%       |

**Table 3** Frequency and percentage representation of demographic variables.

## MEASUREMENT MODEL AND PATH MODEL EVALUATION

A comprehensive assessment of the measurement model was carried out in order to ascertain the validity and reliability of the latent constructs used in the study. The fig 4 is visual representation of measurement model also known as confirmatory factor analysis (CFA).

The CFA in [Figure 4](#) tries to measure the proposed conceptual model through various measures like validity of the construct and reliability of the construct.

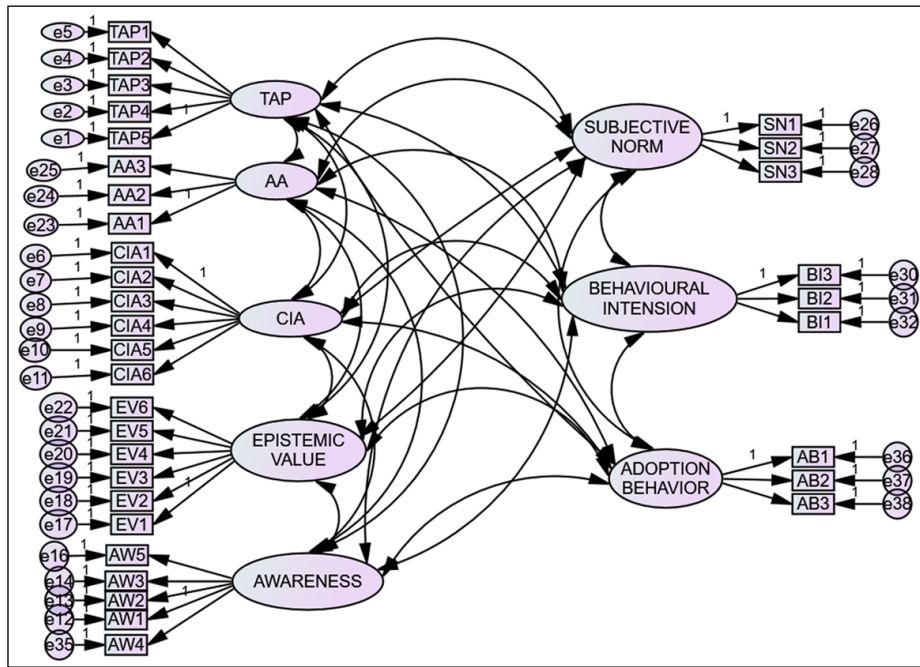
The results of the assessment are shown in [Table 4](#). The strength of the correlation between each observable variable (indicator) and its associated latent construct

is represented by factor loadings. All factor loadings in this study are above the recommended threshold of 0.7, suggesting adequate convergent validity (CV) ([Joseph F. Hair Jr et al., 2009](#)). Higher factor loadings indicate stronger relationships. Composite Reliability (CR), this measure evaluates how well the items assessing each latent concept are internally consistent. All construct has CR values more than 0.7, a sign of adequate reliability. The measure of the amount of variation obtained from the construct in relation to measurement error is called Average variance Extracted (AVE). A construct is deemed to have sufficient CV if its AVE value is more than 0.5. The findings of this research suggest that Awareness (AW) and Epistemic Value (EV) account for a significant portion of the variation in their respective domains, as shown by their greatest AVE values. The Maximum Shared variation (MSV) measure evaluates how much variation latent constructs share with other latent constructs. Discriminant validity is suggested by values less than 0.5, in this study it providing evidence of discriminant validity. In this study corresponding CR values for all constructs, further supporting the reliability of the measurement model. [Table 4](#) displays the square roots of the AVE for every latent construct. These numbers show how much of the variation in each construct's indicators can be attributed to the construct itself in relation to measurement error. Greater values indicate that the construct has captured a larger amount of variation. For instance, the square root of AVE for the construct "TAP" is 0.835, meaning that the construct itself accounts for around 83.5% of the variation in the TAP indicators. Likewise, 'CIA' has a square root of AVE of 0.777, meaning that the construct itself accounts for around 77.7% of the variation in the CIA indicators. These values enhance the evaluation of discriminant validity by offering significant insights into the distinct variation recorded by each latent concept in our model.

To evaluate discriminant validity, the square roots of the AVE for every latent construct are compared to these correlation coefficients, as shown in [Table 5](#). There is enough distinction between the conceptions if the correlation between two of them is less than the square roots of each of their unique AVEs. For example, the evaluation of the discriminant validity of the correlation coefficient of 0.424 between Technology Adoption Propensity (TAP) and challenges in adoption (CIA) by comparing it to the square roots of the AVEs for TAP (0.835) and CIA (0.777). A value of 0.424 indicates sufficient uniqueness between the TAP and CIA conceptions if it is less than both 0.835 and 0.777.

The Absolute Fit Measures which is the chi-square degrees of freedom ratio ( $\chi^2/\text{df}$ ) is a normally used index of absolute fit. In [Table 6](#), the ratio of (CMIN/df) is 2.068, which exceeds the recommended threshold. The Root Mean Square Error of Approximation (RMSEA) and Root Mean Residual (RMR) values are each beneath 0.08,





**Figure 4** Confirmatory factor analysis (CFA) depiction using IBM analysis of movement structure (AMOS) tool.

Source: Authors own creation.

| LATENT CONSTRUCT                            | FACTOR LOADINGS | CR    | AVE   | MSV   | NO OF ITEMS | SQRT (AVE) | CRONBACH'S ALPHA FOR EACH LATENT CONSTRUCT |
|---------------------------------------------|-----------------|-------|-------|-------|-------------|------------|--------------------------------------------|
| <b>Technology adoption propensity (TAP)</b> | –               | 0.920 | 0.697 | 0.275 | 5           | 0.835      | 0.917                                      |
| TAP 1                                       | 0.764           |       |       |       |             |            |                                            |
| TAP 2                                       | 0.879           |       |       |       |             |            |                                            |
| TAP 3                                       | 0.859           |       |       |       |             |            |                                            |
| TAP 4                                       | 0.886           |       |       |       |             |            |                                            |
| TAP 5                                       | 0.779           |       |       |       |             |            |                                            |
| <b>Challenges in adoption (CIA)</b>         | –               | 0.900 | 0.603 | 0.497 | 6           | 0.777      | 0.894                                      |
| CIA1                                        | 0.714           |       |       |       |             |            |                                            |
| CIA2                                        | 0.848           |       |       |       |             |            |                                            |
| CIA3                                        | 0.890           |       |       |       |             |            |                                            |
| CIA4                                        | 0.762           |       |       |       |             |            |                                            |
| CIA5                                        | 0.807           |       |       |       |             |            |                                            |
| CIA6                                        | 0.710           |       |       |       |             |            |                                            |
| <b>Awareness (AW)</b>                       | –               | 0.934 | 0.740 | 0.164 | 5           | 0.860      | 0.932                                      |
| AW1                                         | 0.808           |       |       |       |             |            |                                            |
| AW2                                         | 0.851           |       |       |       |             |            |                                            |
| AW3                                         | 0.904           |       |       |       |             |            |                                            |
| AW4                                         | 0.873           |       |       |       |             |            |                                            |
| AW5                                         | 0.863           |       |       |       |             |            |                                            |
| <b>Epistemic value (EV)</b>                 | –               | 0.944 | 0.737 | 0.333 | 6           | 0.858      | 0.944                                      |
| EV1                                         | 0.815           |       |       |       |             |            |                                            |
| EV2                                         | 0.888           |       |       |       |             |            |                                            |
| EV3                                         | 0.917           |       |       |       |             |            |                                            |

(Contd.)

| LATENT CONSTRUCT                    | FACTOR LOADINGS | CR    | AVE   | MSV   | NO OF ITEMS | SQRT (AVE) | CRONBACH'S ALPHA FOR EACH LATENT CONSTRUCT |
|-------------------------------------|-----------------|-------|-------|-------|-------------|------------|--------------------------------------------|
| EV4                                 | 0.930           |       |       |       |             |            |                                            |
| EV5                                 | 0.837           |       |       |       |             |            |                                            |
| EV6                                 | 0.751           |       |       |       |             |            |                                            |
| Availability and Accessibility (AA) | –               | 0.821 | 0.605 | 0.497 | 3           | 0.778      | 0.817                                      |
| AA1                                 | 0.824           |       |       |       |             |            |                                            |
| AA2                                 | 0.749           |       |       |       |             |            |                                            |
| AA3                                 | 0.759           |       |       |       |             |            |                                            |
| Altruistic Motive (AM)              | –               | 0.777 | 0.538 | 0.164 | 3           | 0.733      | 0.776                                      |
| AM1                                 | 0.755           |       |       |       |             |            |                                            |
| AM2                                 | 0.768           |       |       |       |             |            |                                            |
| AM3                                 | 0.720           |       |       |       |             |            |                                            |
| Behavioural Intension (BI)          | –               | 0.836 | 0.632 | 0.255 | 5           | 0.795      | 0.832                                      |
| BI1                                 | 0.740           |       |       |       |             |            |                                            |
| BI2                                 | 0.874           |       |       |       |             |            |                                            |
| BI3                                 | 0.793           |       |       |       |             |            |                                            |
| Adoption Behaviour (AB)             | –               | 0.856 | 0.672 | 0.030 | 3           | 0.820      | 0.845                                      |
| AB1                                 | 0.891           |       |       |       |             |            |                                            |
| AB2                                 | 0.922           |       |       |       |             |            |                                            |
| AB3                                 | 0.609           |       |       |       |             |            |                                            |

**Table 4** Validity and reliability of measurement model for confirmatory factor analysis.

|            | TAP          | CIA          | AW           | EV           | AA           | AM           | BI           | AB           |
|------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| <b>TAP</b> | <b>0.835</b> |              |              |              |              |              |              |              |
| <b>CIA</b> | 0.424***     | <b>0.777</b> |              |              |              |              |              |              |
| <b>AW</b>  | 0.239***     | 0.237***     | <b>0.860</b> |              |              |              |              |              |
| <b>EV</b>  | 0.494***     | 0.577***     | 0.234***     | <b>0.858</b> |              |              |              |              |
| <b>AA</b>  | 0.524***     | 0.705***     | 0.217***     | 0.567***     | <b>0.778</b> |              |              |              |
| <b>AM</b>  | 0.312***     | 0.151*       | 0.405***     | 0.280***     | 0.281***     | <b>0.733</b> |              |              |
| <b>BI</b>  | 0.505***     | 0.295***     | 0.396***     | 0.339***     | 0.386***     | 0.367***     | <b>0.795</b> |              |
| <b>AB</b>  | 0.055        | 0.075        | 0.060        | 0.006        | 0.076        | 0.088        | 0.173        | <b>0.820</b> |

**Table 5** Discriminant validity.

Note: \*\*\* Significance at 0.01 or 1%.

indicating a very good fit. The Goodness-of-Fit Index (GFI), Adjusted GFI (AGFI), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Incremental FI (IFI) are all above recommended threshold indicating goodness of fit for the proposed model. Incremental Fit Measures like the Normed Fit Index (NFI) exceeds the threshold, similarly helping the good fit of the projected path analysis model. Additionally, the Parsimony adjusted GFI (PGFI) is 0.740, which is above 0.50, indicating that the proposed model achieves a good fit. Finally, the

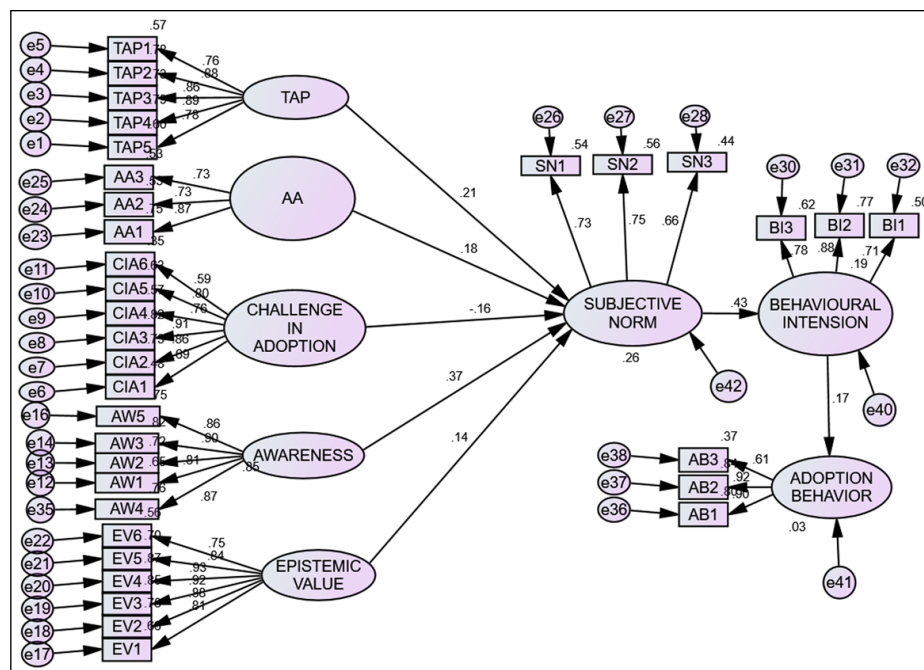
proposed structural equation model demonstrates very good fit for as per these goodness of fit indicator values obtained, as all indicator values are exceeding recommended thresholds. These findings assist the validity and reliability of the proposed model for inspecting the relationships among latent constructs in the research context.

Figure 5 shows a path diagram for SEM. The constructs, viz., technology adoption propensity, availability, and accessibility, challenges in adoption, epistemic value,

| GOODNESS-OF-FIT MEASURE | INDEX                           | BASIC LEVEL THRESHOLD | RESULTS  | MODEL FITTING JUDGMENT |
|-------------------------|---------------------------------|-----------------------|----------|------------------------|
| Absolute fit            | $\chi^2/\text{df}$ or (CMIN/df) | <3                    | 2.068*** | Good                   |
|                         | RMSEA                           | <0.08                 | 0.045    | Good                   |
|                         | RMR                             | <0.08                 | 0.027    | Good                   |
|                         | GFI                             | >0.90                 | 0.912    | Good                   |
|                         | AGFI                            | >0.85                 | 0.861    | Good                   |
| Incremental fit         | CFI                             | >0.90                 | 0.958    | Good                   |
|                         | TLI                             | >0.90                 | 0.952    | Good                   |
|                         | IFI                             | >0.90                 | 0.958    | Good                   |
|                         | NFI                             | >0.90                 | 0.908    | Good                   |
| Parsimony-adjusted      | PGFI                            | >0.50                 | 0.740    | Good                   |

**Table 6:** Models goodness of fit summary of proposed model.

Note: \*\*Significance at <0.05.



**Figure 5** Path analysis for SEM.

Source: Authors own creation.

awareness influencing subjective norm and subjective norm in-turn influencing Behavioural intention of consumers, and finally, Behavioural intention influences adoption Behaviour of consumers. All paths are significant at 5% and 1% significance level, making the model accept all alternative hypotheses framed.

In Table 7 propensity for technology adoption (TAP) to subjective norm (SN) have a considerable positive influence, as seen by the  $B = 0.195$  ( $b = 0.206$  and  $P$  value of <0.001). The findings indicating that those who are more inclined to embrace technology are also more likely to believe that “SGSBM” materials are the standard. Challenges in adoption (CIA) to Subjective norm have a considerable negative influence, as shown

by the  $B = -0.212$  ( $b = -0.159$  and  $P$  value of <0.004). Epistemic value (EV) to Subjective norm notifies that unstandardized estimate of 0.176 (standardized estimate: 0.144) suggests a significant positive influence by EV on subjective norm. The findings demonstrate that individuals who value learning about smart, eco-friendly, and sustainable construction materials more are likely to believe that there are social norms that promote their use. Awareness (AW) to Subjective norm (SN) demonstrates that unstandardized estimate of 0.347 (standardized estimate: 0.374) suggests a significant positive influence by AW on subjective norm. At the  $p < 0.001$  level, the association between Subjective Norm and Awareness is statistically significant, as shown by the critical ratio (C.R.)

| PATH                | UNSTANDARDISED ESTIMATE (B) | STANDARDISED ESTIMATE ( $\beta$ ) | S.E.  | C.R. (CRITICAL RATIO) | P-VALUE  | DECISION     |
|---------------------|-----------------------------|-----------------------------------|-------|-----------------------|----------|--------------|
| SN $\leftarrow$ TAP | 0.195                       | 0.206                             | 0.053 | 3.656                 | 0.001*** | H1 Supported |
| SN $\leftarrow$ AA  | 0.226                       | 0.180                             | 0.074 | 3.066                 | 0.002**  | H2 Supported |
| SN $\leftarrow$ CIA | -0.212                      | -0.159                            | 0.074 | -2.847                | 0.004**  | H3 Supported |
| SN $\leftarrow$ EV  | 0.176                       | 0.144                             | 0.067 | 2.640                 | 0.008**  | H4 Supported |
| SN $\leftarrow$ AW  | 0.347                       | 0.374                             | 0.055 | 6.322                 | 0.001*** | H5 Supported |
| BI $\leftarrow$ SN  | 0.425                       | 0.431                             | 0.066 | 6.482                 | 0.001*** | H6 Supported |
| AB $\leftarrow$ BI  | 0.208                       | 0.173                             | 0.070 | 2.985                 | 0.003**  | H7 Supported |

**Table 7** SEM analysis performed to show significant paths.

Note: \*\*\* Significance at 1% and \*\* Significance at 5%.

of 6.322. This indicates that people who are more aware of “SGSBM” are more likely to believe that subjective norms favor their use in construction. Availability and accessibility (AA) to subjective norm (SN) suggest that AA seems to have a somewhat favorable influence on Subjective Norm, as shown by the unstandardized estimate (B) of 0.226 and the standardized estimate ( $\beta$ ) of 0.180. The association between Subjective Norm and Availability and Accessibility is statistically significant at the  $p = 0.002$  level, as shown by the critical ratio (C.R.) of 3.066. The findings confirm that consumers are more likely to perceive subjective norms supporting the adoption of smart, green, and sustainable building materials if they believe these materials are more readily available and accessible. Subjective norm to Behavioural intention results indicate that Behavioural Intention is strongly influenced positively by subjective norm, as shown by the unstandardized estimate (B) of 0.425 and ( $\beta$ ) of 0.431. At the  $p$  less than 0.001 level, the association between subjective norm and Behavioural intention is very significant, as shown by the critical ratio (C.R.) of 6.482. This suggests that people are more likely to have more Behavioural intentions towards the adoption of smart, green, and sustainable building materials if they perceive stronger subjective norms favoring their adoption. According to the ( $\beta$ ) value of 0.173 and the (B) value of 0.208, Behavioural intention has a favorable influence on adoption Behaviour. The statistical significance of the association between Behavioural intention and adoption Behaviour is shown at the  $p = 0.003$  level by the critical ratio (C.R.) of 2.985. The results confirm that consumers are more likely to display greater adoption Behaviours when they have stronger Behavioural intentions to embrace smart, green, and sustainable building materials.

The indirect effect estimates as in Table 8 show how much the mediator variable influences the outcome variable as a result of the predictor variable. In the context of adopting smart, green, and sustainable building materials, the indirect effects of latent constructs on Behavioural intention (BI) and adoption Behaviour (AB)

are carried out using the bootstrap technique (5000 samples) with a bias-corrected confidence interval of 95% using IBM AMOS 21 software. Indirect Effect of TAP on BI and AB through SN, The calculated 95% confidence interval for the indirect impact of TAP on BI via SN is 0.083, with a range of 0.033 to 0.145. With a standardized estimate of 0.089 and statistical significance ( $p < 0.004$ ), this impact shows that SN is having moderate positive mediation influence. With a 95% confidence interval ranging from 0.028 to 0.187, the estimated indirect impact of AA on BI through SN is 0.096. With a standardized estimate of 0.077, this impact is favorable and statistically significant ( $p = 0.028$ ). With a 95% confidence interval ranging from 0.005 to 0.051, the estimated indirect influence of AA on AB via SN is 0.020. With a standardized estimate of 0.077, this impact is moderately positive and statistically significant ( $p = 0.021$ ). CIA's indirect effect on BI through SN is estimated to be -0.090, with a 95% confidence interval ranging from -0.167 to -0.027. With a standardized estimate of -0.069 and statistical significance ( $p = 0.024$ ), this impact is a moderate positive influence. CIA's indirect effect on AB through SN has been estimated to be -0.019, with a 95% confidence range that spans -0.044 to 0.005. With a standardized estimate of -0.069 and statistical significance ( $p = 0.016$ ), this impact is moderate positive influence. The indirect effect of EV on BI through SN is estimated at 0.075, with a 95% confidence interval ranging from 0.022 to 0.146. This effect is statistically significant ( $p = 0.021$ ), with a standardized estimate of 0.062, indicating a moderate positive influence. The indirect effect of EV on AB through SN is estimated at 0.016, with a 95% confidence interval ranging from 0.005 to 0.037. This effect is statistically significant ( $p = 0.014$ ), with a standardized estimate of 0.062, indicating a moderate positive influence. The estimated 95% confidence interval for the indirect effect of AW on BI via SN is 0.147, with confidence interval ranging from 0.092 to 0.214. This impact has a standardized estimate of 0.161, which indicates a substantial positive influence, and is statistically significant ( $p = 0.001$ ).



| INDIRECT PATH      | UNSTANDARDIZED ESTIMATE | LOWER BOUND | UPPER BOUND | P-VALUE  | STANDARDIZED ESTIMATE |
|--------------------|-------------------------|-------------|-------------|----------|-----------------------|
| TAP → SN → BI      | 0.083                   | 0.033       | 0.145       | 0.004**  | 0.089                 |
| TAP → SN → BI → AB | 0.017                   | 0.006       | 0.040       | 0.002**  | 0.089                 |
| AA → SN → BI       | 0.096                   | 0.028       | 0.187       | 0.028**  | 0.077                 |
| AA → SN → BI → AB  | 0.020                   | 0.005       | 0.051       | 0.021**  | 0.077                 |
| CIA → SN → BI      | -0.090                  | -0.167      | -0.027      | 0.024**  | -0.069                |
| CIA → SN → BI → AB | -0.019                  | -0.044      | -0.005      | 0.016**  | -0.069                |
| EV → SN → BI       | 0.075                   | 0.022       | 0.146       | 0.021**  | 0.062                 |
| EV → SN → BI → AB  | 0.016                   | 0.005       | 0.037       | 0.014**  | 0.062                 |
| AW → SN → BI       | 0.147                   | 0.092       | 0.214       | 0.001*** | 0.161                 |
| AW → SN → BI → AB  | 0.031                   | 0.014       | 0.060       | 0.001*** | 0.16                  |
| SN → BI → AB       | 0.088                   | 0.044       | 0.156       | 0.002**  | 0.075                 |

**Table 8** Indirect mediation effect.

Note: \*\*\* Significant at 1% and \*\* Significant at 5%.

The calculated 95% confidence interval for the indirect impact of AW on AB via SN is 0.031, with a range of 0.014 to 0.060. This impact has a standardized value of 0.161, which indicates a substantial positive influence, and is statistically significant ( $p = 0.001$ ). The indirect effect of SN on AB through BI is estimated at 0.088, with a 95% confidence interval ranging from 0.044 to 0.156. This effect is statistically significant ( $p = 0.002$ ), with a standardized estimate of 0.075, indicating a moderate positive influence.

## DISCUSSION

The findings of the research provide insightful information on the variables affecting consumer intention to use smart, green, and sustainable building materials in Bangalore, India. These studies highlighted the importance of awareness, challenges in adoption, availability, and accessibility in promoting smart, green and sustainable building material. The findings are consistent with previous research, which found that awareness is one of the main factors influencing the desire to embrace environmentally friendly technology adoption (Fatima et al., 2022). This research, however, adds to the body of literature by investigating the impact of other variables on subjective norms and, in turn, subjective norms influence on Behavioural intents and adoption Behaviour. These variables include epistemic values, technology adoption propensity, and subjective norms. Consistent with the findings of Alsaati, El-Nakla and El-Nakla (2020); Antoniou et al., (2022), awareness emerged as a critical factor positively influencing subjective norms and, indirectly, Behavioural intentions and adoption Behaviour. This

highlights the importance of educational initiatives and awareness campaigns to promote the widespread adoption of SGSBM in Bangalore and beyond. The results indicate that subjective norm significantly influenced Behavioural intention toward adopting smart, green, and sustainable building materials. This finding aligns with the Theory of Planned Behaviour Ajzen (1991) and prior research highlighting the importance of subjective norms in sustainable technology adoption (Kulviwat et al., 2007) (Ozaki, 2011). As subjective norms evolve to favor eco-friendly practices, individuals are more inclined to adopt sustainable construction materials. Notably, awareness exhibited the strongest positive influence on subjective norm, underscoring the pivotal role of consumer awareness. When individuals are well-informed about the benefits and applications of smart, green building materials, they are more likely to perceive societal expectations supporting their adoption (Toan, 2021). Campaigns aimed at raising awareness could effectively shape positive subjective norms. Epistemic value, or the desire to learn about smart, green, and sustainable building materials which are innovative by nature, also positively influenced subjective norm. Promotional efforts highlighting the learning opportunities associated with these materials could resonate with such individuals. The negative influence of challenges in adoption (CIA) on subjective norm suggests that the practical advantages of smart, green, and sustainable building materials is negatively perceived which ultimately hinders adoption. Technology adoption propensity and availability and accessibility also positively influenced subjective norm, consistent with previous research on technology adoption (Kulviwat et al., 2007)(Claudy, Peterson and O'Driscoll, 2013). Individuals inclined

toward new technologies and those who perceive SGSBM building materials as readily available may be more attuned to social cues supporting their use. The findings further revealed that Behavioural intention positively influenced adoption Behaviour, aligning with the Theory of Planned Behaviour (Ajzen, 1991). As consumers develop stronger intentions, they are more likely to translate those intentions into actual adoption of smart, green building materials.

## CONCLUSIONS

This study provides valuable insights into the factors influencing consumer intention and adoption behavior towards smart, green, and sustainable building materials in Bangalore, India. The findings highlight the crucial factors such as awareness, challenges in adoption, availability and accessibility, epistemic values, and technology adoption propensity in influencing subjective norms, which, in turn, positively influence Behavioural intention and finally Behavioural intention influencing consumer adoption Behaviour of SGSBM. The results support the importance of raising consumer awareness through educational campaigns and promotional efforts, as awareness emerged as the strongest driver of consumer intention formation through subjective norms. Increasing awareness and understanding about the benefits and applications of SGSBM can influence positive social perceptions, encouraging their widespread adoption. The research findings also indicate that individuals with a propensity towards new technologies perceive SGSBM as readily available are more likely to perceive subjective norms favorably, suggesting the need for improving accessibility and addressing challenges to adoption. This research has major implications for industry stakeholders, legislators, and marketers encouraging smart, green, and sustainable building materials adoption. Educational campaigns to inform consumers about SGSBM benefits, practical advantages like energy efficiency and lower maintenance costs, knowledge sharing on innovative features and environmental impacts, improving availability and accessibility in local markets, targeting early adopters for marketing, and policy incentives like reimbursements for taxes or financial assistance are key strategies. These programs attempt to increase consumer adoption and make construction more sustainable. In conclusion, by fostering awareness, addressing accessibility challenges, and promoting technological advancement, this research highlights the significant role of informed consumer Behaviour in driving the adoption of smart, green, and sustainable building materials, thereby advancing the mission of Future Cities and Environment towards a more sustainable future cities and sustainable urban future.

## LIST OF ACRONYMS/SYMBOLS

| ACRONYM | EXPANDED FORM                                  |
|---------|------------------------------------------------|
| SGSBM   | Smart Green and Sustainable Building Materials |
| TAP     | Technology Adoption Propensity                 |
| CIA     | Challenges in Adoption                         |
| AA      | Availability and Accessibility                 |
| AB      | Adoption Behaviour                             |
| SN      | Subjective Norm                                |
| EV      | Epistemic Value                                |
| AW      | Awareness                                      |
| BI      | Behavioural Intention                          |
| AM      | Altruistic Motive                              |
| CFA     | Confirmatory Factor Analysis                   |
| SEM     | Structural Equation Modeling                   |
| GFI     | Goodness of Fit Index                          |
| AGFI    | Adjusted Goodness of Fit Index                 |
| NFI     | Normed Fit Index                               |
| CFI     | Comparative Fit Index                          |
| CR      | Composite Reliability                          |
| MSV     | Maximum Shared Variance                        |
| PGFI    | Parsimony-adjusted Goodness of Fit Index       |
| RMSEA   | Root Mean Square Error of Approximation        |
| RMR     | Root Mean Residual                             |
| SE      | Standard Error                                 |
| TLI     | Tucker-Lewis Index                             |

## DATA ACCESSIBILITY STATEMENT

The datasets generated during this study are not made available for privacy reasons and maintaining strict confidentiality.

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## COMPETING INTERESTS

The authors have no competing interests to declare.

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