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Sustainability and Green Building Practices in the UK: A Mini Review of Economic, Environmental, and Socio-psychological Impacts

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Abstract
Climate change has compelled constructors, workers, and governments to pursue innovative strategies to alleviate the effects of human activity on the planet. Residential green buildings offer a feasible alternative to conventional green buildings. These structures alleviate the construction industry's environmental impact by integrating features and measures that reduce greenhouse gas emissions and thermal output. This study assesses the contribution of residential structures on promoting sustainability awareness in the UK. This study utilized a survey-based methodology targeting residents of green residential complexes in the UK to achieve its objectives. This study evaluated the impact of eco-friendly design features and sustainable building practices on inhabitants' understanding of sustainability. The advocacy of a sustainable lifestyle constituted the most substantial influence. The residents regarded reduced maintenance expenses as the principal advantage, but elevated building costs were recognized as the most considerable disadvantage. The awareness level of residents was evaluated. Occupants demonstrated a high level of awareness regarding energy-efficient lighting and BREEAM certification, while their awareness of workshops focused on the use of green technologies was comparatively low. In conclusion, organizing events such as Earth Day and utilizing digital displays emerged as the most effective promotional strategies, whereas the publication of sustainable reports was identified as the least effective. Green buildings can effectively enhance occupants' awareness of sustainability, while organizing events serves as a highly effective promotional strategy.

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Introduction

Climate change has become one of the most pressing global issues, with its profound impacts being felt across various sectors, including the construction and building industries. Human activities, particularly those related to urbanization and industrialization, are significant contributors to greenhouse gas emissions (GHGs) and environmental degradation [1]. The building industry, specifically, is responsible for a substantial share of global energy consumption and carbon emissions, making it one of the primary areas where sustainability efforts can be most impactful. As the world's population continues to grow and urbanize, there is an urgent need to find innovative solutions to reduce the environmental footprint of buildings, particularly residential structures [2]. In this context, green buildings have emerged as a viable solution to address the environmental challenges posed by traditional construction practices. Green buildings are designed and constructed with the aim of reducing energy consumption, water usage, and carbon emissions, while simultaneously promoting the health and well-being of their occupants.

These buildings incorporate energy-efficient technologies, sustainable materials, and environmentally friendly construction practices, which collectively help mitigate the building sector's environmental impact [3].

While much of the focus on green buildings has traditionally been placed on commercial and office buildings, the residential sector has increasingly gained attention due to the significant environmental impact of housing. Residential buildings are responsible for a large portion of energy consumption, especially in developed countries like the UK [4]. As urban areas continue to expand, the demand for housing grows, further exacerbating environmental concerns related to residential development. Consequently, residential green buildings represent a critical opportunity to reduce energy consumption and carbon emissions in one of the most energy-intensive sectors of the economy [5].

The adoption of residential green buildings has gained momentum in the UK, driven by the growing recognition of their environmental and economic benefits. These buildings are designed to be more energy-efficient, to use resources more sustainably, and to have a reduced overall environmental impact [6]. They also contribute to occupant health and comfort, offering benefits such as improved air quality, better natural lighting, and increased thermal comfort. However, despite the numerous benefits of green buildings, their widespread adoption in the residential sector has been slower than anticipated. This is due to a variety of barriers, including higher initial construction costs, lack of awareness, and limited knowledge about the long-term benefits [7].

In the UK, BREEAM (Building Research Establishment Environmental Assessment Method) has become one of the most widely recognized certification schemes for sustainable buildings, including residential green buildings. BREEAM certification provides a comprehensive framework for assessing the environmental performance of buildings, with criteria ranging from energy efficiency and water usage to the quality of indoor environments and the use of sustainable materials. However, while certification schemes like BREEAM are widely used, they are not always sufficient to encourage widespread adoption among consumers, developers, and policy-makers [8].

A key factor in promoting the adoption of green buildings is raising sustainability awareness among the public. For residential green buildings to become a mainstream solution, occupants must be informed about their environmental and economic benefits. This awareness not only encourages individuals to make more sustainable lifestyle choices but also helps to create a demand for eco-friendly housing, which in turn drives the market for green building technologies and construction practices [9]. The role of residential green buildings in raising awareness about sustainability is therefore an important area of research that has the potential to inform policy-making and development practices in the UK and beyond [10]. This study focuses on evaluating the role of residential green buildings in increasing awareness about sustainability among their occupants in the UK. The study aims to assess the effectiveness of green building design features and sustainable building practices in raising awareness about sustainability issues. Through a survey-based approach targeting occupants of residential green buildings, the study identifies key factors that influence occupants' knowledge and perceptions of sustainability, and evaluates the most effective modes of promoting sustainability awareness. The research also explores the perceptions of green building occupants regarding the benefits and drawbacks of living in these buildings. While green buildings offer numerous advantages, such as lower maintenance costs and energy savings, there are also challenges associated with their construction, such as higher upfront costs. Understanding these perceptions is crucial for identifying strategies to overcome barriers to adoption and to foster greater acceptance of green buildings among potential residents.

Finally, the study investigates the current awareness levels among occupants of residential green buildings regarding sustainability issues. This includes assessing their knowledge about energy-efficient technologies, certification systems such as BREEAM, and various sustainable building practices. By identifying the gaps in awareness, the study provides valuable insights into how sustainability can be better promoted within the residential sector and how green building initiatives can be scaled up to meet the UK's sustainability goals.

Green Buildings

Sustainable or high-performance buildings are alternative terms for green buildings. They entail the development of sustainable structures that utilize fewer resources, integrating processes throughout a building's life cycle, including siting, design, construction, operation, maintenance, renovation, and deconstruction [11]. Conventional building design considerations encompass construction costs, functionality, durability, and occupant comfort. Green building designs can mitigate these challenges [12]. Research on green buildings has proliferated in the past twenty years, as the green building movement has gained substantial traction, with over 3.6 billion square feet of structures certified under the Leadership in Energy and Environmental Design (LEED) program, initiated in August 1998. LEED has accredited more than 69,000 building projects across 150 nations. Diverse rating systems are available. Nonetheless, all of them focus on health and convenience. The tenants' health credits within the LEED certification proceed under the Indoor Environmental Quality categories [13]. This encompasses adhering to ventilation standards, regulating tobacco smoke, minimizing biological and chemical exposure, and utilizing low-emission materials. Health credits are provided for enhancing ventilation, implementing green cleaning methods, and monitoring indoor air quality. The notion of green buildings prioritizes efficiency in energy use and the utilization of renewable and inexhaustible energy sources. Numerous studies have elucidated that energy-efficient design strategies, including optimal building orientation, enhanced insulation and glazing of the building envelope, and implementing passive solar design techniques, alongside installing energy-efficient electrical gadgets and devices, are crucial. Reducing energy consumption in buildings may facilitate the application of renewable energy materials for energy production. This can enable the total or partial satisfaction of the building's energy requirement [14].

Benefits of Sustainable Architecture

Numerous benefits of green building have been documented. For instance, green buildings incur reduced running expenses and can achieve an average energy savings of 30%. Furthermore, when factoring in additional benefit such as reduced water usage, lower operating costs, enhanced health,

and increased productivity, the financial gains can be tenfold greater than the average cost premium of 1.84%. Numerous significant advantages have been recognized [15]. These advantages encompass a 60% decrease in energy and water usage, a 1-25% enhancement in efficiency, an elevated rate of return alongside asset market value, and a 5-10% improvement in rental rates. Additional advantages of green buildings encompass less maintenance expenses, enhanced property value, better productivity, and a decrease in absenteeism. Additionally, advantages pertaining to health and competitiveness are also evident. Moreover, it has been found that sick building syndrome can be mitigated by 41.5% annually within the health context. Green design features are characteristics that reduce environmental consequences while maximizing the building's efficiency and effectiveness [16].

Eco-friendly Material

It is estimated that garbage from the building industry constitutes 27% of landfill waste in Canada. Seventy-five percent of this garbage is recyclable or reusable. The repurposing of this garbage can enhance the sustainable design of eco-friendly structures. A Life Cycle Analysis (LCA) indicated a decrease in greenhouse gas emissions from 271 kg CO2eq/m2 to 37.0 kg CO2eq/m2 when new materials are substituted with demolition trash. Reports indicate that green building design can significantly mitigate acidification, summer smog formation, nitrification, and the accidental discharge of heavy metals. Agricultural debris may be utilized in the construction of sustainable buildings. These materials are utilized as particle boards composed of cotton stalk, maize husk, paddy straw, groundnut shell, and banana bunch. Agricultural waste can serve as thermal insulators, masonry bricks, and the binding agent for the bricks [17].

Energy effectiveness is a crucial property of green design elements. The objective is to reduce energy consumption and its usage. Kenaf boards serve as thermal insulators. Implementing LEED certification can enhance energy savings by 58% in libraries, while for multi-unit residential buildings, interpretative centers, offices, and public buildings, the reductions are 42%, 32%, 28%, and 21%, respectively [3].

Water Conservation

Water conservation can be accomplished through multiple techniques. Initially, water conservation devices, like advanced taps, shower nozzles, and automatic flushing sensors, can be utilized. Additionally, systems for the storage and distribution of rainwater can be implemented. Ultimately, an intermediate water system can be employed to harness repurposed rainfall. Passive Solar Design utilizes solar energy to optimize heating and cooling systems within an environmentally sustainable building. Design optimization is accomplished through the regulation of heat flow, cooling, heating, and lighting loads, alongside minimizing construction costs while preserving system quality. The reduction of CO2 emissions also enhances the design optimization [18].

Vegetated Roofs and Walls

Green roofs incorporate vegetation in its uppermost layer. They are typically employed to enhance the energy efficiency of structures. Nevertheless, numerous environmental advantages have been documented. Primarily, they can reduce heating and cooling demand. Furthermore, they can enhance air temperature. Thirdly, they can alleviate air pollution while improving urban air quality. Finally, they offer acoustic isolation. Green walls are vertical plant installations that have been utilized since the era of Babylon. The green walls may be conventional, with climbing plants utilizing the structure for support [19]. They may also possess a double skin configuration, supported by a dual-layer framework. The framework is distanced from the wall by an open expanse. Finally, the perimeter flowerpots contain cultivated plants. These pots are arranged perpendicularly around the building. Reports indicate that green walls and roofs can enhance local biodiversity. Nonetheless, biodiversity differs in each instance. Species prevalent on green roofs may be absent in green walls and vice versa. This is due to the varying biological conditions they offer. The significance of sustainability and the function of green buildings [20].

Numerous professionals in the construction sector are beginning to acknowledge that green building initiatives ought to be referred to as sensible building initiatives, particularly in an industry that has clung to ineffective business practices and antagonistic team dynamics. The phrase "green buildings" refers to initiatives designed to minimize environmental impact while maximizing energy efficiency and occupant productivity [11]. While the majority of individuals in this field concur that the popularity of green buildings will rise, few have articulated definitive views regarding the implications of this shift in mentality for their companies. While the professional designers have opted to spearhead conversations on sustainable design and construction, the owners are assessing the role that construction businesses can play in green building projects [21].

A significant debate has emerged among researchers regarding the efficacy of various green building rating tools in facilitating the role of green buildings in attaining sustainability objectives. Green Building Rating Tools (GBRTs) serve as practical instruments that assign scores and rankings based on the adherence of green buildings to diverse sustainable criteria. This allows GBRTs to evaluate the efficacy of green buildings. These instruments have been devised by various nations and areas, considering the local terrain, climate, and cultural attributes. The prevalence of GBRTs has surged in the early 21st century, with hundreds of distinct GBRTs currently employed worldwide [22]. Consequently, numerous buildings have attained accreditation via GBRTs, which have been instrumental in accelerating the sustainable transformation of the construction industry, a vital sector related to the SDGs. GBRTs are accessible and straightforward, serving as an effective evaluative framework and incentive implementation mechanism for attaining the SDGs within the building sector [23]. The significance of green buildings in fostering sustainability awareness among occupants. Researchers have examined methods to promote environmentally friendly behavior among individuals. The primary aim of the researchers was to determine whether conversing with elderly individuals about environmental sustainability would yield significant results. Researchers discovered that it was effective [24]. Secondly, they aimed to determine whether individuals employed and educated in green buildings had a heightened concern for the environment. The individuals in the conventional building exhibited greater concern due to their increased discussions over the environment. This indicates that engaging

individuals in eco-friendly practices is more successful than merely possessing a sustainable structure. The Post Occupancy Evaluation (POE) is an essential method for enhancing building performance. However, discrepancies may arise between the client's desires and the design's outcomes. The United Kingdom initiated an initiative named PROBE to address this issue. Numerous POE studies were conducted on various buildings, resulting in the establishment of a standardized methodology for conducting POE assessments [25]. This facilitates improved POE studies for individuals in the future.

Recent research from the UK and the USA indicates that individuals employed in green buildings are amenable to minor discomfort, provided they have control over temperature and other environmental factors. The "forgiveness factor" quantifies the extent to which individuals disregard issues within their structures. Individuals evaluate various sections of their building on a scale from 1 to 7. Despite the fact that green buildings may have elevated temperatures in summer and reduced temperatures in winter, they remain popular among individuals. Certain experts believe that individuals are more tolerant of slight discomfort due to their enhanced comprehension of outdoor weather conditions in a green building. When individuals may regulate elements such as windows, shade, and lighting, their discomfort diminishes [26].

Impact of Green Building Design Features on Sustainability Awareness

The survey data highlighted that implementing green building design features significantly enhances occupants' sustainability awareness. Features such as energy-efficient lighting, HVAC systems, and renewable energy sources (e.g., solar panels) were consistently identified as impactful [27]. The findings align with existing studies, which demonstrate that green design elements reduce environmental impact while encouraging tenants to adopt sustainable practices. Energy-efficient lighting (mean score = 3.79) and BREEAM certification (mean score = 3.75) were the most widely recognized attributes, indicating a high level of awareness among occupants. These features not only provide environmental benefits but also enhance occupants' understanding of sustainable technologies. However, other features such as rainwater harvesting and green roofs showed comparatively lower awareness levels, suggesting a need for targeted educational efforts to address these gaps [28].

Perception of Benefits and Drawbacks of Green Buildings

The perceived benefits and drawbacks of green buildings among occupants were diverse. Reduced maintenance costs (OPB05) emerged as the most significant benefit, enhancing the financial feasibility of green building investments. Other notable advantages included improved thermal comfort (OPB07) and noise reduction (OPB08), reflecting the operational and social benefits associated with sustainable building designs [29]. These findings align with prior research emphasizing the long-term economic and environmental benefits of green buildings. Conversely, high construction costs (OPB10) and the complexity of planning and approvals (OPB12) were cited as major challenges. These drawbacks highlight the need for financial incentives, government subsidies, and streamlined regulatory processes to mitigate the initial cost barriers associated with green building development. Addressing these challenges can promote wider adoption, especially in residential markets [30].

Current Awareness Levels among Occupants

The analysis revealed a varying degree of awareness about different aspects of sustainability among occupants. While there was strong awareness regarding well-known features such as BREEAM certification and energy-efficient lighting, there was limited awareness about workshops on green technologies and rainwater harvesting systems. These findings emphasize the importance of targeted educational initiatives to improve understanding of less visible but equally impactful green technologies [31].

The study identified several effective strategies for promoting sustainability awareness among occupants. Organizing events like Earth Day (mean score = 3.58) was found to be the most effective mode of engagement. Other impactful methods included public displays and social media campaigns, which provide interactive and visually engaging platforms for educating occupants. However, traditional methods such as publishing sustainability reports were perceived as less effective, reflecting a preference for more dynamic and participatory approaches [32].

The studies conducted in Canada and Hong Kong report similar benefits of green design features, including reduced GHG emissions and improved thermal comfort. However, the challenges identified in this study, such as high costs and limited awareness, indicate unique characteristics in the UK market. These findings highlight the importance of region-specific solutions to enhance the adoption and effectiveness of green building initiatives [33].

Conclusion

In order to combat climate change and advance sustainability, green buildings are essential. The purpose of this study was to assess how residential green buildings in the UK contribute to residents' increased understanding of sustainability. According to the research, green building elements—in particular, HVAC systems, energy-efficient lighting, and BREEAM certification—have a major impact on raising environmental awareness. These characteristics highlight the many advantages of sustainable building, as they not only enhance the standard of living for locals but also encourage environmentally beneficial practices. Important insights were gained from the perception of advantages and disadvantages. The most noteworthy advantage was lower maintenance costs, which demonstrated the long-term viability of green buildings from a financial standpoint. However, the necessity for government assistance in the form of subsidies and expedited clearance procedures was highlighted by the identification of high construction costs and intricate regulatory processes as major obstacles.

The survey also provided insight into tenants' present knowledge levels, highlighting a high level of familiarity with well-known green building characteristics. The significance of focused education and engagement initiatives is highlighted by the lack of knowledge of other sustainable technology, such as rainwater harvesting systems. While traditional methods like releasing sustainability reports were judged to have less of an impact, events like Earth Day and interactive public displays were assessed to be the most effective ways to raise awareness of sustainability.

All things considered, residential green buildings have shown themselves to be a successful tool for raising awareness of sustainability issues and promoting eco-friendly living.

Wider acceptance, however, requires tackling the issues of high upfront costs and low awareness by calculated interventions. The full potential of green buildings to reduce environmental impact and advance sustainable development can be achieved by utilizing educational programs and government incentives. This study lays the groundwork for further research and policy-making in this area while reinforcing the importance of green buildings as a vital instrument for promoting sustainability in the UK.

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Conflict of interest statement
The author declares that they have no conflict of interest.

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