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FACTORS INFLUENCING SUSTAINABLE CONSTRUCTION IN EGYPT

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Abstract. The concern about sustainable development has become a global goal, and as such, the United Nations has adopted the seventeen sustainable development goals that are targeted to be achieved by 2030. Furthermore, to address the energy and Greenhouse gases (GHG) crisis, the world has moved towards developing policies concerned with rationalizing energy consumption and reducing GHG emissions. The main idea of sustainable construction is to avoid the depletion of natural resources for both the present and future generations. Therefore, this study aims to investigate the factors that prevent and delay the adoption of sustainable construction practices in Egypt. Using the survey method, a questionnaire was filled out by professionals and practitioners in Egyptian construction projects. The findings of this study indicate that the most critical factors affecting sustainable construction in Egypt are the "poor market demand for green and recyclable construction materials", and "fear of higher investment costs". The study recommends raising awareness to overcome these factors.

Keywords: sustainable development, sustainable construction, factors, construction industry.

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1. Introduction and background

Sustainability, as an expression, was used for the first time in the Brundtland Report by the United Nations' World Commission on Environment and Development in 1980, and it was defined as "to offer the utilization of the alternatively available or supplementary cementitious material in the production of the concrete" (World Commission on Environment and Development [WCED], 1987; Ortiz et al., 2009). Sustainable development is defined as "the development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (Krizmane et al., 2016). The Marrakech Task Force on Sustainable Buildings and Construction, set up by the UN Department of Economic and Social Affairs (DESA), defines sustainable construction as: "Construction that brings about the required performance with the least unfavorable ecological impacts while encouraging economic, social and cultural improvement at local, regional and global level" (United Nations, 2022).

2. Factors influencing sustainable construction according to previous studies

According to Scopus, the authors collected the literature review respecting the "factors AND influencing AND sustainable AND construction" domain. The authors filtered on two main items in the search process: "Article" and "Journal". The data was analyzed related to Country/territory, keywords, subject area, and year, as shown in Figure 1, Figure 2, Figure 3, and Figure 4, respectively. According to the analysis, as shown in Figure 1, "China" is the first published paper rank, followed by "Australia", "United States", "United Kingdom", "Malaysia", "Hong Kong", "South Africa", "Nigeria", "India", "Iran", and "Egypt". Recently, as shown in Figure 4, researchers worldwide have been working on the factors that affect sustainable construction, such as, housing projects (Ali et al., 2023; Elhegazy et al., 2021, 2023; Moghayedi & Awuzie, 2023; Zhong et al., 2022), small construction projects (Waqar et al., 2023; Jaradat et al., 2024), construction performance (Yao et al., 2023; Chakraborty

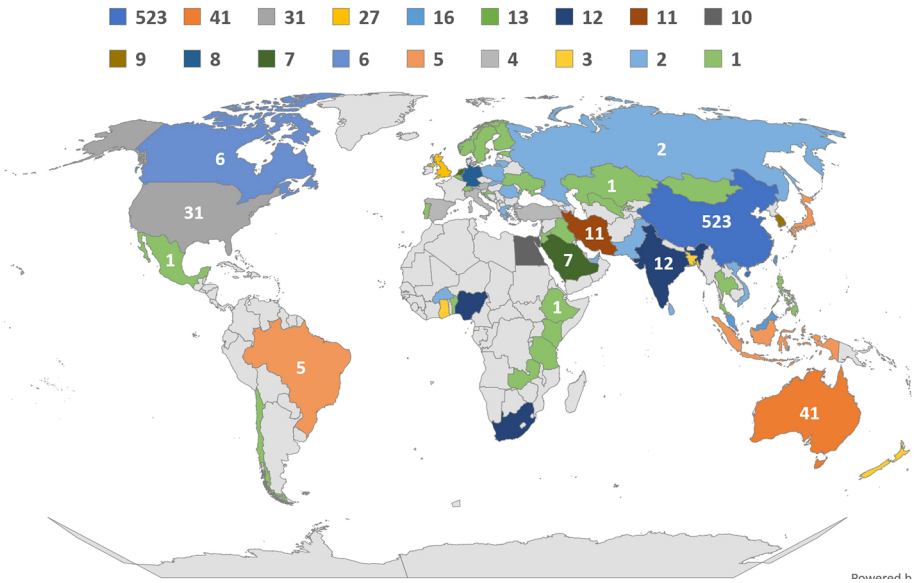

Figure 1. Analysis of the published papers related to the "Country/territory"

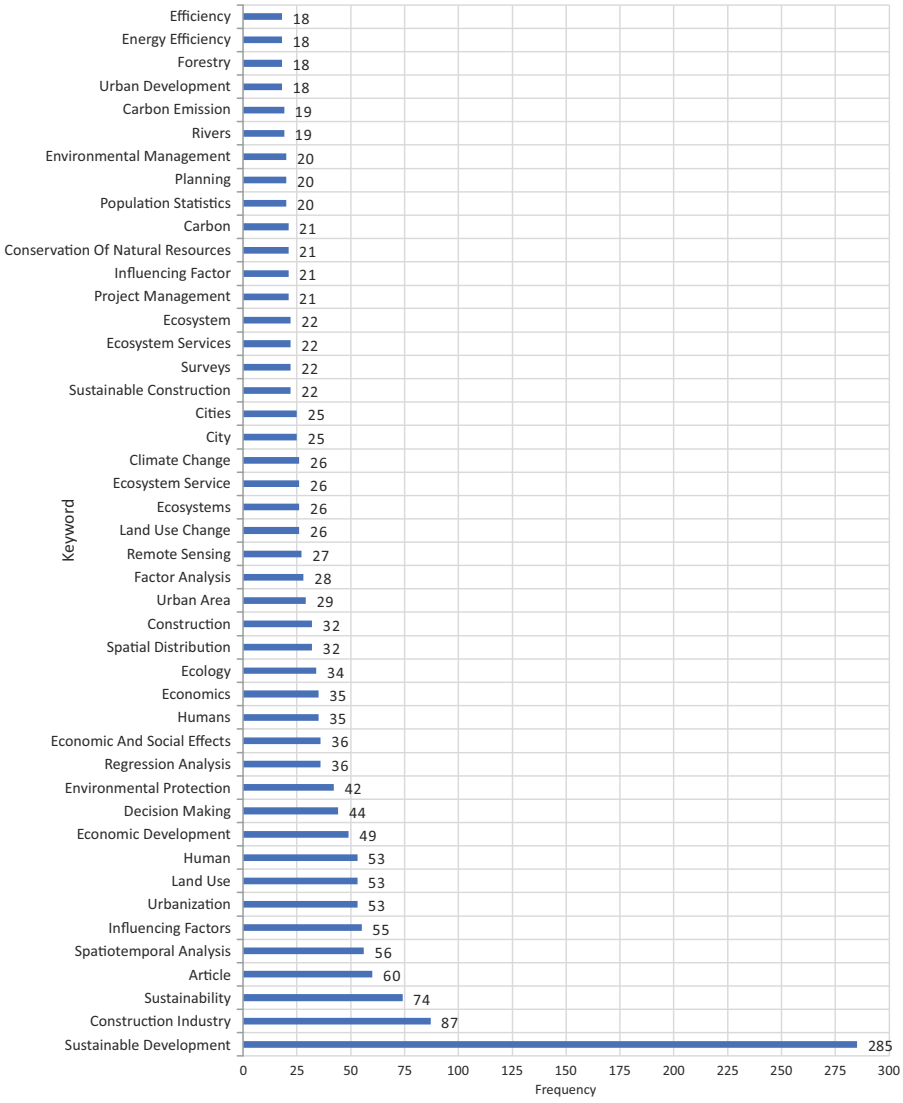

Figure 2. Analysis of the published papers related to the "Keywords"

et al., 2020; Elnaggar & Elhegazy, 2022; Gade & Selman, 2023; Ebolor et al., 2022), and construction technology (Nilimaa, 2023; Barbhuiya & Das, 2023; Barros et al., 2023; Elhegazy et al., 2022; Patel et al., 2023). According to the "Keywords", as shown in Figure 2, "Sustainable Development" is the highest rank and is followed by "Construction Industry" and "Sustainability". According to the "Subject area", as shown in Figure 3, "Environmental Science" is the highest rank followed by "Engineering", "Social Sciences", "Energy", and "Computer Science".

In the Arab region, particularly Jordan, Nasereddin and Price (2021) found that the factors affecting sustainable construction are the lack of awareness, suppliers, and experts, the increase in capital cost, and the use of certain materials, a "cultural factor". In contrast, the drivers for sustainable construction were governmental legislation, managerial concerns, good reputation, and decreasing running costs. In the United Arab Emirates, Rajabi et al. (2022) surveyed construction professionals with 32 sustainability indicators identified from a comprehensive literature review; they were categorized into two groups of environmental and socio-economic indicators to evaluate its importance and weight using the Analytic Hierarchy Process (AHP). Findings showed that renewable energy and construction site safety were the most important indicators, given their local weight in each group. In Oman, Safinia et al. (2017) identified the main barriers preventing the application of sustainable construction materials through a literature review and an interview with experts in the construction industry. Findings showed that these factors were lack of demand and culture of green construction, high costs, and lack of knowledge, respectively. Still in the Middle East, Fathalizadeh et al. (2021) studied the factors delaying sustainable project management in Iran. They defined them as five factors: project context, lack of knowledge, lack of investment in innovation, societal concerns, and the absence of motivation within construction organizations.

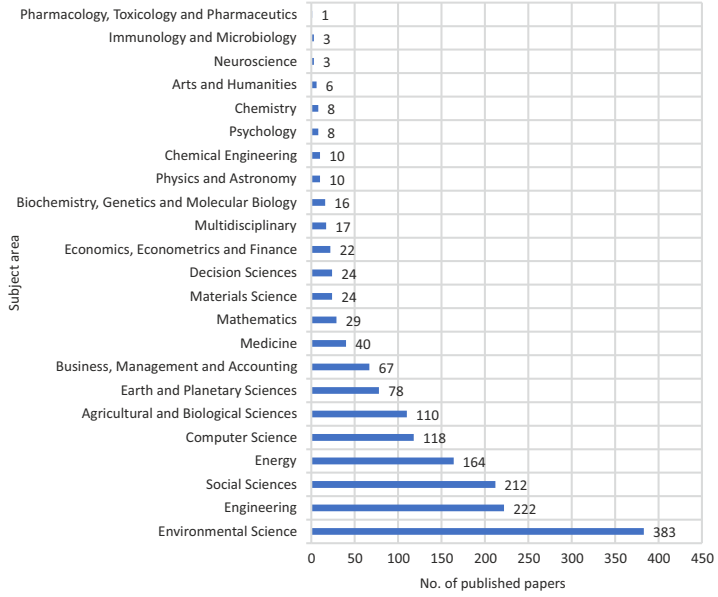

Figure 3. Analysis of the published papers related to the "Subject Area"

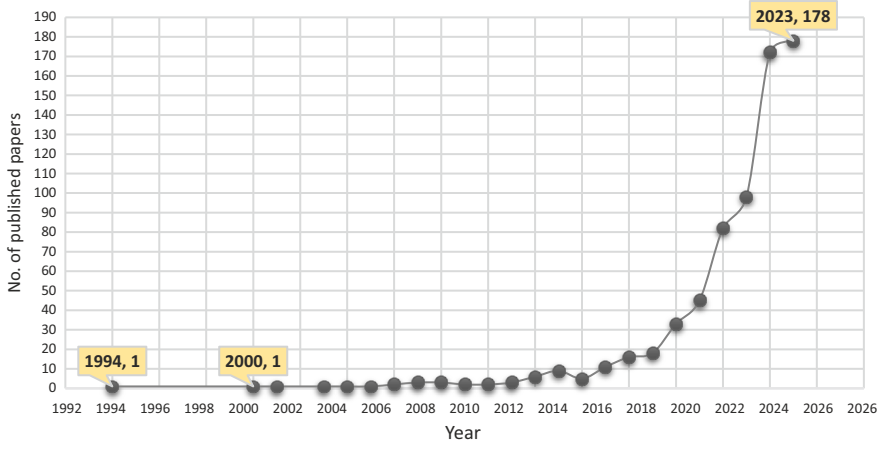

Figure 4. Analysis of the published papers related to the "Year"

In another study, Fathalizadeh et al. (2022) contended that the most significant obstacles to sustainability are "the lack of understanding of the potential benefits; insufficient cooperation among practitioners, research institutions and environmental organizations; and a lack of a systematic approach to pursuing sustainability goals". Ahmed et al. (2023) found the top five obstacles identified in sustainable project construction. are "inadequate green construction codes and regulations", "lack of knowledge and understanding of new techniques", "difficulties in acquiring skills and expertise", "lack of funding due to local market disinterest", and "limited investment caused by low demand". The analysis revealed that Qatar, the UAE, Singapore, Ghana, the United States, Turkey, and Oman face significant barriers. Moreover, "the lack of demand" remains a prominent challenge in adopting green technologies, especially in the Gulf regions. In Africa, particularly in Ghana, Djokoto et al. (2014) studied the barriers to sustainable construction by interviewing consultants. Findings showed these barriers are the lack of demand, strategy, awareness, government support, and high initial cost.

Similarly, Ametepey et al. (2015) used semi-structured interviews and a questionnaire survey to determine the barriers to sustainable construction in Ghana and the measures to overcome these barriers. The five most substantial barriers were "cultural change resistance, lack of government commitment, fear of higher investment costs, lack of professional knowledge, and lack of legislation". These were categorized using factor analysis into six categories: financial, political, management/leadership, technical, sociocultural, and knowledge/awareness barriers. Oke et al. (2019) adopted a quantitative approach by surveying construction professionals in Zambia. They pinpointed an average level of awareness of sustainable construction, nonetheless, a low level of implementation. The main drivers for sustainable construction were laws and legislations, building regulations, developing regulatory mechanisms, raising awareness, and client demand. In China, He and Chen (2021) conducted a case study of a project in Korla City and identified 19 critical factors for sustainable construction practices. Findings showed a strong hierarchy and interrelationships between the factors. The highest drivers for sustainable construction practices were the professionalism and expertise of the project management team and a precise definition of responsibilities.

Similarly, Yu et al. (2018) conducted a case study on HOPSCA projects to examine the critical factors affecting the implementation of sustainable construction practices via an interview of key participants and a critical review of project documents. A total of 17 critical factors were identified, and a structural model was developed to express the interactions among these factors. In Hong Kong, Hazarika and Zhang (2019) found that regulatory instruments, managerial consent, and organizational measures greatly influence organizations to be ecologically innovative. Furthermore, the study pinpointed a strong mediating role of eco-innovative practices in organizations on the likelihood of adoption in the future. That is, regulatory instruments and managerial consent play a role, but they are insufficient for the future adoption of eco-innovative practices within organizations. In Malaysia, Bamgbade et al. (2019) pinpointed the mediating role of an array of organizational capabilities that would help organizations achieve ecological sustainability. These capabilities are "organizational culture, flexible design, quality orientation, product diversity, and customer loyalty" within a regulatory framework that targets large construction organizations' unique configuration and contributes to environmental sustainability.

In Sri Lanka, Karunasena et al. (2016) showed that the factors mitigating sustainable construction are the lack of awareness, regulations, governmental support, experts, and high initial costs. In India, Gehlot and Shrivastava (2022) surveyed practicing professionals from the Indian construction industry on the barriers to adopting sustainable construction. The three most significant barriers were the lack of skilled human resources, reluctant clients, and awareness. In Kazakhstan, Tokbolat et al. (2019) investigated the barriers and drivers to sustainable construction through a survey and structured workshop with professionals and stakeholders in the construction industry. Results showed that addressing environmental issues and various social aspects were important drivers, while the barriers were primarily economic, followed by government and awareness barriers. The lack of awareness and knowledge was the most significant barrier and driver. In Finland, Kinnunen et al. (2022) examined four strategic sustainability dimensions: marketing efforts, business strategy, management, eco-innovation ability, and their influence on sustainability performance and brand value. Findings showed a positive correlation between marketing and sustainability performance, eco-innovation and sustainability performance, and eco-innovation and brand value. In Latvia, Mjakuškina et al. (2019) conducted an in-depth literature analysis to identify the most predominant factors affecting sustainability in construction supervision. The negative factors were "bureaucracy, ambiguous interpretation of regulations, lack of qualified professionals, and lack of clearly defined control criteria". In contrast, the positive factors were the "professional competence of specialists, collaboration with the parties involved, using new technologies, and internal control system". The elements of sustainable construction could be categorized into four categories: social, economic, environmental, and technological elements. In the United Kingdom (UK) Opoku and Fortune (2013) focus on the drivers and challenges faced by construction organizations in the UK when implementing sustainable construction practices. The research involves qualitative interviews with leaders from 15 construction organizations, including sustainability directors, managers, and consultants. The study examines the motivations behind adopting sustainable practices and identifies the main challenges hindering their implementation. The findings reveal that many construction organizations are driven by the desire to enhance their reputation as environmentally friendly businesses and to increase their chances of winning contracts. However, a significant challenge identified is the

lack of client demand for sustainability, primarily due to the misconception that it is costly.

Opoku et al. (2022) conducted a study on the adoption of sustainable procurement in the construction industry and its impact on sustainable development goals (SDGs). The research used questionnaires to identify the drivers and barriers to sustainable procurement implementation. The findings emphasized the importance of the construction industry in achieving the SDGs and the role of sustainable procurement practices in promoting responsible consumption and production. The study recommended collaboration between governments and industry stakeholders to promote sustainable procurement and highlighted the need to consider the environmental, social, and economic impact of procurement decisions.

Summary of the previous studies

A comprehensive list of 71 factors was compiled from previous studies. Identical and similar factors were grouped to streamline the list, reducing distinctive factors. The refined list of factors was then analyzed to avoid overlapping information, resemblance to other factors, and relevance to the research questions, as shown in Figure 5. After thorough deliberation, a final set of 34 factors was determined, as shown in Table 1. For a comprehensive overview of all the factors included in the study, please refer to the questionnaire provided in Appendix. Table 2 illustrates the procedure for selecting the factors. Tables 3 to 8 illustrate the 34 factors affecting sustainable construction in Egypt in order of technical, managerial, financial, political, socio-cultural, and knowledge/ awareness.

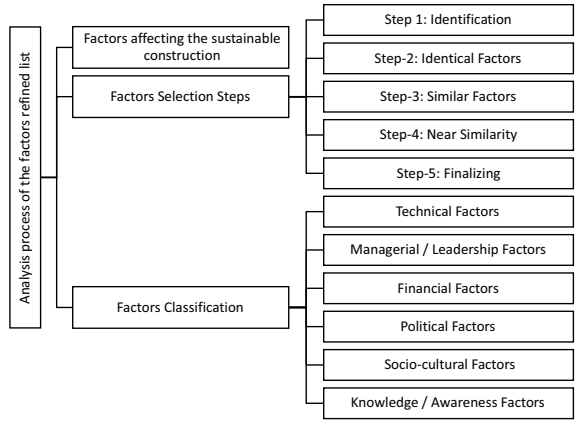

Figure 5. Analysis process of the factors refined list

Table 1. Factors affecting the sustainable construction

No.	Factors	Source
1	Lack of experienced and well-trained workforce with knowledge of sustainability practices in the construction industry	Fathalizadeh et al. (2021)
2	Lack of professional knowledge	Djokoto et al. (2014)
3	Lack of technology	Djokoto et al. (2014)
4	Lack of training	Djokoto et al. (2014)
5	Lack of Design and Construction team	Djokoto et al. (2014)
6	Lack of environmentally sustainable materials	Ametepey et al. (2015)
7	Lack of sustainability measurement tools	Ametepey et al. (2015)
8	Lack of technical ability, chronic skills, and labour shortages	Ametepey et al. (2015)
9	Lack of coordination and misconceptions of benefits of sustainable practices	Gehlot and Shrivastava (2022)
8	Project managers do not possess the required KSAs (knowledge, skill, ability)	Fathalizadeh et al. (2021)
11	Lack of data transparency and information sharing among construction firms and suppliers	Fathalizadeh et al. (2021)
10	Lack of sustainable practices in an organization's vision	Fathalizadeh et al. (2021)
11	Poor market demand for green and recyclable construction materials	Fathalizadeh et al. (2021)
14	Sustainable construction leads to delays in project completion	Gehlot and Shrivastava (2022)
15	The belief of an increase in the scope of work if sustainable practices & materials are adopted	Gehlot and Shrivastava (2022)
16	Insufficient cooperation among practitioners, research institutions, and environmental organizations	Fathalizadeh et al. (2022)
17	Lack of a systematic approach to pursuing sustainability goals	Fathalizadeh et al. (2022)
18	Lack of motivation and aspiration values of managers	Ametepey et al. (2015)
19	Lack of leadership	Ametepey et al. (2015)
20	Lack of investment in sustainability	Fathalizadeh et al. (2021)
21	Fear of higher investment costs	Ametepey et al. (2015), Opoku and Fortune (2013)
22	Fear of long Pay-back period	Ametepey et al. (2015)

End of 1 Table

No.	Factors	Source
23	The client worries about profitability	Ametepey et al. (2015)
24	Lack of support from policymakers	Fathalizadeh et al. (2021)
25	Political constraints and inadequate legislation and legal enforcement by the government	Fathalizadeh et al. (2021)
26	Lack of government policies/support	Ametepey et al. (2015)
27	Lack of building codes on sustainability	Djokoto et al. (2014)
28	Lack of public awareness	Djokoto et al. (2014)
29	Cultural change resistance	Ametepey et al. (2015)
30	Lack of demand for sustainable products	Ametepey et al. (2015), Opoku and Fortune (2013)
31	Lack of knowledge about sustainable Technologies	Ametepey et al. (2015)
32	Lack of awareness of clients	Ametepey et al. (2015)
33	Lack of awareness of benefits	Ametepey et al. (2015)
34	Lack of awareness among various stakeholders	Gehlot and Shrivastava (2022)

Table 2. Factors selection steps

Steps	Factors
Step 1 – Identification	Initially, a total of 71 factors were identified from the literature review
Step 2 – Identical factors	13 factors were found to be identical, resulting in a reduction to 58 factors
Step 3 – Similar factors	Additionally, 9 factors were similar, reducing the total to 49 factors
Step 4 – Near similarity	Due to the similar nature of information, 15 factors were grouped with others, resulting in 34 remaining factors
Step 5 – Finalizing	Finally, these 34 factors were finalized and renamed based on their relevancy and the research requirements

Table 3. Technical factors

Technical Factors	Source
Lack of experienced and well-trained workforce with knowledge of sustainability practices in the construction industry	Fathalizadeh et al. (2021)
Lack of professional knowledge	Djokoto et al. (2014)
Lack of technology	Djokoto et al. (2014)
Lack of training	Djokoto et al. (2014)
Lack of Design and Construction team	Djokoto et al. (2014)
Lack of environmentally sustainable materials	Ametepey et al. (2015)
Lack of sustainability measurement tools	Ametepey et al. (2015)
Lack of technical ability, chronic skills, and labor shortages	Ametepey et al. (2015)
Lack of coordination and misconceptions of benefits of sustainable practices	Gehlot and Shrivastava (2022)

Table 4. Managerial/leadership factors

Managerial/ Leadership Factors	Source
Project managers do not possess the required KSAs (knowledge, skill, ability)	Fathalizadeh et al. (2021)
Lack of data transparency and information sharing among construction firms and suppliers	Fathalizadeh et al. (2021)
Lack of sustainable practices in an organization's vision	Fathalizadeh et al. (2021)
Poor market demand for green and recyclable construction materials	Fathalizadeh et al. (2021)
Sustainable construction leads to delays in project completion	Gehlot and Shrivastava (2022)
Belief in an increase in the scope of work if sustainable practices & materials are adopted	Gehlot and Shrivastava (2022)
Insufficient cooperation among practitioners, research institutions, and environmental organizations	Fathalizadeh et al. (2022)
Lack of a systematic approach to pursuing sustainability goals	Fathalizadeh et al. (2022)
Lack of motivation and aspiration values of managers	Ametepey et al. (2015)
Lack of leadership	Ametepey et al. (2015)

Table 5. Financial factors

Financial Factors	Source
Lack of investment in sustainability	Fathalizadeh et al. (2021)
Fear of higher investment costs	Ametepey et al. (2015), Opoku and Fortune (2013)
Fear of long Pay-back period	Ametepey et al. (2015)
The client worries about profitability	Ametepey et al. (2015)

Table 6. Political factors

Political Factors	Source
Lack of support from policymakers	Fathalizadeh et al. (2021)
Political constraints and inadequate legislation and legal enforcement by the government	Fathalizadeh et al. (2021)
Lack of government policies/support	Ametepey et al. (2015)
lack of building codes on sustainability	Djokoto et al. (2014)

Table 7. Socio-cultural factors

Socio-cultural Factors	Source
Lack of public awareness	Djokoto et al. (2014)
Cultural change resistance	Ametepey et al. (2015)
Lack of demand for sustainable products	Ametepey et al. (2015), Opoku and Fortune (2013)

Table 8. Knowledge/awareness factors

Knowledge/ Awareness Factors	Source
Lack of knowledge about sustainable Technologies	Ametepey et al. (2015)
Lack of awareness of clients	Ametepey et al. (2015)
Lack of awareness of benefits	Ametepey et al. (2015)
Lack of awareness among various stakeholders	Gehlot and Shrivastava (2022)

3. Research methodology

In a quantitative approach, as shown in Figure 6, this study used the survey method through an online questionnaire that surveyed construction professionals from Egypt on factors affecting sustainable construction. After reviewing the literature to identify these factors, these factors were extracted and categorized. Through the review, 34 distinctive factors were identified after grouping similar ones. To collect data, a questionnaire was designed and shared through various channels, including email, WhatsApp, and hard copies sent by hand or mail. A total of 60 valid responses were received from the 100 potential respondents. According to the literature, a sample size of 16 is sufficient to analyze sustainable construction (Banihashemi et al., 2017). The collected data was entered into a Google form and then analyzed in Microsoft Excel. Once the data was deemed fit for analysis, various methods and techniques were used, including the Relative Importance Index (RII), to analyze the data. The results were compared to identify the most significant and least significant factors. Additionally, the results were used to identify the challenges and opportunities for sustainable construction.

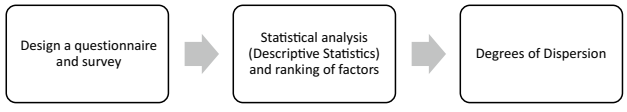

Figure 6. Methodology of the analysis

3.1. Design a questionnaire and survey

The survey questionnaire consists of nine sections and forty-two questions. The first section introduces the survey and its aims, such as the essential question, the background, and the expected outcomes. The second section involves questions relevant to the general information of the participants and the scope of their organizations and construction projects. The third section includes information about the rating scale used for ranking, that is, a 5-point Likert scale that ranges from very low to very high, intending to decide the importance of the impact of every factor on sustainable construction. The fourth section is specific to questions about technical factors, whereas the fifth is about management factors. At the same time, the sixth is pertinent to financial factors, and the seventh is focused on political factors. In contrast, the eighth includes sociocultural factors and the ninth concerns knowledge and awareness barriers.

3.2. Statistical analysis (Descriptive Statistics) and ranking of factors

The factors were ranked according to the Relative Importance Index technique (*RII*), which is used in construction fields to measure attitudes concerning factors being surveyed through questionnaires; the formula of *RII* is:

$$RII = \frac{\sum s_i n_i}{AN} = \frac{1n_1 + 2n_2 + 3n_3 + 4n_4 + 5n_5}{5N}, \quad (1)$$

where s_i is the point given to importance level i; n_i is the number of participants deciding importance level i; A is the highest point that equals 5 in this study; N is the total number of respondents. *RII* ranges from 0 to 1, as shown in Table 9. According to Akadiri (2011), the values for the importance level are as follows.

Table 9. *RII* scale

RII Scale	Impact
0.0–0.2	Low (L)
0.21–0.40	Low Medium (L-M)
0.41–0.60	Medium (M)
0.61–0.80	Medium-High (M-H)
0.81–1	High (H)

4. Results and discussion

4.1. Degrees of dispersion

To test the degree of dispersion, the coefficient of variation is used to indicate the distribution of survey data. The formula is:

$$CV = \frac{\sigma}{\overline{X}}, \quad \overline{X} = \frac{\sum_{i=1}^{N} x_i}{N}, \quad \sigma = \sqrt{\frac{\sum_{i=1}^{N} (x_i - \overline{X})^2}{N}}, \quad (2)$$

where CV is the coefficient of variation; σ is the standard deviation; x_i is the i^{th} data point; $\overline{X}$ is the mean value of all data points; N is the number of data points. Thus, the bigger the CV, the dispersion degree is higher, and vice versa. The higher the CV, the higher the level of dispersion around the mean, while lower CV values indicate a more precise estimate of the results. The CV varies between 0.17 and 0.22 for group factors, whereas the individual factors varied between 0.21 to 0.35. These dispersion values are understandable given the various backgrounds, years of experience, and job designations the surveyed participants have. Therefore, the data collected is credible at these mentioned dispersion degrees.

4.2. Results analysis

The factors were individually ranked according to their *RII* scores, with the study identifying the "poor market demand for green and recyclable construction materials" as the most important factor. This finding is consistent with previous research (Safinia et al., 2017; Fathalizadeh et al., 2022; Djokoto et al., 2014). The study suggests several key strategies to address this factor, including increasing awareness, providing government incentives, fostering collaboration and industry partnerships, implementing building codes and regulations, and investing in research and development.

The "fear of higher investment costs" emerged as the second most important factor, indicating that concerns about financial implications are also significant barriers to sustainable construction practices. This finding aligns with previous studies (Nasereddin & Price, 2021; Safinia et al., 2017; Djokoto et al., 2014; Ametepey et al., 2015; Karunasena et al., 2016; Opoku & Fortune, 2013). To address this factor, the study suggests implementing strategies such as providing financial incentives, promoting cost-saving benefits, facilitating access to financing, encouraging collaboration and knowledge sharing, and supporting research and development.

Furthermore, emphasizing the importance of considering the lifecycle costs over the initial costs can help prioritize long-term financial sustainability and justify sustainable decision-making in the construction industry.

Only these two factors have a high level of importance, as their scores barely surpass 0.8, whereas the rest 32 factors have a high to medium level of importance with scores between 0.6 and less than 0.8. The third most important factor was the "fear of long pay-back period," while the fourth was the "lack of support from policymakers", and the fifth was the "lack of awareness of benefits".

On the contrary, the least important factor was the perception that "sustainable construction leads to delay in project completion", and this is consistent with previous research findings (Gehlot & Shrivastava, 2022), surpassed by the "belief of increase in the scope of work if sustainable practices and materials are adopted" in the 33rd place and the "insufficient cooperation among practitioners, research institutions and environmental organizations" as 32nd as shown in Table 10.

Measuring *RII* for grouped factors that are categorized into six categories showed that the most important factors are the financial factors. In contrast, the least important group of factors is the group of management factors. In other words, the six groups of factors ranked by importance are financial, knowledge, political, sociocultural, technical, and management, respectively, as shown in Table 11.

5. Conclusions

In conclusion, the analysis findings indicate that the most important factor affecting sustainable construction in Egypt is the "poor market demand for green and recyclable construction materials". The "fear of higher investment costs" is the second most important factor. This indicates that the concern about higher investment costs is also a significant barrier to sustainable construction practices.

Table 10. *RII* for individual factors

No	Individual factors	Mean	SD	V	RII	Level	Rank	CV
1	Lack of experienced and well-trained workforce with knowledge of sustainability practices in the construction industry	3.87	1.033	1.067	0.773	H-M	6	0.267
2	Lack of professional knowledge	3.60	0.924	0.854	0.720	H-M	28	0.257
3	Lack of technology	3.60	0.960	0.922	0.720	H-M	29	0.267
4	Lack of training	3.67	1.036	1.073	0.733	H-M	20	0.283
5	Lack of Design and Construction team	3.63	1.089	1.185	0.727	H-M	25	0.300
6	Lack of environmentally sustainable materials	3.72	1.043	1.088	0.743	H-M	16	0.281
7	Lack of sustainability measurement tools	3.53	1.142	1.304	0.707	H-M	30	0.323
8	Lack of technical ability, chronic skills, and labor shortages	3.53	1.081	1.168	0.707	H-M	31	0.306
9	Lack of coordination and misconceptions of benefits of sustainable practices	3.67	1.115	1.243	0.733	H-M	21	0.304
10	Project managers do not possess the required KSAs (knowledge, skill, ability)	3.62	0.993	0.986	0.723	H-M	26	0.275
11	Lack of data transparency and information sharing among construction firms and suppliers	3.70	0.979	0.959	0.740	H-M	18	0.265
12	Lack of sustainable practices in an organization's vision	3.82	0.983	0.966	0.763	H-M	12	0.257
13	Poor market demand for green and recyclable construction materials	4.03	0.991	0.982	0.807	H	1	0.246
14	Sustainable construction leads to delays in project completion	3.33	1.174	1.379	0.667	H-M	34	0.352
15	Belief in an increase in the scope of work if sustainable practices & materials are adopted	3.48	1.081	1.169	0.697	H-M	33	0.310
16	Insufficient cooperation among practitioners, research institutions, and environmental organizations	3.50	1.097	1.203	0.700	H-M	32	0.313
17	Lack of a systematic approach to pursuing sustainability goals	3.65	1.039	1.079	0.730	H-M	23	0.285
18	Lack of motivation and aspiration values of managers	3.62	0.976	0.952	0.723	H-M	27	0.270
19	Lack of leadership	3.67	1.084	1.175	0.733	H-M	22	0.296
20	Lack of investment in sustainability	3.83	1.092	1.192	0.767	H-M	9	0.285
21	Fear of higher investment costs	4.02	0.911	0.830	0.803	H	2	0.227
22	Fear of long Pay-back period	3.90	0.969	0.939	0.780	H-M	3	0.248
23	The client worries about profitability	3.83	1.122	1.260	0.767	H-M	10	0.293
24	Lack of support from policymakers	3.88	0.976	0.952	0.777	H-M	4	0.251
25	Political constraints and inadequate legislation and legal enforcement by the government	3.70	1.078	1.163	0.740	H-M	19	0.291
26	Lack of government policies/support	3.82	1.033	1.068	0.763	H-M	13	0.271
27	Lack of building codes on sustainability	3.72	1.075	1.156	0.743	H-M	17	0.289
28	Lack of public awareness	3.83	1.107	1.226	0.767	H-M	11	0.289
29	Cultural change resistance	3.78	0.976	0.952	0.757	H-M	14	0.258
30	Lack of demand for sustainable products	3.65	0.860	0.740	0.730	H-M	24	0.236
31	Lack of knowledge about sustainable Technologies	3.77	0.871	0.758	0.753	H-M	15	0.231
32	Lack of awareness of clients	3.87	0.999	0.999	0.773	H-M	7	0.258
33	Lack of awareness of benefits	3.88	0.904	0.817	0.777	H-M	5	0.233
34	Lack of awareness among various stakeholders	3.87	0.833	0.694	0.773	H-M	8	0.215

Table 11. *RII* for group factors

Group of factors	Mean	SD	V	RII	Level	Rank	CV
Technical	3.646	0.632	0.399	0.729	H-M	5	0.173
Management	3.642	0.633	0.400	0.728	H-M	6	0.173
Financial	3.896	0.848	0.719	0.779	H-M	1	0.217
Political	3.779	0.808	0.653	0.756	H-M	3	0.213
Sociocultural	3.756	0.821	0.674	0.751	H-M	4	0.218
Knowledge	3.846	0.710	0.504	0.769	H-M	2	0.184

These findings align with previous studies, emphasizing the need to overcome the significant barrier of poor market demand for green and recyclable construction materials in Egypt. The fear of higher investment costs is also recognized as a significant factor hindering sustainable construction practices. To address these challenges, it is crucial to raise awareness about the importance of using green and sustainable materials and prioritize considering lifecycle costs over initial costs. By doing so, the construction industry in Egypt can be encouraged to adopt more sustainable practices and contribute to a greener and more environmentally friendly future.

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APPENDIX

The Questionnaire

1. Introduction

Thank you for agreeing to take this survey. This survey is conducted by researchers from The Construction Management Department at Ain Shams University in Egypt.

This survey is part of a research to evaluate factors influencing Sustainable Construction in Egypt.

We are asking for your participation in this study by completing the enclosed questionnaires. All of the answers you provide in this survey will be kept confidential. This survey takes about 15 minutes to complete.

Essential Question: What are the factors that prevent and delay the adoption of sustainable construction practices in Egypt?

Background: The main idea of sustainable development in the construction industry is to avoid the depletion of natural resources and develop an ecological balance for both the present and future generations. Therefore, this study aims to investigate the factors that prevent and delay the adoption of sustainable construction practices in Egypt.

Expected Outcomes: The collected data will be analyzed to understand the main factors that prevent the adoption of sustainable construction practices in Egypt. Thereafter, simplified strategies and participative efforts will be proposed and conveyed to all the stakeholders of the Egyptian construction industry.

2. General Information

1. Country

- ○ Egypt
- ○ USA and Canada
- ○ China and Hong Kong
- ○ GCC (Saudi Arabia, Kuwait, Bahrain, Oman, UAE, Qatar)

Other (please specify)

2. Please indicate your organization type:

- ○ Academic
- ○ Owner
- ○ Contractor
- ○ Consultant
- ○ Designer/ Architect
- ○ Subcontractor
- ○ Supplier

Other (please specify)

3. Please indicate your job designation

- ○ Academic
- ○ Designer
- ○ Supplier/Manufacturer
- ○ Architect
- ○ Owner
- ○ Resident Engineer
- ○ Project / Construction manager
- ○ Project Engineer
- ○ Site Superintendent

Other (please specify)

4. Please indicate your Industry type

- ○ Superstructure
- ○ Infrastructure
- ○ Oil & Gas
- ○ Industrial

Other (please specify)

5. What is the size of your company?

- ○ Large (> 250 employees)
- ○ Medium (50 < employees < 250)
- ○ Small (10 < employees < 50)
- ○ Micro (< 10 employees)

Other (please specify)

6. How many years have you been working on construction projects?

- ○ Less than 5 years
- ○ 5 to 10 years
- ○ 10 to 15 years
- ○ Over 15 years

7. In your professional career, what is average the percentage level of sustainable construction practice in your past projects?

- ○ 0–20%
- ○ 20–40%
- ○ 40–60%
- ○ 60–80%
- ○ More than 80%

8. What construction materials are most often used in a typical project for your organization? Check all that apply

- ○ Reinforced Concrete
- ○ Structural Steel
- ○ Light-gauge Metal
- ○ Composite (Steel & Reinforced Concrete)
- ○ Composite (Other)
- ○ Not Applicable

Other (please specify)

3. Ranking Causes

Please evaluate the following attributes based on.

- **Importance** (The impact of this factor on sustainable construction)

All of this can be done using a rating scale of 1–5 as shown in the below table:

Rating Scale	Very low	Low	Moderate	High	Very High
	1	2	3	4	5

4. Technical Factors

Factors	Importance
Lack of experienced and well-trained workforce with knowledge of sustainability practices in the construction industry	
Lack of professional knowledge	
Lack of technology	
Lack of training	
Lack of Design and Construction team	
Lack of environmentally sustainable materials	
lack of sustainability measurement tools	
lack of technical ability, chronic skills, and labor shortages	
Lack of coordination and misconceptions of benefits of sustainable practices	

5. Management/ Leadership barriers Factors

Factors	Importance
Project managers do not possess the required KSAs (knowledge, skill, ability)	
Lack of data transparency and information sharing among construction firms and suppliers	
Lack of sustainable practices in an organization's vision	
Poor market demand for green and recyclable construction materials	
Sustainable construction leads to delays in project completion	
The belief of an increase in scope of work if sustainable practices & materials are adopted	
Insufficient cooperation among practitioners, research institutions, and environmental organizations	
Lack of a systematic approach to pursuing sustainability goals	
Lack of motivation and aspiration values of managers	
Lack of leadership	

6. Financial Factors

Factors	Importance
Lack of investment in sustainability	
Fear of higher investment costs	
Fear of long Pay-back period	
The client worries about profitability	

7. Political Factors

Factors	Importance
Lack of support from policymakers	
Political constraints and inadequate legislation and legal enforcement by the government	
Lack of government policies/support	
Lack of building codes on sustainability	

8. Socio-cultural Factors

Factors	Importance
Lack of public awareness	
Cultural change resistance	
Lack of demand for sustainable products	

9. Knowledge/Awareness barriers Factors

Factors	Importance
Lack of knowledge about sustainable Technologies	
lack of awareness of clients	
lack of awareness of benefits	
Lack of awareness among various stakeholders	

We appreciate your response and seeking to understand your opinions
Thank you for your time and your participation in this survey