The embeddedness of sustainability in the construction industry: Identifying key drivers and barriers to implementation

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Abstract. Sustainable buildings play a critical role in mitigating climate change. Despite the growing significance of the sustainability agenda driven by EU decarbonization targets, the integration of sustainability criteria in decision-making remains limited. In this study, key factors influencing the implementation of sustainability are identified based on data from an empirical study conducted with construction industry experts in November 2022. Focus groups, comprising real estate project managers, architects, engineers, construction managers, real estate brokers, real estate appraisers, and researchers were engaged to analyze the drivers and barriers to sustainability adoption in practice. Legal regulations, company reputation, and stakeholder demand are recognized as pivotal factors driving the integration of sustainability within the construction industry. Conversely, the main causes for limited implementation are linked to deficiencies in the legislative framework, financial considerations, late adoption of sustainable practices, and lack of awareness among stakeholders. The study reveals a significant impact of legislation, emphasizing that the most substantial influence on sustainability implementation derives from national regulations and international directives, which highlights the imperative to comprehensively integrate various aspects of sustainability within regulatory frameworks. To overcome financial constraints, it is imperative to offer financial incentives and address the prevailing perception gap by substantiating the long-term financial benefits of sustainable buildings to stakeholders, supported by empirical research.

1 Introduction

The increasing environmental impact of buildings in the context of rapid urbanization highlights the importance of the sustainability of the built environment. The buildings sector accounts for one-third of global energy-related emissions, with a significant share arising from both operational activities (26%) and embodied emissions (7%) associated with material production [1]. Despite heightened regulatory measures in the EU over the past decade, operational emissions have consistently increased at an annual rate of 1% since 2015. Achieving alignment with the Net Zero Emissions Scenario by 2030, a pivotal goal within the EU Green Deal's [2] decarbonization objectives, necessitates a substantial operational emissions reduction of approximately 50% from the 2022 baseline.

The accelerated global expansion of floor area surpasses the pace of efficiency and decarbonization efforts. The rapid dynamics of urbanization are particularly alarming given the prolonged lifespan of buildings, posing a risk of 'locking in' inefficient and high-emission infrastructure. Despite the expanding scope and increasing rigor of minimum performance standards and building energy codes across the EU, driven by legislative frameworks such as the Energy Performance of Buildings Directive EU/2018/844 [3] and the Energy Efficiency Directive EU/2023/1791 [4], the practical implementation of sustainability faces various challenges. The industry's complex ecosystem, characterized by diverse stakeholders, traditional building methods, and economic considerations, hinders the adoption of environmentally conscious practices. Therefore, to achieve systemic change in sustainable construction, it is necessary to identify important drivers and barriers to adoption.

2 Literature

Conceptualized by the World Commission of Environment and Development in 1987, sustainable development is outlined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs [5]. In the context of the construction industry, sustainable construction is defined as the creation of a healthy built environment using resource-efficient, ecologically-based principles [6]. Comprising three fundamental pillars, sustainable construction thus refers to the development of the built environment that integrates measures to foster the sustainable well-being of environmental, social, and economic systems [7].

While critical for mitigating climate change, the resistance to the adoption of sustainability practices is evident at the industry level. The construction sector is distinguished by its inherent conservatism and is further

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characterized by the presence of strong path dependencies and a tendency to adhere to well-established construction methods and materials [8]. One of the main constraints to the adoption of innovative solutions, such as prefabrication, lies in the reluctance among contractors' firms to embrace changes in their practices [9]. The challenges hindering the use of sustainable materials are associated with higher material costs, and potential project cost overruns, where the overarching project budget often poses a substantial constraint, resulting in reduced investment in the incorporation of sustainable materials [10]. The construction sector displays resistance to adopting circular practices, with industry participants showing a preference for traditional methods characterized by low technological adoption [11]. The shift toward sustainability is hindered by a lack of widespread awareness at the ecosystem level regarding the benefits of employing environmentally conscious construction materials [12]. There is a need to develop comprehensive standards and guidelines to foster the wider adoption of sustainable materials in construction projects [10].

The role of government and local authorities is acknowledged in overseeing institutional regulation within the construction sector [8], [10]. While explicit restrictions and adherence to performance-based codes may pose initial barriers, governments can support innovation activities to ensure regulatory compliance and address constructability issues through research and development tools [13]. The pivotal role of municipalities in advancing sustainability within the construction sector is evident when considering gradual changes introduced by national programs promoting wood construction [8]. The implementation of sustainability features is attributed to key government initiatives, with a focus on sustainability aspects relating to minimum energy efficiency standards, green building certifications, and energy benchmarking [14]. The incorporation of sustainability features is guided by business strategies focused on Environmental, Social, and Governance (ESG) considerations, to safeguard asset value and proactively address potential challenges arising from tightening legislation [15].

While the increased emphasis on sustainable practices within the built environment has prompted extensive research, the predominant focus of existing studies in this field revolves around post-occupancy energy performance, indoor environment quality, and occupants' comfort [16], [17], [18]. Policy-making predominantly centers on energy efficiency and carbon neutrality, with limited attention to life cycle thinking, resulting in the infrequent application of life-cycle tools for assessing the effectiveness of circular strategies [8], [11]. Therefore, a comprehensive integration of sustainability dimensions is needed in the construction industry to achieve systemic change.

3 Methods

Conducted in November 2022, the empirical study aimed to identify key factors influencing sustainability implementation, recognize barriers in the construction sector and forecast the long-term significance of sustainability attributes. Employing a multi-layered qualitative research approach, the study comprehensively analyzed the behavior and practices of stakeholders in decision-making regarding sustainability implementation within the construction industry. Purposive sampling was utilized to recruit a diverse group of construction industry professionals. To ensure representation across expertise in the construction industry domain, 264 potential participants in Lithuania from various stakeholder groups were invited, including real estate development project managers, architects, engineers, construction managers, real estate brokers, real estate appraisers, and researchers specializing in the disciplines of construction management and real estate. The final selection was based on positive responses, ensuring representative groups covering a wide range of roles, and involved 36 experts. Primary data were collected through a survey featuring a series of closed-ended and open-ended questions aligned with the study's objectives, facilitating a comprehensive exploration of sustainability practices within the construction industry. The data obtained from the qualitative study were coded, marking E for experts, followed by the two letters indicating the expert's field of expertise (RD – real estate development, AR – architecture, EN – engineering, CO – construction, RB – real estate brokerage, RV – real estate valuation, and AC – research and education), and a number representing the respondent's identification. Based on the responses to open-ended questions, motivating and limiting factors have been comprehensively examined.

4 Results

The study investigated the perspectives of experts concerning the evolving significance of sustainability indicators within the construction sector. Survey data revealed that 68.6% of experts underscored a substantial increase in the importance of sustainability indicators over the past decade, while 28.5% noted a modest rise. Only a minority, comprising 2.9%, asserted no perceptible change. In addition, 94.4% of experts indicated an anticipated growth in the significance of building sustainability characteristics.

The main factors influencing the implementation of sustainability measures in the construction industry were assessed by the experts, as shown in the diagram (Fig. 1).

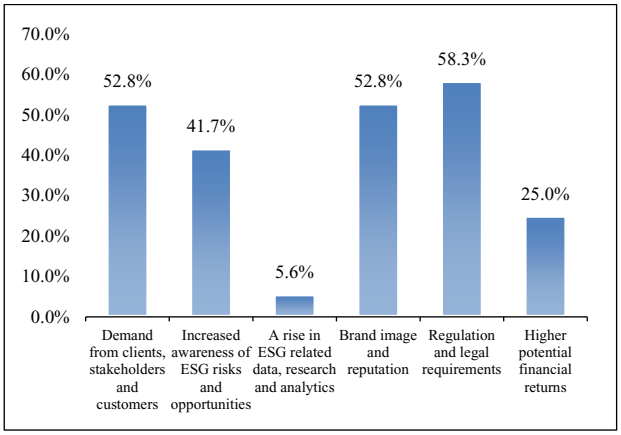

Fig. 1. Factors driving sustainability implementation.

Based on the study findings, the respondents assigned the highest weight to construction technical regulations and legal requirements (58.3% of respondents) as the most significant factor for implementing sustainability. Additionally, company image and reputation, along with demand from clients, users, and stakeholders, were identified as significant factors (52.8% each). Relatively lower importance was attributed to heightened awareness of ESG investment risks and opportunities (41.7%). Notably, only 25.0% of experts associated sustainability implementation with increased financial returns. A mere 5.6% of experts indicated the influence of empirical research results on the implementation of sustainability in practice. Therefore, it can be argued that there is a lack of research addressing pressing questions regarding the rationale for implementing sustainability and/or insufficient spread of the research findings to the construction sector stakeholders. The research results demonstrate a clear top-down influence, with institutional regulation exerting the most substantial impact, while the impact is least apparent in evidence-based research regarding the benefits of sustainability.

The developed assessment system for evaluating building sustainability comprised nine criteria groups: 1) Flexibility and Adaptability of Use, 2) Energy Use, 3) Water Use, 4) Accessibility and Mobility, 5) Safety and Security, 6) Health and Well-being, 7) Pollution, 8) Waste Management, and 9) Ecology. To assess the importance of sustainability criteria for the long-term value of buildings, the Relative Importance Index (RII) method was employed. The process involved the indirect determination of indicator weights through a scoring system, wherein experts assessed the significance of criteria on a scale ranging from 1 to 5. The relative importance was determined using the formula:

$$RII = \frac{\sum_{t=1}^{r} \omega_{jt}}{\max_t \omega_{jt} \times r} \quad (1)$$

where ω_{jt} is the weighting given to each criterion by the respondents, $max_t \omega_{jt}$ is the highest weight, and r is the total number of respondents.

Kendall's concordance coefficient W was calculated to assess the level of agreement among expert opinions across different stakeholder groups. The resulting concordance coefficient W of 0.791 indicated a high degree of consensus. Further assessment of expert opinion compatibility and the significance of the concordance coefficient was conducted using the χ^2 criterion. With a significance level of $\chi = 0.05$, the critical value of χ^2 was determined from the χ^2 distribution table with $\chi = m - 1$ degrees of freedom. The derived chi-squared test value of 44.305 significantly surpassed the critical χ^2 value of 15.507, affirming consensus among expert evaluations.

A normalization process was implemented to determine criteria weights, ensuring the harmonization of the relative importance of criteria. Based on the empirical findings, the significance of sustainability criteria in influencing the long-term value of buildings, as assessed by expert groups and normalized within the evaluation criteria system, is presented in Table 1.

Table 1. The significance of the sustainability criteria.

No	Criteria	RII_{RD}	RII_{AR}	RII_{EN}	RII_{CO}	RII_{RB}	RII_{RV}	RII_{AC}	**Normalized weights**
G_1	Flexibility and Adaptability of Use	0.820	0.750	0.770	0.810	0.880	0.840	0.830	**0.115**
G_2	Energy Use	0.888	0.780	0.792	0.816	0.856	0.864	0.872	**0.149**
G_3	Water Use	0.690	0.733	0.620	0.650	0.680	0.700	0.700	**0.096**
G_4	Accessibility and Mobility	0.900	0.833	0.870	0.850	0.910	0.880	0.790	**0.122**
G_5	Safety and Security	0.780	0.817	0.730	0.690	0.820	0.740	0.850	**0.110**
G_6	Health and Well-being	0.890	0.850	0.850	0.900	0.890	0.870	0.850	**0.123**
G_7	Pollution	0.760	0.750	0.610	0.700	0.800	0.640	0.760	**0.102**
G_8	Waste Management	0.840	0.756	0.653	0.653	0.773	0.653	0.733	**0.077**
G_9	Ecology	0.790	0.701	0.710	0.690	0.820	0.710	0.820	**0.106**

Following the study results, factors limiting the implementation of sustainability were identified, which can be categorized into four groups: 1) policy and regulation, 2) financial considerations, 3) perceptions and attitudes, and 4) professional competence.

Policy and regulation were highlighted as one of the key areas of concern. The study findings revealed deficiencies in the legislative framework (EAC26), misalignment of criteria in sustainability assessment systems with normative requirements, and inconsistencies in the definition of sustainability (EEN22). It is noted that there is a need for more proactive development of laws promoting sustainable construction, and providing support, such as incentives, to developers undertaking sustainable real estate projects (EAC04). It is noteworthy that, based on the key drivers identified, sustainability criteria are increasingly associated with company image and reputation. However, the absence of a precise definition of sustainability criteria in the legislation poses a risk, making it possible to assign a sustainability label for marketing purposes even to buildings that do not meet sustainability characteristics. Concerns were raised

regarding the deceptive practice of 'greenwashing,' which is evident in the sector (EEN22). This indicates that regulatory measures serve as one of the primary driving factors and, in the context of deficiencies in policy and regulation, also emerge as one of the key obstacles hindering the implementation of sustainability within the construction industry.

Financial considerations emerged as a significant constraint, with indicated high initial investment costs (EAR02, EAR07, EEN28, EEN16, EAC21), lower return on investment (ERV17), extended payback periods (ERD05, EAR06), high cost of sustainability assessment systems (EEN22), developer reluctance to invest in eco-friendly building materials (ERB35), high cost of sustainable solutions to achieve high levels of sustainability (ERB22), and an overarching focus on maximizing profit margins (ERD15, EAR09), impacting competitiveness in the market (ERD13). Notably, the financial aspect is dominant among all the limiting factors, as indicated by representatives of all respondent groups in the study. The study draws attention to a notable disparity in perception concerning the projected versus actual costs in the design and construction of sustainable buildings, based on the assumption that sustainable projects incur significantly higher costs compared to code-compliant conventional buildings. While empirical research does indicate a rise in the construction costs associated with sustainable buildings, approximately 6.5% [19], it is crucial to note that sustainable buildings, in turn, command a premium in rental and sales prices, ranging from 4% to 8%, and from 8% to 22%, respectively [20], [21], [22]. Moreover, studies on discounted cash flow analysis suggest a noteworthy 9.0% increase in asset value associated with sustainability certification [21]. This underscores the importance of obtaining empirical data on investment performance regarding long-term benefits and financial incentives necessary for fostering the adoption of sustainable practices.

Perceptions and attitudes toward sustainability are shaped by long-term beliefs that guide decisions in favor of sustainable choices over alternative options, such as economically efficient buildings that meet minimum building codes. The challenges to implementing sustainability are intertwined with the prioritization of financial considerations over sustainability features in consumer decision-making. Experts emphasized the limited societal awareness regarding the importance of investing in sustainable projects (EAR25), with sustainability not emerging as a priority for buyers amid various factors influencing their decisions (EAR07, ERB29, EAC08). The emphasis on the initial cost of a property contributes to the low demand for buildings with sustainability features (ECO12). Despite recognizing the importance of sustainability, it often remains a declarative concept. In practice, price tends to outweigh quality criteria, shaping value preferences. However, it is worth noting that the construction sector is significantly influenced by consumers' purchasing power, and real estate remains a challenging affordability for buyers (EAR07). Consequently, there is a tendency to prioritize constructing more cost-effective buildings without giving due consideration to their sustainability (EAC27). Therefore, depending on the economic context of a country, even a relatively modest increase in the prices of sustainable buildings becomes a crucial factor for end-users.

Insufficient professional competence poses a significant obstacle to the successful implementation of sustainable practices, primarily attributed to the lack of knowledge (EAR10) and the delayed integration of innovative sustainable solutions in the project development phase (EEN22). Notably, challenges arise from increased workloads in designing sustainable projects (EEN22). The construction quality is often attained only when the final user is clearly defined (EAR09). Therefore, from the perspective of professional competencies, two crucial aspects are emphasized – the ability of professionals to design and implement buildings characterized by sustainable features, and the integration of sustainable solutions during the early design stage of the project.

A summary of the study findings, featuring identified areas of concern and barriers to further implementation, is depicted in the diagram (Fig. 2).

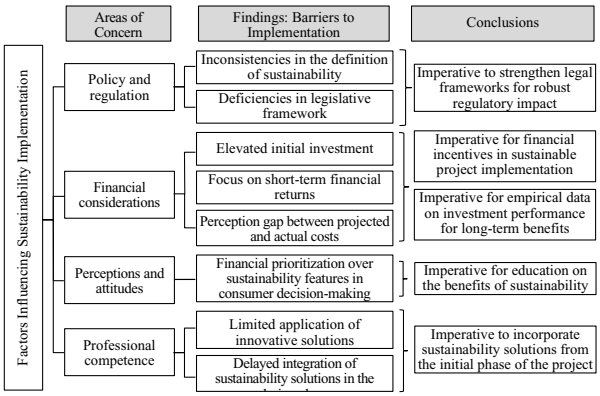

Fig. 2. Factors constraining sustainability implementation.

5 Conclusions

The findings of the study underscore the substantial influence of top-down measures on sustainability implementation in the construction industry, with policy and regulation emerging as pivotal motivating factors. Conversely, significant barriers include deficiencies in the legislative framework and inconsistencies in defining sustainability criteria. Addressing these challenges requires initiatives to strengthen legal frameworks, ensuring robust regulatory impact at both EU and national levels. Proactive development of laws supporting sustainable construction and incentives for developers engaged in sustainable projects is essential to foster sustainability in the industry.

Challenges in sustainability implementation result from prioritizing financial considerations over sustainable features in consumer decisions. Limited societal awareness of the significance of investing in sustainable projects and end-users focus on the initial property cost contribute to low demand for sustainable buildings. Notably, the construction sector is greatly influenced by consumers' purchasing power. Given the ongoing affordability challenges in real estate for buyers,

even a modest increase in sustainable building prices becomes a significant factor for end-users.

Limited professional competence, attributed to knowledge gaps, and delayed adoption of innovative sustainable solutions in project development, poses a significant obstacle to successful sustainability implementation. Thus, there is a critical need for enhanced professional expertise and the early integration of sustainability solutions in project design stages.

The leading constraints to sustainability implementation in the construction industry are associated with financial considerations, as relatively higher construction costs impact the initial investment. The study indicates a prevalent perception that sustainable buildings are financially demanding rather than offering direct financial benefits. Therefore, it is necessary to justify the long-term financial benefits to stakeholders, supported by empirical evidence on investment performance.

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