

## **Perceptions of Civil Engineers on the Use of Recycled Construction Materials in Kuwait: Barriers and Opportunities**

**Mohammad KH Alenezi<sup>1</sup> and Mohammad H Alrashidi<sup>2</sup>**

<sup>1</sup>Construction Training Institute -The Public Authority for Applied Education and Training (PAAET), email: [mk.elenizi@paaet.edu.kw](mailto:mk.elenizi@paaet.edu.kw)

<sup>2</sup>Construction Training Institute -The Public Authority for Applied Education and Training (PAAET), email: [mh.shlash@paaet.edu.kw](mailto:mh.shlash@paaet.edu.kw)

### **Abstract**

Sustainable construction practices increasingly rely on recycled construction materials (RCMs) to reduce environmental impacts and support responsible resource management. However, the extent to which these materials can be integrated into construction activities depends largely on how engineering professionals perceive their feasibility and performance. This study investigates the awareness, attitudes, perceived barriers, opportunities, and overall perceptions of civil engineers in Kuwait regarding the use of RCMs. A validated questionnaire consisting of 39 Likert-scale items was administered to a purposive sample of 83 engineers working across public, private, and consulting sectors. Descriptive statistics and reliability analyses were conducted to evaluate engineers' responses



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and assess the consistency of each construct. Results show high awareness of the environmental benefits of RCMs and generally positive attitudes toward their use, yet significant technical and economic concerns persist, including the lack of testing data, unclear evaluation guidelines, high processing costs, and limited material availability. Cultural and market-related barriers, such as client resistance and perceptions of low quality, further restrict adoption. Engineers identified clear regulations, improved testing standards, awareness campaigns, and financial incentives as key enablers that could enhance industry readiness. The study concludes that while engineers recognize the potential value of RCMs, substantial structural and informational gaps must be addressed to advance their use in Kuwait. These findings contribute to the regional sustainability literature and offer practical insights for policymakers seeking to strengthen the role of recycled materials in the construction sector.

**Keywords;** Recycled construction materials; sustainable construction; perceptions; barriers; opportunities; Kuwait.

## Introduction

The construction sector consumes large quantities of natural resources, making the adoption of recycled materials an important strategy for reducing environmental impact. Although interest in sustainable material use is increasing, the industry still faces challenges such as unstable raw material prices, limited resource availability, rising demand, inadequate waste management systems, and outdated recycling technologies. These factors complicate efforts to integrate recycled construction materials into routine practice (Ghufran et al., 2022). Many countries have introduced strategies, regulations, and incentives to promote the reuse and recycling of materials in building and infrastructure projects, reflecting a broader recognition that sustainable material management is essential for long-term environmental resilience (Kylili & Fokaides, 2017). Despite this progress, the integration of RCMs into mainstream construction practices varies widely across regions, often influenced by local regulatory environments, market readiness, material availability, and professional perceptions within the industry (Bloom et al., 2016).

Kuwait, like many Gulf states, experiences high construction demand driven by rapid urban development, infrastructural investments, and population growth. This development, however, generates significant quantities of construction waste and places pressure on natural material resources (AlSanad, 2024). Although RCMs could help address these issues by reducing environmental impact and supporting

sustainability goals, their adoption in Kuwait remains noticeably limited. Reports and regional assessments suggest that factors such as limited awareness, insufficient recycling infrastructure, unclear regulations, and cultural preferences for conventional materials may hinder the broader acceptance of recycled alternatives (Adegoke et al., 2019; Ignatius & Opeyemi, 2014; Oyenuga & Bhamidimarri, 2015). Yet, while these challenges are often referenced conceptually, there is a lack of empirical evidence that captures how engineering professionals—the individuals most directly responsible for evaluating, selecting, and recommending construction materials—perceive the use of RCMs within the Kuwaiti context.

Civil engineers, in particular, play a critical role in determining the feasibility, safety, and performance of materials used in construction projects. Their professional judgments influence whether innovative materials are considered technically acceptable, economically viable, and suitable for long-term structural performance. Therefore, understanding how civil engineers view recycled construction materials, what barriers they identify, and what opportunities they recognize is essential for designing interventions that can encourage sustainable material adoption. However, despite their central role, there is currently no research that specifically examines civil engineers' perceptions of RCMs in Kuwait.

This study addresses this gap by examining the awareness, attitudes, perceived technical and economic barriers, cultural and market acceptance factors, and

perceived opportunities related to the adoption of RCMs among civil engineers in Kuwait. By capturing engineers' insights through a structured and validated survey instrument, the study provides evidence-based understanding that can inform future sustainability initiatives, regulatory improvements, and industry strategies aimed at integrating recycled materials into Kuwait's construction practices.

### **Literature review**

The shift toward sustainable construction has increased interest in RCMs as alternatives to traditional products. Engineers' perceptions are especially important because their technical judgments and material decisions directly influence whether RCMs are adopted. This literature review examines current evidence on engineers' attitudes, perceived barriers, and opportunities related to the use of RCMs.

Shooshtarian et al. (2020) showed that stakeholders' motivations, attitudes, and behavioral dynamics significantly shape whether recycled construction and demolition (CandD) waste products are adopted. Through a systematic review, the authors identified a range of enabling factors and barriers that influence stakeholder decisions. Their analysis highlighted that stakeholder perceptions, especially concerns about quality, regulations, and market readiness, play a crucial role in determining the use of recycled materials. The study also proposed an emergent model capturing these factors, providing policymakers with insights to support more effective recycling policies.

Knoeri, Binder and Althaus (2011) found that decisions regarding recycled mineral construction materials (RMCs) in Switzerland are heavily influenced by interactions between stakeholders. Using an analytical hierarchy process, the study revealed that engineers' recommendations strongly shape material selection, while sustainability-focused public-sector specifications have limited practical impact. The authors concluded that although RMCs are well accepted in civil engineering, they remain underutilized in structural engineering due to perceived performance limitations.

Balador (2020) demonstrated that stakeholder perceptions toward reused and recycled building materials (RRBMs) in New Zealand vary widely across professions. Using a mixed-method approach involving architects, builders, environmentalists, regulators, and consumers, the study showed that environmental attitudes, knowledge levels, and socio-demographic factors influence the willingness to adopt RRBMs. Architects emerged as the most influential group in encouraging their use, while consumers had the lowest awareness. Both barriers (cost, uncertainty about material performance) and opportunities (education, certification, stakeholder collaboration) were identified.

Jin et al. (2017) revealed that China remains in the early stages of CandD waste recycling and reuse. Based on survey responses from industry professionals, the study found that limited client demand, inadequate training, and low confidence in recycled materials hinder adoption. Engineers and consultants were more

optimistic about the benefits of recycling compared to construction managers. The findings emphasized that economic feasibility and governmental supervision are major factors influencing progress in this area.

Alsalem (2023) showed that sustainable construction practices in Kuwait face significant challenges, including limited awareness and weak regulatory enforcement. Through in-depth interviews with practitioners, the study found that perceptions of sustainability vary widely and that professionals view regulations as key drivers in encouraging more sustainable construction behaviors. Thematic analysis identified major barriers such as lack of knowledge, insufficient incentives, and inconsistent application of environmental standards.

Al-Raqeb et al. (2023) found that waste management practices in Kuwait fall short of supporting circular construction principles. Surveying multiple stakeholders, the study identified significant barriers including inadequate enforcement of regulations, low public awareness, and limited economic incentives. Stakeholders emphasized the need for stronger legislation, better materials recovery systems, and greater emphasis on the economic benefits of recycling to improve adoption.

Otasowie et al. (2024) reported that client acceptance of recycled construction materials is constrained by lack of information, limited material availability, insufficient recycling facilities, and resistance to change. Survey results showed that logistical and technological limitations significantly reduce the willingness of

professionals to specify recycled materials. The study recommended enhancing recycling infrastructure and providing awareness campaigns to increase acceptance.

Oyedele, Ajayi and Kadiri (2014) showed that designers in the UK seldom specify recycled products due to concerns about quality, uncertain costs, limited market availability, and negative client perceptions. The study identified several strategies to promote adoption, including incentives, regulatory changes, stronger collaboration across stakeholders, and improved education about recycled products. These insights highlight both the challenges and potential enabling mechanisms for wider use of recycled materials in construction.

Akadiri (2015) identified cost concerns, lack of information, and uncertainty about sustainable material performance as the main barriers to selecting sustainable building materials in Nigeria. The study used surveys and case studies to confirm that designers and contractors remain hesitant to adopt sustainable materials without better evidence of performance and clear regulatory guidance. Recommendations included improved access to information and stronger support frameworks.

Across the reviewed studies, several themes consistently emerge: stakeholders in many countries face barriers related to cost, availability, performance uncertainty, limited information, and weak regulations when considering recycled construction materials. Many studies examined stakeholder groups such as

architects, builders, regulators, clients, and material suppliers across regions including New Zealand, China, Switzerland, Nigeria, and the UK. However, no study specifically focuses on civil engineers' perceptions in Kuwait, despite their central role in material specification, project design, and technical feasibility assessments. Furthermore, although some studies address sustainability perceptions in Kuwait, none examine engineers' attitudes, awareness levels, and perceived technical, economic, and cultural barriers to using recycled construction materials within the Kuwaiti context. There is also a lack of empirical studies assessing the opportunities and enablers, such as policy interventions, economic incentives, and improved standards, that could promote RCM adoption. Therefore, a clear gap exists in understanding how civil engineers in Kuwait perceive the opportunities and constraints associated with RCMs, and how these perceptions influence the integration of recycled materials into national construction practices. This study addresses this gap by providing a comprehensive, quantitative assessment of civil engineers' perceptions, barriers, and opportunities related to RCM use in Kuwait.

## **Methodology**

This study employed a quantitative, cross-sectional survey design to examine the perceptions of civil engineers in Kuwait regarding the use of RCMs and to identify the barriers and opportunities influencing their adoption. The design was appropriate for capturing engineers' attitudes, awareness levels, and experiences at a single point in time while allowing for statistical comparison across multiple

constructs. Data were collected using a structured, self-administered questionnaire consisting of demographic items and 39 Likert-scale statements covering awareness, attitudes, technical barriers, economic barriers, cultural acceptance, opportunities, and overall perception. The instrument was validated through expert panel review and pilot testing prior to administration, ensuring content accuracy and reliability. A total of 83 engineers from public and private sector organizations participated, providing a sample that reflects the diversity of engineering roles in Kuwait's construction industry. The cross-sectional nature of the design enabled efficient collection of perception-based data and facilitated descriptive and comparative analysis to address the study objectives.

### **Study Population and Sample**

The study population consisted of practicing civil engineers working in Kuwait across public, private, and consulting sectors who are directly involved in construction planning, design, supervision, or materials evaluation. This population was selected because civil engineers play a central role in deciding whether RCMs can be integrated into infrastructure and building projects. Given the practical constraints and the relatively limited number of civil engineers in Kuwait, a non-probability purposive sampling approach was adopted to ensure that participants possessed relevant expertise and exposure to construction materials decision-making. A total of 83 civil engineers were recruited as the study sample, representing a diverse mix of engineering roles, experience levels, and organizational backgrounds. This sample size was considered adequate and

representative for the exploratory nature of the research and aligns with recommended minimum requirements for perception-based survey studies. Stratification by sector (public and private) was considered during recruitment to enhance representativeness and capture variations in practices across institutional contexts.

### **Study Tool**

The primary data collection instrument for this study was a structured, self-administered questionnaire specifically designed to measure civil engineers' perceptions of RCMs in Kuwait. The questionnaire consisted of two main parts: a demographic section capturing participants' experience, sector, specialization, and prior exposure to RCMs; and a comprehensive set of 39 Likert-scale items distributed across seven constructs central to the research objectives. These constructs included awareness and knowledge, attitudes toward RCMs, technical barriers, economic barriers, cultural and market acceptance barriers, opportunities and enablers, and overall perception and future adoption. All items were measured using a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), allowing for quantitative assessment of agreement intensity. The questionnaire was originally developed based on relevant literature and contextual considerations in Kuwait's construction sector, then refined through expert review and pilot testing to ensure clarity, relevance, and internal consistency. The final validated instrument served as the primary tool for collecting standardized and comparable data from the study sample of civil engineers.

## **Instrument Development and Validation**

To ensure the validity and reliability of the survey instrument, a multi-stage process of development and validation was undertaken prior to full data collection. The initial version of the questionnaire was derived from relevant literature on recycled construction materials, sustainability adoption, and engineering perceptions, and was aligned with the study's objectives examining awareness, attitudes, technical barriers, economic barriers, cultural barriers, opportunities, and overall perceptions.

The first validation step involved a review by a panel of five subject-matter experts, including two senior civil engineers from the public sector, one academic specializing in sustainable construction materials, and two engineers from the private contracting sector. Each expert evaluated the items for clarity, relevance, wording adequacy, and alignment with the construct definitions. Experts rated each item using a 4-point relevance scale (1 = not relevant, 4 = highly relevant).

The content validity assessment demonstrated strong agreement among expert reviewers, with Item-level Content Validity Index (I-CVI) values ranging from 0.80 to 1.00 and a Scale-level CVI (S-CVI/Ave) of 0.93. Three items with I-CVI scores below 0.80 were refined to enhance clarity, primarily through rewording within the technical and cultural barriers sections. No items were removed during this process, as each was judged to be conceptually important and aligned with the intended constructs of the questionnaire.

After expert refinement, the questionnaire was piloted with a pilot sample of 18 civil engineers (who were not included in the final sample). Respondents represented various sectors in Kuwait, ensuring that the tool was tested across diverse engineering roles. The pilot aimed to assess item clarity, response scale suitability, and preliminary reliability of each construct.

Participants reported high clarity and minimal ambiguity; however, two items in the “Economic Barriers” and “Cultural Barriers” sections were further simplified to improve comprehension.

Then, the internal consistency for each construct was calculated using the pilot sample, the following are the results of this step.

**Table 1. Internal Consistency Reliability of the Questionnaire Constructs**

<b>Construct</b>	<b>No. of Items</b>	<b>Cronbach's Alpha</b>	<b>Interpretation</b>
Awareness and Knowledge	5	0.84	Good
Attitudes Toward RCMs	4	0.81	Good
Technical Barriers	6	0.87	Good–High
Economic Barriers	6	0.83	Good
Cultural and Market Barriers	5	0.79	Acceptable–Good
Opportunities and Enablers	8	0.88	High
Overall Perception and Future Adoption	5	0.80	Good

All constructs exceeded the commonly accepted threshold of 0.70, confirming that the instrument demonstrated satisfactory internal consistency. No items were removed at this stage because each contributed positively to reliability and conceptual coverage. After the finalization of the questionnaire, the validated version was then administered to the main study sample of 83 civil engineers across Kuwait.

### **Data Collection**

Data for this study were collected using the validated questionnaire administered to civil engineers working across various organizations in Kuwait. Following the pilot phase and finalization of the instrument, the questionnaire was distributed electronically through email invitations and professional engineering networks, including public-sector engineering departments, private contracting firms, consultancy offices, and professional groups. This approach ensured accessibility and convenience for participants while supporting wider reach across the engineering community. Participation was voluntary, and respondents were informed of the study's purpose, confidentiality assurances, and the approximate time required to complete the survey. To enhance response rates, two follow-up reminders were sent over a two-week period. The questionnaire was designed to be completed in approximately 8–10 minutes, and responses were automatically captured through a secure online form. In total, 83 valid responses were obtained and screened for completeness, with no cases removed due to missing data or

inconsistent patterns. The collected data were then exported for statistical analysis to address the study objectives.

### **Data Analysis**

Descriptive statistics, including means, standard deviations, and ranking, were computed to summarize responses across the questionnaire's constructs, such as awareness, attitudes, perceived barriers, and opportunities. Reliability of the multi-item scales was assessed using Cronbach's alpha to ensure internal consistency of each construct. Additionally, frequency and percentage distributions were used to profile the demographic characteristics of the participants. All analyses were conducted using statistical software to ensure accuracy and consistency, enabling the interpretation of engineers' perceptions and the identification of key factors influencing the adoption of recycled construction materials.

### **Results**

The sample consisted of 83 civil engineers working across Kuwait. Most participants (41%) had 5–10 years of experience, followed by 29% with 11–15 years, 18% with more than 15 years, and 12% with less than 5 years. A total of 52% worked in the private sector, 35% in the public sector, and the remaining 13% in consulting or contracting roles. In terms of specialization, 38% were structural engineers, 31% worked in construction or project management, 20% were materials engineers, and the rest specialized in design and related fields. About

46% reported previous use of RCMs, particularly in infrastructure and road projects, while others had used them in building applications.

### Awareness and Knowledge

The findings related to engineers' awareness and knowledge of recycled construction materials (RCMs) indicate generally positive but varied levels of understanding across the construct. As shown in Table (2), the highest-rated items were engineers' understanding of the environmental benefits of RCMs ( $M = 4.12$ ,  $SD = 0.78$ ; Rank 1) and the belief that RCMs contribute to waste reduction and sustainability ( $M = 4.05$ ,  $SD = 0.82$ ; Rank 2), both reflecting a high level of awareness. Familiarity with the overall concept of RCMs also scored moderately high ( $M = 3.68$ ,  $SD = 0.91$ ; Rank 3). However, more specialized knowledge, such as awareness of international standards ( $M = 3.21$ ,  $SD = 0.97$ ; Rank 5) and understanding of performance characteristics ( $M = 3.44$ ,  $SD = 0.88$ ; Rank 4), received lower mean scores, indicating moderate awareness in these areas.

**Table 2. Descriptive Statistics for Engineers' Awareness and Knowledge of RCMs**

Item	Rank	Mean	Standard deviation	Level
I am familiar with the concept of recycled construction materials.	3	3.68	0.91	Moderate
I understand the environmental benefits of RCMs.	1	4.12	0.78	High
RCMs reduce waste and	2	4.05	0.82	High

support sustainability.				
I am aware of international standards for RCMs.	5	3.21	0.97	Moderate
I know about performance characteristics of RCMs.	4	3.44	0.88	Moderate

### Attitudes Toward RCMs

The results presented in Table (3) show generally positive attitudes among civil engineers toward the adoption of recycled construction materials (RCMs). The highest-rated item was engineers' willingness to use RCMs in future projects ( $M = 4.02$ ,  $SD = 0.84$ ; Rank 1), indicating strong openness to integrating these materials into practice. Viewing RCM usage as a reflection of responsible engineering practice also scored highly ( $M = 3.88$ ,  $SD = 0.86$ ; Rank 2), further demonstrating favorable attitudes aligned with sustainability principles. However, perceptions of performance were more cautious. While engineers moderately agreed that RCMs can perform as well as traditional materials ( $M = 3.55$ ,  $SD = 0.92$ ; Rank 3), confidence in RCM performance under established standards was slightly lower ( $M = 3.49$ ,  $SD = 0.89$ ; Rank 4).

**Table 3. Descriptive Statistics for Engineers' Attitudes Toward RCMs**

Item	Rank	Mean	Standard deviation	Level
I am willing to use RCMs in future projects.	1	4.02	0.84	High
RCMs can perform as well	3	3.55	0.92	Moderate

as traditional materials.				
Using RCMs reflects responsible engineering practice.	2	3.88	0.86	High
I trust RCM performance when standards exist.	4	3.49	0.89	Moderate

### Technical Barriers

The results in Table (4) indicate that civil engineers perceive several substantial technical barriers to the adoption of recycled construction materials (RCMs) in Kuwait. The highest-rated concerns were the lack of sufficient testing data for RCMs ( $M = 4.22$ ,  $SD = 0.77$ ; Rank 1) and the absence of clear guidelines for evaluating these materials ( $M = 4.11$ ,  $SD = 0.81$ ; Rank 2), both of which reflect strong uncertainty regarding the technical validation of RCM performance. Concerns about long-term durability in Kuwait's harsh climate also scored high ( $M = 3.89$ ,  $SD = 0.83$ ; Rank 3), highlighting engineers' apprehension about environmental suitability. Moderate barriers were noted related to inconsistent mechanical properties ( $M = 3.76$ ,  $SD = 0.88$ ; Rank 4), limited availability of accredited laboratories for certification ( $M = 3.55$ ,  $SD = 0.94$ ; Rank 5), and the insufficient quantities of RCMs for large-scale projects ( $M = 3.41$ ,  $SD = 0.91$ ; Rank 6).

**Table 4. Descriptive Statistics for Technical Barriers to RCM Adoption**

Item	Rank	Mean	Standard deviation	Level
There is insufficient testing data for RCMs in Kuwait.	1	4.22	0.77	High
Engineers lack guidelines for evaluating RCMs.	2	4.11	0.81	High
RCM mechanical properties are inconsistent.	4	3.76	0.88	Moderate
Long-term durability in Kuwait's climate is uncertain.	3	3.89	0.83	High
Lack of accredited labs for material certification.	5	3.55	0.94	Moderate
RCM quantities are insufficient for large projects.	6	3.41	0.91	Moderate

### **Economic Barriers**

The results presented in Table (5) highlight the prominence of economic barriers in shaping engineers' perceptions of recycled construction materials

(RCMs) in Kuwait. The highest-rated barrier was the perceived high cost associated with processing and certifying RCMs ( $M = 4.16$ ,  $SD = 0.79$ ; Rank 1), followed closely by transportation costs that reduce feasibility, particularly given the geographical distribution of recycling facilities ( $M = 3.91$ ,  $SD = 0.87$ ; Rank 2). Engineers also moderately agreed that using RCMs increases overall project costs ( $M = 3.84$ ,  $SD = 0.90$ ; Rank 3) and that traditional materials remain cheaper and more readily accessible ( $M = 3.72$ ,  $SD = 0.89$ ; Rank 4), reinforcing the financial advantage of conventional options. Additional economic constraints included the absence of financial incentives to encourage adoption ( $M = 3.55$ ,  $SD = 0.93$ ; Rank 5) and the low market demand that undermines the economic viability of RCM production ( $M = 3.44$ ,  $SD = 0.92$ ; Rank 6).

**Table 5. Descriptive Statistics for Economic Barriers to RCM Adoption**

Item	Rank	Mean	Standard deviation	Level
Processing/certification of RCMs is costly.	1	4.16	0.79	High
Using RCMs increases project cost.	3	3.84	0.90	Moderate
Transportation cost reduces RCM feasibility.	2	3.91	0.87	High
Traditional materials are cheaper and more accessible.	4	3.72	0.89	Moderate
No financial incentives exist for RCM adoption.	5	3.55	0.93	Moderate
Low market demand affects economic feasibility.	6	3.44	0.92	Moderate

## Cultural and Market Acceptance Barriers

The results in Table (6) indicate that cultural and market acceptance factors present notable challenges to the adoption of recycled construction materials (RCMs) in Kuwait. The most prominent barrier identified by engineers was client resistance toward using recycled materials ( $M = 4.05$ ,  $SD = 0.83$ ; Rank 1), suggesting that end-users and project owners remain hesitant to approve alternatives to traditional materials. Perceptions of RCMs as being of lower quality also ranked high ( $M = 3.91$ ,  $SD = 0.86$ ; Rank 2), reflecting persistent concerns about product reliability within the construction community. Moderate barriers included contractors' reluctance to adopt RCMs ( $M = 3.82$ ,  $SD = 0.88$ ; Rank 3) and a general preference among decision-makers for conventional materials ( $M = 3.74$ ,  $SD = 0.91$ ; Rank 4), both of which point to entrenched practices and conservative material-selection norms. Finally, the lack of public awareness regarding the benefits and performance of RCMs ( $M = 3.62$ ,  $SD = 0.93$ ; Rank 5) further contributes to limited acceptance.

**Table 6. Descriptive Statistics for Cultural and Market Acceptance Barriers**

Item	Rank	Mean	Standard deviation	Level
Clients resist using recycled materials.	1	4.05	0.83	High
Contractors hesitate to adopt RCMs.	3	3.82	0.88	Moderate
RCMs are perceived as low-quality.	2	3.91	0.86	High

Decision-makers prefer traditional materials.	4	3.74	0.91	Moderate
Lack of public awareness affects acceptance.	5	3.62	0.93	Moderate

### Opportunities and Enablers

The findings in Table (7) highlight several promising opportunities that could facilitate the wider adoption of recycled construction materials (RCMs) in Kuwait. The strongest enabling factor identified by engineers was the establishment of clear regulations to guide the use of RCMs ( $M = 4.22$ ,  $SD = 0.73$ ; Rank 1), indicating that regulatory clarity is viewed as critical for building industry confidence. Awareness campaigns were also highly rated ( $M = 4.15$ ,  $SD = 0.78$ ; Rank 2), suggesting that increased visibility and understanding of RCM benefits could significantly influence acceptance. Engineers further emphasized the importance of improved testing standards ( $M = 4.05$ ,  $SD = 0.81$ ; Rank 3) and financial incentives ( $M = 3.98$ ,  $SD = 0.85$ ; Rank 4), both of which could strengthen trust and reduce perceived risks. Additionally, participants recognized the environmental benefits of RCMs ( $M = 3.88$ ,  $SD = 0.86$ ; Rank 5) as an important driver of adoption. Moderate enablers included the need for more suppliers to enhance material availability ( $M = 3.71$ ,  $SD = 0.89$ ; Rank 6), training programs to improve engineers' readiness ( $M = 3.66$ ,  $SD = 0.92$ ; Rank 7), and research collaborations to advance technologies ( $M = 3.55$ ,  $SD = 0.90$ ; Rank 8).

**Table 7. Descriptive Statistics for Opportunities and Enablers of RCM Adoption**

Item	Rank	Mean	Standard deviation	Level
Awareness campaigns would improve acceptance.	2	4.15	0.78	High
Financial incentives would increase adoption.	4	3.98	0.85	High
Clear regulations would improve industry confidence.	1	4.22	0.73	High
More suppliers would enhance availability.	6	3.71	0.89	Moderate
Improved testing standards increase trust.	3	4.05	0.81	High
RCMs help achieve environmental goals.	5	3.88	0.86	High
Training programs would improve readiness.	7	3.66	0.92	Moderate
Research collaborations can enhance RCM technologies.	8	3.55	0.90	Moderate

### Overall Perception and Future Adoption

The results in Table (8) illustrate generally moderate but encouraging perceptions among civil engineers regarding the future use of recycled construction materials (RCMs) in Kuwait. The strongest area of agreement was the willingness to recommend RCMs if appropriate standards were in place ( $M = 4.09$ ,  $SD = 0.82$ ;

Rank 1), underscoring the importance of clear and credible technical guidelines in building professional confidence. Engineers also expressed moderate optimism that RCM use will increase over the next decade ( $M = 3.85$ ,  $SD = 0.88$ ; Rank 2) and that adoption will expand with supportive policy directives ( $M = 3.78$ ,  $SD = 0.90$ ; Rank 3). However, perceptions of the industry's current readiness for sustainable materials were more cautious ( $M = 3.41$ ,  $SD = 0.95$ ; Rank 4), suggesting that significant structural and cultural adjustments may still be required. Finally, the overall positive perception toward RCMs received the lowest mean among the items ( $M = 3.35$ ,  $SD = 0.97$ ; Rank 5), indicating that while attitudes are generally favorable, broader acceptance remains in a developmental stage.

**Table 8. Descriptive Statistics for Overall Perception and Future Adoption of RCMs**

Item	Rank	Mean	Standard deviation	Level
Kuwait's construction industry is ready for sustainable materials.	4	3.41	0.95	Moderate
RCM use will increase within the next decade.	2	3.85	0.88	Moderate
I would recommend RCMs if standards were improved.	1	4.09	0.82	High
Adoption will grow with clear policy directives.	3	3.78	0.90	Moderate
Overall, I have a positive perception of RCMs.	5	3.35	0.97	Moderate

## Discussion

The purpose of this study was to examine civil engineers' perceptions of recycled construction materials (RCMs) in Kuwait by assessing their awareness, attitudes, perceived barriers, opportunities, and overall views regarding future adoption. The findings provide important insights into how engineers evaluate the feasibility and desirability of RCMs within the local construction sector, and they align closely with patterns reported in international research.

The results show that engineers in Kuwait possess moderate to high awareness of the environmental benefits of RCMs, particularly their role in reducing waste and supporting sustainability. This aligns with findings reported by Shooshtarian et al. (2020), who noted that environmental motivations often underpin positive perceptions of recycled materials. However, similar to the conclusions reached by Jin et al. (2017) in China and by Balador (2020) in New Zealand, more specialized knowledge, such as familiarity with performance standards and technical specifications, was less developed among engineers. This suggests that while general sustainability awareness is increasing, detailed technical understanding remains limited, which may restrict the confident integration of RCMs into engineering practice.

Attitudinal results further reinforce this observation. Engineers expressed willingness to use RCMs and viewed such use as part of responsible engineering

practice, yet performance-related concerns persisted. This duality reflects the pattern noted by Oyedele et al. (2014), who found that although professionals may conceptually support recycled materials, apprehension about reliability and long-term performance can moderate adoption. The present findings also resonate with Knoeri et al. (2011), who observed that structural applications tend to face higher skepticism compared with civil works, a trend that appears to hold true within the Kuwaiti context.

The perceived barriers identified in this study provide additional nuance. Engineers highlighted technical challenges as the most significant obstacles, particularly the lack of testing data, absence of clear evaluation guidelines, and uncertainty regarding durability in Kuwait's harsh climatic conditions. These concerns mirror the barriers documented by Otasowie et al. (2024) and Al-Raqeb et al. (2023), who both emphasized the importance of testing infrastructure and material certification in shaping market confidence. Economic barriers were also notable, with respondents pointing to the high cost of processing, transportation challenges, and the absence of incentives. Similar constraints have been reported in studies from developing and developed countries alike, suggesting that economic feasibility remains a universal determinant of RCM implementation. Cultural and market acceptance barriers, including client resistance and prevailing perceptions of low material quality, align closely with the findings of Balador (2020), Oyedele et al. (2014), and Alsalem (2023), indicating that entrenched preferences for

traditional materials are not unique to Kuwait but form part of a broader global challenge.

Despite these constraints, the engineers identified several opportunities that could significantly advance RCM adoption. Clear regulatory standards, awareness campaigns, improved testing procedures, and financial incentives were among the strongest enablers. Similar enablers have been emphasized in earlier studies, particularly those advocating for stronger governance and market-based incentives to support sustainable material use (Shooshtarian et al., 2020; Al-Raqeb et al., 2023). The study thus confirms that engineers recognize the potential for RCMs to contribute positively to environmental goals, but that industry-wide structural support is needed to unlock this potential.

From a theoretical standpoint, the findings contribute to the broader understanding of material adoption behaviors within the construction industry. The study highlights how engineers' acceptance of RCMs is shaped by a combination of cognitive (awareness), affective (attitudes), and contextual (barriers/opportunities) factors, consistent with decision-making frameworks in sustainability and construction innovation research. The results suggest that adoption is not limited to technical feasibility alone but is shaped by interconnected economic, cultural, and regulatory conditions, reinforcing multi-dimensional theoretical models described in international literature.

Practically, the study offers clear implications for policymakers, regulatory bodies, and industry leaders in Kuwait. The strong emphasis engineers placed on guidelines, testing standards, and regulations indicates that institutional actions, such as developing national specifications for RCMs, expanding certification facilities, and offering financial incentives, could positively influence adoption. Increasing awareness through training programs and engineering education may improve technical understanding and address misconceptions about performance. Additionally, market interventions that encourage suppliers to expand RCM availability could strengthen supply chains and support larger-scale projects.

However, the study is not without limitations. The sample size, while adequate for the study objectives, represents a subset of civil engineers and may not capture all perspectives across Kuwait's construction sector. The cross-sectional design limits the ability to assess changes in perceptions over time, especially as sustainability policies evolve. Furthermore, the study focused specifically on civil engineers; future research could incorporate other professional groups, such as architects, contractors, or policymakers, to develop a more holistic understanding of the adoption environment.

## **Conclusion**

This study examined the perceptions of civil engineers in Kuwait regarding the use of recycled construction materials (RCMs), providing empirical evidence on awareness, attitudes, perceived barriers, opportunities, and overall readiness for

future adoption. The findings show that engineers possess a generally positive understanding of the environmental value of RCMs and exhibit a willingness to incorporate them into projects, especially if clear standards and guidelines are established. However, the study also highlights several persistent challenges, including limited technical data, inadequate testing infrastructure, economic constraints, and cultural resistance rooted in concerns about material quality. These barriers closely mirror those observed in international studies, suggesting that Kuwait faces similar structural and perceptual obstacles that affect RCM adoption globally.

Despite these challenges, engineers identified meaningful opportunities, such as the development of regulations, awareness campaigns, improved testing protocols, and financial incentives, that could support the integration of RCMs within the national construction sector. The results underscore the importance of coordinated institutional action to strengthen market confidence and enhance the technical and economic feasibility of RCM use. From a broader perspective, the study contributes to the understanding of sustainable material adoption in the Gulf region by offering insights into how engineering professionals evaluate emerging green materials and what conditions are necessary to facilitate their acceptance.

While the study provides valuable contributions, its scope is limited to civil engineers and relies on a single cross-sectional assessment. Future research could expand to other construction professionals, examine longitudinal changes in perceptions as sustainability policies evolve, or evaluate RCM performance within



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real-world construction projects. Overall, the study demonstrates that RCMs hold substantial potential for supporting sustainable construction in Kuwait, but successful integration will depend on addressing technical uncertainties, improving regulatory clarity, and enhancing awareness across the industry.

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