



African Journal of Biological Sciences



Awareness Status of Sustainable Buildings in Bhutan

Pema Chheda¹, Pushpendra Kumar Sharma^{2*} and Amit Kumar Dhir²

¹Research Scholar, ²Professor and ³Associate Professor

pemchox2006@gmail.com, pushpendra.23437@lpu.co.in, amitdhir2k4@gmail.com

School of Civil Engineering, Lovely Professional University, Phagwara, 144411, Punjab, India

*Corresponding Author's Email: p.sharmaji10@gmail.com

Abstract:

Though Bhutan is carbon-negative and one of the water-rich countries in the world exporting hydroelectricity to neighboring countries. Nevertheless, due to its location in the high Himalayas, it requires abundant heating during the cold season when electricity generation decreases. During this season when energy consumption increases because of climatic circumstances in the high Himalayas, the nation imports electricity at a cost of millions of Ngultrums annually. According to the national newspaper dated 23rd September 2023 the country had imported 367.17 million units of electricity, worth 1.75 billion within four months (December 2022 to March 2023) the demand is anticipated to reach 1,500MW by 2030.

The demand for electricity keeps on increasing every year, huge expenditure is incurred in importing the energy. This can be reduced if we go for energy-efficient (sustainable or green buildings. As of today, not a single building is certified as a green building in Bhutan.

Therefore, this study of assessment of awareness status aims to spread awareness and promote green building construction, which has the greater benefit of energy efficiency (low consumption of electricity). Before undertaking this study, I reviewed past research papers and then prepared questionnaires in the context of Bhutan. Data was collected online, using Google Forms, and analyzed using Python software. All the stakeholders engaged in the development of Bhutan particularly the construction sector, such as project managers, project engineers, architects, contractors, policymakers, and educators of young minds such as academicians, teachers in the schools, and instructors were the target group for this survey data. A total of 140 questionnaires were distributed via emails and other social media platforms such as Facebook Messenger and WhatsApp, out of which 118 responses were received which is 84.28%. The study findings revealed that the level of awareness is low and needs to focus more on advocacy programs to make aware of the benefits of green building.

Keywords: Green Building Construction, Energy Efficient and Environmentally friendly

INTRODUCTION

The overuse of natural resources, which severely affects air pollution and global warming [1], is mainly caused by the growing world population and rising living standards [2]. However, when the consumption of fundamental resources is restricted, economic growth and technical advancement are feasible and environmentally sustainable [3]. Sustainable development strategies in this context promote economic and technological advancement without compromising the environment's capacity to help future generations of people [1].

Quantifying the sustainability efficacy of construction structures and systems that will be created is essential in the current global context of social, environmental, and economic awareness [4]. It is essential to compare this performance with that obtained from currently available technologies and materials [5]. As a result, the problem of sustainability needs to be tackled from all angles, taking into account the three primary pillars of sustainability—economic, environmental, [6] and social—as well as additional elements like technology, governance, and culture when making decisions [7]. The current approaches, guidelines, and instruments may not be appropriate for carrying out comprehensive agile evaluations on particular construction components and procedures, particularly for those more creative and still in the early stages of development [8]. Global challenges include continuous ecological degradation and climate change [9]. As a result, Europe embraced the New Green Deal as a tactic to lower carbon and gas emissions and develop a competitive, resource-efficient economy [10]. Programs for the circular economy that focus on a product's Life Cycle of Engineering (LCE) help conserve natural resources and increase the reuse of industrial waste. One of the least environmentally friendly industries is the building sector, and the EU's Raw Material Initiative has acknowledged the need for a more sustainable use of natural resources [11].

Based on statistical data, the building sector plays a significant role in unsustainable development and has a noteworthy impact on the environment and the economy [12]. According to the building industry uses 40% of the world's Energy is produced, 40% of all raw materials, and 25% of all lumber worldwide [13]. It also accounts for 16% of the world's total water use and 40% of the extraction of natural resources in industrialized nations [14]. According to the building sector generates 45–65% of landfill waste and contributes 35% of global CO₂ emissions [15]. Moreover, the construction industry and its related activities are accountable for a significant number of detrimental emissions, making up around 30% of the greenhouse gases produced worldwide due to the operations that typically occur throughout construction [16].

1.2 Green buildings and sustainable construction

It is customary to use the phrases "green buildings" and "sustainable construction" interchangeably [17]. Sustainable building still primarily addresses the community's financial, social, and environmental health. Thus, green buildings are considered a first step towards integrating sustainability into the construction sector and as a subset of sustainability [18]. A "green building" is defined as "a building that provides the specified building performance requirements [19] while minimizing disturbance to and improving the functioning of local, regional, and global ecosystems both during and after its construction and specified service life," according to the American Society of Testing and Materials (ASTM) Standard E2114-06a [20]. This definition underlines that green architecture should give both the comfort and durability that modern construction requires [21].

The sustainable standard definition is "Using resources to meet present needs without jeopardizing the ability of future generations to meet their own needs [22]." The Royal Institute of Chartered Surveyors defines sustainability as an approach that aims to "ensure that our businesses, public services, natural resources, economy, and community can continue."

According to Kibert, for a building to be considered green and sustainable [23], it needs to have a solid design and be built with an eye on the environment, making the most of the available resources [24]. Thus, environmentally friendly design and sustainable principles are used to construct green and sustainable buildings. The terms environmentally sustainable design and green design are commonly employed when applying these concepts [22].

Green construction can satisfy existing requirements by considering potential problems that future tenants could have. Has carried out studies to assess how effective green buildings are and how much they lessen adverse environmental effects [25]. The results of this study indicate that global sustainability assessment methodologies should be in charge of determining whether a building is green [26]. Although the techniques used to construct green buildings and conventional structures differ, they have several traits, most notably the recurrent disputes and controversies [27]. These writers also caution against "green legal action," which may present a hurdle to new entrants in the green market, who are frequently inexperienced with this subject as a result, with proper experience and knowledge of green construction, it is possible to complete an environmentally friendly construction project [28].

Because green construction is closely tied to environmental sustainability, it is critical to describe the principles of sustainable construction [29]. As stated by Kibert, the CIB (International Council for Research and Innovation in Building and Construction) articulated eight principles of sustainable construction to serve as a guideline for the design and construction phases, as well as

to encourage decision-making throughout the building's life cycle. These seven criteria (given in figure 1) aid in assessing and evaluating green building features and construction assets.

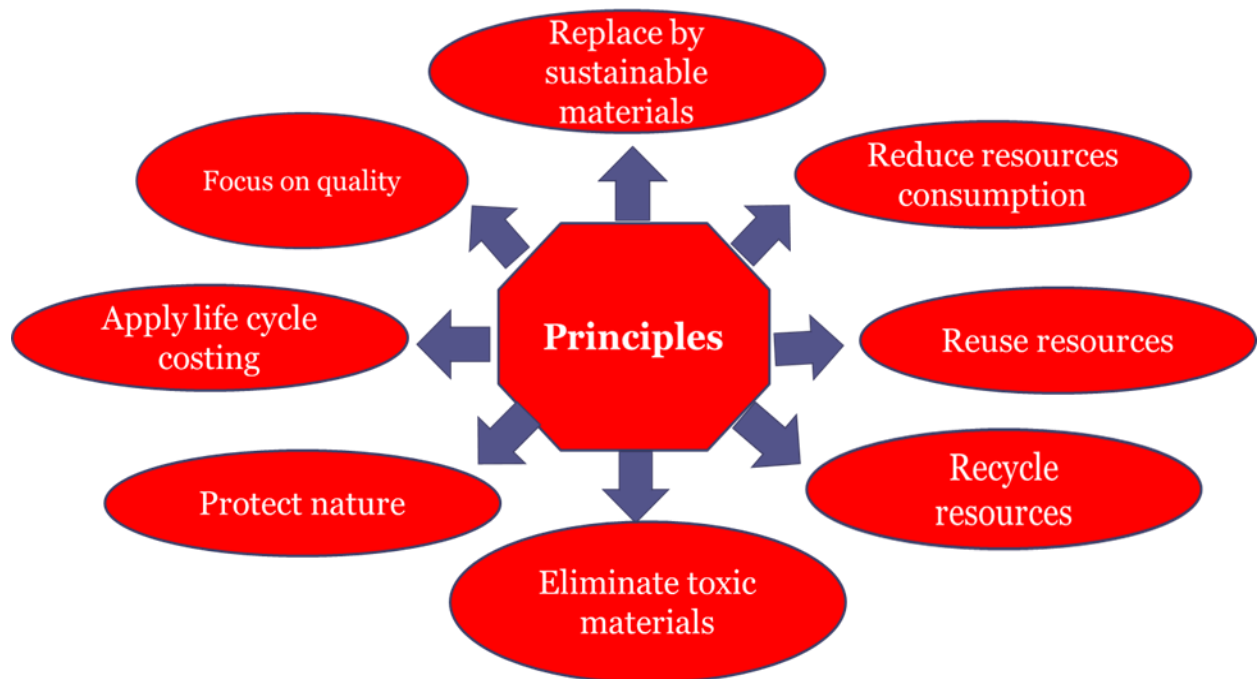


Figure 1. Principles of Sustainable Construction

Figure 1 depicts sustainable construction in connection to the life cycle of a green building, which extends from building planning to demolition. Furthermore, as indicated in Figure 2, the resources necessary to develop and run the structure throughout its life cycle are incorporated into the principles of sustainable construction. Land, water, Energy, and ecosystems are all essential resources [2]. The phases of sustainable construction are based on the resources needed to complete the project [30]. These ideas are also helpful in managing resources and the overall sustainable construction process [31].

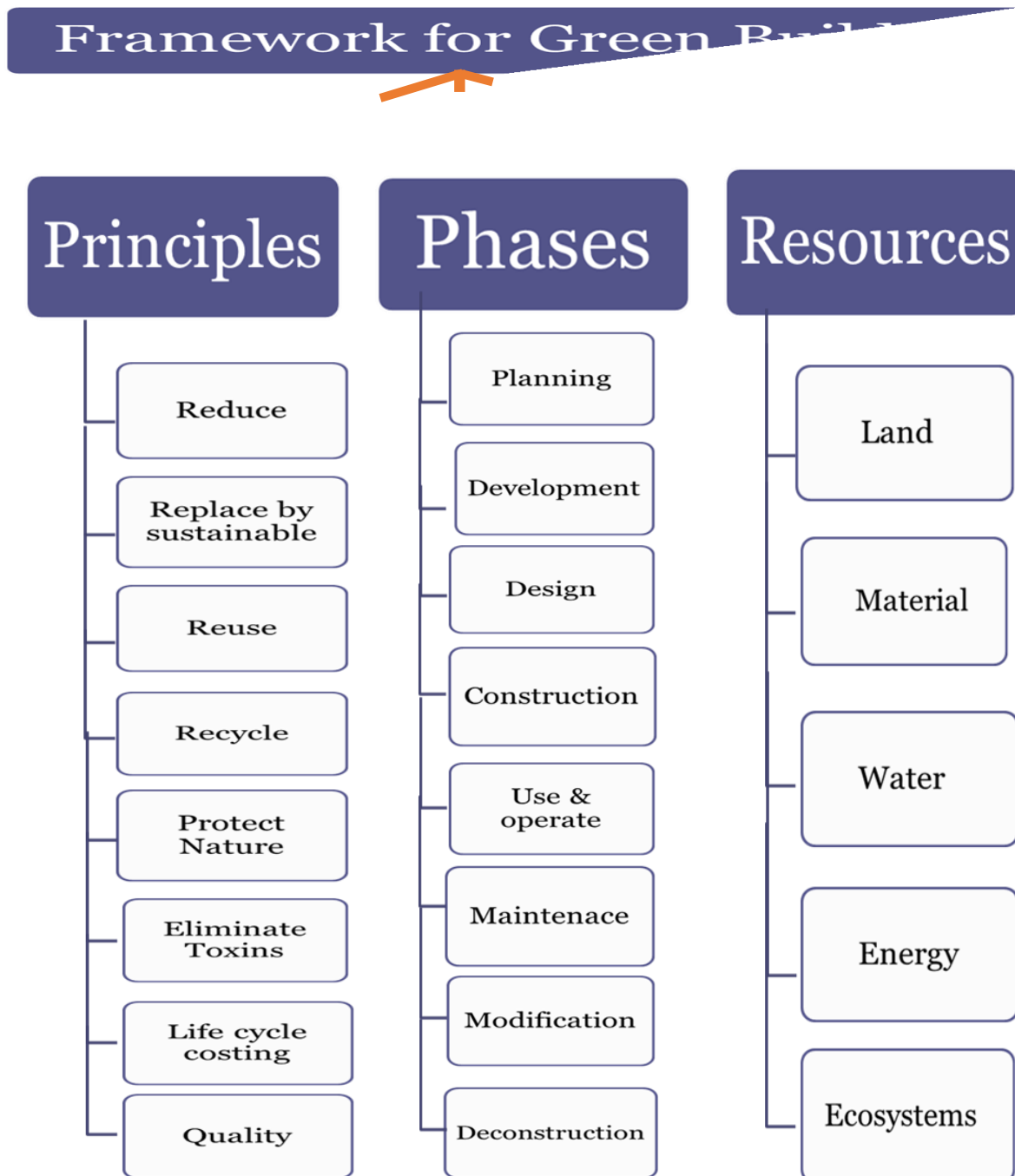


Fig 2. Frame Work for Sustainable Construction

1.3 Bhutan Moving Towards Sustainable Construction

The renowned Kingdom of Bhutan is acknowledged for creating Gross National Happiness (GNH) and being the first country to attain carbon neutrality. The term "Gross National Happiness," which holds greater significance than the GDP, was initially used in 1972 by His Majesty King Jigme Singye Wangchuck, the fourth king of Bhutan. The GNH has four pillars they are environmental conservation, cultural preservation and promotion, sustainable development, and good governance. The Sustainable Development Goals and the International

Day of Happiness have been established by the United Nations (UN) in his honour. Today, Gross National Happiness is widely acknowledged on a global scale.

The Gelephu, a southern region of Bhutan has been designated as a smart city by King Jigme Khesar Namgyel Wangchuck, the Fifth King of Bhutan, to further implementation of the GNH sustainable and better future ideas. The King announced on December 17, 2023, the 116th National Day of Bhutan, the new city's plans in Thimphu. The King's statement that the city would serve as Bhutan's economic capital and an opportunity to profit from the economic corridor that connects South and Southeast Asia motivated thousands of Bhutanese and notable foreign industrialists and entrepreneurs.

The Gelephu region is recognized as the first mindfulness city in the world, and it is expected to grow into a sustainable development bridge connecting South and Southeast Asia.

According to the World Bank, trade between the two regions grew ninefold between 2000 and 2018, from \$38 billion to \$349 billion. Bhutan will use the land route that passes via Assam and Northeast India and connects Gelephu or Samdrup Jongkhar to Myanmar, Thailand, Cambodia, Laos, Vietnam, Malaysia, and Singapore.

Coordinated development will be the three key areas of attention for the Gelephu Mindfulness City project: Energy, skills, and connectivity. This city will utilize sustainable building techniques by harnessing renewable energy sources like solar, thermal, wind, and hydroelectric power.

The construction of Gelephu's international airport and digital infrastructure will enhance connectivity. The initiative will also attract trained foreign labour and upskill Bhutanese citizens. The program will upskill Bhutanese nationals and import skilled personnel from outside.

This mindfulness city is in the southern Himalayan foothills, between the Phibsoo Wildlife Sanctuary and Royal Manas National Park, also known as the sustainable environment zone. The projected transportation infrastructure will make accessing the 1,000-square-kilometer flatland known as Gelephu much easier. As a gesture of goodwill, the Indian government has committed to constructing and modernizing significant roadways connecting to Bhutan and establishing railroad connections between border towns. The fact that Gelephu can accommodate all of the country's towns and cities proves its immense size.

This environmentally conscious, energy-efficient metropolis integrates all the green building concepts. It is a thoughtful and intelligent city.

LITERATURE REVIEW

2.1 Green Wall

The green building is made up of different components of green materials, majorly such as green walls, green floors, green ceilings, and green roofs [32]. A "green wall," sometimes called a living wall or vertical garden, is any wall covered entirely or partially in plants, flowers, or even herbs. Both environmental and aesthetic factors contribute to the popularity of these walls [33]. They are frequently utilized in urban settings with limited green space and can be installed indoors and outdoors [34]. Green walls, a form of plant embedded into buildings, offer a practical natural solution to urban heat stress and environmental issues [35]. Originating from the German phrase "Fassadenbe grünung," which translates to "Building-front greening," [36] other terms that are frequently used are "vertical garden," "green façade," "living wall," and "vertical greenery system." Green walls are classified into two categories using a dichotomous approach: (1) herb-shrub green wall (HGW) and (2) climber green wall (CGW) [37]

2.1.1 The advantages of green walls are as follows:

Plants generally purify the air by releasing oxygen into the atmosphere and absorbing carbon dioxide [38].

Aesthetic appeal: Green walls can accentuate a space's beauty by providing texture, color, and brightness [39].

Insulation: Green walls with plants can act as thermal insulation, lowering energy use and regulating internal temperature.

Noise reduction: By blocking and absorbing sound, plants on green walls help to lessen noise pollution [40].

Biodiversity: Green walls enhance urban biodiversity by giving insects and birds a place to live.

Health and well-being: Research has demonstrated that being in an environment with greenery lowers stress, elevates mood, and boosts productivity [41].

Green walls come in a variety of forms. Soil-based systems involve growing plants in a media supported by a structure; hydroponic or aeroponic systems, on the other hand, grow plants in a soilless medium and provide them with water and nutrients via a drip or misting system [42]. Many variables influence the system selection, including the need for upkeep, available space, and the intended aesthetic result [43]. A building's proportion of wall space covered by a green wall can vary significantly based on many variables, including the desired design, building codes, structural issues, and the objectives behind the wall installation [44]. Sometimes, a green wall

will cover a small section of the façade of a structure as a decorative element or to offer specific environmental advantages. In some cases, the green wall may enclose a more significant portion of the building's exterior, possibly even complete facades, especially in sustainable or green construction designs.

The percentage of a building's wall covered by a green wall can generally range from less than 1% to 50% or more. However, it is essential to consider the particular context and goals motivating the installation of the green wall. Furthermore, structural and engineering factors will determine the degree to which a green wall can be integrated into a building's design [45].

2.1.2 Energy saving by use of green walls

The building location, size, orientation, temperature, and unique features of the building itself are some of the variables that can affect the percentage of energy reduction that can be accomplished with a green wall. Green walls can help save Energy by providing better shading and insulation, but each project will have a different amount of energy saving [46].

According to research and case studies, green walls can help save Energy by minimizing heat gain in the summer and heat loss in the winter, which lowers the need for heating and cooling systems. However, the precise amount of Energy saved might differ significantly depending on several variables, including building design, regional temperature, and the effectiveness of the current HVAC system [47].

Green walls can result in energy savings of 10% to 25% for buildings in specific climates and situations. These are only estimates, and actual energy savings will vary depending on the particulars of each project. A thorough analysis and simulation must be performed to ascertain the potential energy savings of integrating a green wall into a building design [48].

According to the authors **S A Palermo and M Turco**, the green wall system is the one low-impact development (LID) technique that can increase green space in urban areas [41]. Its goals include improving building aesthetic value and reducing the adverse environmental effects of urbanization and climate change. Since we speak to all types of vegetation used for facades when we talk about "green wall systems," the first examples date back to the Hanging Gardens of Babylon, which existed 2,500 years ago. The Roman Empire also had examples of comparable vegetation used for facades [42]. Over the ages, there were numerous applications until the 19th century, when these methods were employed as decorative features and for thermal purposes in several cities in Europe and North America. The author also came up with a beautiful figure

demonstrating how the green wall should be implemented according to the availability of space and the design of the building.

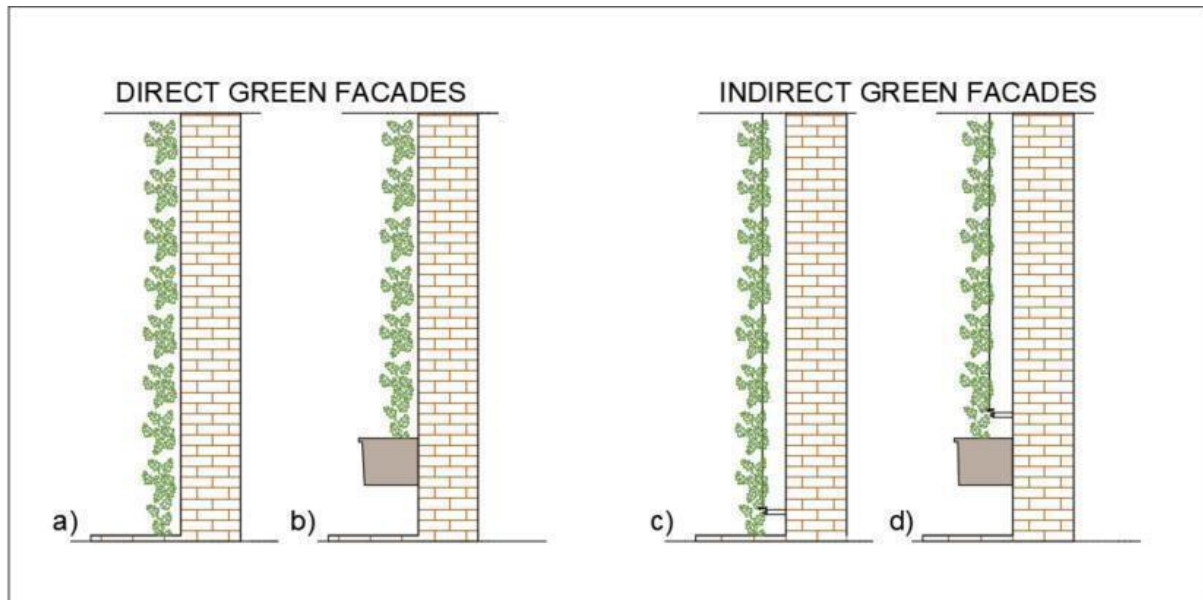


Figure 3. Different types of Green Facades: (a) Direct Green Facade with vegetation planted into the soil; (b) Direct Green Facade with plants rooted in the box; (c) Indirect Green Facade with vegetation planted into the soil; (d) Indirect Green Facades with plants rooted in the box [41].

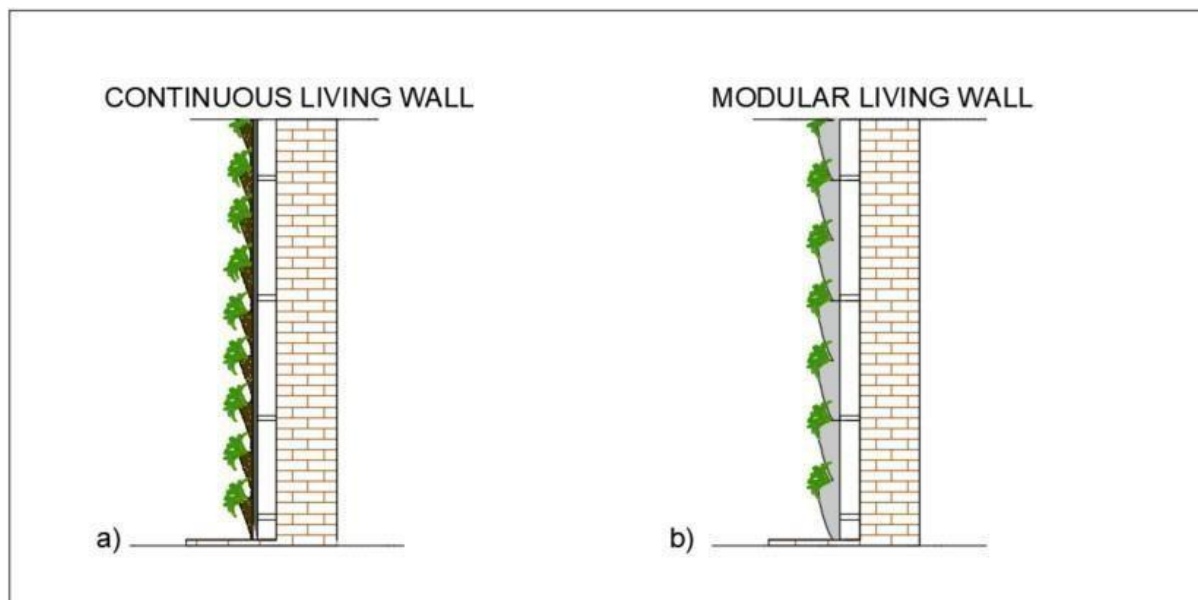


Figure 4. Different types of Living Walls: (a) Continuous Living Wall; (b) Modular Living Wall.

Compared to green facades, Living Walls (LWs) are a more modern concept that enables towering buildings to become covered in greenery quickly. A vast range of plant species, including grasses, perennials, shrubs, succulents, and more, can be used for these green walls,

depending on the region. Condition is the ability to withstand dryness, the growth of the roots, and precisely merging to produce visual effects [49].

Depending on their application, the LW systems can be either continuous (Fig. 3a) or modular (Fig. 3b).

More specifically, the continuous LWs do not need a soil substrate; the plants develop in absorbent, lightweight screens made of felt that have been sliced to create pockets in the fabric. This layer is joined to other layers (root-proof, flexible, and permeable screens) [50].

2.2 Green Flooring

Sustainable and eco-friendly flooring materials are referred to as "green flooring." From production to disposal, the environmental Impact of these flooring solutions is intended to be as low as possible (Ramesh et al., 2017) [51].

2.2.1 The typical forms of green flooring are as follows:

Bamboo Floors: Compared to hardwood trees, bamboo regenerates considerably more quickly. Bamboo flooring comes in various designs and hues, is fashionable, and is long-lasting [52].

Cork flooring: Cork flooring is made from the bark of cork oak trees, which replenish themselves naturally. It is a regenerative resource with superior insulating qualities and a padded surface.

Linoleum flooring: Linoleum is made from natural ingredients, including wood flour, cork dust, linseed oil, and tree resins. It is long-lasting and biodegradable, and it comes in a variety of hues and patterns.

Recycled Glass Tile: Glass tiles manufactured from recycled glass are a sustainable flooring alternative. They use recycled materials, lower waste, and are available in various colours and styles.

Reclaimed Wood Flooring: Reclaimed wood is taken from barns, ancient buildings, and other structures and transformed into flooring, which lessens the demand for fresh materials while giving it a distinctive character.

Natural stone flooring: Stone is a naturally occurring material that is strong and long-lasting. Examples of this include slate, travertine, and marble. Selecting locally produced stone lessens the Effect of transportation on the environment.

Rubber Flooring: Recycled rubber, such as used tyres, is frequently used to make rubber flooring. It is vital, non-slip, and offers superior sound absorption.

Concrete flooring: Concrete flooring is a robust and adaptable choice for flooring. Incorporating recycled elements into the concrete mix can improve its sustainability, and it can be polished and stained to create distinctive shapes.

Wool Carpet: Wool is a biodegradable carpet composed of natural fibres. It is a regenerative resource that offers cosy warmth beneath your feet.

The flooring is selected considering many factors such as climatic conditions of the place, durability, how often repair and maintenance are required, and indoor air quality. More importantly, preserving the environment and public health is a growing concern in interior design. The importance of non-toxic adhesives for wood floors to improve the indoor atmosphere and create a healthy living atmosphere is one principle of a green building. Reducing or eliminating volatile organic compounds (VOCs) in wood flooring adhesives is necessary to enhance indoor air quality in architectural design. Most adhesives used today are made of petroleum-based polymers [53]. However, these adhesives emit formaldehyde and other volatile organic compounds.

2.3 Green Ceiling

The green ceiling refers to the use of sustainable materials, similar to the green floor. The type of ceiling we use should have a low environmental effect [54]. Energy-efficient ceilings might sometimes be referred to as "green ceilings." Insulating materials that limit heat movement between interior and outdoor regions may be used to save money on heating and cooling. Energy savings can also be increased using ceiling fans and energy-efficient lighting fixtures [55].

Another aspect of green ceilings is using techniques for daylighting and natural ventilation [56]. Optimizing natural light and lessening the need for artificial lighting throughout the day may involve skylights, clerestory windows, or light wells in the ceiling design [57]. In addition to helping to enhance interior air quality, proper ventilation design can lessen the need for mechanical HVAC systems [58].

Regarding green building certifications such as LEED (Leadership in Energy and Environmental Design), a building's total sustainability rating may be influenced by specific ceiling-related requirements. This could involve thermal comfort, acoustic performance, and low-emission ceiling materials [59].

2.3.1 Eco-friendly ceilings are as follows:

Recycled content ceilings: Recycled content ceilings are constructed from recycled materials like glass, metal, or repurposed wood.

Bamboo Ceilings: Planks or panels for ceilings can be made from this quickly replenishing resource.

Cork ceilings: Cork is a sustainable material that can be used for ceiling tiles or panels. It is extracted from the bark of cork oak trees.

Natural Fiber Ceilings: Compared to synthetic materials, ceilings composed of natural fibres like hemp, jute, or sisal are more environmentally friendly [60].

2.3.2 Energy-Efficient Ceiling

Insulated Ceilings: By reducing heat gain and loss in the summer and winter, additional insulation to the ceiling lowers the Energy needed for heating and cooling.

Light-Reflective Ceilings: High light reflectance can save Energy by reducing the need for artificial lighting and encouraging daylighting.

Ceilings with Integrated Lighting: electricity-efficient LED lighting fixtures installed in ceilings can save electricity while still providing illumination.

2.4 Green Roof

A vegetated or living roof, sometimes called a green roof, is a type of roofing that includes plants and other greenery over a structure [61]. Green roofs offer numerous social, economic, and environmental advantages. The following are essential features and advantages of green roofs:

2.4.1 Environmental Benefits

Stormwater Management: By absorbing rainfall, green roofs lessen runoff and ease the strain on stormwater infrastructure. They can also hold onto a sizable quantity of precipitation, lowering the chance of floods [62].

Better Air Quality: Green roof plants create oxygen and filter air pollutants, improving the quality of the air in cities.

Thermal Regulation: Because green roofs naturally insulate, they minimize heat absorption in the summer and reduce heat loss in the winter. This reduces the Energy needed for heating and cooling, lowering greenhouse gas emissions [63].

Biodiversity: Green roofs support ecological balance and urban biodiversity by providing homes for birds, insects, and other wildlife.

Urban Heat Island Mitigation: Green roofs help reduce the urban heat island effect, which causes cities to experience hotter temperatures than nearby rural regions, by reflecting and absorbing solar radiation [64].

2.4.2 Economic Benefits

Energy Savings: Green roof insulation can result in significant energy savings by lowering the cost of heating and cooling.

Increased Roof Lifespan: By shielding the waterproofing membrane from UV rays, temperature changes, and mechanical damage, green roofs increase the lifespan of the roof and lower maintenance expenses.

Increased Property Value: Structures featuring green roofs are frequently more valuable as properties and may draw renters or buyers prepared to pay more for eco-friendly features.

Tax Incentives and Grants: Several jurisdictions offer tax incentives, grants, or rebates for installing green roofs as part of sustainable building programs [65].

2.4.3 Social Benefit

Aesthetic Improvement: Buildings with green roofs have a more appealing appearance and contribute to a more pleasant urban environment.

Recreational Space: To give building inhabitants more usable space, green roofs might occasionally be constructed to feature gardens, recreational areas, or outdoor seats.

Health & Well-Being: Access to green spaces has been associated with better mental and physical health. Green roofs provide opportunities for leisure, recreation, and natural connection in metropolitan settings.

METHODOLOGY

Given the nature of the data necessary for this investigation, a questionnaire was explored [1]. The research required measurable data to achieve the study's aims of highlighting the benefits of green principles in building and encouraging green building practices in Bhutan. A questionnaire was utilized [2] to measure respondents' perceptions of various aspects of green building techniques applied to collect primary data to answer the study questions. Questionnaires are frequently used in Bhutan's descriptive or explanatory research [2]. Descriptive research, such as attitude and opinion questionnaires and organizational practice questionnaires, will allow the researcher to discover and characterize the variability in various phenomena [66]

The literature research provided the foundation and parameters for developing the questionnaire [67]. The questionnaire was prepared to address the study questions and objectives and was intended to be completed by the respondent without the researcher's presence. The final version of the questionnaire included categorical items and questions based on the Likert [68]. The majority of the questionnaire's questions were purposefully brief and closed-ended. The questionnaire was sent to Bhutanese stakeholders in the construction sectors (Project Managers, Project Engineers, Architects, Site supervisors, and contractors), policymakers (Members of Parliament and National Council), technical universities, building owners, and consultants in Bhutan. These sections of people were chosen to complete the questionnaire because they are directly involved in implementing this concept on the ground [69]. The questionnaires were also designed so that these professionals could easily understand the real challenges and opportunities to implement and where the government should focus more on spreading awareness and education. Despite their possible Impact on the replies given, which in turn had the potential to affect the survey's outcome, such issues were taken into account when drafting and organizing

the questionnaire [2]. A web-based questionnaire (Google Forms) was created to aid respondents and enhance response rates, and the link was distributed to all respondents via email and other social media channels. To preserve the high legitimacy of the received data, 140 questionnaires were distributed via emails and other social media platforms such as Facebook Messenger and WhatsApp, out of which 118 responses were received, making it 84.28%. The responses received are interpreted accordingly as below.

RESULTS AND DISCUSSION

4.1 Respondents Profile

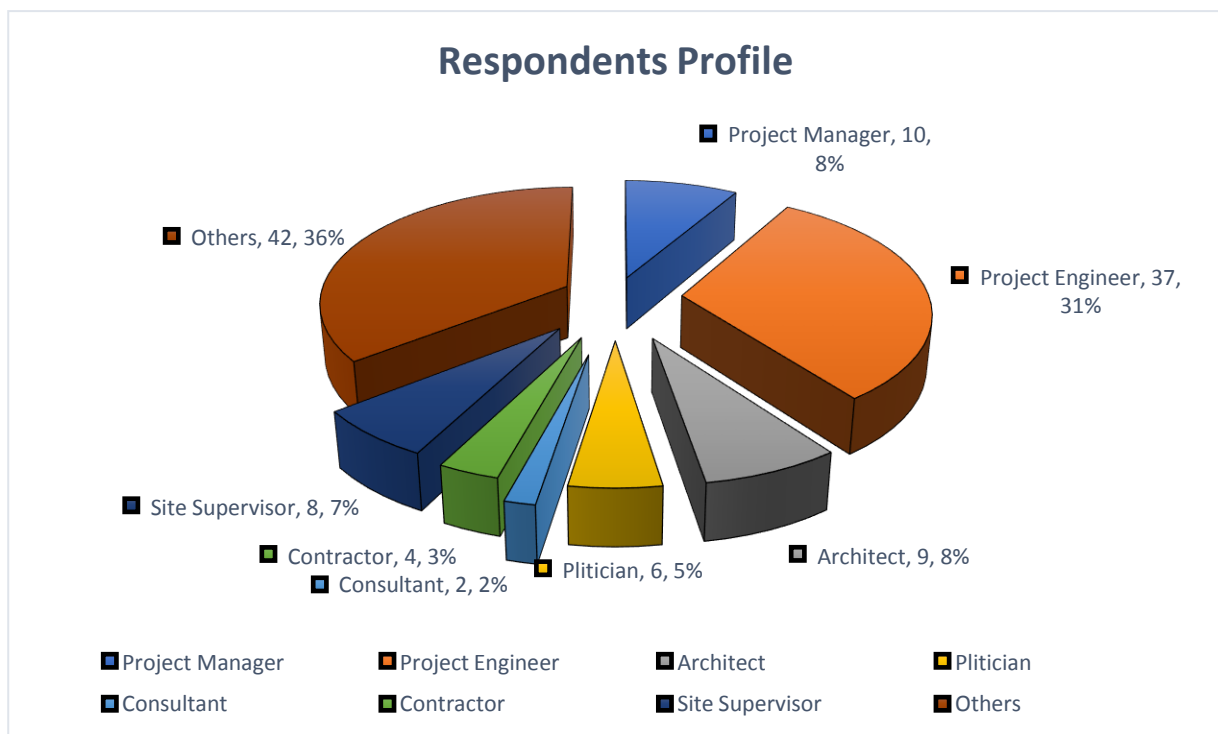


Fig 5. Respondent's profile

The highest response is from the other category, 36%. This group comprises a variety of stakeholders like building owners, educators, and university faculty. Building owners in Bhutan significantly influence the built environment through their choices about upkeep, repair, and construction methods. Teachers in schools and university professors help students and colleagues learn about sustainability and green construction ideas [70]. This could have an impact on future generations of experts in the industry.

Project Engineers have followed this with 31%. Project engineers play pivotal roles in executing plans and programs on the ground; similarly, they are the main actors in the field when implementing sustainable construction initiatives [71]. They supervise construction operations, guaranteeing adherence to rules and regulations, driving the project as per the desire and expectation of the client—sustainability requirements, and converting design thoughts into workable plans. In Bhutan, integrating green building elements and technology into infrastructure development initiatives is a critical responsibility of project engineers, as environmental

protection is firmly engrained in national policy and cultural ethos[72].

Architects (9%): The planning and design of sustainable building construction heavily rely on architects; they are one of the leading players. To build structures that reduce their ecological footprint and harmonize with the surrounding environment [73], architects in Bhutan combine traditional Bhutanese architectural aspects with contemporary sustainable approaches. Their knowledge of energy efficiency, material selection, and spatial design will significantly advance the implementation of sustainable construction in Bhutan.

Project managers make up 8% of the respondents. They are responsible for managing construction projects from start to finish. They oversee resources, manage a variety of stakeholders, and guarantee that projects are completed on schedule and within budget. Project managers are essential to implementing green construction projects in Bhutan. They prioritize sustainability objectives throughout the project lifecycle and facilitate collaboration among various teams.

Site Supervisors contribute 7% of total responses, oversee construction operations on the job site, and ensure safety and quality regulations are followed. Site supervisors in Bhutan are essential in implementing design on the ground, incorporating all specifications. Similarly, they are responsible for implementing sustainable building practices. They will be at the site 24/7 to ensure that energy-efficient technology, waste management plans, and environmentally friendly construction methods are carried out correctly [74].

Politicians' (5%) participation in the survey suggests that they are aware of and may impact Bhutan's green construction laws and policies. Legislation, funding, and incentives that encourage the nation's wide adoption of sustainable construction practices must have the backing of the political establishment.

Contractors (3%): Contractors are responsible for building projects and are crucial in implementing sustainable building principles locally. In Bhutan, contractors must see that sustainable building requirements are fulfilled and building techniques and materials are applied.

The consultants, participation is the lowest with (2%). They offer specific knowledge and direction in their field; therefore, to implement sustainable practices in Bhutan, the consultant firm plays a critical role in sustainable building certifications, technology, and strategies. Although they made up the smallest percentage of respondents, consultants are essential in providing stakeholders with advice on achieving sustainability objectives and overcoming obstacles associated with implementing green buildings in Bhutan.

In general, all the stakeholders directly involved in promoting sustainable construction

approaches in Bhutan participated in this research; they are policymakers, designers, and implementors. Comprehensive research has been carried out to study the awareness, knowledge, and interest level in implementing green buildings. This research will help determine the area we focus on and the type of incentives that the government should come up with to encourage our Bhutanese citizens to implement green buildings.

The following are the questionnaires asked of the respondents, which are critical and relevant to assisting the green building awareness and implementation of the concept.

Section A

I. Gender
118 responses

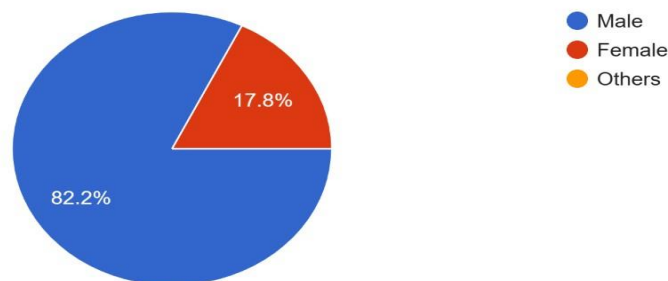


Figure 4.1

Questionnaire No. 1 describes the gender participation in the survey; as per the report, 82.2% are male, and 17.8% are female. There is a significant disparity of gender in the field of construction between male and female respondents. This data revealed that fewer females work in the construction sector. The lower number of females in the construction sector is because the construction business has historically been perceived as being controlled by men, and women may be discouraged from entering or staying in the field. Societal conventions, cultural expectations, and misconceptions about gender roles can influence opportunities and professional decisions for women.

II. Age
118 responses

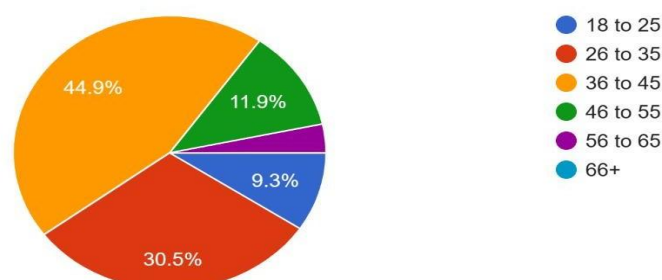


Figure 4.2

Age Group 36-45 (44.9%) This age group depicts the highest number of respondents in the survey. This clearly shows the traditional ideals of stability and experience in Bhutanese culture. People in this age bracket likely have much work experience and may have steady jobs. They might benefit now from having explored possibilities for education and training earlier in life. Bhutan's recent economic growth has given this age group more employment options, which has increased its presence in the population under study.

Age Group 26-36 (30.5%) The remarkable prevalence of people in the 26-35 age group indicates that a considerable proportion of the Bhutanese workforce is in their early to mid-career stages. This age group could consist of those who have recently graduated. Younger Bhutanese adults may have had more job opportunities due to economic and social changes, such as the expansion of industries outside of traditional sectors like agriculture and tourism, which may have contributed to their representation in the questioned population.

Age Group 46-55 (11.9) The smaller proportion of respondents aged 46-55 indicates a relatively lower representation of individuals in the later stages of their careers. This could be attributed to retirement, reduced workforce participation due to family obligations, or slower career progression opportunities compared to younger age groups. In Bhutan, where familial and community ties are substantial, older individuals may also prioritize family responsibilities over career advancement, leading to a more miniature representation in the surveyed population.

Age Group 18-25 (9.3%) The lowest percentage of people between the ages of 18 and 25 may be the result of several circumstances, including educational goals, a lack of entry-level employment possibilities, or cultural norms that encourage younger people to prioritize their schooling or apprenticeships before ultimately entering the workforce. The government's investment in youth development programs and Bhutan's emphasis on education may impact the professional paths of individuals in this age group, which could explain their reduced presence in the questioned population.

III. Education background
118 responses

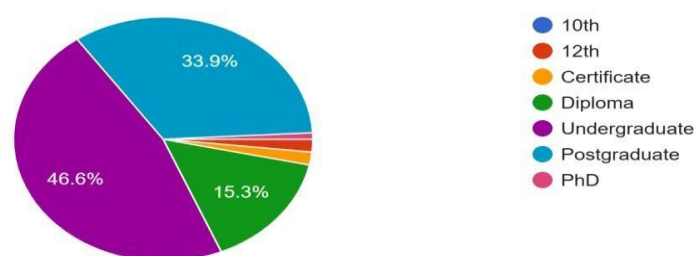


Figure 4.3

Undergraduate (46.6%): The proportion of respondents with an undergraduate degree indicates that a sizeable section of Bhutan's population has finished a bachelor's degree in higher education. This suggests that the Bhutanese young are becoming more aware of the need for higher education and are motivated to seek bachelor's degrees to improve their employment opportunities and support the socio-economic growth of their nation.

Postgraduate (33.9%): This percentage of responders with postgraduate training emphasizes the growing tendency to go after advanced degrees like master's or doctorate degrees. This points to a group of highly educated people with specific knowledge and abilities in their disciplines who can work in the public and private sectors.

Diploma (15.3%): The proportion of respondents having a diploma shows the significance of vocational and technical education in Bhutan, even though it is lower than that of undergraduate and postgraduate degrees. Institutes that provide specialized training in industries including engineering, agriculture, and healthcare and that support skill development to meet specific workforce needs can award diplomas.

Others (Insignificant): People with non-traditional credentials, licenses, or career training outside of the typical educational framework may fall into the category of "others" with insignificant representation. These people might have learned their talents through specialized courses designed to satisfy industry standards, apprenticeships, or on-the-job training.

IV. What is your current profession or designation?

118 responses

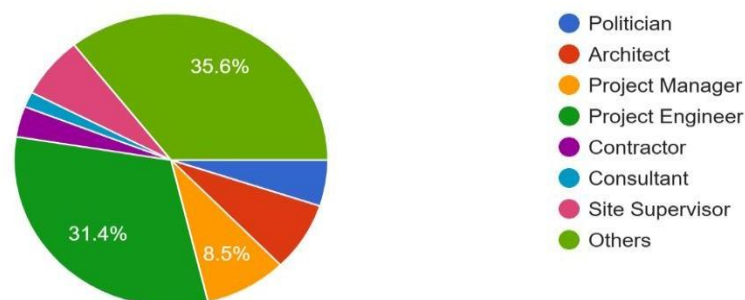


Fig: 4.4

Building owners are essential participants in this poll because they have the last word on how buildings are laid up, what materials will be used, and how well they are maintained. Consequently, building owners have a significant role in sustainable construction.

Therefore, owners have a critical role in supporting sustainability in Bhutan, with an increasing emphasis on traditional architectural traditions and environmental protection. These choices include using green construction materials, energy-efficient designs, and waste-reduction

measures. Professors and Teachers: Through study, instruction, and advocacy, educators in Bhutan support activities aimed at sustainability. They are essential in spreading knowledge about environmentally friendly building methods and concepts, encouraging creativity, and educating the upcoming generation of professionals in these areas. Their participation in the poll serves as further evidence of the value of information sharing and education in achieving sustainable development objectives.

Section B

1. How well-informed are you about green buildings?

118 responses

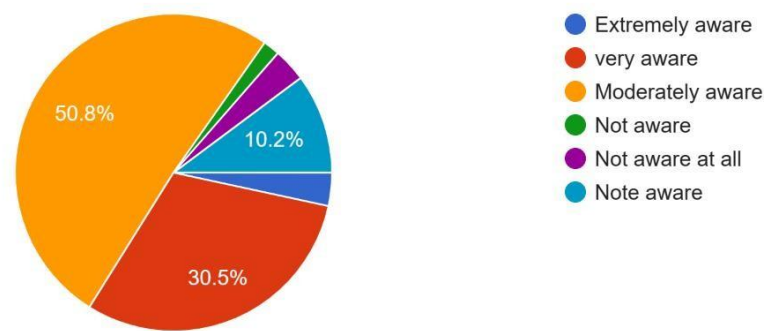


Fig:4.5a

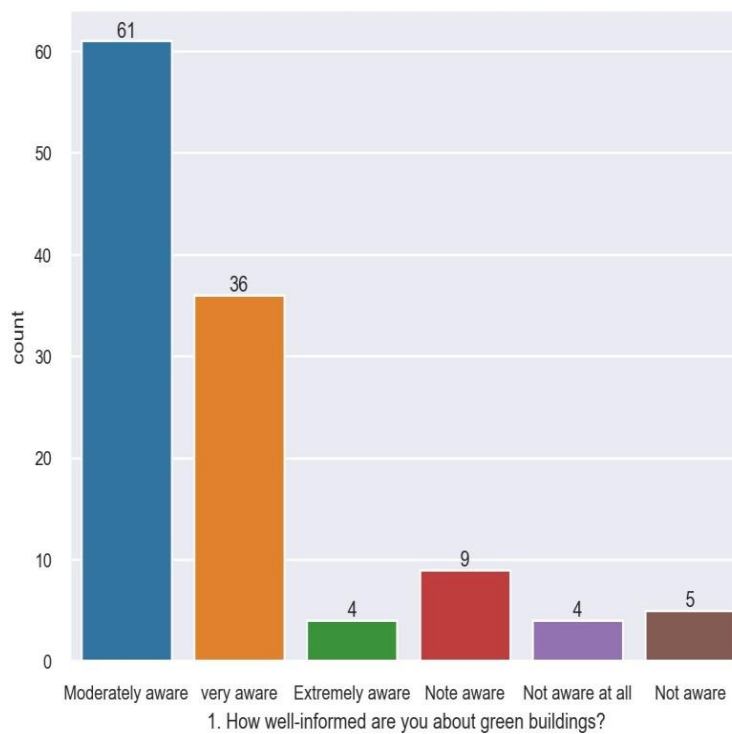


Fig: 4.5b

Moderately Aware (50.8) The fact that a sizable fraction of respondents fell into the "Moderately Aware" group indicates that Bhutan has a basic understanding of green building techniques. This degree of awareness would suggest that people are somewhat aware of ideas like resource conservation, energy efficiency, and environmental impact reduction that are important to sustainable building.

This moderate level of awareness may be attributed to initiatives like educational programs, training workshops, and awareness campaigns by government agencies, NGOs, and academic institutions in Bhutan, where sustainable development is emphasized in national policies and cultural values. It indicates a rising understanding of how crucial it is to incorporate environmental factors into building procedures.

Very Aware (30.5%) The significant proportion of participants who were categorized as "Very Aware" implies a greater degree of familiarity and involvement with the concepts and methods of green building. These people know cutting-edge sustainability ideas, technology, and eco-friendly building best practices better.

The increased awareness of green building in Bhutan could be attributed to various sources, including international collaborations, government regulations that support sustainable development, and a growing global debate on environmental conservation and climate change. To improve their proficiency in the design and execution of green buildings, experts in domains like engineering, urban planning, and architecture may also proactively pursue specialized education and certifications.

Not Aware (10.2%) Despite being a relatively small number of respondents, the "Not Aware" category highlights a segment of the construction industry that may not be familiar with or knowledgeable about green building principles. This shows that certain educational interventions and capacity-building projects are required to increase knowledge and encourage the use of sustainable construction techniques.

Bhutanese initiatives to overcome this awareness gap could include creating specialized training programs, making educational materials accessible, and encouraging stakeholders to share their knowledge. Connecting with professional associations, trade associations, and academic institutions may assist in reaching those who are not aware of the advantages and prospects of green building.

2. How many workshops, training sessions, or educational programs on green building or sustainable construction have you attended in the past three years?

117 responses

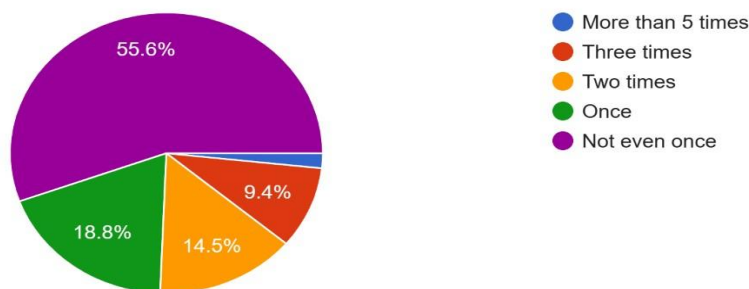
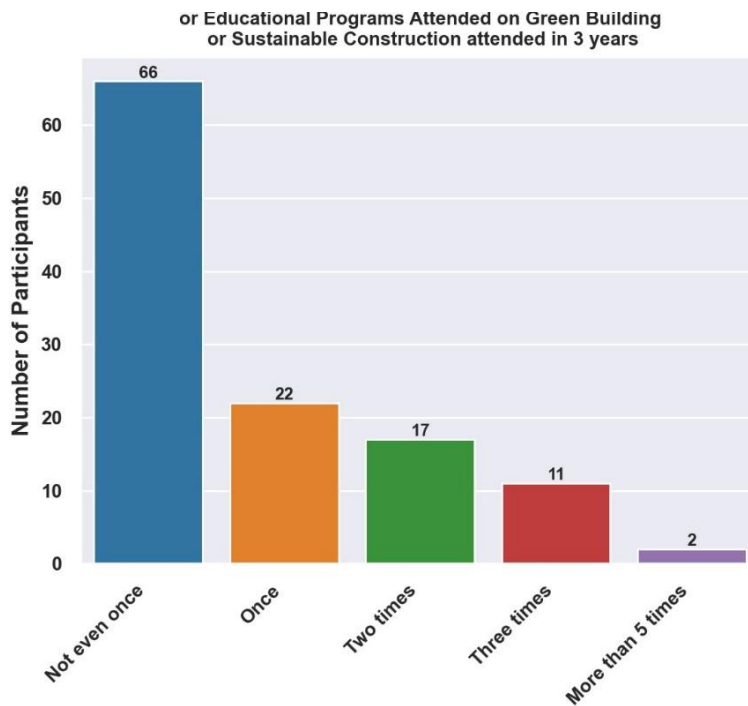


Fig:4.6a

**Fig:4.6b**

Not even once (55.6%) There is a noticeable lapse in the number of respondents who fall into the "Not Attended even once" category. This implies that a sizable portion of Bhutan's construction sector would not have received official training in sustainable building techniques and methods.

The comparatively high proportion of people who have not attended training or workshops in Bhutan, a country that prioritizes sustainable development and has initiated initiatives to promote eco-friendly construction, may reflect issues like restricted access to educational resources, a lack of knowledge about opportunities, and conflicting priorities within the industry.

They attended Once (18.8%). The proportion of respondents who reported having once attended workshops or training points to a moderate level of involvement with capacity-building programs for the development of sustainable buildings. Even though they make up a lower percentage of the population polled, their involvement shows that they are willing to invest in their professional growth and increase their understanding of sustainable construction techniques.

In Bhutan, circumstances including a person's interest, an employer's requirements, or the needs of a particular project may motivate someone to attend training or seminars once. It emphasizes a first step toward increasing knowledge and proficiency in sustainable building methods, which may eventually lead to a broader acceptance and application of green building concepts.

Attended Two Times (14.5) The percentage of participants who got an opportunity for training or workshops twice suggests a more extraordinary dedication to ongoing education and skill enhancement in sustainable building construction. Professionals who understand how important it is to stay current on changing industry trends, laws, and best practices are probably included in this group.

Multiple training or workshop attendance in Bhutan may indicate a proactive approach to professional development and a desire to expand one's knowledge of sustainable construction techniques. These people might look for mentorship programs, specialist certificates, or advanced training courses to further hone their abilities and support green initiatives in the building industry.

Attended Three Times (9.4%) The comparatively lower proportion of participants got to undergo workshops or training sessions three times in three years. These sections of people are primarily architects and project managers; however, project engineers and site supervisors need to gain exposure to sustainable approaches to construction. These people could influence industry standards and bring about positive change in their organizations and communities by acting as mentors, role models, and champions for sustainability.

3. How well-versed are you on the environmental advantages of green building or sustainable construction?

118 responses

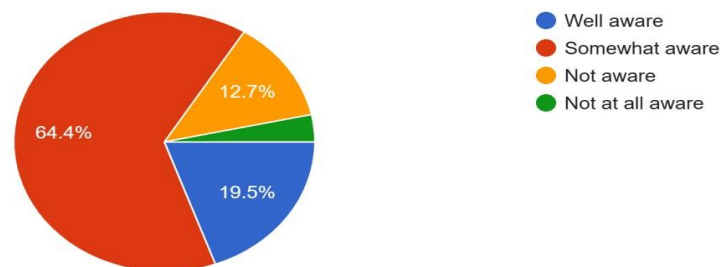
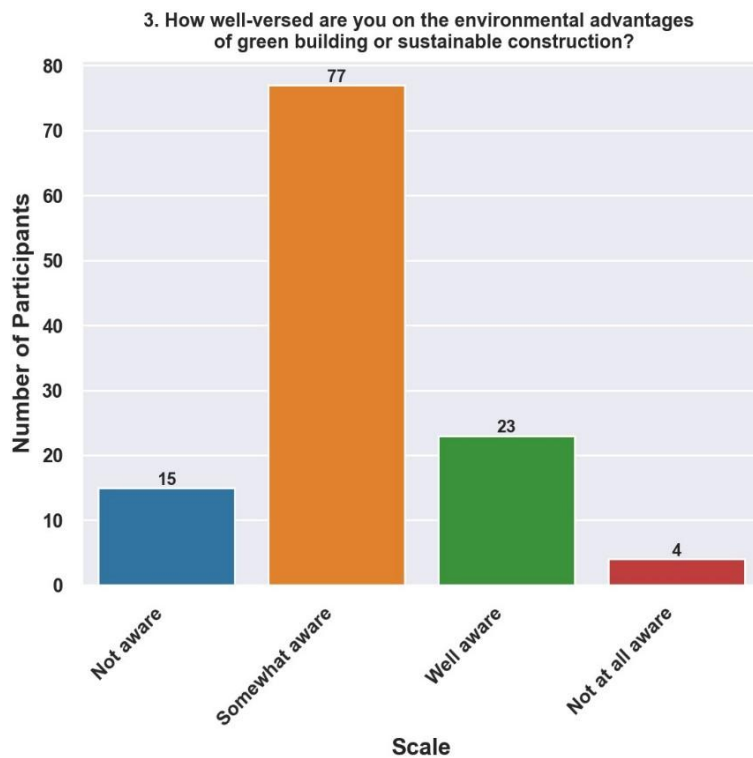


Fig: 4.7a

**Fig:4.7b**

Somewhat aware (64%) The majority of respondents who fell into the "Somewhat Aware" group indicate that they have a basic awareness of the benefits that green building practices provide for the environment. This degree of awareness suggests that a sizable section of Bhutan's construction labor force especially project managers, architects, and Project engineers is aware of the potential advantages of sustainable building practices, including cheaper energy costs, lower carbon emissions, and improved indoor air quality.

The comparatively high proportion of people in Bhutan who are at least somewhat aware of the environmental benefits of green building may be ascribed to continuous efforts to promote sustainability through advocacy, education, and policy interventions, as environmental conservation is deeply ingrained in national policies and cultural values. Nonetheless, there might still be chances to engage and educate stakeholders further to increase their comprehension and appreciation.

Well aware (19.5) The proportion of respondents who rated themselves as "Well Aware" they are more aware of and appreciative of the benefits green construction practices have for the environment. These people probably have a better grasp of the particular environmental advantages of sustainable building practices as well as the wider ramifications for resource preservation, climate resilience, and ecosystem health.

The presence of a sizable portion of respondents who are well aware of the environmental benefits of green building in Bhutan, where there is growing recognition of the interconnectedness between human well-being and environmental sustainability, indicates a commitment to advancing holistic development approaches that prioritize both ecological integrity and socio-economic prosperity. These people might fervently support green construction regulations, make investments in eco-friendly technology, and support creative fixes.

Not aware (12.7%) Although the proportion of respondents who answered "Not Aware" is low, it highlights the existence of a group in the construction industry that might not be fully informed about the environmental benefits of green building approaches. This shows that to increase awareness and develop capacity among stakeholders who might not be as familiar with sustainability principles, focused education and outreach initiatives are needed.

In Bhutan, initiatives to close this awareness gap could include making educational materials easily accessible and culturally appropriate, planning awareness campaigns and training sessions, and encouraging collaborations between government offices, universities, and business associations to advance knowledge exchange and capacity building in green building techniques.

4. Do you believe that an awareness campaign is important to promote green building in Bhutan?
118 responses

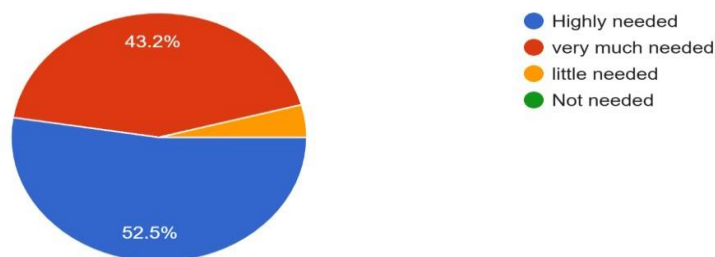


Fig:4.8a

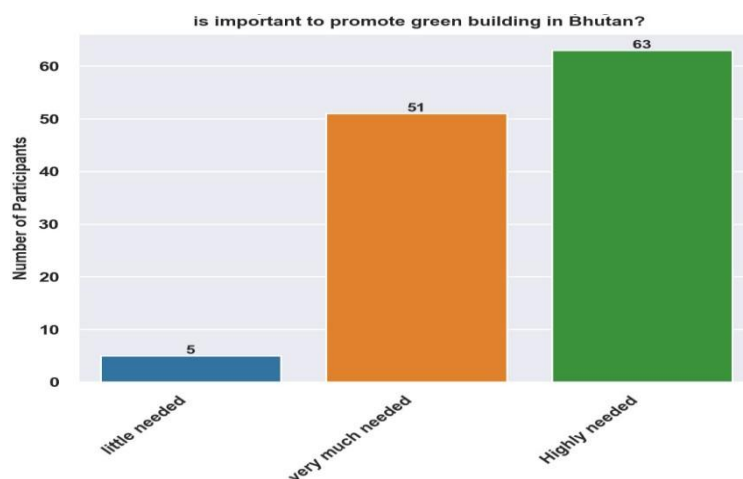


Fig:4.8b

Highly needed (52.5%) There appears to be a broad acknowledgement of the necessity and significance of increasing public knowledge about sustainable practices in the construction industry, as indicated by most respondents who expressed a strong need for awareness campaigns. This shows that all relevant parties—professionals, decision-makers, and the general public—acknowledge awareness campaigns' vital role in promoting change and a sustainable culture. The perceived high need for awareness campaigns in Bhutan, where environmental conservation is deeply ingrained in cultural values and sustainable development is a national priority, may be attributed to several factors, including limited information access, a lack of opportunities for education and training, and a lack of knowledge about the advantages and consequences of sustainable practices.

Very much needed (32.2%) The significant proportion of participants who expressed a strong need for awareness campaigns highlights the general agreement regarding the significance of taking proactive steps to improve knowledge and instruction regarding sustainability in the construction industry. This implies that stakeholders strongly desire focused interventions and programs that can clearly explain the benefits of sustainable practices and encourage behavioural change.

The perceived urgent need for awareness campaigns in Bhutan, where there is a growing understanding of the interdependence of environmental health, socioeconomic prosperity, and human well-being, reflects a shared commitment to advancing sustainable, holistic development approaches. Awareness campaigns can ignite revolutionary change in the construction sector and society by encouraging creativity and teamwork.

5. What do you believe should be the top priorities for green building efforts in Bhutan in the coming years?

118 responses

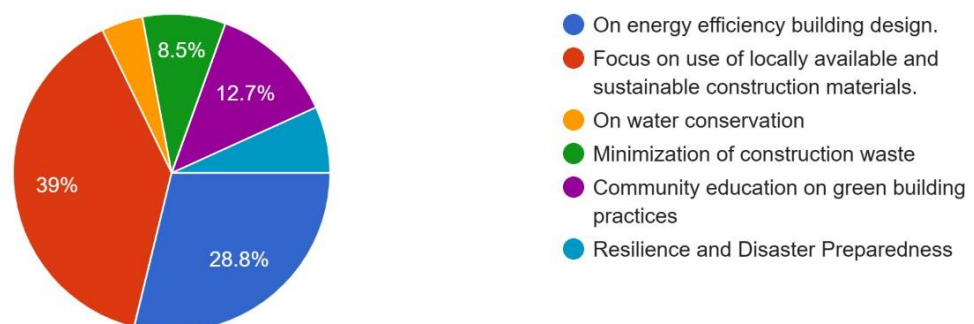
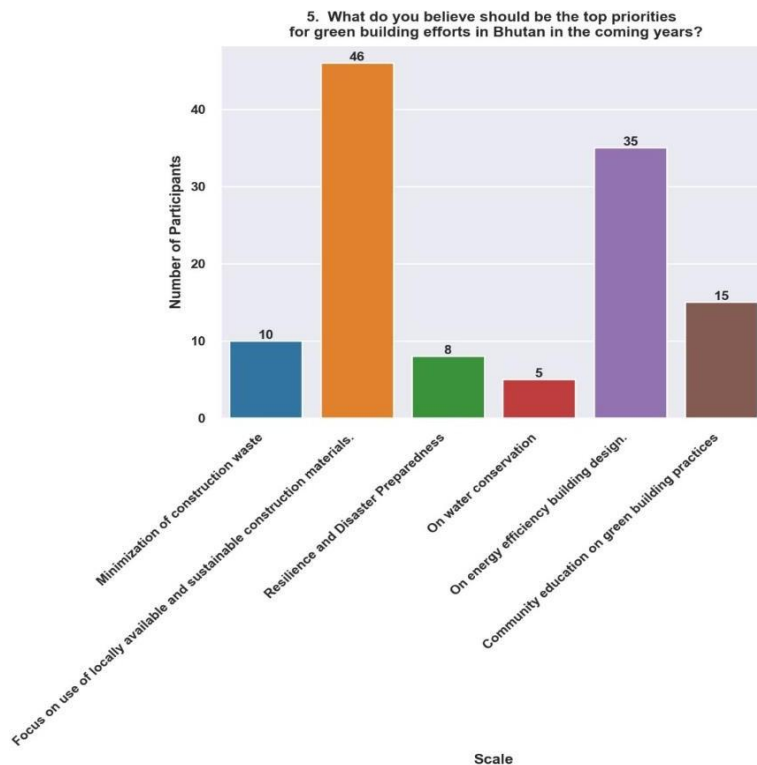


Fig:4.9a

**Fig:4.9b****Utilization of Sustainable and Locally Available Building Materials (39%)**

Bhutan is rich in natural resources, including earth, stone, and timber, that can be gathered responsibly and used for building. Bhutan's commitment to environmental conservation and cultural preservation is consistent with its priority of using locally available and sustainable resources. It encourages using locally produced building supplies and methods that lessen transportation expenses, lower carbon footprints, and boost regional economies.

Green building initiatives that prioritize using locally produced materials can also strengthen cultural identity, promote self-sufficiency, and preserve traditional craftsmanship—all of which can help communities become more resilient. It also lessens dependency on imported materials, which lessens the adverse environmental effects of resource extraction and long-distance transportation.

Disaster Preparedness and Resilience (28.8%)

Bhutan is prone to earthquakes, landslides, and floods, emphasizing the significance of preparedness and resilience in the built environment. Enhancing resilience through green building can reduce vulnerability to climate-related risks and promote community well-being by improving the safety, durability, and adaptability of buildings and infrastructure.

Resilient design elements, such as green roofs, flood-resistant foundations, and earthquake-resistant buildings, can lessen the effects of disasters and advance sustainable development goals.

By prioritizing resilience in green building initiatives, Bhutan can create more robust, safer, and more sustainable communities that can handle environmental challenges.

Green building practices education in the community (12.7%)

In Bhutan, community education is essential for raising stakeholders' knowledge, comprehension, and sense of ownership over green building methods. Educating communities on energy efficiency strategies, environmentally responsible building practices, and sustainable construction methods can spur community-based initiatives to advance sustainability and increase demand for green building products.

Community education programs can involve a wide range of people through training, workshops, awareness campaigns, and demonstration projects, such as students, builders, homeowners, and legislators. Bhutan can use the collective strength of communities to accelerate progress towards green building targets and produce good social, environmental, and economic consequences by investing in capacity building and promoting a culture of sustainability at the local level.

Minimization of Construction Waste (8.5%)

In Bhutan, reducing building waste is crucial to preserving the environment, preserving resources, and advancing the circular economy. Throughout the construction lifecycle, green building initiatives prioritizing waste reduction can maximize material utilization, improve resource efficiency, and reduce pollution.

Reusing, recycling, and reusing materials are some tactics that can be used to keep waste out of landfills, save raw materials, and reduce building expenses. By giving waste minimization top priority in green building methods, Bhutan may progress toward a more resilient and sustainable built environment while advancing more general environmental and climate goals.

Section C

1. How eager or ready are you to use green building or sustainable construction principles to your upcoming projects give rating in percentage?

118 responses

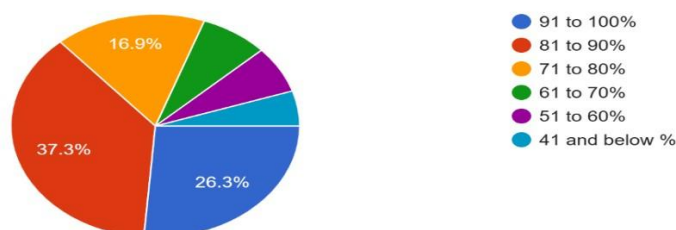
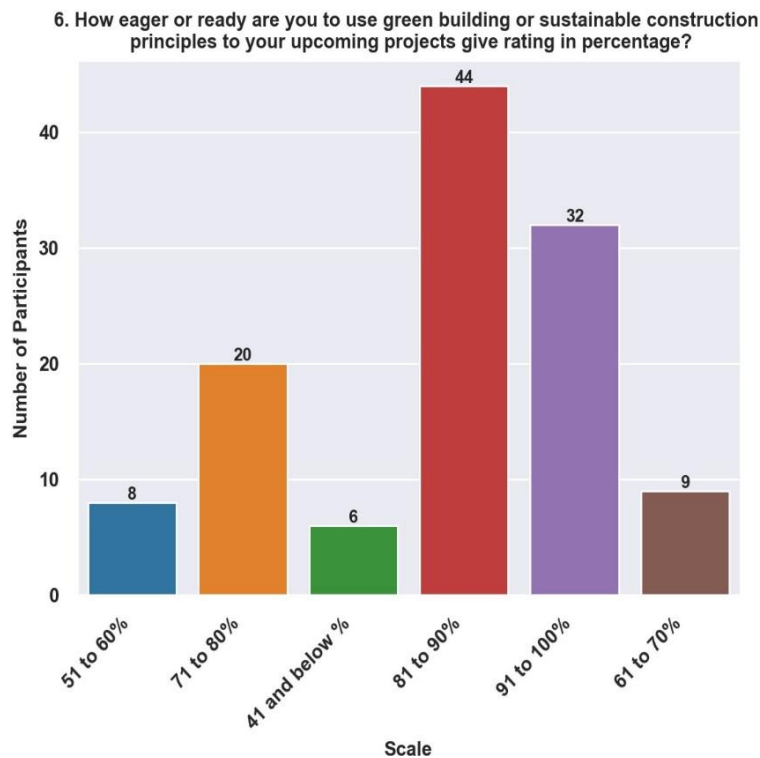


Fig: 4.10a

**Fig:4.10b****81 to 90% willing (37.3%)**

The noteworthy proportion of participants with a preparedness level ranging from 81 to 90% suggests a high preference for integrating green construction principles into future projects. This indicates that a sizable percentage of Bhutanese stakeholders are aware of the benefits of sustainable construction methods and are eager to incorporate them into their projects to a large degree.

The willingness of stakeholders to adopt green building principles reflects a commitment to advancing holistic development approaches that prioritize environmental stewardship, social equity, and economic resilience in Bhutan. Environmental conservation is deeply ingrained in national policies and cultural values, and sustainable development is prioritized there. This degree of readiness indicates that participants are ready to put in the time, money, and effort necessary to embrace green building techniques and support favourable socioeconomic and environmental results.

91 to 100% willing (26.3%)

The proportion of participants with a preparedness level ranging from 91% to 100% suggests a heightened dedication and excitement for incorporating green construction principles into forthcoming projects. Stakeholder values, project objectives, and sustainability goals are strongly aligned in this way, with a precise aim to prioritize and completely integrate green building concepts starting with the planning phase.

The high degree of willingness to adopt green building principles in Bhutan, where resilience, sustainable development, and well-being are becoming increasingly important, reflects a shared desire to create built environments that are socially, environmentally, and economically viable. Stakeholders in this range of preparation will actively seek ways to achieve sustainability goals through partnerships, resources, and opportunities.

71 to 80% willing (16.9%)

Even while a lesser portion of respondents (between 71 and 80%) said they were prepared to use green construction concepts in prospective projects, this still shows considerable openness and receptivity. This implies that while a sizable percentage of Bhutanese stakeholders recognize the value of sustainability, their confidence, familiarity, or ability to adopt green construction concepts entirely may differ.

Stakeholders expressing readiness levels in this range may need additional support, guidance, and incentives in Bhutan, where obstacles like restricted access to technical expertise, financial resources, or regulatory support may exist. This is necessary to fully leverage the advantages of green building practices and overcome obstacles. Attempts to increase awareness, develop supportive situations, and develop capability for

2. How much of an influence, in your opinion, do government programs and incentives have on the use of green building practices?

118 responses

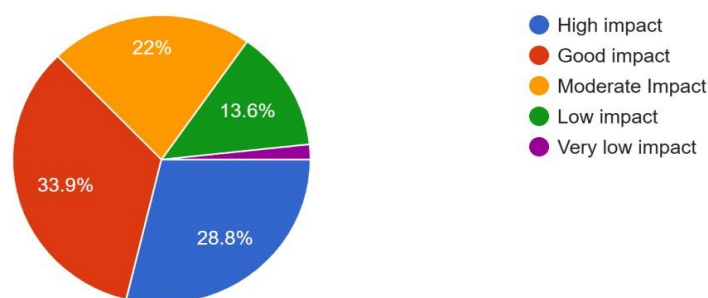
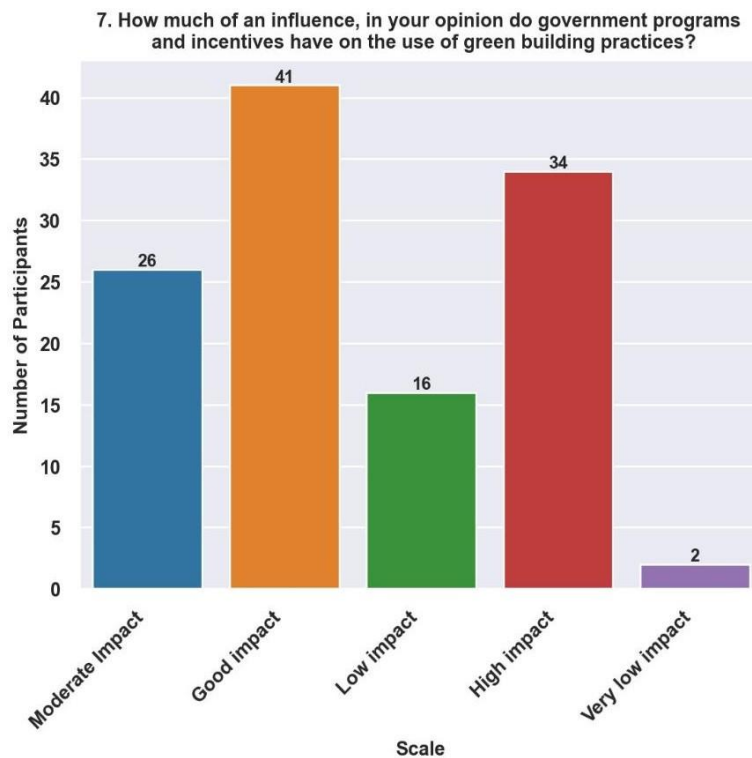


Fig:4.11a

**Fig:4.11b**

High Impact 33.9% The proportion of respondents who said it had a positive influence indicates that government initiatives and subsidies have significantly aided in promoting green building techniques. This indicates that stakeholders have a favourable opinion of the importance and efficacy of government initiatives to advance sustainability in the building industry.

The perceived positive effects of government initiatives are highlighted in Bhutan, where environmental conservation is deeply embedded in governance structures and sustainable development is prioritized nationally. This highlights the significance of policy leadership, regulatory frameworks, and financial incentives in promoting positive change. Government programs, including financing support, tax breaks, certification programs, and green building rules, can offer the essential direction, tools, and incentives needed to encourage sustainable construction methods and remove adoption hurdles.

High Effect (28.8%) The proportion of participants who expressed a high effect implies a more robust support for government initiatives and financial rewards to advance environmentally conscious building standards. This suggests that government initiatives have had a significant and revolutionary impact on the building industry, promoting the industry's adoption of sustainable building practices and cultivating a sustainability-conscious mindset.

The perceived high Impact of government programs in Bhutan, where the government is centrally involved in setting the agenda for sustainability and driving national development priorities, indicates a coordinated and all-encompassing strategy to promote green building principles. By implementing focused policies, capacity-building programs, and strategic investments, the government may foster an environment that encourages sustainability, innovation, and stakeholder cooperation to pursue common environmental objectives.

Moderate Impact (22%) The proportion of respondents who said that there was a moderate influence points to differing opinions about how well government incentives and programs work to promote green construction techniques. Stakeholders may identify gaps in implementation or areas for development that prevent the full realization of sustainability objectives, even when they understand the significance of government actions.

Government programs may encounter obstacles in Bhutan in attaining their intended Impact, including but not limited to restricted resources, institutional capability, and stakeholder cooperation. To address these issues and improve the efficiency and responsiveness of government actions over time, it is necessary to engage stakeholders, monitor and evaluate programs continuously, and use adaptive management techniques.

Low Impact (13.6%) The proportion of respondents who said they had little impact points to the belief that government initiatives and subsidies have not done much to advance green building techniques in the construction industry. This could reflect worries about how healthy government actions meet stakeholder requirements and priorities or their scope or sufficiency.

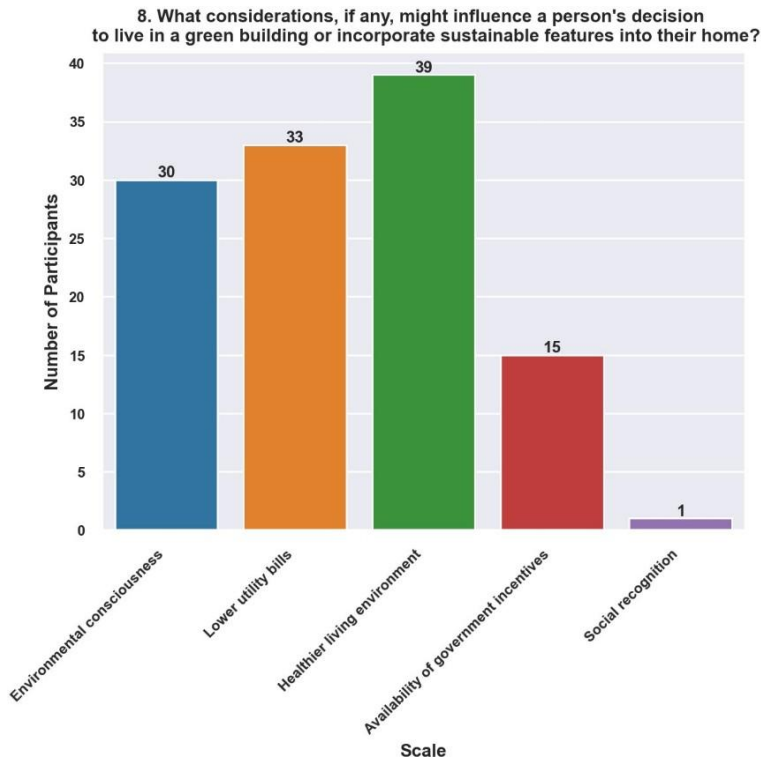
The apparent lack of Impact of government initiatives in Bhutan, where sustainability goals are central to national development strategies and cultural values, may indicate that policy needs to be improved, resources need to be reallocated, or stakeholders need to be involved to remove obstacles and increase effectiveness. It emphasizes how crucial accountability, transparency, and participatory governance are to ensuring that government actions are fair, inclusive, and responsive.

3. What considerations, if any, might influence a person's decision to live in a green building or incorporate sustainable features into their home?

117 responses



Fig:4.12a

**Fig: 4.12b**

Healthier Living Environment (32.5%) The substantial proportion of participants who identified a healthier living environment as a crucial element highlights the increasing acknowledgement of the significance of health and well-being when making housing selections. The relationship between human health, the environment, and happiness is becoming more widely recognized in Bhutan, where Gross National Happiness (GNH) is valued more highly than GDP.

Improved indoor air quality, natural lighting, and non-toxic materials are prioritized in Bhutanese green buildings because they can improve occupant comfort, productivity, and health. Bhutan's dedication to supporting sustainable and people-centred development practices that promote the welfare of individuals and communities aligns with the emphasis on holistic well-being.

Low utility bills (28.2%) Many respondents cited cheaper utility bills as a driving force, indicating green buildings' financial advantages. The potential for lower energy usage and utility costs can be a strong motivator for selecting green housing alternatives in Bhutan, where residents prioritize affordability and energy access.

Bhutanese green buildings combine passive design techniques, renewable energy sources, and energy-efficient technologies to reduce energy use and utility costs. This aligns with the nation's initiatives to advance energy security, affordability, and sustainability while enabling households

to make financial savings and allocate funds to other vital areas like healthcare, education, and cultural pursuits.

Environmental consciousness (25.6%) The proportion of respondents who emphasized environmental consciousness emphasizes how crucial it is to make morally and ethically based housing decisions. People in Bhutan may prioritize living in green buildings to integrate their lifestyle with their ideals and promote sustainability, as appreciation for the natural world and environmental stewardship are fundamental to their cultural identity and spiritual beliefs.

Bhutan's dedication to sustainable development and reverence for the natural world is reflected in its green building practices, which uphold the values of ecological harmony, resource conservation, and environmental responsibility. Living in a green building is a concrete way to show that you care about the environment, want to lessen your ecological impact, and encourage coexistence with the natural world.

Availability of government incentives (13.6%) The proportion of respondents who mentioned the availability of government incentives highlights how important financial incentives and policy assistance are in influencing housing preferences. Incentives like tax breaks, grants, and subsidies can encourage investment in green buildings and drive market demand in Bhutan, where the government is heavily involved in setting national development priorities and encouraging sustainability. Bhutanese government incentives are designed to level the playing field for sustainable development, encourage innovation, and remove obstacles to adopting green buildings. Using policy instruments and financial frameworks, the government can incentivize private sector participation, foster employment opportunities, and expedite the shift towards a more sustainable built environment congruent with domestic priorities and worldwide sustainability objectives.

4. Do you think the government should enact strong regulations to compel Bhutanese builders to use sustainable construction methods?

118 responses

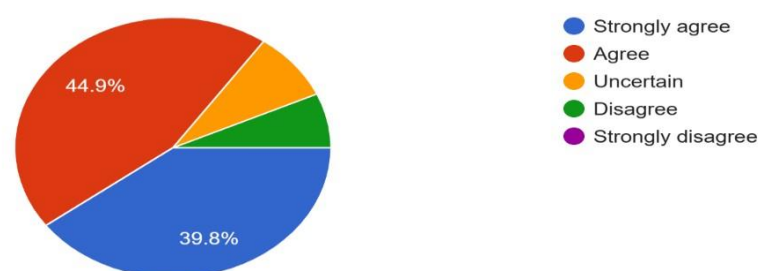


Fig:4.13a

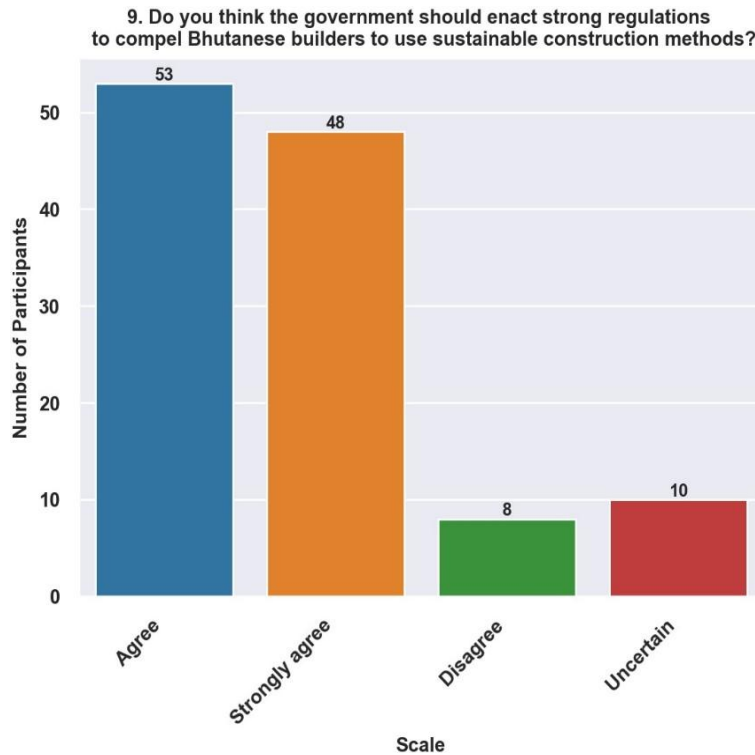


Fig:4.13b

44.9% of respondents agree, and 39.8% strongly agree that the government should enact strong regulations to promote Bhutanese builder's sustainable construction methods. The aggregate proportion of participants who express or strongly agree suggests a resounding endorsement of government involvement in advancing environmentally friendly building techniques. This implies a general understanding of the limitations of volunteer initiatives and the necessity of regulatory frameworks to promote systemic change and guarantee industry responsibility.

5.What incentives should be used if the government needs to start green building or sustainable construction in Bhutan?

117 responses

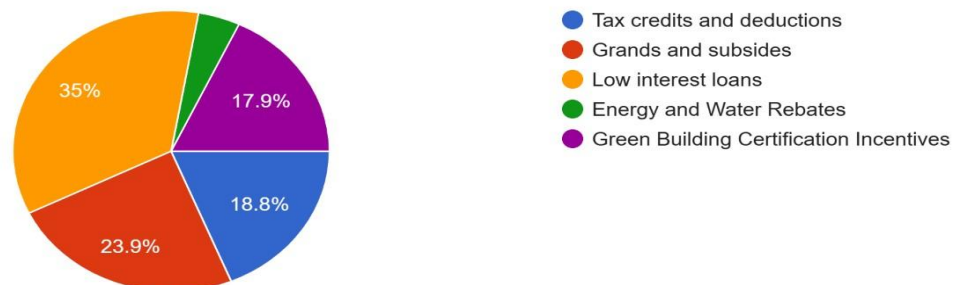
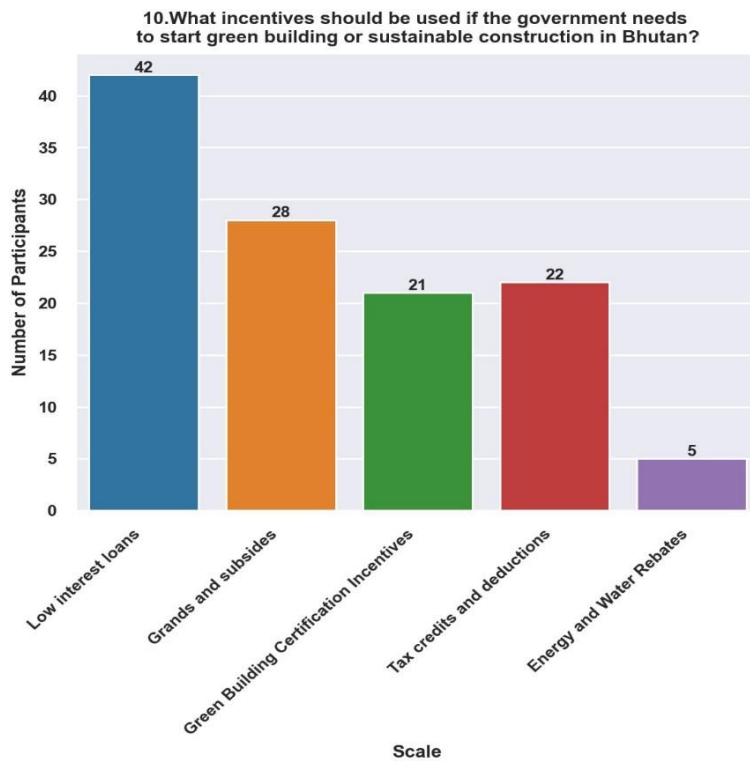


Fig:4.14a



Low-interest Loans (35%) of respondents preferred low-interest loans as a motivator, suggesting that there is awareness of the potential financial obstacles that could prevent investment in environmentally friendly building practices. With the help of low-interest loans, developers and builders can finance green building projects without having to pay unreasonably high borrowing charges. In Bhutan, where financing may be scarce, particularly for smaller-scale projects, low-interest loans can promote market change and investment in environmentally friendly buildings.

Grands and subsidies (23.9%) The proportion of respondents who supported grants and subsidies emphasizes how crucial direct financial support is for encouraging sustainable building practices. The initial expenses of adopting green building techniques, such as those related to energy-efficient technology, renewable energy systems, and environmentally friendly materials, can be lessened with grants and subsidies. Targeted grants and subsidies can help builders in Bhutan, where there may be resource limitations and conflicting development agendas, particularly in the early stages of the switch to sustainable construction techniques.

Tax credits and deductions (18.8%) The inclination towards tax credits and deductions implies a desire to utilize financial incentives to encourage environmentally friendly building practices. Tax incentives can lessen the financial burden on builders by providing deductions or credits for costs associated with green building activities, such as energy-efficient improvements, water conservation measures, and investments in green infrastructure. Tax credits and deductions

promote the broad adoption of sustainable construction techniques in Bhutan, where tax policy can be used to reward desirable behaviours and investments. They can also stimulate economic growth and job creation in green businesses.

Green building certification(17.9%) The emphasis on incentives for green building certification highlights how crucial it is to honour and incentivize superiority in sustainable building practices. Building Research Establishment Environmental Assessment Method (BREEAM) and LEED (Leadership in Energy and Environmental Design) are two examples of green building certification systems that offer frameworks for evaluating and benchmarking the environmental performance of buildings. If builders are offered incentives like reduced fees, accelerated permitting, or public recognition for certified projects, they will be more inclined to obtain green building certifications and raise the bar for sustainability in Bhutan's built environment.

Section D

1. Do you believe that there is a need for increased awareness and education about the benefits of green building practices among stakeholders in Bhutan?

117 responses

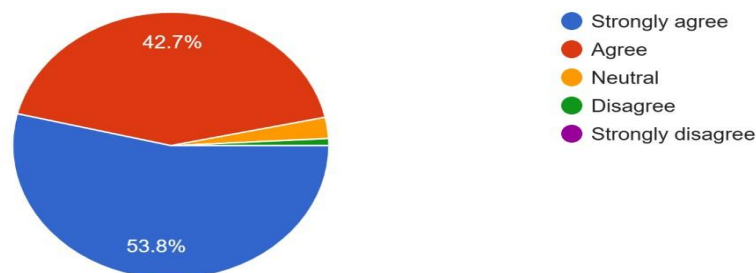


Fig: 4.15a

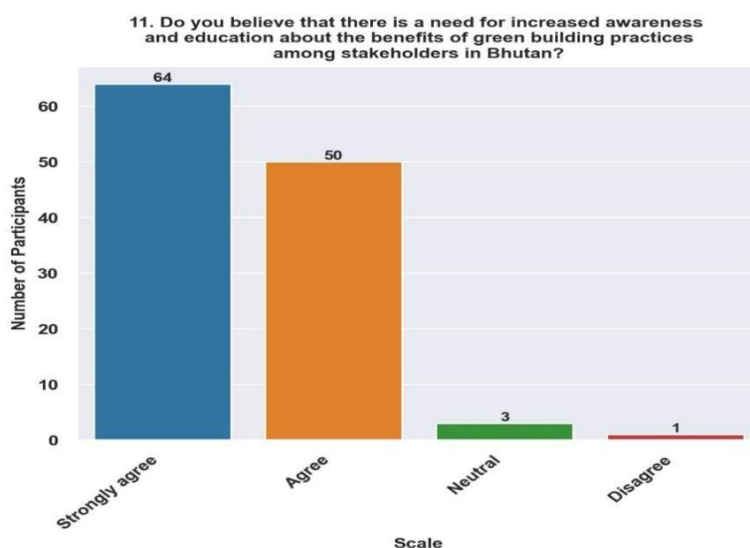


Fig: 4.15b

The significant proportion of participants expressing strong agreement (53.8%) and agreement (42.7%) for raising awareness and providing education about the advantages of green building practices among Bhutanese stakeholders highlights the significance of information sharing in promoting sustainable development in the building industry. This is a thorough analysis of the results. Bhutan's dedication to sustainable development principles and Gross National Happiness (GNH) makes a compelling case for funding initiatives that promote knowledge of green building techniques. Bhutan should better link its development policies with the ideals of social fairness, environmental stewardship, and economic resilience by making information distribution a priority. This will ultimately help Bhutan achieve its sustainable progress and holistic well-being goals.

2. How important is it to integrate renewable energy sources like solar and wind power in Bhutanese structures in order to achieve energy efficiency?

117 responses

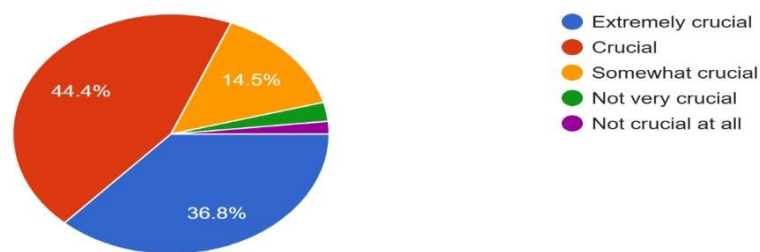


Fig:4.16a

12. How important is it to integrate renewable energy sources like solar and wind power in Bhutanese structures in order to achieve energy efficiency?

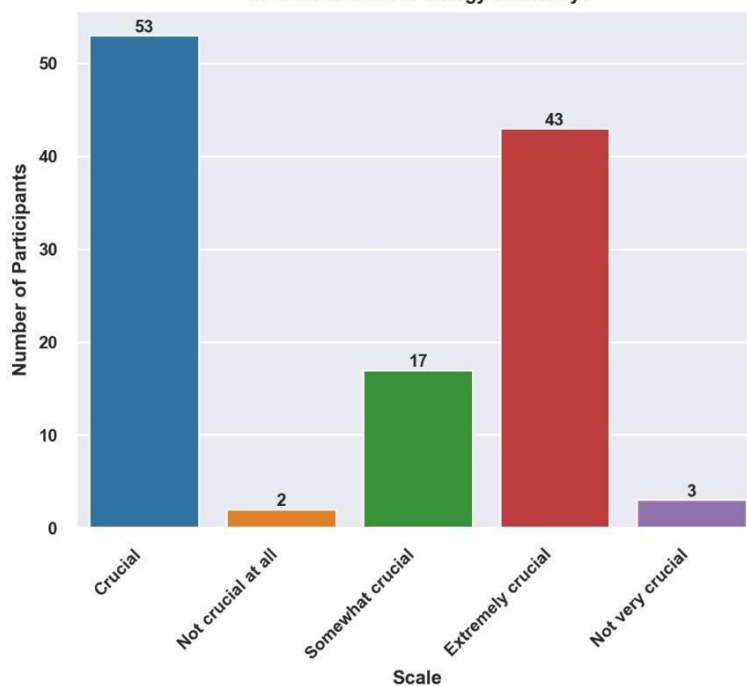


Fig: 4.16b

Incorporating renewable energy sources into Bhutanese institutions is essential, as indicated by the combined percentage of respondents who deem it crucial (44.4%), extremely crucial (34.8%), and moderately crucial (14.5%). This suggests that stakeholders generally agree on this. Bhutan has many sustainable energy resources, such as wind, solar, and hydropower. Utilizing these resources to produce clean electricity is consistent with Bhutan's mission to combat climate change, promote sustainable development, and protect the environment. In addition to increasing energy independence, Bhutan may diversify its energy mix and contribute to international efforts to mitigate climate change by utilizing solar and wind power and hydropower.

3. How important is collaboration between the government, private sector, and NGOs in driving green building initiatives in Bhutan?

117 responses

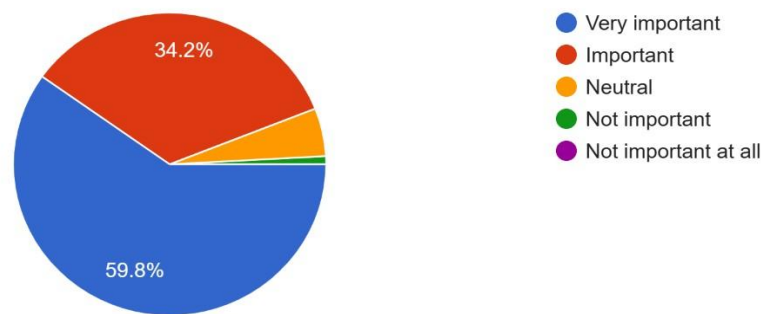


Fig: 4.17a

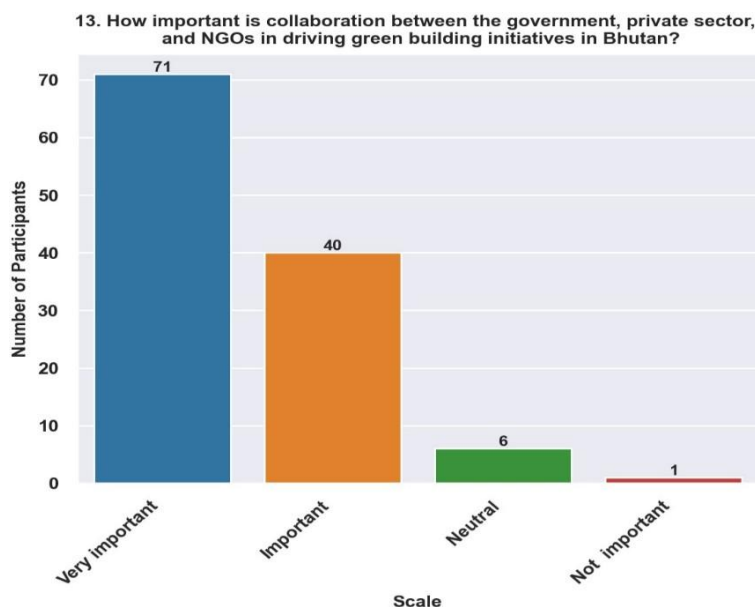


Fig: 4.17b

Almost all the respondents felt that collaboration between the government, private sector, and non-governmental organizations in Bhutan further promotes sustainable building construction. The percentage of respondents who consider collaboration very significant (59.8%) and

(34.2%) found it important. This indicates that stakeholders generally agree that various actors are interdependent and interconnected when achieving green building efforts. This acknowledgement shows that sustainable development necessitates coordinated efforts across numerous sectors, disciplines, and stakeholders to have a significant and long-lasting impact.

Role of Government to implement Green Building in Bhutan

In Bhutan, the government is primarily responsible for establishing the legal framework, industry standards, and financial incentives that influence green construction practices. Working together, the government and other stakeholders—such as the business community and non-governmental organizations—is crucial to achieving implementation hurdles, generating resources, and turning policy objectives into practical actions. By offering leadership, vision, and support, the government can create an atmosphere conducive to innovation, investment, and partnership creation in the green building sector.

Role of the Private Sector to Implement Green Building in Bhutan

In Bhutan, the private sector—which includes manufacturers, builders, developers, and architects—is essential for advancing technological advancement, fostering innovation, and providing green building solutions. Collaboration with the private sector facilitates the adoption of sustainable construction technologies and procedures, allowing for the exchange of best practices, resources, and expertise. By collaborating with private sector entities, the government can harness market dynamics, foster competition, and release private sector capital to expedite attaining green construction objectives.

Role of the Non-Governmental Organizations to implement Green Building in Bhutan

Non-government Organizations can play a critical role in promoting green construction initiatives in Bhutan because they engage the community, raise awareness, and advocate for these causes. Working with non-governmental organizations (NGOs) facilitates the mobilization of community groups, grassroots organizations, and civil society to promote policy changes, increase public knowledge of sustainability issues, and enable citizens to participate in decision-making. To guarantee that green building projects are inclusive, participatory, and sensitive to community needs, the public and commercial sectors can collaborate with non-governmental organizations (NGOs) to gain access to local networks, expertise, and resources.

When NGOs, the Private sector, and the government work together to promote green construction efforts, synergies and co-benefits can increase the Impact and efficacy of actions. By aligning

resources, using complementary capabilities, and pooling expertise, stakeholders can increase collective Impact, reduce effort duplication, and maximize efficiency. In Bhutan, collaboration is the key to fostering innovation, cross-sectoral learning, and revolutionary change toward a more resilient and sustainable built environment.

4. What steps do you think are necessary to promote green building practices in Bhutan?

117 responses

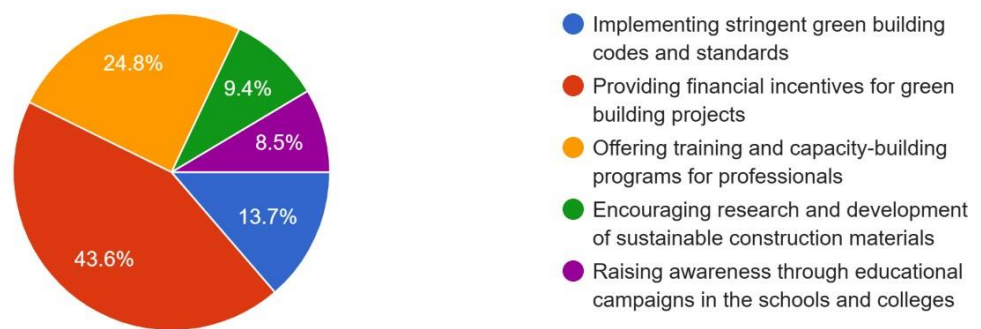


Fig: 4.18a

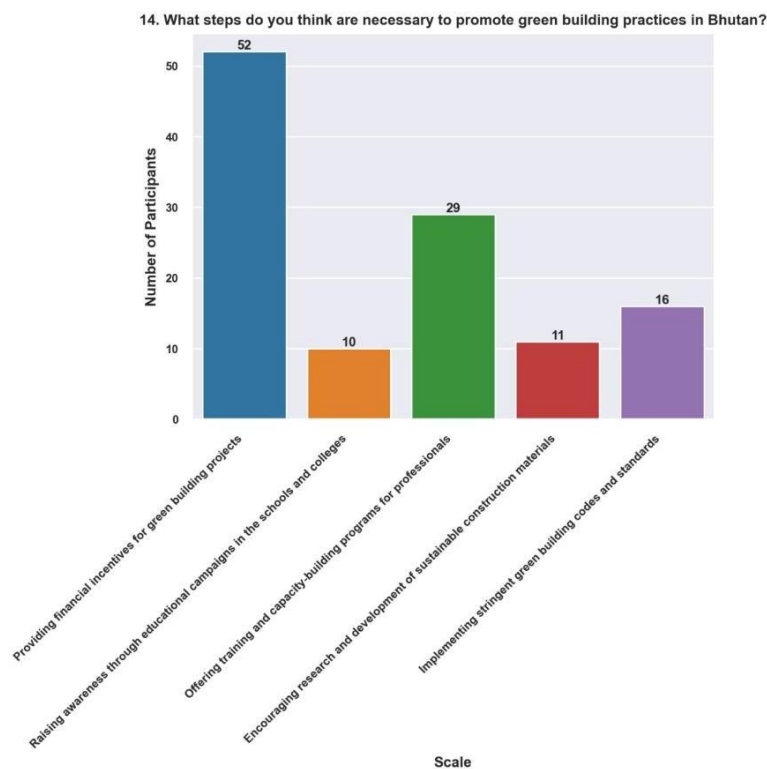


Fig: 4.18b

Providing Financial Incentives for Green Building Projects (43.6%)

Most respondents believe offering financial incentives is one of Bhutan's most critical tactics for encouraging green building. Financial incentives that mitigate the higher upfront costs associated with green construction measures include grants, subsidies, tax credits, and low-interest loans. By offering incentives for investment in sustainable construction, the government can boost market demand, foster innovation, and hasten the adoption of ecologically friendly building technology and materials.

Offering Training and Capacity-building Programs for Professionals (24.8%)

The considerable proportion of participants who prioritized training and capacity development initiatives highlights the significance of augmenting the abilities and expertise of professionals operating in the construction industry. Architects, engineers, contractors, and other stakeholders can benefit from training programs that offer specific knowledge in green building technology, best practices, and concepts. Bhutan can develop a trained labour force capable of completing high-calibre, environmentally friendly building projects and spearheading changes in the sector by investing in human capital development.

Implementation of Stringent Green Building Codes and Standards (13.7%)

A noteworthy percentage of respondents support the establishment of strict green construction norms and standards as a regulatory approach to promote sustainability. Green construction codes outline energy efficiency, water conservation, interior environmental quality, and other sustainability objectives in minimum terms. The government may set a higher standard for construction techniques, guarantee consistency and accountability, and level the playing field for builders who want to use sustainable methods by requiring adherence to green building regulations.

Encouraging Research and Development of Sustainable Construction Materials (9.4%)

Research and development (R&D) is essential, and those who acknowledged this point emphasized how innovation advances sustainable building practices in Bhutan. Putting money into research and development (R&D) projects can help create new and better sustainable building materials, technologies, and procedures. Bhutan may address particular issues with climate resilience, resource efficiency, and environmental conservation by fostering collaboration between academia, business, and research institutes. This will also stimulate innovation and foster locally driven solutions.

Raising Awareness through Educational Campaigns in the Schools and Colleges (8.5%)

Even though a smaller percentage of respondents supported awareness programs at universities and schools, this nevertheless emphasizes the significance of outreach and education in

influencing young people's attitudes and behaviours toward sustainability. Education initiatives can encourage future generations to adopt sustainable living habits, increase public understanding of the advantages of green building, and foster an environmental consciousness. Bhutan can foster a culture of environmental stewardship and enable young people to be change agents by incorporating sustainability into the curriculum and encouraging experiential learning.

5. What role do you believe government policies and regulations play in promoting green building practices in Bhutan?

115 responses

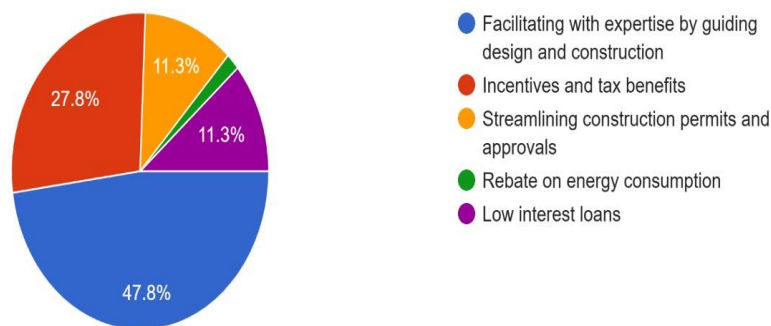


Fig: 4.19a

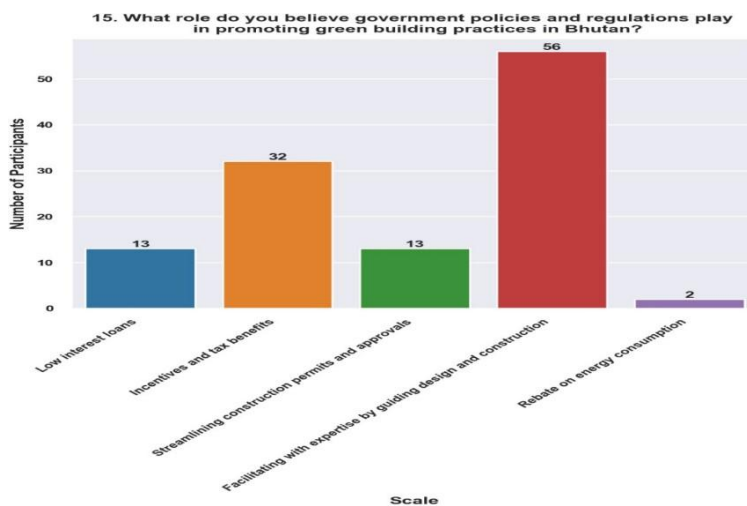


Fig:4.19b

Facilitating with Expertise by Guiding Design and Construction (47.8%)

Due to Bhutan's distinct cultural, environmental, and socioeconomic circumstances, creating green structures that blend in with the nation's natural and cultural landscape requires specialist knowledge. To ensure that green building concepts are successfully incorporated into design and construction procedures, the government may help architects, engineers, and builders by concentrating on facilitating expertise and offering technical support, capacity building, and advisory services.

In Bhutan, where modern construction technologies and traditional building techniques coexist, providing supporting expertise can encourage the adoption of creative and culturally sensitive approaches to sustainable construction. Government-led projects that include design support, knowledge-sharing forums, and training programs can enable stakeholders to meet culturally and environmentally sensitive building standards while navigating challenging sustainability issues.

Incentives and Tax Benefits (27.8%)

Encouraging investment in green building projects and removing financial barriers to adoption need offering tax breaks and other benefits. In Bhutan, where builders and developers may struggle to afford the upfront costs of adopting sustainable construction practices, financial incentives like grants, subsidies, and tax credits can increase market demand, encourage innovation, and hasten the shift to greener building methods.

Incentives run by the government can be directed toward specific sustainability targets, like water conservation, energy efficiency, and the integration of renewable energy sources, all of which fit in with Bhutan's development goals and national priorities. By providing financial incentives, the government can foster a policy environment that rewards environmentally conscious behaviour, promotes private sector engagement, and leads to favourable socioeconomic and environmental outcomes.

Low-Interest Loan (11.3%)

Encouraging investment in green building projects requires easy access to inexpensive financing, especially for small and medium-sized businesses (SMEs) and prospective homeowners. Low-interest loans can give developers and builders the money to finance green infrastructure projects, energy-efficient renovations, and installations of renewable energy sources.

Low-interest loans can be essential in enabling investment opportunities in sustainable construction in Bhutan, a country where financial resources may be few and borrowing prices may be prohibitive. The government can collaborate with financial institutions and development organizations to provide low-interest loans suited to the construction industry's demands. This will help promote affordability, accessibility, and inclusion in green building efforts.

Streamlining Construction Permits and Approvals (11.3%)

Reducing bureaucratic obstacles and accelerating green building adoption requires streamlining construction permits and approvals. In Bhutan, ineffective permitting systems can stifle innovation, extend project timeframes, and drive up developers' prices. This is because administrative procedures and regulatory processes can be convoluted and time-consuming.

The government may foster a more favourable regulatory environment for sustainable construction by optimizing permits and approvals. This will expedite project delivery, lessen administrative burdens, and improve predictability for builders. Enhancing openness, accountability, and efficiency in the construction industry through online platforms for permit applications, streamlined procedures, and clear rules can create a favourable environment for green building innovation and investment.

Section E

1. In your opinion, what are the main barriers to adopting green building practices in Bhutan?

118 responses

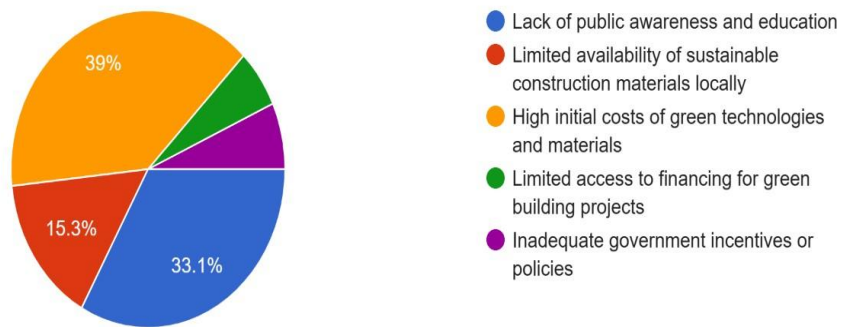


Fig:4.20a

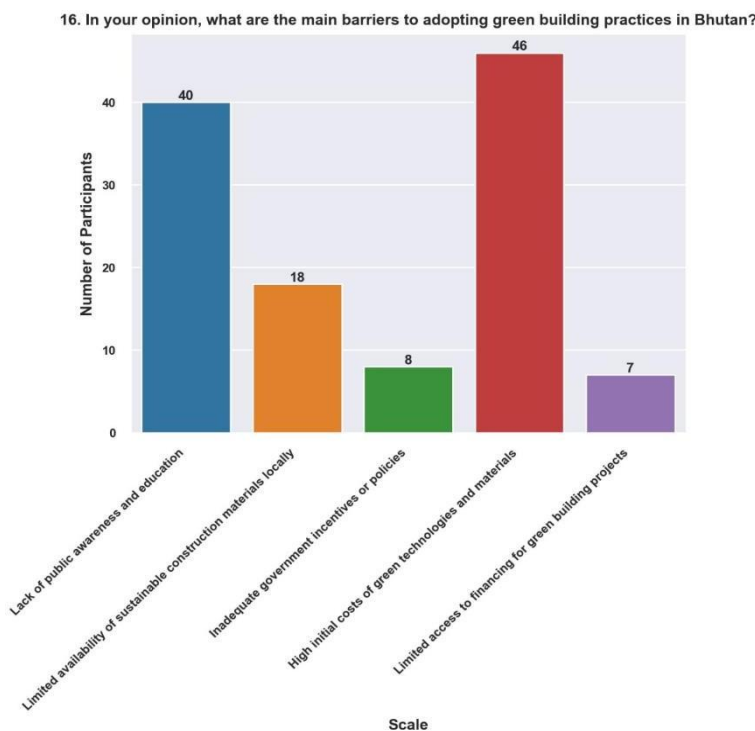


Fig:4.20b

High initial Costs of Green Technologies and Materials (39%)

Adopting green building principles in Bhutan is significantly hampered by the assumption of high initial costs. Due to upfront costs and perceived dangers, builders and developers could hesitate to invest in green technologies and materials. The government may remove this obstacle by implementing support systems and financial incentives to help with the upfront expenditures of green building initiatives. This can entail tax breaks, grants, and subsidies to promote investment in environmentally friendly building practices. To offer accessible and reasonably priced financing choices for green building efforts, the government can also create green financing schemes, such as revolving funds or low-interest loans.

Lack of Public Awareness and Education (33.1%)

A lack of public education and understanding of the advantages and significance of these approaches hampers the widespread implementation of green construction practices in Bhutan. Inadequate information and comprehension could prevent stakeholders from prioritizing sustainability or pushing for green construction solutions.

To overcome this hurdle, the government should prioritize awareness-raising and educational efforts to increase the public's, professionals', policymakers', and other stakeholders' understanding and appreciation of green building methods. This could entail creating teaching resources, holding seminars and training sessions, and utilizing media outlets to spread knowledge about green buildings' economic, social, and environmental advantages.

Limited availability of Sustainable Construction Materials Locally (15.3%)

In Bhutan, green building principles might be complex for builders due to the area's scarcity of sustainable building materials. Reliance on imported resources may raise transportation-related expenses, logistical difficulties, and environmental effects.

To remove this obstacle, the government can encourage creating and applying locally produced and ecologically friendly building materials. This can entail creating standards and certification programs to guarantee the sustainability and quality of materials acquired locally, encouraging the manufacture of sustainable materials locally, and supporting R&D projects to create new materials. The government should also help local suppliers, manufacturers, and stakeholders form partnerships to improve domestic supply chains and lessen dependency on imported commodities.

2. What strategies do you believe would be effective in overcoming the barriers to green building implementation?

118 responses

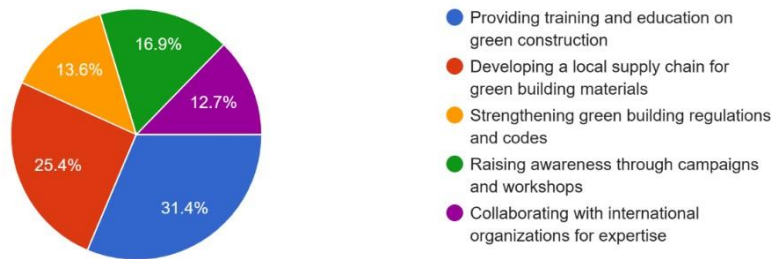


Fig: 4.21a

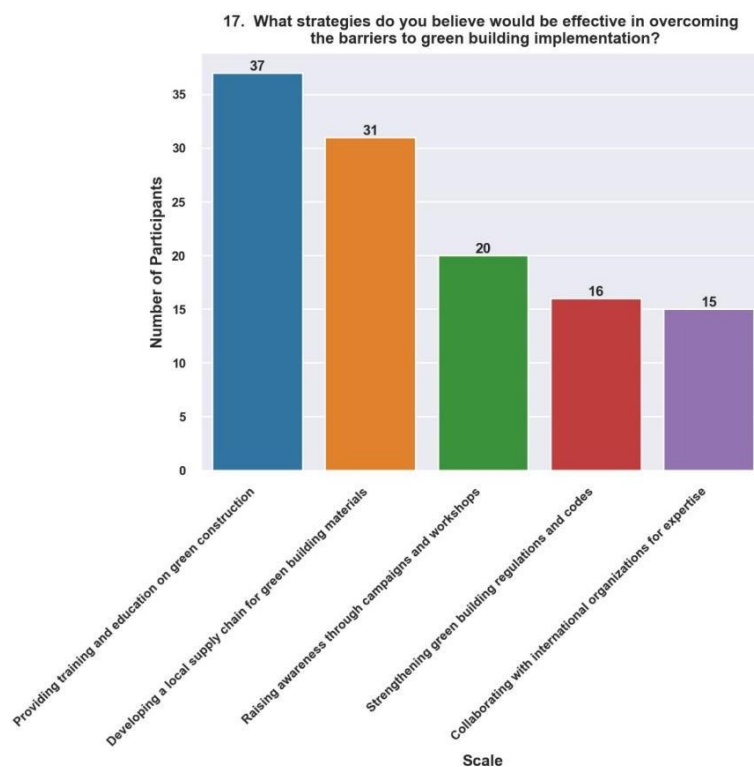


Fig: 4.21b

Providing Training and Education on Green Construction (31.4%)

Training and education initiatives on green construction must be funded to increase professional capacity and experience in Bhutan's construction industry. By offering training opportunities, workshops, and certification programs centred on green building techniques, the government may equip architects, engineers, contractors, and other stakeholders with the information and abilities required to design, build, and maintain sustainable buildings.

Furthermore, by incorporating green building principles into technical and vocational education curricula, educational institutions may guarantee that the next generation of construction professionals has the skills to support sustainable growth in Bhutan.

Developing a Local Supply Chain for Green Building (25.4%)

Establishing a local supply chain for green building materials is imperative to improving the sustainability of construction projects in Bhutan and lessening reliance on imported resources. By encouraging the production, sourcing, and utilization of locally derived products, the government can stimulate economic growth, provide jobs, and reduce the environmental impact of transportation.

This tactic incentivizes regional producers, craftspeople, and suppliers to provide environmentally friendly building materials like bamboo, rammed earth, and locally obtained wood. Furthermore, the government might set standards, certifications, and quality assurance procedures to guarantee the dependability and effectiveness of locally sourced materials.

Raising Awareness through Campaigns and Workshops (16.9%)

Awareness-building campaigns, workshops, and outreach initiatives are crucial to promoting a sustainable culture and encouraging behaviour change among stakeholders in Bhutan. The government may motivate people, groups, and communities to prioritize sustainability in building projects by propagating knowledge regarding the advantages of green building approaches.

Awareness-raising campaigns might focus on various audiences, including legislators, business executives, homeowners, and the general public. By educating themselves on green buildings' social, economic, and environmental benefits through dynamic seminars, captivating campaigns, and instructive materials, stakeholders can be inspired to use sustainable construction methods in their projects.

Collaborating with international Organizations for Expertise (12.7%)

In order to help Bhutan's green building projects, cooperation with foreign organizations can give access to knowledge, best practices, and technical support. The government can harness global expertise and assets to surmount obstacles and expedite attaining sustainability objectives through collaboration with pertinent entities, including academic institutions, non-governmental organizations (NGOs), and multilateral agencies.

International cooperation may help in energy efficiency, integrating renewable energy sources, and developing green infrastructure by facilitating knowledge sharing, capacity building, and

technology transfer. By utilizing global networks and collaborations, Bhutan may take advantage of the most recent advancements in green building technology and contribute to regional and global initiatives to combat climate change and advance sustainable development.

3. How do you perceive the level of government support for promoting green building practices in Bhutan?

117 responses

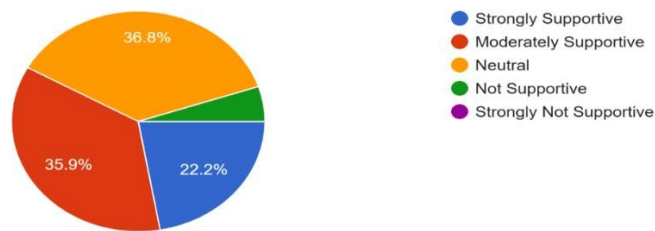


Fig:4.22a

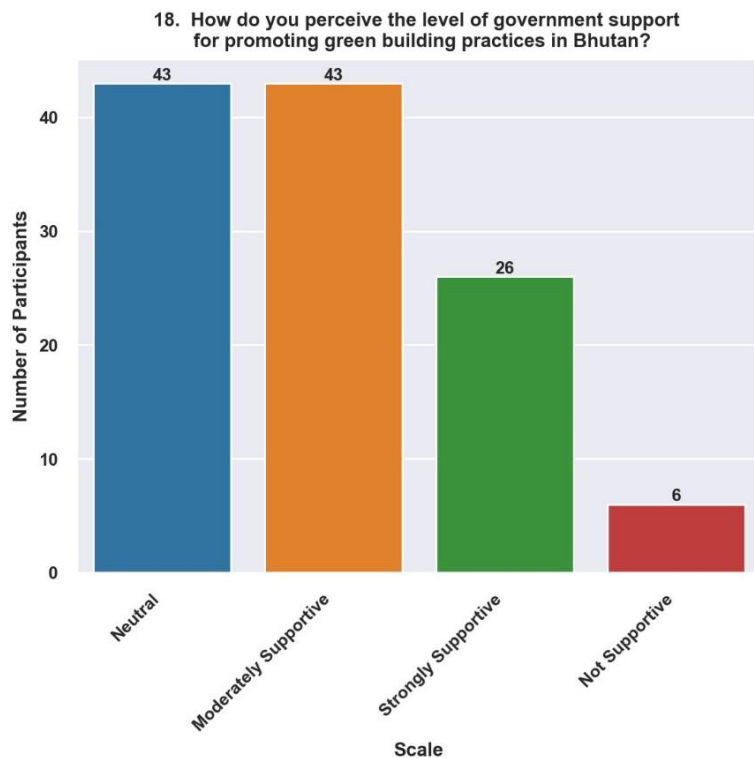


Fig:4.22b

Neutral (36.8%)

The neutral response may indicate the respondents' ambivalence or ambiguity about the government's degree of support for green construction efforts. This may be due to a perceived lack of overt measures or targeted policies aimed at sustainable building, or it can reflect the need for government officials to communicate and commit to encouraging green building practices.

In a more transparent manner.

To change this attitude, the Bhutanese government should make aggressive outreach and communication efforts to educate stakeholders about its green building-related laws, programs, and projects. This might demonstrate the government's commitment to sustainability and its efforts to assist green construction initiatives by publishing reports, holding stakeholder discussions, and participating in public forums.

Moderately supportive (35.9%)

The respondents' moderately supportive reaction suggests that while the government promotes green development, it may need to do more to meet expectations or thoroughly remove all obstacles. This impression can indicate better financial incentives, more investment in capacity-building and awareness-raising initiatives, or more robust policy execution.

It is recommended that policymakers emphasize the creation and implementation of focused policies and activities aimed at speeding the adoption of sustainable construction methods and removing obstacles to improve government support for green building in Bhutan. Increasing financial incentives, fortifying legal frameworks, and funding training initiatives to elevate the skill levels of construction industry professionals are a few examples of how to do this.

Strongly Supportive (22.2%)

The overwhelmingly positive response suggests that respondents favour the government's initiatives to encourage green building in Bhutan. This acknowledgment implies that stakeholders think the government is actively putting sustainability first and implementing practical policies to assist green building projects, the National Housing Development Corporation had already initiated sustainable construction in their ongoing projects. It might indicate contentment with current regulations, initiatives, or rewards meant to promote sustainability in the building industry.

This answer is positive, but it also presents a chance for the government to expand on its current initiatives and bolster its backing for green development even more. This could entail growing outreach and awareness efforts, scaling up successful programs, and working with stakeholders to pinpoint new opportunities and difficulties in sustainable construction.

4. What specific challenges have you encountered when attempting to use sustainable construction practices?

117 responses

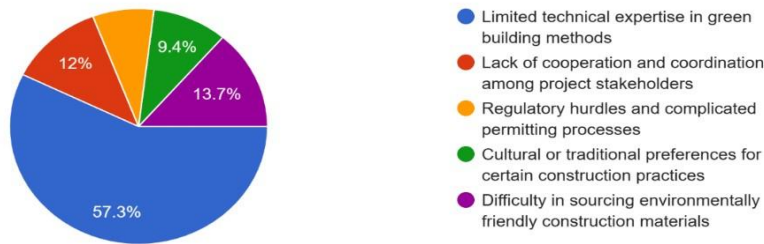


Fig:4.23a

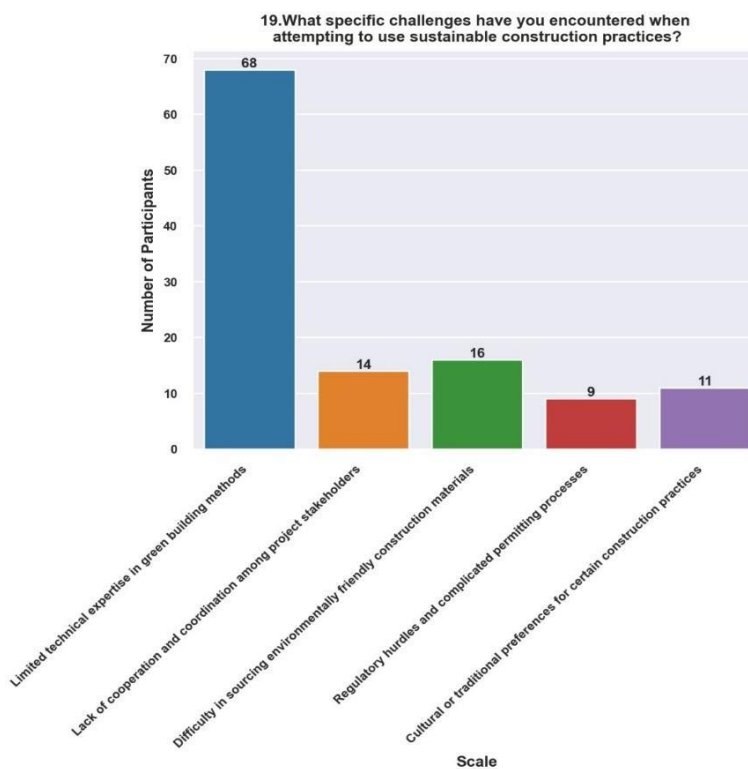


Fig: 4.23b

Limited Technical Expertise in Green Building methods (57.3%)

The prevailing lack of technical proficiency underscores the need for construction professionals to possess specific knowledge and competencies in green building techniques. Bhutan may need more professional training in energy-efficient technologies, green building regulations, sustainable design principles, and contractors. Investing in training and capacity-building initiatives to improve the abilities and expertise of those working on construction projects is necessary to meet this challenge. This could involve training programs, accreditations, and educational campaigns centered around sustainable building techniques, guaranteeing that experts possess the know-how to apply green building techniques successfully.

Difficulty in Sourcing Environmentally Friendly Construction Materials (13.7%)

Difficulties locating eco-friendly building supplies highlight issues with sustainable building materials' accessibility, cost, and availability in Bhutan. Low local production capacity and conventional building methods could result in a limited supply of environmentally acceptable materials. To address this issue, the government might provide incentives for manufacturing and using locally sourced materials that comply with green construction standards. This could entail fostering eco-friendly manufacturing techniques, supporting the development of sustainable forestry methods, and pushing for alternative building materials like bamboo and rammed earth. Furthermore, cultivating alliances with manufacturers and suppliers might aid in increasing the market's accessibility to ecologically friendly building supplies.

Lack of Cooperation and Coordination Among Stakeholders (12%)

In sustainable building projects, a lack of coordination and cooperation among project stakeholders can impede progress and lead to inefficiencies. Architects, engineers, contractors, government agencies, and other relevant parties must collaborate effectively to guarantee the integration of green building objectives throughout the construction process. The government can solve this difficulty through project management frameworks, regulatory processes, and stakeholder engagement programs by facilitating communication and collaboration. To ensure that sustainable building projects are effectively completed, obstacles to collaboration and coordination among project stakeholders can be removed with clear roles and duties, a culture of teamwork, and open communication.

Culture and Traditional Preference for Certain Sustainable Practices (9.4%)

The adoption of sustainable building techniques in Bhutan is mainly hampered by the Impact of cultural customs and preferences on building practices. Local populations may have strong links to traditional building materials and methods, making it difficult or reluctant to embrace new ideas. Engaging with communities, increasing knowledge, and showcasing the advantages of sustainable construction methods in ways that respect and honour cultural traditions are crucial to addressing this difficulty. This could entail emphasizing sustainable materials' financial and environmental benefits, incorporating traditional architectural features and aesthetics into green construction designs, and encouraging pride in regional ingenuity and craftsmanship. Bhutan may encourage a comprehensive approach to building by integrating sustainable construction techniques with traditional cultural values.

5. How do you perceive the role of government policies in promoting green building practices?

117 responses

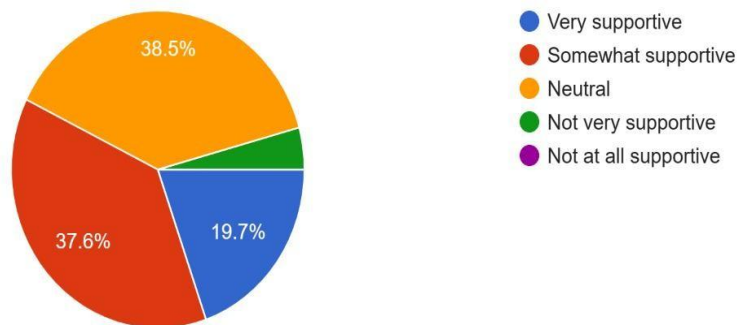


Fig:4.24a

20. How do you perceive the role of government policies in promoting green building practices?

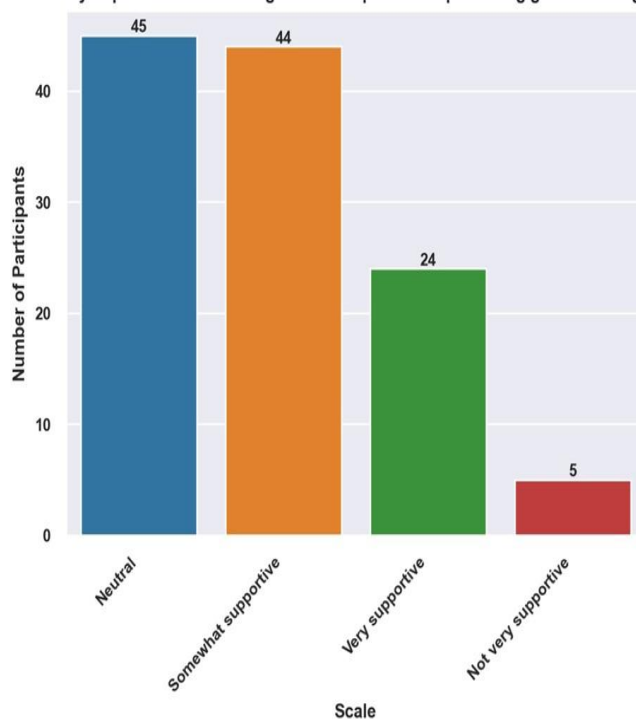


Fig: 4.24b
Neutral (38.5%)

The response indicates that no significant move from the government is entirely sure how well the government's present initiatives are working to promote green building techniques. This can result from a lack of knowledge of specific regulations aimed at sustainability in the building industry, or it might suggest a belief that current regulations need to be more robust and effective. The Bhutanese government should make proactive outreach and communication efforts to educate stakeholders about its green construction policies and projects to rectify this image. This

could entail promoting pertinent laws, rules, and incentives and showcasing best practices and successful case studies. Enhancing information accessibility and transparency might help the government gain stakeholders' trust and confidence in its commitment to advancing sustainability in the construction industry.

Somewhat supportive (37.6%)

The slightly supportive response indicates that even while the respondents accept the government's efforts to promote green building, they may believe that further steps or improvements are required to fully realize these policies' potential. This perception may stem from a desire for more extensive incentives, stringent enforcement, or better alignment with national development goals.

To rectify this picture, the Bhutanese government can review and enhance existing policies to address gaps and tackle new difficulties in encouraging green building. This could mean reviewing policies, seeking input and recommendations from relevant parties, and, if needed, introducing new legislation or initiatives. The government can increase support by being flexible in response to stakeholder feedback and continuously improving policy frameworks.

Very Supportive (19.7%)

The overwhelmingly affirmative response suggests that respondents have a favourable opinion of the role played by government initiatives in encouraging green building in Bhutan. This shows that those involved think the policies are successful, have an impact, and support national environmental preservation and sustainability goals.

This response is positive, but it also presents a chance for the government to expand its initiatives and fortify its green construction policy frameworks. Raising the bar for environmental performance in the construction industry could entail implementing new legislation or standards, growing incentives, and raising funding for sustainability projects. By leveraging the momentum of current support, the government may encourage further investment, innovation, and cooperation in green building methods, eventually furthering Bhutan's objectives for sustainable development.

The findings show that most Bhutanese people in the construction sector are moderately aware of sustainable construction. However, more than 55% of the respondents had never attended training or workshops even once within three years, which indicates that the government and NGOs need to work more to educate the people, particularly in the construction sector. Through awareness and education, the lifestyle and attitude of those people can be changed to reduce high CO₂ emissions.

Self-motivation and dedication are the keys to bringing about behavioural changes. Individuals and organizations are motivated to take action when they are satisfied with themselves and their ideals. Knowledge sharing must be maintained to inspire people to accept the new concept of green construction. As a result, construction stakeholders will learn about this new approach through execution and experience. Increasing the number of conferences, seminars, training, and workshops is advised to raise awareness. The public and private sectors must coordinate and collaborate to encourage and accelerate the green building movement.

According to the findings, most respondents believe that education is critical to accelerating the push toward putting green construction practices at the forefront of future projects. The low demand for green buildings reflected in these findings could also be attributed to the high initial cost of green technologies and materials. An improved understanding of the benefits of green buildings could increase construction stakeholders' interest in incorporating sustainable techniques; however, most respondents believed that this could be best accelerated by providing government subsidies through low-interest loans for sustainable construction. Furthermore, construction businesses' senior management teams may communicate the benefits of green buildings to society and individuals and their long-term cost benefits, raising national awareness of the need for a sustainable construction model.

According to the literature, the government's role is critical in supporting green construction. Other change agents, on the other hand, may be equally important. Highlighting the change drivers is critical to understanding what factors push construction enterprises to apply green construction.

According to the findings, "education programs are viewed as the primary driver in accelerating the implementation of green construction in Bhutan. This is consistent with previous findings in this study, in which the educational element was recognized as the primary hindrance to lack of awareness. Knowledge programs are aimed at various stakeholders, expand general knowledge about green principles, and raise awareness and demand for sustainable construction processes. Understanding stakeholders is crucial because they are the primary decision-makers in choosing sustainable construction practices. However, the construction sector should lead in directing participants' attention to sustainability issues and educating them on the benefits of using sustainable and green practices.

The fourth driving reason, 'Economic incentives,' is also a driving factor in supporting the sustainable movement. Demonstrates that financial incentives could assist stakeholders in stimulating demand. Financial incentives, as well as stricter laws and legislation, that support and encourage sustainable practices in construction standards and planning policy would provide a

minimum level of equality across the industry. This should eventually offset the "higher cost" barrier.

Reported Barriers to Green Building Practice Adoption

Respondents were asked to rank each element in terms of its importance as a barrier to implementing green building methods in Bhutan. The collected data was then examined and analyzed using the mean values. This is due not just to a need for more awareness, understanding, and concern for the environment but also to the belief that traditional methods of executing design, construction, and maintenance projects are adequate. In this regard, increasing knowledge through implementing an educational program in this sector would result in more experienced consumers demanding more efficient construction projects from the companies they work with, supporting sustainable practices.

1. Which one out of awareness, Drivers, Actions and Removal of barriers of Green Building is most effective solution?

119 responses

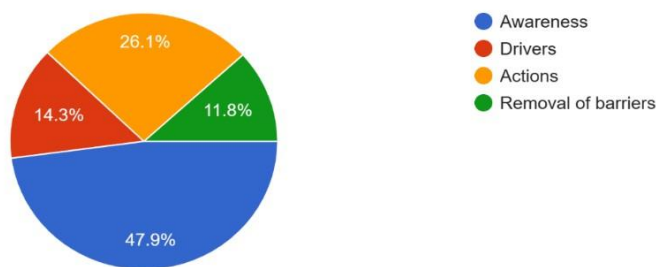


Fig:4.25a

21. Which one out of awareness, Drivers, Actions and Removal of barriers of Green Building is most effective solution?

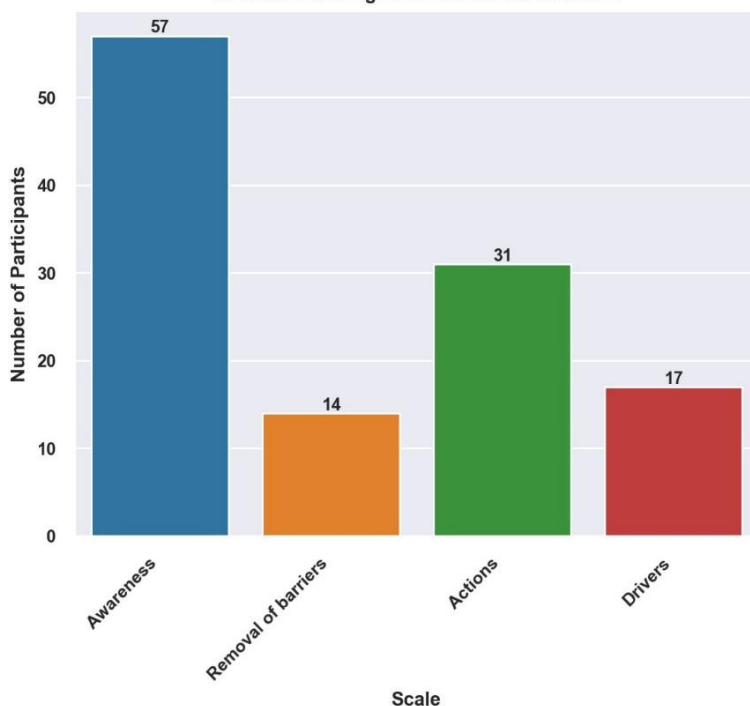


Fig:4.25b

Awareness (47.9%)

Awareness is the degree of knowledge and comprehension that people, communities, and stakeholders have about green construction's significance, advantages, and practices. In Bhutan, promoting green building practices means teaching people about the benefits of sustainable construction techniques in terms of the environment, society, and economy. This entails advocating for ideas like water conservation, energy efficiency, using renewable resources, and reducing carbon footprints in building design and construction.

Among the methods for raising awareness in Bhutan could be:

- Implementing educational initiatives that target multiple stakeholders, such as architects, engineers, policymakers, and the general public, through various mediums, such as workshops, seminars, and awareness programs.
- Incorporating green building principles into the curricula of universities, colleges, and institutions of vocational training.
- Collaborating with nearby communities, non-governmental organizations, and pertinent governmental bodies to distribute resources and knowledge on green building methods.

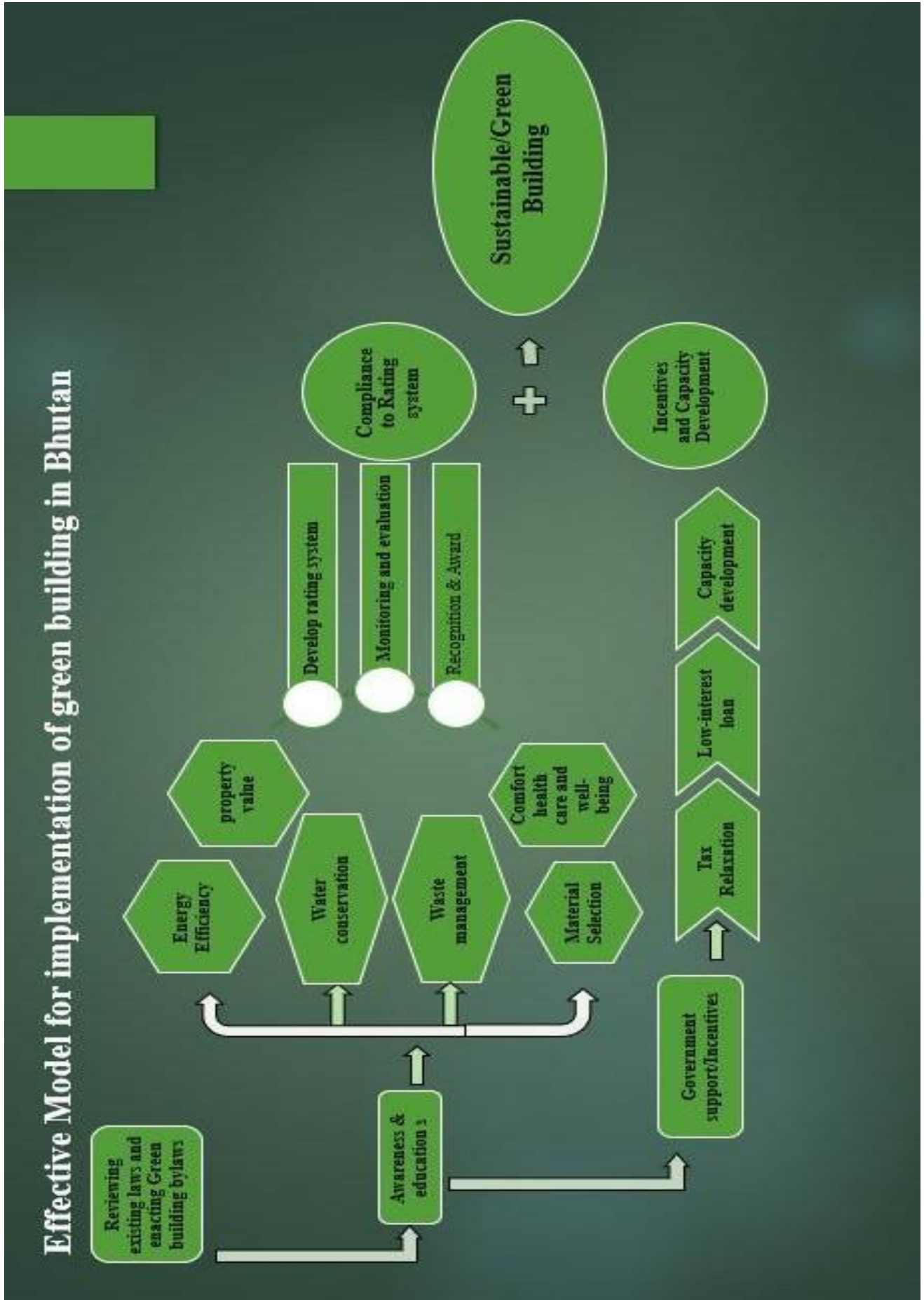
Action (26.1%)

The term "actions" refers to the concrete measures people, groups, and governments have made to incorporate green building principles into building projects. Using waste management systems, implementing energy-efficient technologies, adopting eco-friendly building materials, and adhering to green building standards and certifications like the Green Building Council of Bhutan (GBCB) or the Leadership in Energy and Environmental Design (LEED) are a few examples of actions that can be taken in Bhutan.

They offer tax discounts, grants, preferential credit programs, and other incentives and subsidies for green building projects.

It creates and implements building codes and laws that require or reward sustainable building techniques.

Promoting the use of traditional Bhutanese building methods and concepts that emphasize harmony with the environment and nearby resources



CONCLUSION AND FUTURE PERSPECTIVE

This study featured data obtained via a questionnaire as well as an analysis of the results [75]. The questionnaire's objectives were to investigate the level of awareness of sustainable and green practices among Bhutanese construction stakeholders, to assess how active the respondents and their organizations were in the field of green construction, to assess the respondents' perspectives on key issues related to sustainable design, and to investigate the drivers and any barriers that may exist toward implementing the practice of green construction [76]. To accomplish these goals, the questionnaire was distributed to experienced stakeholders in Bhutan's building and construction industry; 101 completed questionnaires were used for this portion of the study project.

The questionnaire data from the Google form was then directly taken to interpret based on the responses provided [77]. The findings revealed that a popular understanding of the idea of green building is aware among the people of Bhutan [78]. However, Greater awareness-raising efforts are still needed to speed the growth, adoption, and implementation of green building concepts in Bhutan. Furthermore, the questionnaire findings suggested that green construction approaches are underutilized and that rules and regulations are needed as guidelines for satisfying the needs of both society and the environment [79]. To promote the green concept, the government could amend existing standards or enact new rules, as well as issue appropriate recommendations for the application of green practices to ensure that sustainable methods are used [80]. This will then motivate all stakeholders to make modifications to comply with the new legislation [81]. Cooperation between the commercial and public sectors is essential to guarantee that standards and norms are created in an appropriate and achievable manner so that the construction industry can adapt and implement the new legislation appropriately [82]. This necessitates an examination of the current impediments and the need to remove them so that the construction industry can transition and execute the new legislation with the least interruption and risk. An investigation of the current legislation's application is suggested to address the 'lack of government enforcement' element, which respondents perceived as one of the existing causes for the lack of implementation of green construction technologies.

Reference

1. Munaro, M. R., & Tavares, S. F. (2023). A review on barriers, drivers, and stakeholders towards the circular economy: The construction sector perspective. *Cleaner and Responsible Consumption*, 8, 100107.
2. AlSanad, S. (2015). Awareness, drivers, actions, and barriers of sustainable construction in Kuwait. *Procedia engineering*, 118, 969-983.
3. Pattinson, S., Damij, N., El Maalouf, N., Bazi, S., Elsahn, Z., Hilliard, R., & Cunningham, J. A. (2023). Building green innovation networks for people, planet, and profit: A multi-level, multi-value approach. *Industrial Marketing Management*, 115, 408-420.
4. Silva, B. V., Holm-Nielsen, J. B., Sadrizadeh, S., Teles, M. P., Kiani-Moghaddam, M., & Arabkoohsar, A. (2023). Sustainable, green, or smart? Pathways for energy-efficient healthcare buildings. *Sustainable Cities and Society*, 105013.
5. Zhang, X., Ren, Y., Zhang, D., & Li, K. (2022). Construction of the green infrastructure network for adaption to the sustainable future urban sprawl: A case study of Lanzhou City, Gansu Province, China. *Ecological Indicators*, 145, 109715.
6. Kim, J. H., Augenbroe, G., & Suh, H. S. (2013). Comparative study of the LEED and ISO-CEN building energy performance rating methods.
7. Yang, J., Jiang, P., Suhail, S. A., Sufian, M., & Deifalla, A. F. (2023). Experimental investigation and AI prediction modelling of ceramic waste powder concrete—An approach towards sustainable construction. *Journal of Materials Research and Technology*, 23, 3676-3696.
8. Ramos, M., Martinho, G., Vasconcelos, L., & Ferreira, F. (2023). Local scale dynamics to promote the sustainable management of construction and demolition waste. *Resources, Conservation & Recycling Advances*, 17, 200135.
9. Wong, R. W., & Loo, B. P. (2022). Sustainability implications of using precast concrete in construction: An in-depth project-level analysis spanning two decades. *Journal of Cleaner Production*, 378, 134486.
10. Goel, A., Ganesh, L. S., & Kaur, A. (2019). Sustainability integration in the management of construction projects: A morphological analysis of over two decades' research literature. *Journal of Cleaner Production*, 236, 117676.
11. Ngayakamo, B., & Onwualu, A. P. (2022). Recent advances in green processing technologies for valorisation of eggshell waste for sustainable construction materials. *Heliyon*, 8(6).
12. Schwartz, Y., & Raslan, R. (2013). Variations in results of building energy simulation tools, and their impact on BREEAM and LEED ratings: A case study. *Energy and Buildings*, 62, 350-359.
13. Meshram, S., Raut, S. P., Ansari, K., Madurwar, M., Daniyal, M., Khan, M. A., ... & Hasan, M. A. (2023). Waste slags as sustainable construction materials: a compressive review on physico mechanical properties. *Journal of Materials Research and Technology*, 23, 5821-5845.
14. Rajabi, S., El-Sayegh, S., & Romdhane, L. (2022). Identification and assessment of sustainability performance indicators for construction projects. *Environmental and Sustainability Indicators*, 15, 100193.
15. Zambrano-Prado, P., Pons-Gumí, D., Toboso-Chavero, S., Parada, F., Josa, A., Gabarrell, X., & Rieradevall, J. (2021). Perceptions on barriers and opportunities for integrating urban agri-green roofs:

- A European Mediterranean compact city case. *Cities*, 114, 103196.
16. Jareemit, D., Suwanchaisakul, A., & Limmeechokchai, B. (2022). Assessment of key financial supports for promoting zero energy office buildings investment in Thailand using sensitivity analysis. *Energy Reports*, 8, 1144-1153.
 17. Rana, A., Sadiq, R., Alam, M. S., Karunathilake, H., & Hewage, K. (2021). Evaluation of financial incentives for green buildings in Canadian landscape. *Renewable and Sustainable Energy Reviews*, 135, 110199.
 18. Neidig, J., Anguelovski, I., Albaina, A., & Pascual, U. (2022). "We are the Green Capital": Navigating the political and sustainability fix narratives of urban greening. *Cities*, 131, 103999.
 19. Hayes, S., Desha, C., & Baumeister, D. (2020). Learning from nature—Biomimicry innovation to support infrastructure sustainability and resilience. *Technological Forecasting and Social Change*, 161, 120287.
 20. Lebdioui, A. (2022). Nature-inspired innovation policy: Biomimicry as a pathway to leverage biodiversity for economic development. *Ecological Economics*, 202, 107585.
 21. Zhuang, D., Zhang, X., Lu, Y., Wang, C., Jin, X., Zhou, X., & Shi, X. (2021). A performance data integrated BIM framework for building life-cycle energy efficiency and environmental optimization design. *Automation in Construction*, 127, 103712.
 22. Altieri, D., Patel, M. K., Lazarus, J., & Branca, G. (2023). Numerical analysis of low-cost optimization measures for improving energy efficiency in residential buildings. *Energy*, 273, 127257.
 23. Li, Q., Zhang, L., Zhang, L., & Wu, X. (2021). Optimizing energy efficiency and thermal comfort in building green retrofit. *Energy*, 237, 121509.
 24. Liu, Q., & Ren, J. (2020). Research on the building energy efficiency design strategy of Chinese universities based on green performance analysis. *Energy and Buildings*, 224, 110242.
 25. Franco, M. A. J. Q., Pawar, P., & Wu, X. (2021). Green building policies in cities: A comparative assessment and analysis. *Energy and buildings*, 231, 110561.
 26. Fan, Y., & Xia, X. (2018). Energy-efficiency building retrofit planning for green building compliance. *Building and Environment*, 136, 312-321.
 27. Gan, V. J., Lo, I. M., Ma, J., Tse, K. T., Cheng, J. C., & Chan, C. M. (2020). Simulation optimisation towards energy efficient green buildings: Current status and future trends. *Journal of Cleaner Production*, 254, 120012.
 28. Mustapa, S. I., Rasiah, R., Jaaffar, A. H., Bakar, A. A., & Kaman, Z. K. (2021). Implications of COVID-19 pandemic for energy-use and energy saving household electrical appliances consumption behaviour in Malaysia. *Energy Strategy Reviews*, 38, 100765.
 29. Zhang, Z., & Zhu, W. (2023). Residential mobility and household energy-saving appliances purchasing behavior in urban areas: Evidence from China. *Energy Reports*, 9, 387-396.
 30. Silvi, M., & Rosa, E. P. (2021). Reversing impatience: Framing mechanisms to increase the purchase of energy-saving appliances. *Energy Economics*, 103, 105563.
 31. He, S., Blasch, J., & van Beukering, P. (2022). How does information on environmental emissions influence appliance choice? The role of values and perceived environmental impacts. *Energy Policy*, 168, 113142.

32. Guardigli, L., Monari, F., & Bragadin, M. A. (2011). Assessing environmental impact of green buildings through LCA methods: A comparison between reinforced concrete and wood structures in the European context. *Procedia Engineering*, 21, 1199-1206.
33. Feng, H., Zhao, J., Hollberg, A., & Habert, G. (2023). Where to focus? Developing a LCA impact category selection tool for manufacturers of building materials. *Journal of Cleaner Production*, 405, 136936.
34. Hollberg, A., Kiss, B., Röck, M., Soust-Verdaguer, B., Wiberg, A. H., Lasvaux, S., ... & Habert, G. (2021). Review of visualising LCA results in the design process of buildings. *Building and Environment*, 190, 107530.
35. Poorova, Z., Kapalo, P., & Vranayova, Z. (2019). Effect of an interior green wall on the environment in the classroom. In *Advances and Trends in Engineering Sciences and Technologies III* (pp. 521-526). CRC Press.
36. Alimin, N. N., Pertiwi, E. G., & Purwaningrum, L. (2021, November). Establishing sustainable habits of students in Green School Bali through green interior design. In *IOP Conference Series: Earth and Environmental Science* (Vol. 905, No. 1, p. 012075). IOP Publishing.
37. Lee, L. S., & Jim, C. Y. (2021). Quantitative approximation of shading-induced cooling by climber green wall based on multiple-iterative radiation pathways. In *Eco-efficient Materials for Reducing Cooling Needs in Buildings and Construction* (pp. 79-100). Woodhead Publishing.
38. Sadeghian, M. M. (2016). A Review on green wall, classification and function. *International Journal of Scientific Research in Science and Technology*, 2(2), 47-51.
39. Mayrand, F., & Clergeau, P. (2018). Green roofs and green walls for biodiversity conservation: a contribution to urban connectivity?. *Sustainability*, 10(4), 985.
40. Lee, L. S., & Jim, C. Y. (2019). Energy benefits of green-wall shading based on novel-accurate apportionment of short-wave radiation components. *Applied energy*, 238, 1506-1518.
41. Palermo, S. A., & Turco, M. (2020, January). Green Wall systems: where do we stand?. In *IOP conference series: Earth and environmental science* (Vol. 410, No. 1, p. 012013). IOP Publishing.
42. Alonso, M. J., Liu, P., Marman, S. F., Jørgensen, R. B., & Mathisen, H. M. (2023). Holistic methodology to reduce energy use and improve indoor air quality for demand-controlled ventilation. *Energy and Buildings*, 279, 112692.
43. Peterková, J., Michalčíková, M., Novák, V., Slávik, R., Zach, J., Korjenic, A., ... & Raich, B. (2019). The influence of green walls on interior climate conditions and human health. In *MATEC Web of Conferences* (Vol. 282, p. 02041). EDP Sciences.
44. Lee, L. S., & Jim, C. Y. (2020). Multidimensional analysis of temporal and layered microclimatic behavior of subtropical climber green walls in summer. *Urban ecosystems*, 23(2), 389-402.
45. Davtalab, J., Deyhimi, S. P., Dessi, V., Hafezi, M. R., & Adib, M. (2020). The impact of green space structure on physiological equivalent temperature index in open space. *Urban Climate*, 31, 100574.
46. Kucuktuvek, M. (2020). Green-Wood Flooring Adhesives. *Green Adhesives: Preparation, Properties and Applications*, 205-225.
47. Ramesh, M., Palanikumar, K., & Reddy, K. H. (2017). Plant fibre based bio-composites: Sustainable and renewable green materials. *Renewable and Sustainable Energy Reviews*, 79, 558-584.

48. Mulki, S., & Ormsby, A. A. (2022). Breaking Green Ceilings: podcasting for environmental and social change. *Journal of Environmental Studies and Sciences*, 12(1), 18-27.
49. Ismaeel, W. S. (2018). Midpoint and endpoint impact categories in Green building rating systems. *Journal of Cleaner Production*, 182, 783-793.
50. von Castell, C., Hecht, H., & Oberfeld, D. (2018). Which attribute of ceiling color influences perceived room height?. *Human factors*, 60(8), 1228-1240.
51. Fontanini, A., Olsen, M. G., & Ganapathysubramanian, B. (2011). Thermal comparison between ceiling diffusers and fabric ductwork diffusers for green buildings. *Energy and Buildings*, 43(11), 2973-2987.
52. Kazemi, M., & Courard, L. (2021). Simulation of humidity and temperature distribution in green roof with pozzolana as drainage layer: Influence of outdoor seasonal weather conditions and internal ceiling temperature. *Science and Technology for the Built Environment*, 27(4), 509-523.
53. Li, G., Li, J., & Sun, X. (2019). Measuring green brand equity in relationship interactions and its impact on brand loyalty. *Revista de Cercetare Si Interventie Sociala*, 66, 278-297.
54. Teotónio, I., Silva, C. M., & Cruz, C. O. (2021). Economics of green roofs and green walls: A literature review. *Sustainable Cities and Society*, 69, 102781.
55. Maraj, A., Kértusha, X., & Lushnjari, A. (2022). Energy performance evaluation for a floating photovoltaic system located on the reservoir of a hydro power plant under the mediterranean climate conditions during a sunny day and a cloudy-one. *Energy Conversion and Management: X*, 16, 100275.
56. Peng, Z., Chen, X., & Yao, L. (2021). Research status and future of hydro-related sustainable complementary multi-energy power generation. *Sustainable Futures*, 3, 100042.
57. Jong, F. C., Ahmed, M. M., Lau, W. K., & Lee, H. A. D. (2022). A new hybrid Artificial Intelligence (AI) approach for hydro energy sites selection and integration. *Heliyon*, 8(9).
58. Ogino, K., Dash, S. K., & Nakayama, M. (2019). Change to hydropower development in Bhutan and Nepal. *Energy for Sustainable Development*, 50, 1-17.
59. Kuriakose, J., Anderson, K., Darko, D., Obuobie, E., Larkin, A., & Addo, S. (2022). Implications of large hydro dams for decarbonising Ghana's energy consistent with Paris climate objectives. *Energy for Sustainable Development*, 71, 433-446.
60. Tortajada, C., & Saklani, U. (2018). Hydropower-based collaboration in South Asia: The case of India and Bhutan. *Energy Policy*, 117, 316-325.
61. Ali, S., Stewart, R. A., Sahin, O., & Vieira, A. S. (2023). Integrated GIS-AHP-based approach for off-river pumped hydro energy storage site selection. *Applied Energy*, 337, 120914.
62. Field study of the building physics properties of common building types in the Inner Himalayan valleys of Bhutan
63. Zam, K., Gupta, M. K., & Uddin, S. M. N. (2021). The residential energy futures of Bhutan. *Energy Efficiency*, 14, 1-12.
64. Hashemi, A., Sutman, M., & Medero, G. M. (2023). A review on the thermo-hydro-mechanical response of soil–structure interface for energy geostructures applications. *Geomechanics for Energy and the Environment*, 33, 100439.

65. Zhang, H., Cao, Q., & Ma, Y. (2023). Comparison of two hydro-sediment models based on energy principle of water movement in saturated/unsaturated soils. *Energy Reports*, 9, 1561-1570.
66. Chen, W., Gao, W., Jiang, J., Wei, X., & Wang, R. (2021). Feasibility analysis of decentralized hybrid rainwater-graywater systems in a public building in Japan. *Sustainable Cities and Society*, 69, 102870.
67. Reang, S., & Nath, H. (2021). Grey water treatment with spiral wound UF and RO membranes. *Materials Today: Proceedings*, 46, 6253-6259.
68. Garraín, D., & Lechón, Y. (2023). Sustainability assessments in solar energy projects: Results of case studies. *Solar Compass*, 6, 100039.
69. Formolli, M., Kleiven, T., & Lobaccaro, G. (2023). Assessing solar energy accessibility at high latitudes: A systematic review of urban spatial domains, metrics, and parameters. *Renewable and Sustainable Energy Reviews*, 177, 113231.
70. Govindarajan, L., Batcha, M. F. B. M., & Abdullah, M. K. B. (2023). Solar energy policies in southeast Asia towards low carbon emission: A review. *Heliyon*.
71. Masera, K., Tannous, H., Stojceska, V., & Tassou, S. (2023). An investigation of the recent advances of the integration of solar thermal energy systems to the dairy processes. *Renewable and Sustainable Energy Reviews*, 172, 113028.
72. Spiru, P. (2023). Assessment of renewable energy generated by a hybrid system based on wind, hydro, solar, and biomass sources for decarbonizing the energy sector and achieving a sustainable energy transition. *Energy Reports*, 9, 167-174.
73. Spiru, P. (2023). Assessment of renewable energy generated by a hybrid system based on wind, hydro, solar, and biomass sources for decarbonizing the energy sector and achieving a sustainable energy transition. *Energy Reports*, 9, 167-174.
74. Lunevich, I., & Kloppenburg, S. (2023). Wind energy meets buildings? Generating socio-technical change in the urban built environment through vanguard visions. *Energy Research & Social Science*, 98, 103017.
75. Fournier, A., Martinez, A., & Iglesias, G. (2023). Impacts of climate change on wind energy potential in Australasia and South-East Asia following the Shared Socioeconomic Pathways. *Science of The Total Environment*, 882, 163347.
76. Karakislak, I., & Schneider, N. (2023). The mayor said so? The impact of local political figures and social norms on local responses to wind energy projects. *Energy Policy*, 176, 113509.
77. Veselka, J., Nehasilová, M., Dvořáková, K., Ryklová, P., Volf, M., Růžička, J., & Lupíšek, A. (2020). Recommendations for Developing a BIM for the Purpose of LCA in Green Building Certifications. *Sustainability*, 12(15), 6151.
78. Navabi, D., Amini, Z., Rahmati, A., Tahbaz, M., Butt, T. E., Sharifi, S., & Mosavi, A. (2023). Developing light transmitting concrete for energy saving in buildings. *Case Studies in Construction Materials*, 18, e01969.
79. Haseeb, Q. S., Yunus, S. M., Shoshan, A. A. A., & Aziz, A. I. (2023). A study of the optimal form and orientation for more energy efficiency to mass model multi-storey buildings of Kirkuk city, Iraq. *Alexandria Engineering Journal*, 71, 731-741.

80. Kissi, E., Sadick, M. A., & Agyemang, D. Y. (2018). Drivers militating against the pricing of sustainable construction materials: The Ghanaian quantity surveyors perspective. *Case studies in construction materials*, 8, 507-516.
81. Umbark, M. A., Alghoul, S. K., & Dekam, E. I. (2020). Energy consumption in residential buildings: Comparison between three different building styles. *Sustainable Development Research*, 2(1), p1-p1.
82. Filippini, M., & Obrist, A. (2022). Are households living in green-certified buildings consuming less energy? Evidence from Switzerland. *Energy Policy*, 161, 112724.