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Smart and Sustainable Built Environment

Cognitive biases that shape the drivers and barriers to embracing green construction practices

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Abstract

Purpose – The challenges associated with cognitive biases can significantly impact individuals, particularly when making informed decisions about driving and adopting green construction practices. Recognising and approaching these barriers with understanding and empathy is essential, as they often stem from deeply rooted habits and perceptions. This study highlights the drivers and barriers to green building construction practices and identifies the cognitive biases associated with these factors that can aid global project managers, policymakers and construction professionals.

Design/methodology/approach – A dual systematic literature review was employed to assess academic journal articles published between 2018 and 2023, ensuring the recency of the information and utilising narrative and thematic analysis to conclude.

Findings – The study's results reveal the profound influence of cognitive biases on the factors that shape the adoption of green building practices. A total of 95 factors and 71 cognitive biases were identified, providing substantial evidence and information for our study. These findings, presented in tables and a dynamic map, highlight the intricate interrelationships in this context, offering a comprehensive understanding of the subject matter.

Research limitations/implications – Using a systematic literature review (SLR) as a qualitative research method imposes constraints on accessing the most up-to-date industry knowledge, as it limits the selection of reviewed literature. In addition, the absence of diverse academic databases restricts the availability of valuable and credible sources to support the study. Moreover, focusing solely on English-language resources overlooks relevant references published in other languages. Despite these limitations, strict adherence to journal articles and the Prisma process enhances the credibility and reliability of the paper's findings.

Practical implications – The research offers valuable insights for project managers, construction professionals and policymakers, highlighting the cognitive biases that influence decision-making in green building construction. It provides a detailed analysis of the interconnected factors that promote sustainable practices and identifies the challenges that hinder their implementation. Additionally, the study explores how existing beliefs and biases influence the decisions of builders, architects and developers in their pursuit of sustainability. The theoretical implications of our study extend to future research, providing a foundation for exploring the human perspective within the construction industry.

Originality/value – This paper novelly explores interconnected factors by examining the key drivers that promote sustainable building practices, the barriers that hinder their implementation and the cognitive biases that influence decision-making in this context. It specifically examines the key drivers that promote sustainable

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building practices, the barriers that hinder their implementation and the cognitive biases that influence decision-making in this context.

Keywords Drivers, Barriers, Green building, Sustainable construction, Cognitive bias, Decision-making
Paper type Literature review

1. Introduction

Climate change began to show its noticeable environmental effects in the 1970s, which called for a united response from global organisations. This led the United Nations Environment Programme (UNEP) to form the International Panel on Climate Change (IPCC) in response to the growing concerns regarding the environmental impact caused by human activities and the resulting weather catastrophes that follow (MacGregor *et al*., 2018). In addition, through the initiative of the IPCC, two significant efforts were established to address climate change: the Kyoto Protocol in 1997 and the Paris Agreement in late 2015, with the primary collective goal of controlling greenhouse gas emissions that affect the overall global temperature. Many countries make serious efforts in this regard.

1.1 Green building: an overview

The concept of green building is the integration of green design with the primary focus on reducing a structure's environmental impact while improving the occupants' quality of life during its whole lifecycle compared to a traditional "non-green" facility (Ali'and Al Nsairat, 2009). Aside from improving the environment and public health, Ali and Al Nsairat (2009) also indicated that green design lowers the structure's lifecycle costs, enhances the marketability of buildings and organisations, boosts occupant efficiency, and aids in developing sustainable communities. In general, green building is associated with sustainable construction, but despite their frequent interchange, the terms "green" and "sustainable" are not synonymous in scholarly discourse (Doan *et al*., 2021). In contrast, Purvis *et al*. (2019) suggest that sustainable construction encompasses a holistic view of sustainable development, encompassing the economic, social, and environmental aspects of a building, which are the three pillars of sustainability. These three aspects have been long accepted for organisational sustainability reporting, and many building evaluation technologies have considered them to provide organised and comprehensible information on social, economic, and environmental solutions (Du Plessis, 2007). Ali and Al Nsairat (2009) identified these evaluation tools as a comprehensive system that measures the environmental impact of a building. Among the global green rating tools are BREEAM (Great Britain), GBTool (Canada), LEED (US), EcoProfile (Norway), and Environmental Status (Sweden) (Ali and Al Nsairat, 2009). New Zealand has the Green Star NZ as its primary green rating system (Doan *et al*., 2021). However, it was the least effective among the green rating tools described as limited to a single aspect of sustainability: the environment.

1.2 Decision-making in construction industry literature

In the construction decision-making process, decisions can take many forms, from strategic to corrective, and are essential for all projects (Love *et al*., 2023). Decision-making is, therefore, necessary to ensure the success of projects. Love *et al*. (2023) also noted that prompt decision-making is crucial to ensure that no responsibilities are delayed and that the project's timeline is met. Additionally, Kamranfar *et al*. (2022) suggested that it is vital to carefully evaluate the significance of each criterion, factor, and structure to enhance the quality of holistic decision-making. Literature is abundant regarding decision-making, addressing various construction perspectives and offering different approaches to identify factors that affect the construction industry. Conveying decision-making strategies in the construction sector assists in assessing and prioritising innovative drivers towards sustainable development (Van Nguyen, 2023). Kamranfar *et al*. (2022) related decision-making in uncovering the significance and connections among

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construction sustainability indicators. Moreover, Sun *et al.* (2022) employed a similar approach to reveal causal relationships and intensity within system elements, thereby facilitating the successful implementation of green supply chain management. Furthermore, decision-making is associated with understanding the causal effects of interrelationships among barriers in sustainable waste management (Negash *et al.*, 2021).

1.3 Cognitive bias in decision-making

From the construction industry perspective, heuristics are generally regarded as liabilities resulting from cognitive biases in decision-making, particularly when determining risks and unpredictable situations (Ika *et al.*, 2022). Moreover, different factors affect the decision-making to achieve sustainable development, and these factors also influence human behaviour and judgement through cognitive biases (Korteling *et al.*, 2023). Korteling *et al.* (2023) suggested that cognitive biases may lead to prompt, sensible, and fulfilling judgements in a natural and fundamental application. However, these decisions may be inefficient and potentially harmful in addressing various modern, complex, and long-term issues, such as mitigating climate change or preventing pandemics. One notable example is the influence of cognitive biases within the Lean environment. Purushothaman *et al.* (2023) implied that managers could stimulate cognitive biases to benefit from Lean and its applications. The study also contributed to the well-known biases and how they affect the ideas that now assess and lessen the challenges in the Lean environment. On the contrary, cognitive biases are particularly prominent in terms of drawbacks to decision-making. Collusive bidding (Peng *et al.*, 2022) and contracting practices (Jennejohn *et al.*, 2022) succumb to the adverse behavioural effects of cognitive biases.

This paper analysed different drivers and barriers associated with the global construction industry, which are further investigated through the association of cognitive biases. The research questions for this study are:

(1) What drivers and barriers are prevalent in green and sustainable construction practices?

(2) What are the associated cognitive biases that affect drivers and barriers to green and sustainable construction practices?

This paper's originality lies in its thorough examination of the diverse and interconnected factors that shape the construction practices associated with green buildings. It meticulously investigates the primary influences that encourage sustainable building methods, highlighting the motivating forces behind adopting eco-friendly practices. Additionally, the discussion addresses the various obstacles that impede the successful implementation of these practices, analysing the challenges faced by stakeholders in the industry. Furthermore, the paper examines the cognitive biases that can influence decision-making in this realm, illuminating how preconceived notions and biases may impact the choices made by builders, architects, and developers in their pursuit of sustainability.

2. Research methodology

To address the first research question in this study:

(1) A systematic literature review (SLR) was employed to identify the drivers and barriers associated with green and sustainable construction practices.

(2) The data analysis of the known drivers and barriers employs thematic analysis related to the well-established political, economic, social, technological, legal, and environmental (PESTLE) framework.

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(3) The results are presented in a system dynamic mapping, specifically a causal loop diagram, using the *Vensim* simulator.

To address the second research question in this study:

(1) The identification of associated cognitive biases among different factors in the construction industry is through a systematic literature review (SLR) based on the initial results from the first question.

(2) Data on the cognitive biases concerning the factors is analysed through narrative analysis.

This study employs an *idealistic* methodology that defines various experiences from various sources (Hughes and Sharrock, 2016; Ormston *et al*., 2014). The study focuses on the cognitive biases related to drivers and barriers and the decision-making process of green construction, suggesting a subjective approach because different construction practices would have distinct cognitive biases. Thus, idealism was selected as the ontological perspective of the study. Decision-makers constantly construct research solutions in idealistic situations (Bryman, 2016). This research adopts a constructivist epistemological position, focusing on known factors and cognitive biases. Following the constructivist approach, the study will adopt interpretivism as its theoretical position, as the associated factors and cognitive biases are interpreted through different analyses based on the individual scope of human behaviour, as implied by Cohen *et al*. (2002). Moreover, to discuss the comprehensive data analysis, the study will follow a qualitative *narrative inquiry* as its methodology to achieve a thorough comprehension (Murray, 2009; Savin-Baden and Niekerk, 2007). The summary of research methodology is viewed as a research onion, as shown in Figure 1.

This study employed the systematic literature review (SLR) method, a thoroughly constructed and methodological review of the literature that answers research questions by identifying, selecting, and critically assessing the findings from the studies included in the review process (Rother, 2007). Moreover, Pradana *et al*. (2023) stated that SLR provides a straightforward and impartial comprehensive assessment of different types of literature, uncovers research gaps, gathers and integrates evidence, and suggests further research possibilities. This method is similar to the methodology used by Purushothaman and Seadon (2023), where the literature retrieved and included in the research consists of English texts, primarily focusing on journal articles, conference proceedings, and books to ensure credibility and reliability. The papers were reviewed at least twice to ensure quality control of data and information, thereby enhancing the dependability of the study. In addition, careful analysis was practised by observing the theme of the topic, which focuses on architecture, engineering, management, sustainability, and construction.

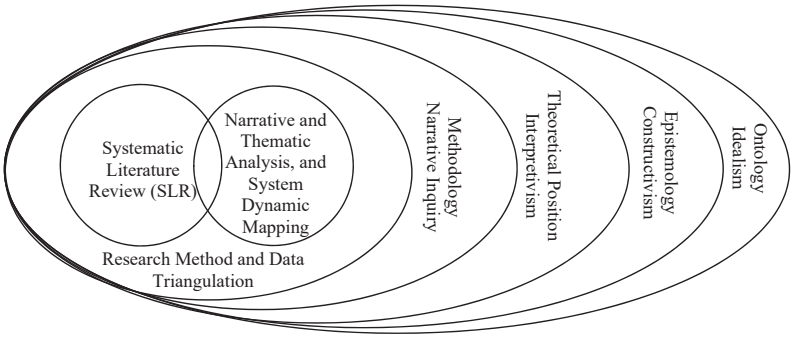

Figure 1. Research onion of the methodology. Source: Authors' own work based on the model by Crotty (1998)

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2.1 Research framework

The framework (shown in Figure 2) of the study began with Stage 1 Systematic Literature Review (SLR), which identified the various drivers and barriers associated with green buildings. The identified factors were thematically analysed following the concept of the PESTLE framework but using a more straightforward approach that consists of three sub-categories. After the factors were subcategorised, the interrelationships among the factors were discussed from the authors' perspective. They were collated in pairwise analysis, which was transferred into a causal loop diagram to visualise the pattern of interrelationships. Finally, stage two of SLR concluded the research by identifying the cognitive biases corresponding to the sub-categories of the factors. These cognitive biases were added to the causal loop diagram to describe the interplay between cognitive biases and factors related to green building.

2.2 Research database

The research was conducted in two stages using three reliable academic databases and providers: Scopus, EBSCOhost, and ScienceDirect. The databases also employ similar methods to process and assess keyword searches by matching query details to the search fields, specifically title, abstract, and keywords (TIABKW), as described by Penning de Vries *et al.* (2020). Scopus and Science Direct have straightforward and similar search strategies. On the other hand, *EBSCOhost* is a database provider that offers numerous databases to categorise the search and make it easier for researchers. For this study, the databases available on EBSCOhost were selected to align with the research topic's theme, specifically Art and Architecture Complete, Business Source Complete, and GreenFile.

2.3 Boolean search method

The keyword search centres on the central theme of cognitive biases influencing the decision-making process in green building practice. Stage one of the SLR focused on identifying the factors, barriers, and/or drivers that affect green construction practices, while stage two focused on cognitive biases related to the identified factors.

2.3.1 Stage 1. In Stage One, the main keywords used in the search were "factors," "affect," and "green construction." The keywords were assessed utilising synonymous ideas, as shown in Table 1. The final keyword search was formatted using the Boolean search strategy for the different databases. Moreover, proximity search was utilised on all platforms to refine the search queries, and its implementation varies across different databases, as shown in Table 2. The stage one keyword search yielded 2,279 publications, of which 58 relevant articles were

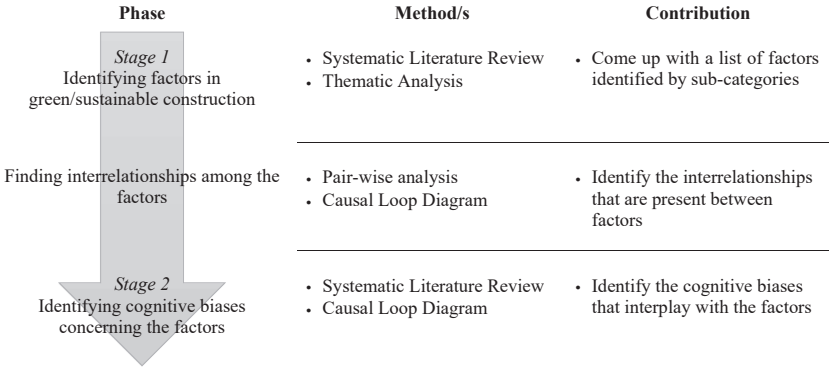

Figure 2. Research framework. Source: Authors' own work inspired by the framework of Van Nguyen (2023, p. 6)

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Table 1. Keyword ideas (stage 1)

Subject	Keywords
Factors	factors, drivers, barriers
Affect	affects, affect, affecting
Green	green build, green building/s, green construction/s, sustainable building/s, sustainable
Construction	construction/s, green star rating

Source(s): Authors' own work

Table 2. Search string across different databases (stage 1)

Database/Platform	Search string	Articles
Scopus	*(TITLE-ABS-KEY (factors OR drivers OR barriers) AND TITLE-ABS-KEY (affect*) AND TITLE-ABS-KEY ("green build*" OR "green construc*" OR "sustainable constr*" OR "sustainable build*" OR "green star rating"))*	639
Scopus (Proximity Search)	*TITLE-ABS-KEY (factors OR drivers OR barriers) W/8 ("green build*" OR "green construc*" OR "sustainable constr*" OR "sustainable build*" OR "green star rating"))*	957
EBSCOhost	*(factors OR drivers OR barriers) AND (affect*) AND ("green build*" OR "green construc*" OR "sustainable constr*" OR "sustainable build*" OR "green star rating")*	226
EBSCOhost (Proximity Search)	*(factors OR drivers OR barriers) N8 ("green build*" OR "green construc*" OR "sustainable constr*" OR "sustainable build*" OR "green star rating")*	283
Science Direct	*(factors OR barriers OR drivers) AND (affecting) AND ("green building" OR "green construction" OR "sustainable construction" OR "sustainable building" OR "green star rating")*	71
Science Direct (Proximity Search)	*(factors OR barriers OR drivers) AND (affect) AND ("green building" OR "green construction" OR "sustainable construction" OR "sustainable building" OR "green star rating")*	103

Source(s): Authors' own work

rigorously and systematically analysed using bibliometric and qualitative approaches. The keywords from articles retrieved from all databases were imported into VOSviewer to determine the co-occurrences of the keywords based on the bibliographic data from the initial systematic literature review (SLR), as shown in Figure 3. The most common keywords across all publications are construction industry, sustainable development, sustainability, green building, and project management, all of which are relevant to the research topic.

2.3.2 Stage 2. In Stage Two, the keyword search centres on cognitive bias and the factors associated with green and/or sustainable construction based on themes identified through a PESTLE analysis. However, instead of focusing on the individual PESTLE category, the factors were divided into three main sub-categories: environmental and health-related factors, industry and economy-related factors, and policy and awareness factors, as shown in Table 3. Different studies inspired the idea to form a more understandable system from complex information (Al Harazi *et al.*, 2023; Zulu *et al.*, 2023). Table 4 shows the Stage 2 keyword search, which generated 274 articles that were analysed, resulting in 24 relevant papers.

2.4 Database search findings

2.4.1 Stage 1. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram (Page *et al.*, 2021) was used to keep a systematic journal that highlights the specific steps conducted to analyse the publications that yielded the final 58, as shown in Figure 4. The stage one PRISMA diagram initial screening is based on the following criteria:

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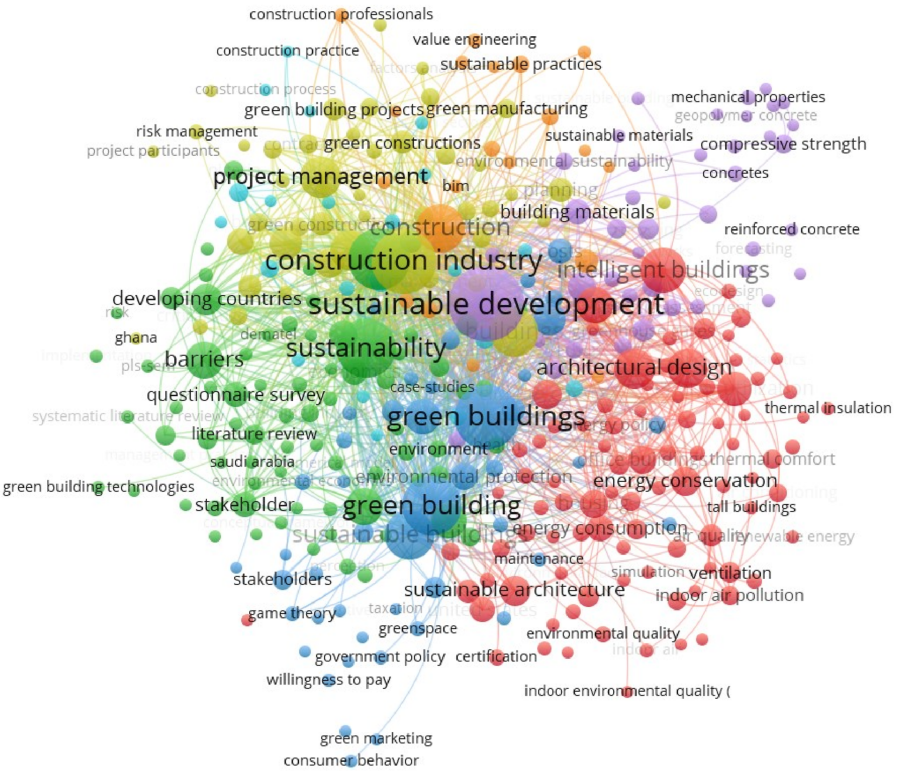

Figure 3. Co-occurrences of keywords (stage 1). Source: Authors' own work based on VOS viewer

Table 3. Keyword ideas (stage 2)

Subject	Keywords
Cognitive Bias	cognitive bias, cognitive biases
Sub-categories	
• Environmental and Health	environment, environmental, health, environmental and health
• Industry and Economy	industry, economy, industry and economy
• Policy and Awareness	policy, awareness, policy and awareness
Green Construction	green building/s, green construction/s, sustainable building/s, sustainable construction/s, construction/s

Source(s): Authors' own work

(1) Duplicated Records—The study was optimised by automating the detection of duplicated records from different databases offered by the reference manager EndNote. In stage one, 627 articles were identified as duplicates.

(2) Records within the selected timeline—The literature in stage one included in the study were within the 2019 to 2023 timeline to maintain the recency in the current digital era, relevance and dependability of the journal articles. This screening criteria removed 791 papers that were not within the selected timeline.

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Table 4. Search string across different databases (stage 2)

Database/ Platform	Search string	Articles
Scopus	*(TITLE-ABS-KEY ("cognitive bias*") AND TITLE-ABS-KEY (environment* OR health OR "environmental and health") AND TITLE-ABS-KEY ("green building*" OR "green construc*" OR construc* OR "sustainable construc*"))*	112
	(TITLE-ABS-KEY ("cognitive bias") AND TITLE-ABS-KEY (industry OR economy OR "industry and economy") AND TITLE-ABS-KEY ("green building*" OR "green construc*" OR construc* OR "sustainable construc*"))*	39
	(TITLE-ABS-KEY ("cognitive bias") AND TITLE-ABS-KEY (policy OR awareness OR "policy and awareness") AND TITLE-ABS-KEY ("green building*" OR "green construc*" OR construc* OR "sustainable construc*"))*	41
EBSCOhost	*cognitive bias* AND environment* OR health OR "environmental and health" AND "green building*" OR "green construc*" OR construc* OR "sustainable construc*"*	29
	cognitive bias AND industry OR economy OR "industry and economy" AND "green building*" OR "green construc*" OR construc* OR "sustainable construc*"*	0
	cognitive bias AND policy OR awareness OR "policy and awareness" AND "green building*" OR "green construc*" OR construc* OR "sustainable construc*"*	22
Science Direct	*(cognitive bias OR cognitive biases) AND (environment OR health OR "environmental and health") AND ("green building" OR "green construction" OR construction OR "sustainable construction")*	11
	(cognitive bias OR cognitive biases) AND (industry OR economy OR "industry and economy") AND ("green building" OR "green construction" OR construction OR "sustainable construction")	4
	(cognitive bias OR cognitive biases) AND (policy OR awareness OR "policy and awareness") AND ("green building" OR "green construction" OR construction OR "sustainable construction")	16

Source(s): Authors' own work

(3) Non-English texts—This study focuses solely on the English language as its medium and found only one article that is not written in English.

(4) Title screening—This concept opted for the direct approach in selecting the articles, which were then thoroughly screened based on their titles. The primary objective of this screening process was to select literature that included factors, drivers, and/or barriers in its titles, thereby maintaining coherence with the study's intended focus. In total, 576 articles were excluded solely based on this criterion.

(5) Retrieved full-text papers—The study focused on articles with open access to avoid inconvenience in searching for relevant information, as securing data requires additional time and cost. This screening process ensured that all papers included for the second screening were available online to the public, yielding 270 retrieved documents.

The 270 retrieved papers were then screened for the second time following the criteria to maintain relevance according to the research questions:

(1) Reasons 1 and 2: Methodology of the articles—This study employs SLR as its primary method, thereby excluding papers that use a similar process to highlight the valuable quantitative methods of other articles. This paper also excluded papers that utilised "modelling," which included articles that used variables based on a data matrix, as these papers are very comprehensive and would require extensive time to analyse. Fifty-two papers were excluded from this screening due to these reasons.

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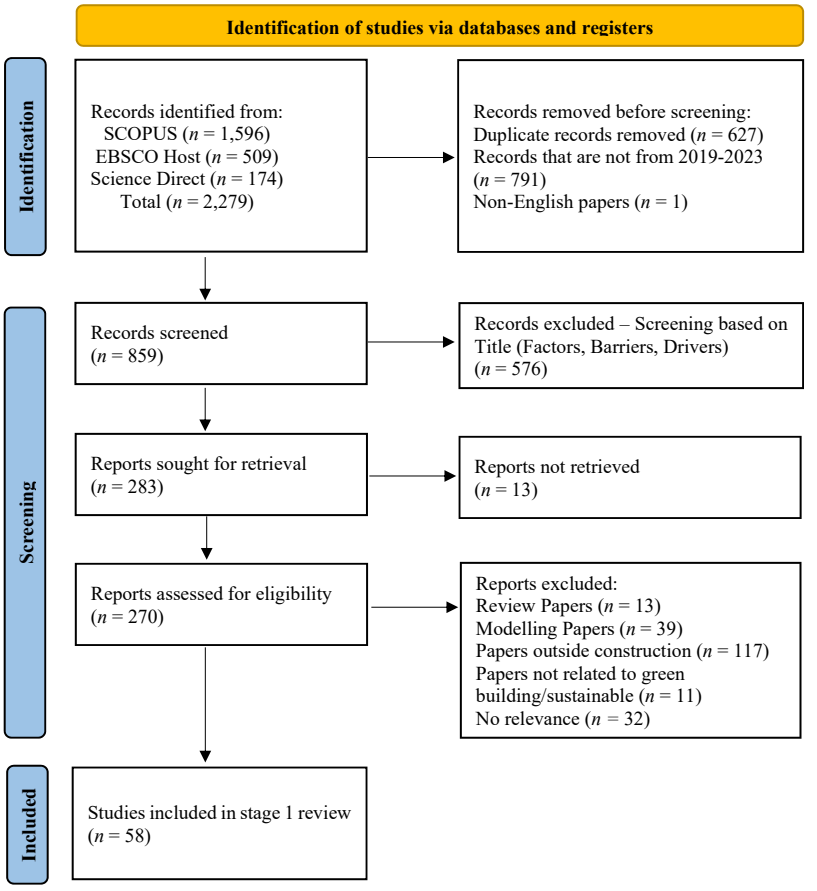

Figure 4. PRISMA diagram for SLR (Stage 1). Source: Authors' own work

(2) Reason 3: Articles out of scope – This study focuses on the construction industry and excludes papers that involve technology integration, such as artificial intelligence, blockchain, and cloud computing, as these research areas fall outside the scope. In total, 117 articles were removed following this reason.

(3) Reason 4: Papers that are within scope but not the topic—This paper focuses on the construction industry, excluding other elements such as waste management, supply chain, and geotechnical data. These papers tend to focus more on specific information instead of the adoption factors in green construction, which is one of the main ideas of this study. This reason excluded a total of 11 papers.

(5) Reason 5: No relevance—This study excluded 32 articles that were not directly relevant to the information on factors influencing the adoption of green construction.

2.4.2 Stage 2. Figure 5 presents a summary of stage two of the SLR, which follows the same concept and format as stage one of the SLR. The initial stage of the screening in stage two is very similar to stage one but with only a difference in the selected timeline of 2020–2023 in stage two to analyse more recent information and exclude non-academic articles instead of the title exclusion for stage two. The main difference was in the second screening, which stage two had the following criteria:

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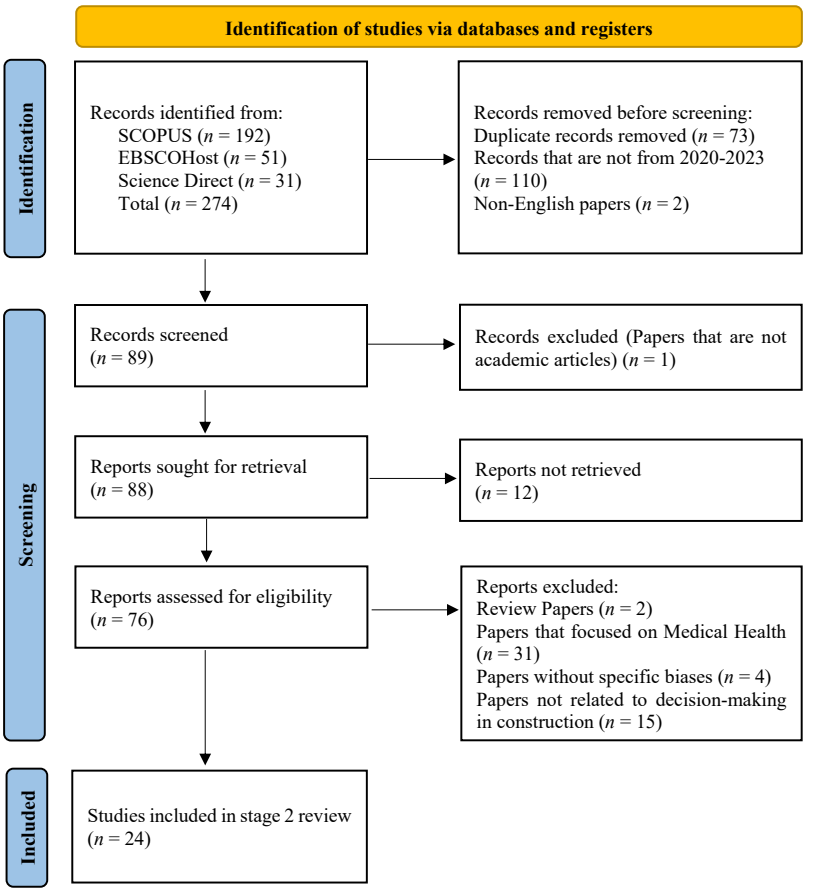

Figure 5. PRISMA Diagram for SLR (Stage 2). Source: Authors' own work

(1) Reason 1: Review papers – This section removed two SLR papers, similar to stage one.

(2) Reason 2: Medical articles—Cognitive bias focuses on the medical aspect of literature, which was excluded in this research. A total of 31 medical-focused articles were removed from the selection.

(3) Reason 3: Papers that do not have specific information—Four papers were excluded from this study because they addressed the general idea of cognitive biases. The study omitted them since this paper needed to identify specific cognitive biases.

(4) Reason 4: Articles not in the construction decision-making process—This research focuses on cognitive biases regarding decision-making in the green construction industry. In this regard, 15 papers were excluded since they focused on decision-making in different sectors.

3. Results and discussions

This section provides detailed information on the SLR results, a discussion of the various factors, their interrelationships, and the associated cognitive biases that influence the decision-making process in green construction.

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3.1 Results

3.1.1 Stage 1 SLR. The 58 relevant SLRs, as shown in Table 5, have identified 48 barriers and 47 drivers, totalling 95 factors that influence the adoption of green construction. Table 6 shows the individual factors identified and organised according to the sub-category, as classified using thematic analysis in Table 7. Moreover, a stacked bar chart in Figure 6 was created to visualise the total number of studies concerning the countries where the articles were conducted. By geography, Nigeria has the highest number of related articles, with a total of seven references between 2019 and 2023. Malaysia follows it with five papers, and then South Africa with four. These results indicate that most factors, particularly barriers, are prevalent in developing nations, as illustrated in Table 5.

3.1.2 Thematic analysis. The qualitative thematic analysis revolved around the PESTLE analysis, which is a management tool to identify associated factors, drivers, and/or barriers concerning the political, economic, social, technological, legal, and environmental aspects that are prone to influence complex processes (Capobianco *et al*., 2021). They further implied that the PESTLE framework assists decision-makers in contemplating possibilities that may affect the efficacy of their decisions. Moreover, the analysis is also inspired by the three pillars of sustainability: economic, social, and environmental factors. This study identified three sub-categories in identifying the drivers and barriers to adopting green construction, as shown in Table 7.

Table 8 and Table 9 show the rankings of the drivers and barriers in green buildings. The rankings are according to the number of occurrences of each factor from the 58 screened academic journals. The top ten drivers and barriers were listed to highlight the prevalent factors in adopting green building construction. A total of thirteen drivers and ten unique barriers were identified. PARD-04 was the prevailing driver with 28 occurrences. At the same time, PARB-11 had the most occurrences for the barriers, with 45 references stating that lack of awareness about the benefits of sustainable and green construction is the predominant reason for not adopting green building construction.

3.1.3 Interrelationship. The absence of a quantitative study in the SLR necessitated a dynamic diagram of the system to analyse the collected information thoroughly. Thus, a causal loop diagram (CLD) or a system dynamic map is created to identify the interlinks between the factors and the cognitive biases associated with them (Purushothaman and Seadon, 2023). The diagram illustrates the visual representation of the links and polarities among the elements in this study, which include barriers (B), drivers (D), and cognitive biases (CB). Blair *et al*. (2021) discussed how the CLD begins with a primary objective and proceeds backward, adding either positive (+) or negative (−) factors until it reaches viable interrelations.

The system dynamic mapping was created using the information taken from Table 10. However, due to the large number of factors (95), the top 10 drivers and barriers from Tables 8 and 9 were considered. This method simplifies the understanding of the interrelationship between the most common factors that were identified in the tables. There were 10 total drivers and 13 barriers; all were listed and interconnected using the *Vensim* application. On the other hand, the data in Table 10 are based on the pairwise comparison between the individual factors in Table 6. Nordstokke and Stelnicki (2014) referred to pairwise comparison as a statistical process in evaluating connections and links between two or more data. Moreover, Nordstokke and Stelnicki (2014) further implied that pairwise comparison would comprehensively analyse the relationship between the dependent variables. The factors from *Table 6* are listed in the rows and columns where the SLR articles determine the intersecting relationship among each variable. The relationship may be either positive, where factor A amplifies or supports factor B, or negative, where the connection diminishes the impact between the factors. In *Table 10*, the positive and negative relationships are denoted by P and N, respectively. The digits beside P and N represent the number of occurrences of each relationship from different references.

This research uncovered 433 positive interactions or relationships between drivers and barriers in green construction adoption. These relationships exhibit varying frequencies of occurrence: 397 instances where each unique relationship was mentioned only once (1P), 22

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Table 5. *SLR (Stage 1): Drivers and barriers*

S/N	Author/s (year)	Country	Drivers	Barriers
1	Zulu *et al.* (2023)	Zambia	19	20
2	Wijayaningtyas *et al.* (2023)	Indonesia	4	11
3	Van Nguyen (2023)	Vietnam	15	16
4	Tunji-Olayeni *et al.* (2023)	South Africa	15	13
5	Susanto and Sujana (2023)	Indonesia	0	18
6	Mottaeva *et al.* (2023)	Russia	11	8
7	Marandi Alamdari *et al.* (2023)	Global	0	13
8	Jaradat *et al.* (2023)	Jordan	12	12
9	De Beer and Kajimo-Shakantu (2023)	South Africa	9	14
10	Al-Awag *et al.* (2023)	Malaysia	8	22
11	Al Harazi *et al.* (2023)	Yemen	35	0
12	Akindele *et al.* (2023)	Nigeria	11	22
13	Adekunle *et al.* (2023)	South Africa	0	29
14	Sun *et al.* (2022)	China	0	20
15	Omopariola *et al.* (2022)	Nigeria	0	17
16	Maisham *et al.* (2022)	Malaysia	0	21
17	Mahat *et al.* (2022)	Malaysia	0	15
18	Lam (2022)	UK	19	0
19	Khural *et al.* (2022)	India	0	20
20	Kamranfar *et al.* (2022)	Iran	0	17
21	Iqbal *et al.* (2022)	Pakistan	24	1
22	Fathalizadeh *et al.* (2022)	Iran	0	28
23	Cooper *et al.* (2022)	South Africa	4	11
24	Bathrinath *et al.* (2022)	India	0	8
25	Babalola and Harinarain (2022)	Nigeria	16	19
26	Al-Otaibi *et al.* (2022)	Global	1	17
27	Wang *et al.* (2021)	China	0	24
28	On and Techapeeraparnich (2021)	Cambodia	0	27
29	Okoye (2021)	Nigeria	21	23
30	Negash *et al.* (2021)	Somaliland	0	20
31	Nasereddin and Price (2021)	Jordan	20	17
32	Iqbal *et al.* (2021)	Pakistan	0	26
33	Garg *et al.* (2021)	India	17	22
34	Ershadi *et al.* (2021)	Australia	0	11
35	El Touny *et al.* (2021)	Egypt	19	0
36	Doan *et al.* (2021)	New Zealand	4	16
37	Al-Hosani and Rashid (2021)	UAE	18	0
38	Zhao *et al.* (2020)	Singapore	4	17
39	Yee *et al.* (2020)	Malaysia	20	21
40	Tunji-Olayeni *et al.* (2020)	Nigeria	16	0
41	Tran *et al.* (2020)	Vietnam	20	13
42	Tokbolat *et al.* (2020)	Kazakhstan	17	17
43	Tayeh *et al.* (2020)	Israel	13	3
44	Tafazzoli *et al.* (2020)	USA	3	9
45	Shan *et al.* (2020)	Singapore	20	2
46	Pham *et al.* (2020)	Vietnam	12	19
47	Osuizugbo *et al.* (2020)	Nigeria	6	17
48	Karji *et al.* (2020)	USA	0	17
49	Susanti *et al.* (2019)	Indonesia	0	20
50	Simion *et al.* (2019)	Romania	16	15
51	Shurrab *et al.* (2019)	UAE	27	0
52	Olowosile *et al.* (2019)	Nigeria	2	16
53	Oke *et al.* (2019)	Zambia	21	5
54	Martek *et al.* (2019)	Australia	0	23
55	Mahat *et al.* (2019)	Malaysia	17	26

(*continued*)

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Table 5. Continued

S/N	Author/s (year)	Country	Drivers	Barriers
56	Khoury (2019)	Lebanon	20	0
57	Hazem and Breesam (2019)	Global	19	0
58	Hammond *et al*. (2019)	Global	0	14

Source(s): Authors' own work

cases where a relationship was cited twice (2P), 10 occurrences where relationships were referenced three times (3P), two instances where a relationship appeared four times (4P), and five occurrences where distinct relationships were reiterated twice (5P). On the other hand, a total of 315 negative relationships were identified. The frequencies are as follows: 306 were found once (1N), eight relationships were repeated twice (2N), and a single negative relationship was reiterated thrice (3N).

3.1.4 Stage 2 SLR. The 24 articles included in this research for Stage Two have identified a total of 71 cognitive biases based on the sub-categories identified in Table 7. Table 11 presents the number of cognitive biases identified by each author, along with the countries in which the studies were conducted. Moreover, the top 8 cognitive biases were ranked according to the number of occurrences in the articles, as shown in Table 12. On the other hand, Table 13 presents the cognitive biases identified from the 24 articles found in Stage 2, categorised by the sub-factors from Stage 1. The top bias is the status quo bias, with eight references, which is also part of the related barrier from stage one SLR, the fifth common barrier (PARB-15), with a total of 34 occurrences. The articles cover various aspects of the construction industry, including quality of living, policymaking, collusive bidding, lean construction, and risk management.

3.2 Discussions

3.2.1 General discussion. The most prevalent barrier identified by the SLR was the lack of awareness regarding adopting green building construction (PARB-11). This includes the benefits it offers, as well as the various parties involved in adopting a green approach. On the other hand, this aligns with the top driver: the clear and comprehensive government policies and building regulations regarding green construction (PARD-04). Yee *et al*. (2020) implied that inadequate awareness is the most significant impediment to green construction development. This suggests that raising awareness of green building practices requires additional support, particularly from the government. The government and authority accountable for this must develop a supportive presence by enforcing policies and principles (Yee *et al*., 2020). This understanding aligns with the findings of Tunji-Olayeni *et al*. (2020). The lack of awareness imposes a need for the government and stakeholders to take action together to improve public awareness through information dissemination and the implementation of innovative ideas. Tunji-Olayeni *et al*. (2020) believed that with proper public awareness about the benefits and implications of green building construction, it is more likely that the community and organisations will embrace green building implementation. Moreover, Jaradat *et al*. (2023) noted that establishing concrete guidelines to enforce green building construction will raise public awareness and encourage stakeholders to adopt green construction practices.

Most studies that highlight the drivers and barriers are from developing countries. Based on the geographic locations of the articles in Table 5, the top three countries with the most articles regarding factors affecting green building practices were Nigeria, with seven articles, Malaysia, with five, and South Africa, with four total papers from 2019 to 2023. For instance, Tunji-Olayeni *et al*. (2020) compared the drivers between developed and developing

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Table 6. Identified barriers and drivers with given codes

Category	Sub-category	Code	Barrier/Driver/Factor
Barriers	Environmental and Health-Related Barriers	EHRB-01	Lack of demand/interest in sustainable practices
		EHRB-02	Complex design of green construction
		EHRB-03	Uncertainty of the performance of green construction according to the climate and regional-local context
		EHRB-04	Lack of environmental concern
		EHRB-05	Inability to manage the risks associated with green construction
		EHRB-06	Difficulty in waste management
		EHRB-07	Limited infrastructure for waste management
	Industry and Economy-Related Barriers	IERB-01	Lack of financial support from stakeholders
		IERB-02	Lack of systematic planning for the application
		IERB-03	Lack of managerial enforcement
		IERB-04	Lack of stakeholder involvement/collaboration
		IERB-05	Lack of innovation and adaptability among stakeholders
		IERB-06	Looking at green construction as luxurious
		IERB-07	Higher initial/capital cost associated with sustainable options compared to traditional options
		IERB-08	Lack of availability/affordability of quality sustainable materials
		IERB-09	Limited availability of suppliers of sustainable resources
		IERB-10	Economic needs are of higher priority than environmental
		IERB-11	Additional time is required to ensure sustainability
		IERB-12	Lack of an executive plan for green construction with economic justification
		IERB-13	Long pay-back periods from sustainable practices/short-term profits
		IERB-14	Uncertain return on investment
		IERB-15	Cost overruns
		IERB-16	Lack of local, sustainable material alternative
		IERB-17	Economic turbulence
		IERB-18	Incompetence to secure green projects
		IERB-19	Green construction maintenance
		IERB-20	Diverse/fragmented market
		IERB-21	High cost of waste management
	Policy and Awareness-Related Barriers	PARB-01	Limited government involvement/enforcement that covers sustainable procurement
		PARB-02	Lack of government financial incentives to stimulate the adoption of sustainable construction
		PARB-03	Inadequate/lack of legislation and policies
		PARB-04	Lack of promotion of sustainable construction practices
		PARB-05	Lack of efficient sustainability codes and standards
		PARB-06	Complexity of codes and strict regulations on green building and sustainable construction
		PARB-07	Lack of clear national goals towards green construction practices
		PARB-08	Lack of quantitative assessment tools for green performances
		PARB-09	Difficulty dealing with government agencies
		PARB-10	Effects of corruption in developing countries
		PARB-11	Lack of awareness about the benefits of sustainable construction
		PARB-12	Lack of knowledge/research on sustainable technologies
		PARB-13	Lack of training and education
		PARB-14	Lack of professional expertise/Workforce
		PARB-15	Resistance to change/status quo
		PARB-16	Complex operation between industries, academe, and organisations
		PARB-17	Lack of new technology adoption
		PARB-18	Absence of communication among the project team
		PARB-19	Lack of long-term and strategic goals for local urban development
		PARB-20	Conflicts of interest and lack of cooperation between related organisations

(*continued*)

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Table 6. Continued

Category	Sub-category	Code	Barrier/Driver/Factor
Drivers	Environmental and Health-Related Drivers	EHRD-01	The need for greater energy and resource efficiency
		EHRD-02	Buildings that enhance occupants' health and well-being/ Improve quality of life
		EHRD-03	Reducing environmental impact
		EHRD-04	Effective waste management
		EHRD-05	Reduced carbon emissions and environmental pollution
		EHRD-06	Improving indoor environmental quality
		EHRD-07	Improving water efficiency
		EHRD-08	Availability of green construction experts
		EHRD-09	Increased resilience to climate change
		EHRD-10	Service quality
		EHRD-11	Effective Risk Management
		EHRD-12	Design of construction products for reuse, recycling, recovery of material, and parts
	Industry and Economy-Related Drivers	IERD-01	Stakeholders financial support
		IERD-02	Reduced whole life-cycle cost
		IERD-03	Competitive edge over the market
		IERD-04	Enhancing company image and reputation
		IERD-05	Increased efficiency in construction processes and management practices
		IERD-06	Support for local/national economic growth
		IERD-07	Enhanced marketability of buildings
		IERD-08	Commercial viability
		IERD-09	Enhanced long-term economic goals
		IERD-10	High return on investment
		IERD-11	Increased monetary value of the building
		IERD-12	Professional expertise, competency, and capability
		IERD-13	Product innovation of green construction
		IERD-14	Effective cost control
		IERD-15	Mobilisation of sustainable building tools
		IERD-16	International/External Pressure
		IERD-17	Greater availability/affordability of green products
		IERD-18	Committed workforce
		IERD-19	Community participation
		IERD-20	Stakeholder engagement
		IERD-21	Employment
	Policy and Awareness-Related Drivers	PARD-01	Increased awareness and promotion of green building benefits
		PARD-02	Preserving culture/heritage
		PARD-03	Increased green construction education and training
		PARD-04	Clear and comprehensive government policies and building regulations for green construction
		PARD-05	Advanced and innovative technology/design trends
		PARD-06	Urban planning
		PARD-07	Government financial incentives and support
		PARD-08	Setting a standard for future design and construction
		PARD-09	Commitment to corporate social responsibility by participating in environmental sustainability initiatives
		PARD-10	Clients are demanding environmentally friendly buildings
		PARD-11	Facilitating a culture of best practice sharing
		PARD-12	Introduction of green building rating system
		PARD-13	Capability to adopt change
		PARD-14	Creating awareness about green construction through Continuing Professional Development (CPD) programmes

Source(s): Authors' own work

countries. They implied that in the US, environmental factors such as energy conservation (EHRD-01) and waste reduction (EHRD-04) are primary drivers of sustainable construction, while in Nigeria, major drivers include clients' demand (PARD-10), international pressure (IERD-16), corporate social responsibility (PARD-09), and reputation (IERD-04), which were

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Table 7. Sub-categories of the drivers and barriers to adopting green construction

Sub-category	Description
Environmental and Health-Relate Factors	The environmental aspect of the factors that affect the construction industry interacts with the health of individuals who will occupy or use the facility throughout its lifecycle
Industry and Economy-Related Factors	The economic aspect of the construction sector is closely related to industry factors, including the supply chain, logistics, and cost management
Policy and Awareness-Related Barriers	Policy-related factors directly correlate with public awareness since the governing bodies mandating the policies, legal actions, and codes affect society within their area of jurisdiction

Source(s): Authors' own work

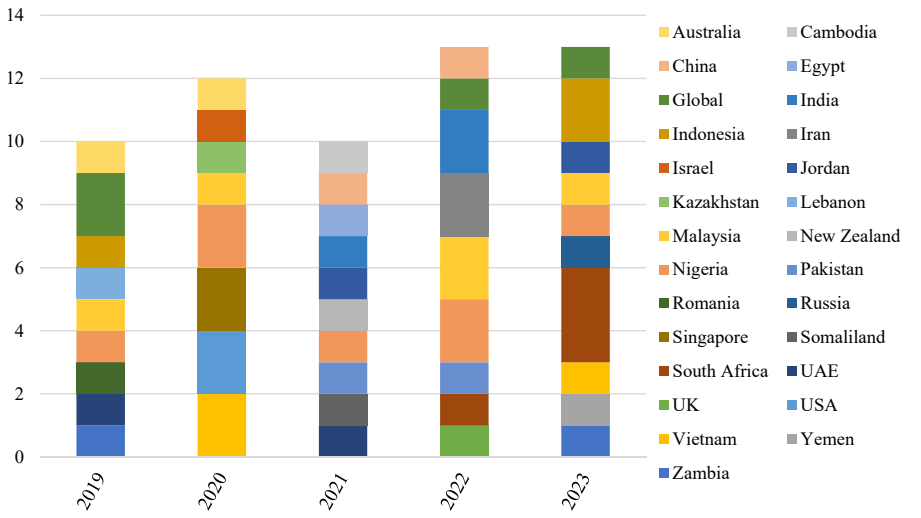

Figure 6. Stacked column chart of articles based on country of origin. Source: Authors' own work

Table 8. Top 10 drivers

S/N	Code	Factors	Occurrence	Rank
1	PARD-04	Clear and comprehensive government policies and building regulations for green construction	28	1
2	PARD-01	Increased awareness and promotion of green building benefits	26	2
3	PARD-03	Increased green construction education and training	25	3
4	PARD-07	Government financial incentives and support	25	3
5	EHRD-01	The need for greater energy and resource efficiency	21	5
6	PARD-05	Advanced and innovative technology/design trends	20	6
7	IERD-02	Reduced whole life-cycle cost	19	7
8	EHRD-04	Effective waste management	17	8
9	PARD-09	Commitment to corporate social responsibility by participating in environmental sustainability initiatives	17	8
10	EHRD-03	Reducing environmental impact	16	10
11	IERD-03	Competitive edge over the market	16	10
12	IERD-17	Greater availability/affordability of green products	16	10
13	IERD-20	Stakeholder engagement	16	10

Source(s): Authors' own work

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Table 9. Top 10 barriers

S/N	Code	Factors	Occurrence	Rank
1	PARB-11	Lack of awareness about the benefits of sustainable construction	45	1
2	PARB-12	Lack of knowledge/research on sustainable technologies	40	2
3	PARB-14	Lack of professional expertise/Workforce	39	3
4	IERB-07	Higher initial/capital cost associated with sustainable options compared to traditional options	35	4
5	PARB-15	Resistance to change/status quo	34	5
6	PARB-13	Lack of training and education	33	6
7	PARB-01	Limited government involvement/enforcement that covers sustainable procurement	32	7
8	PARB-02	Lack of government financial incentives to stimulate the adoption of sustainable construction	30	8
9	EHRB-01	Lack of demand/interest in sustainable practices	29	9
10	PARB-03	Inadequate/lack of legislation and policies	28	10

Source(s): Authors' own work

consistent with previous research. Sustainable construction practices in Nigeria also involve material reuse (EHRD-12) and public awareness campaigns (PARD-01) to improve environmental conditions and stakeholder understanding and support. These findings were supplemented by the study of Akindele *et al*. (2023), which emphasised that education and training on sustainable and green practices (PARD-03) will be the solution to the lack of knowledge (PARB-12) and awareness (PARB-11) regarding green construction, the prevalent barriers in Nigeria. Moreover, Akindele *et al*. (2023) stated that the positive progress from developed countries inspired most drivers of sustainable practices in Nigeria. The US and UK utilise sustainable assessment tools, such as LEED and BREEAM, which serve as rating systems for green building practices (PARD-12).

In contrast to other similarly developed nations, New Zealand adopts a conservative approach in its laws and incentives aimed at encouraging green building practices (Doan *et al*., 2021). Doan *et al*. (2021) stated that the absence of legislation or government incentives (PARB-02) is perceived as a barrier preventing New Zealand from fully embracing green construction practices. Moreover, legislation is viewed as a cost-effective and suitable method to align the construction industry with NZ's overarching sustainability goals while providing incentives for significant investments like solar panel installations that could further motivate developers to transition towards more sustainable building practices (Doan *et al*., 2021).

3.2.2 Interrelationship. Based on Table 10, the high initial/capital cost associated with green building practice compared to traditional (IERB-07) and the lack of awareness about the benefits of sustainable construction (PARB-11) has the highest number of interrelationships among the factors, especially with the lack of demand/interest for sustainable practices (EHRB-01). The positive interrelation between IERB-7 and EHRB-01, as well as PARB-11 and EHRB-01, was observed five times among the 58 journal articles in the systematic literature review (SLR). This means that the expensive investment required for green building construction constitutes an inadequate demand for green building practices. Tran *et al*. (2020) implied that the high cost of green building technologies is one of the most significant disadvantages and a crucial hindrance to their adoption in both developing and developed markets. One of Vietnam's most significant challenges to implementing green construction practices is the lack of stakeholder awareness regarding green building costs and sustainability, as well as the absence of a comprehensive governmental and institutional framework (Tran *et al*., 2020; Pham *et al*., 2020). In Jordan, the perception of sustainable buildings is often limited due to limited awareness and high costs (Nasereddin and Price, 2021). Zhao *et al*. (2020) also iterated that the perceived high-cost premium is a significant challenge to adopting

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Table 10. Pairwise comparison of the factors that affect green building adoption

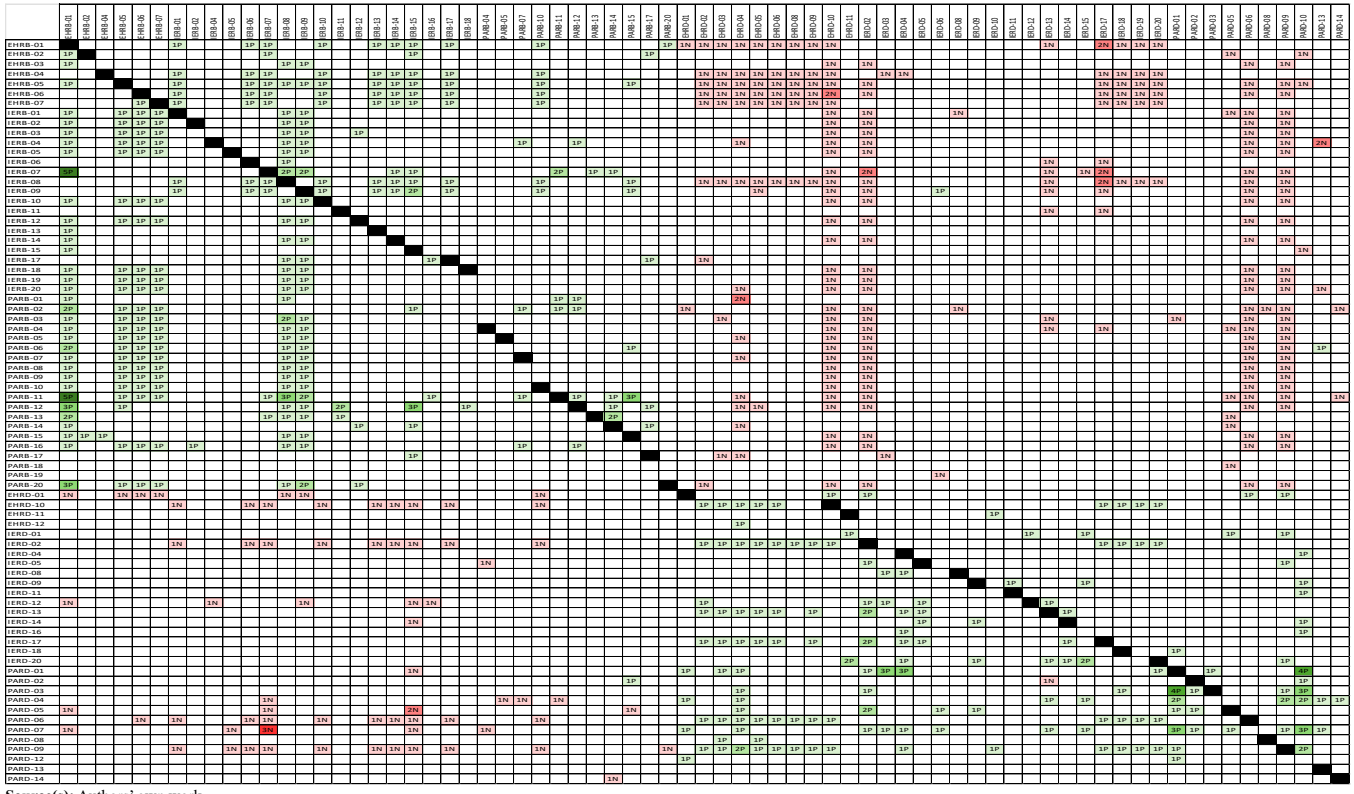

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Table 11. SLR (Stage 2): cognitive biases associated with the factors

S/N	Authors (year)	Country	Cognitive biases
1	Yang *et al*. (2023)	China	3
2	Wang *et al*. (2023)	China	3
3	Purushothaman *et al*. (2023)	Global	19
4	Love *et al*. (2023)	Global	16
5	Claeys (2023)	Global	4
6	Xu and Wu (2022)	China	1
7	Shkromyda *et al*. (2022)	Global	1
8	Qi and Barclay (2022)	USA	4
9	Pooladvand *et al*. (2022)	USA	3
10	Pooladvand and Hasanzadeh (2022)	USA	2
11	Peng *et al*. (2022)	China	12
12	Lv *et al*. (2022)	China	3
13	Jennejohn *et al*. (2022)	USA	4
14	Hofman *et al*. (2022)	Netherlands	3
15	Espinosa *et al*. (2022)	Global	3
16	da Rocha *et al*. (2022)	Global	1
17	Bian and Lin (2022)	China	3
18	Weber *et al*. (2021)	Global	7
19	Wangzhou *et al*. (2021)	Global	2
20	Galluccio (2021)	Global	4
21	Vargas-Lama and Osorio-Vera (2020)	Latin America	12
22	Meneganzin *et al*. (2020)	Global	5
23	Li *et al*. (2020)	China	3
24	Chen (2020)	Taiwan	1

Source(s): Authors' own work

Table 12. Top 18 cognitive biases

S/N	Bias	Occurrence	Rank
1	Status Quo Bias	8	1
2	Bounded Rationality	7	2
3	Underestimation Bias	5	3–4
4	Confirmation Bias	5	
5	Availability Bias	4	5–8
6	Subjective Bias	4	
7	Anchoring Bias	4	
8	Overconfidence	4	

Source(s): Authors' own work

green building practices in Singapore. Furthermore, Kamranfar *et al*. (2022) stated that the economic aspect of sustainable construction holds considerable importance in construction projects and is often cited as the primary barrier to the adoption of green buildings in Iran.

Nevertheless, the lack of awareness emerges as a significant barrier, the root cause of various obstacles to the sustainability transition (Martek *et al*., 2019). Individuals across different levels of the industry and policymakers are affected by misunderstandings and misconceptions about sustainability in the building industry. With the inclusion of the government, Tran *et al*. (2020) implied that it is imperative to integrate educational, legal, and policy measures to encourage the demand for green building construction. Moreover, the government should be more proactive in responding to the trend of sustainable construction by enacting robust legal regulations and appropriate incentive policies, such as grants or loans, to

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Table 13. Author-cognitive bias matrix

S/N	Author	Year	Cognitive bias: Memory bias	Implicit evaluation	Negativity bias	Recency bias	Peak-end rule	Availability bias	Subjective bias	Risk aversion	Conservatism	Nudging	Perception	Projection bias
1	Yang *et al*. (2023)	2023	x			x	x							
2	Wang *et al*. (2023)	2023												
3	Purushothaman *et al*. (2023)	2023												
4	Love *et al*. (2023)	2023						x						
5	Claeys (2023)	2023												
6	Xu and Wu (2022)	2022												
7	Shkromyda *et al*. (2022)	2022												
8	Qi and Barclay (2022)	2022												
9	Pooladvand *et al*. (2022)	2022												
10	Pooladvand and Hasanzadeh (2022)	2022												
11	Peng *et al*. (2022)	2022						x						
12	Lv *et al*. (2022)	2022							x					
13	Jennejohn *et al*. (2022)	2022							x	x				
14	Hofman *et al*. (2022)	2022									x			
15	Espinosa *et al*. (2022)	2022							x			x		
16	da Rocha *et al*. (2022)	2022												
17	Bian and Lin (2022)	2022											x	
18	Weber *et al*. (2021)	2021	x	x	x								x	
19	Wangzhou *et al*. (2021)	2021												
20	Galluccio (2021)	2021											x	

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Table 13. Continued

Cognitive bias														
S/N	Author	Year	Memory bias	Implicit evaluation	Negativity bias	Recency bias	Peak-end rule	Availability bias	Subjective bias	Risk aversion	Conservatism	Nudging	Perception	Projection bias
21	Vargas-Lama and Osorio-Vera (2020)	2020						x	x					x
22	Meneganzin *et al*. (2020)	2020												
23	Li *et al*. (2020)	2020						x						
24	Chen (2020)	2020												

Cognitive bias														
S/N	Author	Year	Focusing effect	Egocentric bias	Hot-cold empathy gap	say-do gap/ value action gap	Endpoint bias	Shifting baseline syndrome	Hyperbolic discounting	Myopia	Bounded rationality	Overestimation bias	Underestimation bias	Confirmation bias
1	Yang *et al*. (2023)	2023												
2	Wang *et al*. (2023)	2023									x	x	x	
3	Purushothaman *et al*. (2023)	2023									x	x	x	x
4	Love *et al*. (2023)	2023												
5	Claeys (2023)	2023									x			
6	Xu and Wu (2022)	2022												
7	Shkromyda *et al*. (2022)	2022									x			

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Table 13. Continued

Cognitive bias														
S/N	Author	Year	Focusing effect	Egocentric bias	Hot-cold empathy gap	say-do gap/ value action gap	Endpoint bias	Shifting baseline syndrome	Hyperbolic discounting	Myopia	Bounded rationality	Overestimation bias	Underestimation bias	Confirmation bias
8	Qi and Barclay (2022)	2022												
9	Pooladvand *et al.* (2022)	2022										x	x	
10	Pooladvand and Hasanzadeh (2022)	2022											x	
11	Peng *et al.* (2022)	2022												
12	Lv *et al.* (2022)	2022									x		x	
13	Jennejohn *et al.* (2022)	2022									x			
14	Hofman *et al.* (2022)	2022												x
15	Espinosa *et al.* (2022)	2022									x			
16	da Rocha *et al.* (2022)	2022												
17	Bian and Lin (2022)	2022												
18	Weber *et al.* (2021)	2021												x
19	Wangzhou *et al.* (2021)	2021												
20	Galluccio (2021)	2021												

(*continued*)

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Table 13. Continued

Cognitive bias														
S/N	Author	Year	Focusing effect	Egocentric bias	Hot-cold empathy gap	say-do gap/ value action gap	Endpoint bias	Shifting baseline syndrome	Hyperbolic discounting	Myopia	Bounded rationality	Overestimation bias	Underestimation bias	Confirmation bias
21	Vargas-Lama and Osorio-Vera (2020)	2020	x	x	x	x								x
22	Meneganzin *et al.* (2020)	2020					x	x	x	x				
23	Li *et al.* (2020)	2020												x
24	Chen (2020)	2020												

Cognitive bias														
S/N	Author	Year	Optimism bias	Pessimism bias	Self-affirmation/ Prejudice	Subjective validation/ Personal validation	Present bias	Status quo bias	Planning fallacy	Chain reaction bias	Convenience bias	Critical response bias	Group reaction bias	Health and safety bias
1	Yang *et al.* (2023)	2023												
2	Wang *et al.* (2023)	2023												
3	Purushothaman *et al.* (2023)	2023	x		x	x	x	x	x	x	x	x	x	x
4	Love *et al.* (2023)	2023												
5	Claeys (2023)	2023												
6	Xu and Wu (2022)	2022												
7	Shkromyda *et al.* (2022)	2022												
8	Qi and Barclay (2022)	2022						x						
9	Pooladvand *et al.* (2022)	2022												
10	Pooladvand and Hasanzadeh (2022)	2022												
11	Peng *et al.* (2022)	2022												

(*continued*)

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Table 13. Continued

Cognitive bias														
S/N	Author	Year	Optimism bias	Pessimism bias	Self-affirmation/ Prejudice	Subjective validation/ Personal validation	Present bias	Status quo bias	Planning fallacy	Chain reaction bias	Convenience bias	Critical response bias	Group reaction bias	Health and safety bias
12	Lv *et al*. (2022)	2022												
13	Jennejohn *et al*. (2022)	2022						x						
14	Hofman *et al*. (2022)	2022						x						
15	Espinosa *et al*. (2022)	2022												
16	da Rocha *et al*. (2022)	2022												
17	Bian and Lin (2022)	2022	x	x										
18	Weber *et al*. (2021)	2021						x						
19	Wangzhou *et al*. (2021)	2021												
20	Galluccio (2021)	2021												
21	Vargas-Lama and Osorio-Vera (2020)	2020	x					x	x					
22	Meneganzin *et al*. (2020)	2020						x						
23	Li *et al*. (2020)	2020												
24	Chen (2020)	2020						x						

Cognitive bias														
S/N	Author	Year	Organisational policy bias	Standard operating procedure (SOP) bias	Stress bias	System-wide approach bias	Representativeness bias	Anchoring bias	Adjustment bias	Recognition heuristics	Take-the-first heuristics	Take-the-best heuristics	Fluemcy bias	Tallying heuristic
1	Yang *et al*. (2023)	2023												
2	Wang *et al*. (2023)	2023												
3	Purushothaman *et al*. (2023)	2023	x	x	x	x								

(*continued*)

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Table 13. Continued

S/N	Author	Year	Cognitive bias: Organisational policy bias	Standard operating procedure (SOP) bias	Stress bias	System-wide approach bias	Representativeness bias	Anchoring bias	Adjustment bias	Recognition heuristics	Take-the-first heuristics	Take-the-best heuristics	Fluemcy bias	Tallying heuristic
4	Love *et al.* (2023)	2023					x	x	x	x	x	x	x	x
5	Claeys (2023)	2023												
6	Xu and Wu (2022)	2022												
7	Shkromyda *et al.* (2022)	2022												
8	Qi and Barclay (2022)	2022						x						
9	Pooladvand *et al.* (2022)	2022												
10	Pooladvand and Hasanzadeh (2022)	2022												
11	Peng *et al.* (2022)	2022					x	x						
12	Lv *et al.* (2022)	2022												
13	Jennejohn *et al.* (2022)	2022												
14	Hofman *et al.* (2022)	2022												
15	Espinosa *et al.* (2022)	2022												
16	da Rocha *et al.* (2022)	2022												
17	Bian and Lin (2022)	2022												

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Table 13. Continued

Cognitive bias														
S/N	Author	Year	Organisational policy bias	Standard operating procedure (SOP) bias	Stress bias	System-wide approach bias	Representativeness bias	Anchoring bias	Adjustment bias	Recognition heuristics	Take-the-first heuristics	Take-the-best heuristics	Fluemcy bias	Tallying heuristic
18	Weber *et al.* (2021)	2021												
19	Wangzhou *et al.* (2021)	2021												
20	Galluccio (2021)	2021												
21	Vargas-Lama and Osorio-Vera (2020)	2020						x						
22	Meneganzin *et al.* (2020)	2020												
23	Li *et al.* (2020)	2020												
24	Chen (2020)	2020												

Cognitive bias													
S/N	Author	Year	Satisficing	Fast-and-frugal trees	Equality heuristic	Default bias	Tit-for-tat	Imitate-the-successful heuristic	Imitate-the-majority heuristic	Self-reference bias	Incompleteness	Indeterminacy	Overconfidence	Framing effect
1	Yang *et al.* (2023)	2023												
2	Wang *et al.* (2023)	2023												
3	Purushothaman *et al.* (2023)	2023												
4	Love *et al.* (2023)	2023	x	x	x	x	x	x	x					
5	Claeys (2023)	2023								x	x	x		
6	Xu and Wu (2022)	2022											x	

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Table 13. Continued

S/N	Author	Year	Cognitive bias: Satisficing	Fast-and-frugal trees	Equality heuristic	Default bias	Tit-for-tat	Imitate-the-successful heuristic	Imitate-the-majority heuristic	Self-reference bias	Incompleteness	Indeterminacy	Overconfidence	Framing effect
7	Shkromyda *et al.* (2022)	2022												
8	Qi and Barclay (2022)	2022												x
9	Pooladvand *et al.* (2022)	2022												
10	Pooladvand and Hasanzadeh (2022)	2022												
11	Peng *et al.* (2022)	2022											x	x
12	Lv *et al.* (2022)	2022												
13	Jennejohn *et al.* (2022)	2022												
14	Hofman *et al.* (2022)	2022												
15	Espinosa *et al.* (2022)	2022												
16	da Rocha *et al.* (2022)	2022												
17	Bian and Lin (2022)	2022												
18	Weber *et al.* (2021)	2021												
19	Wangzhou *et al.* (2021)	2021												
20	Galluccio (2021)	2021											x	
21	Vargas-Lama and Osorio-Vera (2020)	2020												
22	Meneganzin *et al.* (2020)	2020												
23	Li *et al.* (2020)	2020											x	
24	Chen (2020)	2020												

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Cognitive bias

S/N	Author	Year	Loss aversion	Risk compensation	Illusion of control	Cognitive dissonance	Normality bias	Regret aversion	Information cascade	Endowment effect	Sunk cost fallacy	Self-attribution bias	Conjunction fallacy
1	Yang *et al*. (2023)	2023											
2	Wang *et al*. (2023)	2023											
3	Purushothaman *et al*. (2023)	2023											
4	Love *et al*. (2023)	2023											
5	Claeys (2023)	2023											
6	Xu and Wu (2022)	2022											
7	Shkromyda *et al*. (2022)	2022											
8	Qi and Barclay (2022)	2022	x										
9	Pooladvand *et al*. (2022)	2022		x									
10	Pooladvand and Hasanzadeh (2022)	2022		x									
11	Peng *et al*. (2022)	2022	x		x	x		x		x	x	x	
12	Lv *et al*. (2022)	2022											
13	Jennejohn *et al*. (2022)	2022											
14	Hofman *et al*. (2022)	2022											
15	Espinosa *et al*. (2022)	2022											
16	da Rocha *et al*. (2022)	2022											x
17	Bian and Lin (2022)	2022											
18	Weber *et al*. (2021)	2021				x							
19	Wangzhou *et al*. (2021)	2021						x	x				
20	Galluccio (2021)	2021				x	x						
21	Vargas-Lama and Osorio-Vera (2020)	2020											
22	Meneganzin *et al*. (2020)	2020											
23	Li *et al*. (2020)	2020											
24	Chen (2020)	2020											

Source(s): Author's own work

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stimulate social demand for green building. This constitutes the top driver identified in the SLR, which is that there should be clear and comprehensive government policies and building regulations about green building practices (PARD-04), which can also be related to the top barrier, PARB-11. To compensate for the inadequate awareness concerning green building adoption, the government needs to be more responsive to sustainable trends in the industry by enacting mandatory legal regulations and technical codes/standards and guidelines to regulate and control the environmental performance of buildings (Tran *et al*., 2020). Furthermore, the government should assume responsibility as a key promoter by selecting and providing direct financial and non-financial incentive policies, such as awards, deficit subsidies, direct grants, discounted development application fees, tax reliefs, low-interest loans, gross floor area, and concession schemes.

Based on the interrelationships shown in Table 10, the typical relationship between a barrier and a driver is usually negative, while the relationship between similar drivers and barriers is positive. However, there were unique instances where a driver implies a positive relationship to a barrier and vice versa. One example is preserving culture/heritage (PARD-02), which is positive to resistance to change/status quo bias (PARB-15). In Vietnam, Pham *et al*. (2020) stated that the industry's practical and results-driven mindset has led to innovation management being somewhat undervalued, with the prevailing culture (PARD-02) appearing to be unsupportive of innovation (PARB-15) and sustainability efforts. This relationship aligns with the findings of Garg *et al*. (2021), which indicate that people in India are risk-averse about adopting green practices but remain resistant to change regarding innovative green products and practices. This is also true for the unique correlation that PARD-02 is negative to product innovation in green construction (IERD-13). Moreover, Iqbal *et al*. (2021) found that the complex codes and the strict regulations of green construction practices (PARB-06) in Pakistan will ensure that the industry is capable of change (PARD-13) if necessary. This means that given that PARB-06 serves as a barrier to adopting green building practices (Marandi Alamdari *et al*., 2023; Van Nguyen, 2023; Zulu *et al*., 2023), stakeholders and private organisations will abide by and adopt the stringent regulations when imposed (PARD-13). The last unique relationship pertains to the limited availability of suppliers of sustainable resources (IERB-09), which is positive towards supporting local/national economic growth (IERD-06). This is analogous to the study of Doan *et al*. (2021), where the scarcity of green-certified products in New Zealand frequently leads to an ironic scenario where environmentally friendly materials accrue significant carbon emissions from overseas sourcing, highlighting the need for adjustments to the green rating system to accommodate locally sourced products better and enable contractors to utilise them more readily.

The system dynamic map shown in Figure 7 shows the interplay between barriers, drivers, and the adoption of green building practices. The barriers are denoted by the negative (N) as they hinder the adoption of green construction. At the same time, the drivers are represented by a positive (P) sign as they promote and stimulate the implementation of sustainable construction. The top 10 barriers and drivers were shown, and their interconnectivity was taken from *Table 10*. Moreover, the interrelationship between factors produced seven total reinforcing loops: three positive barriers loops, two positive drivers' loops, and two negative reinforcing loops. Reinforcing loops depict a situation where a change in one variable leads to further changes in the same direction, thus reinforcing the original change (Lannon, 2012). In contrast, balancing loops illustrate a situation where a change in one variable prompts adjustment in the opposite direction, working to counteract the original change and maintain equilibrium within the system.

3.2.3 Cognitive biases and factors affecting green building construction. The interplay between cognitive bias and the factors affecting the adoption of green construction practices plays a vital role in decision-making. For example, Yang *et al*. (2023) implied that the dynamic operation of improving indoor air quality (EHRD-06) in a facility is affected by different cognitive biases. One is memory bias, which influences a person's recall by modifying the information, offering valuable insights when assessing heating experiences. Moreover,

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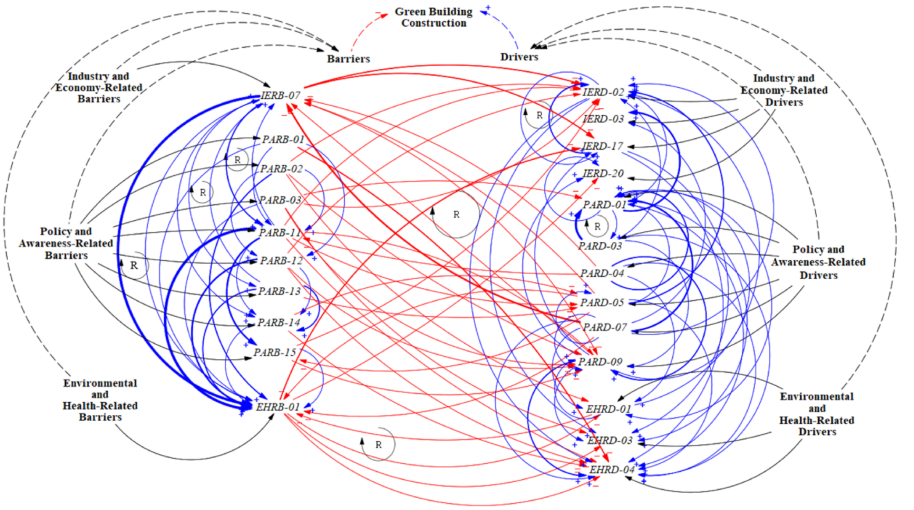

Figure 7. System dynamic map of the factors that affect green building adoption. Source: Authors' own work

recency bias and peak-end rule are also biases associated with thermal comfort where people remember the most recent expertise on whether the temperature is hot or cold, which are the two ends of temperature (Yang *et al*., 2023). Political and government decision-making is another aspect influenced by cognitive bias. Espinosa *et al*. (2022) suggested that nudge theory describes how policymakers can design systems to guide the behaviour of less privileged individuals toward improved well-being, both for individuals and communities. This approach assumes that policymakers are aware of people's goals and methods, aiming to create effective policies through government intervention. Moreover, the goal is to guide actions toward positive outcomes without conflicting with the well-being of those with fewer resources (Espinosa *et al*., 2022). On the other hand, Weber *et al*. (2021) found that confirmation bias and status quo bias are prevalent among policymakers. Policymakers tend to exhibit confirmation bias, relying on their preconceptions of what is true, even when presented with fact-checkers. In addition, this self-confirming bias is supported by the resistance to change among officials and legislators, which affects consumer welfare and public policy (PARD-04) (Weber *et al*., 2021).

Cognitive biases are also present in construction practices, such as in lean implementation (da Rocha *et al*., 2022; Purushothaman *et al*., 2023) and in safety and risk management (Galluccio, 2021; Li *et al*., 2020; Pooladvand and Hasanzadeh, 2022; Pooladvand *et al*., 2022; Wang *et al*., 2023). Purushothaman *et al*. (2023) have identified nine innovative biases concerning lean implementation, seven of which are prevalent in the New Zealand environment. These biases are in conjunction with da Rocha *et al*. (2022), where the understanding of lean and flow in construction management is clouded with cognitive biases. Meanwhile, underestimation bias is prevalent in risk management, which was common among the three articles. Wang *et al*. (2023) have identified that underestimating bias, together with overestimating bias, often transpire among flood risk where the farmers' bounded rationality entails that there is limited knowledge and uncertainty about the risk. Pooladvand *et al*. (2022) have associated underestimation bias, which leads workers to overlook risks and rely more on safety intervention. This is similar to the study of Pooladvand and Hasanzadeh (2022), where the decision-making process of an individual, when faced with time constraints and mental burden, tends to focus more on seeking gains and is prone to underestimating the risk involved in the task. Furthermore, Hammond *et al*. (2019) implied that loss aversion influences

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decision-making in construction, often resulting in a strong inclination toward resistance to change. This aversion can trigger other biases, such as the status quo bias and regret aversion, all of which contribute to a preference for not adopting over adopting in green building decision-making.

The 24 papers in Stage 2 were classified according to each theme, using the sub-categories listed in Table 7, to visualise the relationship between the cognitive biases and the factors identified in Stage 1. The causal loop diagram created using Vensim summarises the link between the different biases from Table 12 and the factors identified in Table 7 (see Figure 8). The thickness of each arrow depicts the number of occurrences for each bias concerning the factors.

4. Conclusion

The current status of implementing green building construction practices varies globally. However, the triple bottom line of sustainability needs to be prioritised to provide a better living condition for future generations. The drivers that motivate the adoption of green practices should outweigh the current barriers. The cultural difference hinders the ability to adopt green practices and view them as an improvement over traditional methods rather than a problem due to additional costs. The construction industry worldwide should be aware of and knowledgeable about the long-term benefits of sustainable construction practices, which help preserve the environment and improve the end-user quality of life. The interplay of cognitive bias in this research suggests that proper education and training will likely enhance awareness of green construction practices while mitigating the biases that may interfere.

4.1 Results

Stage one of the systematic literature review (refer to *Section 2*) has identified 95 factors that affect the adoption of green construction practices. There were 48 barriers, while 47 drivers were identified from 58 relevant academic journal articles (see Table 5 and Table 6). These factors were categorised based on three specific themes: Environmental and Health-Related factors, Industry and Economy-Related factors, and Policy and Awareness-Related factors to facilitate a simple analysis of the factors. The top 10 factors and barriers are shown in Table 8 and Table 9 and were discussed in Section 3. The next stage of the literature review focuses on

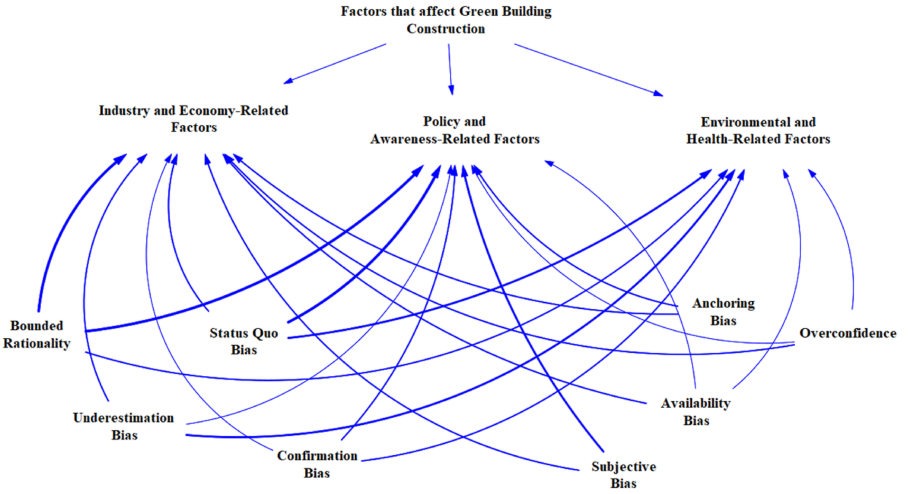

Figure 8. System dynamic map of the cognitive biases related to the factors. Source: Authors' own work

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the cognitive biases that interact with the identified factors. Seventy-one cognitive biases were identified in 24 journal articles (see Tables 11 and 12) and are also discussed in Section 3. Lastly, the interrelationships among the different factors are presented in Table 10, accompanied by a causal loop diagram that illustrates these relationships and identifies loops, as shown in Figure 7.

4.2 Limitations

The use of SLR as a qualitative research methodology limits researchers from accessing the most current industry knowledge, as it sets parameters for reviewing the literature. Additionally, the absence of other academic databases limits the number of valuable and credible sources that can support the study. Moreover, with English being the preferred medium for all resources, the study overlooks related references published in other languages. In addition, the strict use of journal articles sets a constraint but ensures the credibility and dependability of the paper's outcome. Furthermore, the study acknowledges the limitation regarding conference papers, which may not be peer-reviewed, and grey literature that provides factual information based on expert opinions.

4.3 Practical and theoretical implications

This study provides valuable insights into green building construction practices, emphasising the need to acknowledge the impact of cognitive biases on decision-making in the construction industry. As key decision-makers significantly shape the direction and outcomes of the industry, understanding these biases is crucial. Furthermore, the research adds to the global academic knowledge on this critical topic. This study offers important insights into green building construction practices, highlighting the necessity of recognising the influence of cognitive biases on decision-making within the construction industry. By analysing these elements, the study aims to provide a deeper understanding of how stakeholders can navigate the complexities of green building construction, ultimately fostering more effective strategies for sustainability in the architectural and construction industries. Since key decision-makers, such as project managers, construction professionals, and policymakers, play a crucial role in shaping the industry's direction and outcomes, it is vital to understand the human perspective, specifically cognitive biases. By analysing these elements, the study aims to provide a deeper understanding of how stakeholders can navigate the complexities of green building construction, ultimately fostering more effective strategies for sustainability in the architectural and construction industries. Additionally, this research contributes to the global body of academic knowledge on this significant topic.

4.4 Originality/value

This paper novelly offers a comprehensive exploration of the various interconnected factors that influence the construction practices of green buildings. It specifically delves into the key drivers that promote sustainable building practices, the barriers that hinder their implementation, and the cognitive biases that affect decision-making in this context. This study offers a comprehensive and detailed analysis of the various and interconnected elements influencing the construction practices related to green buildings. It carefully explores the key factors that promote sustainable building techniques, emphasising the driving forces behind embracing eco-friendly methods. Moreover, the examination addresses the challenges that hinder the effective implementation of these practices, examining the difficulties faced by industry stakeholders. Additionally, for the first time, the paper explores the cognitive biases that can influence decision-making in this area, highlighting how existing beliefs and biases may impact the decisions made by builders, architects, and developers as they strive for sustainability.

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4.5 Future research

Future research could focus on individual biases affecting specific drivers and barriers, and assess their influence. Further research should focus more on the particular cognitive biases present within the construction industry of different nations. Moreover, quantitative research about the cognitive biases in the decision-making process for green building adoption is highly needed to identify possible ways and solutions to address these biases.

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