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# Constraints to Clients' Acceptance of Recycled Construction Materials in Developing Nations: Professionals' Perspective †

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**Abstract:** Recycling construction materials minimises waste, but client preference for raw materials presents challenges. This study examines the constraints to client acceptance of recycled materials. Surveying 120 construction professionals, 110 responses were analysed using descriptive statistics. The results show that constraints including lack of recycling facilities, resistance to change, absence of appropriate technology, limited availability of materials, lack of information about recycled products, and lack of proper standards are significant obstacles to clients' acceptance of recycled construction materials. Addressing logistical challenges, such as enhancing material availability and accessibility through improved recycling infrastructure and awareness campaigns, is crucial for overcoming these constraints.

**Keywords:** constraints; client acceptance; construction materials; recycling



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## 1. Introduction

The global population is growing rapidly. Hence, this has resulted in urbanisation, which also benefits the economy and overall growth of the construction industry. However, ref. [1] argues that the need for urbanisation is the sole cause of excessive construction and demolition waste accompanied by a greater depletion of natural raw materials. Construction industry activities lead to more air and land pollution caused by manufacturing and transporting goods to the site. The construction industry is huge, and several projects can take place simultaneously, which means more raw materials will be needed, causing the depletion of raw materials, destruction of the biodiversity, and risk to the overall health and safety of the ecosystem. The construction industry has a major impact on climate change due to the excessive activities performed in one project that emits gases that are harmful to the atmosphere and environment [2]. Additionally, construction waste like concrete causes acid rain and air pollution and consequently increases the rate of climate change, whereby if the concrete waste is left unattended, then it will result in a severe environmental problem [2]. To mitigate this environmental problem, ref. [3] posits that some developed countries use recycled and reused construction and demolition waste to substitute the excessive use of raw materials. However, developing countries have not fully accepted this substitution.

Recycling construction materials is a valuable approach to prevent construction and demolition waste disposal in landfills [4]. Furthermore, it is more ecologically friendly and better to recycle construction materials for waste management rather than for landfill disposal [5]. Moreover, recycled construction materials transform construction waste into fresh materials for application [6]. Recycled construction materials are seen as essential to managing construction waste [7]. In addition, it has been generally accepted that

encouraging recycled construction materials is essential to lowering construction and demolition waste [8]. However, raising people's knowledge of recycled construction materials through educational initiatives may encourage them to recycle more [8]. For this reason, recycled construction materials are essential to attaining construction sustainability, improving the economy, and protecting the environment. Hence, recycled construction material is a standard procedure in some industrialised nations. Creating and using several new materials as alternatives to recycled construction materials is possible. Moreover, construction and demolition waste strategies are usually considered recycled construction materials [6]. Thus, promoting recycling in projects will improve the use of recycled construction materials [9].

Nevertheless, in contrast to other stakeholders in the construction industry, construction clients are the ones who drive project inception, transformation, and governance [10,11]. According to [12–14], the client is the one who can drive change in the sector to make it more effective, productive, and sustainable. Refs. [15,16] opine that clients can influence projects directly or indirectly to provide creative solutions. Ref. [17] notes that, as corroborated by [14], clients can impede innovation in the construction industry. Thus, creative solutions will likely become less common without a favourable and encouraging client. However, considering that construction and demolition waste in most projects is reusable and has a good impact on the environment [3], and that recycling will help to reduce the use of raw construction materials and landfills [2], it is imperative that construction clients are motivated and willing to accept recycled construction materials. For this to happen, ref. [1] posits that more knowledge is required, as clients believe that raw materials are better than recycled materials.

Therefore, this study evaluates the constraints on clients' acceptance of recycled construction materials in developing nations. The study reviews the extant literature to determine the constraints to fulfil the research aim. Each constraint's significance (weight) is then ascertained using descriptive statistics. Furthermore, a Kruskal–Wallis test is utilised to compare the responses based on the different construction professions. This research has two contributions to make. It is the first effort, to start with, to identify the constraints to clients' acceptance of recycled construction materials in developing nations. Second, the Kruskal–Wallis test is employed in this study to give a clear idea of the responses based on the different professions within the construction industry.

## 2. Construction Material Recycling and Clients' Acceptance

The importance of recycling construction materials cannot be overstated in the quest for sustainable development within the construction industry. Construction material recycling is a pivotal aspect of sustainable construction practices, aiming to mitigate the environmental impact of building activities while conserving valuable resources. According to the traditional circular economy paradigm, recycling construction materials is acknowledged as an integral part of the "R management principles" (i.e., reduce, reuse, and recycle). It offers advantages as well as limitations when compared to other methods. Recycling construction materials not only keeps waste out of landfills but also minimises using natural resources and safeguards non-renewable ones [18,19]. Recycling helps to reduce environmental demands on construction projects and is in line with sustainable construction guidelines [20]. Recycling programs may be economically and environmentally beneficial, as demonstrated by [21]. When recycling is more ecologically and economically sustainable than producing new materials, recovered or recycled resources can be a valuable component of a sustainable supply chain [4].

Therefore, as awareness of environmental issues grows, there is an increasing emphasis on integrating recycled materials into construction projects. Construction material recycling is pivotal in sustainable construction practices, offering economic, environmental, and social benefits. However, its successful implementation hinges significantly on clients' acceptance and willingness to adopt recycled materials in construction projects. The function of construction clients in connection to innovation and transformation in the

construction industry is a topic of great interest and controversy [12,22,23]. Construction clients have the position of procurer and are ultimately in charge of overseeing projects [23]. Clients are essential to the utilisation of recycled items in the construction industry. Clients' attitudes towards sustainability and corporate social responsibility can influence their acceptance of construction material recycling. Those who prioritise environmental stewardship and community engagement may be more inclined to support recycling initiatives, viewing them as a means of reducing resource depletion and minimising ecological impact. Conversely, clients primarily focused on immediate project costs and timelines may prioritise conventional materials over recycled alternatives. According to business marketing theories, customers' reluctance to choose recycled items plays a significant role. Ref. [24] contends that customers may hesitate when deciding between new and recovery products because various factors, including product appearance, economic performance, and environmental impact, can affect consumers' perceptions of quality and their purchasing behaviour. Ref. [25] posits that clients would rather see new construction done using virgin materials.

## 3. Constraints to Clients' Acceptance of Recycled Construction Materials

Ref. [26] argues that one of the top constraints to using recycled construction material is the viability of the durability of the recycled materials. The quality and performance of recycled construction and demolition materials are affected by unorganised deconstruction procedures, as there is no confirmation of the comparability of quality and execution between virgin assets and the recycled item. Although the cost of using recycled materials is less expensive than when using natural raw materials, clients and contractors fear carrying the responsibility of failed structures; if the constructed structure fails, then the recycled materials will be the suspect for the failure, and in that case, there will be more to lose [27]. Furthermore, clients believe the environmental benefits of using recycled materials are insufficient compared to how their quality might affect the overall structure [27]. In addition, ref. [1] posits that the use of recycled construction material is frustrated by the absence of data. It has been identified that clients are the core motivators of every project; thus, to increase the use of recycled construction materials, there should be appropriate client education and practical testing in place [26]. Clients need to be informed about recycled products as far as private and commercial projects are concerned. However, there is a deviation. While commercial clients with more experience argue that traditional materials have enhanced technical abilities compared to recycled products, private clients have a more adjusted weighting regarding technical aspects [1].

Furthermore, one of the constraints hindering the acceptance of recycled materials is that there are no specialised factories available locally that can be used to perform the extraction and separation processes [2]. Also, the lack of standards is a significant constraint [28]. The existence of relevant standards for recycled materials would improve clients' acceptance and guarantee the quality of the material. In addition, the limited availability of recycled materials is one of the main constraints to client acceptance. Clients tend to choose easily accessible materials due to project time limitations [29]. In contrast, according to [30], clients may resist using recycled materials due to inertia from the traditional practices they are familiar with. This resistance could be because they do not know the performance and durability of recycled materials.

## 4. Methodology

The study adopted a post-positivist perspective and employed quantitative techniques via a structured questionnaire survey. This survey consisted of two segments: the first aimed at collecting demographic data, and the second focused on identifying constraints to clients' acceptance of recycled construction materials. Qualified construction industry professionals (including engineers, architects, quantity surveyors, and construction managers) with a minimum of five years of experience in South Africa were requested to rate these constraints on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly

agree). Convenience sampling was utilised, resulting in the distribution of 120 questionnaires, out of which 110 were deemed suitable for analysis. Data analysis encompassed several statistical techniques, such as standard deviation, percentages, mean item scores, one-sample *t*-tests, and Kruskal–Wallis tests, following the methodology outlined by [31,32]. The questionnaire's reliability was confirmed through Cronbach's alpha test, producing a score of 0.939, which surpassed the acceptable threshold of 0.6 as suggested by [33], thus affirming its high reliability.

## 5. Results

The survey, conducted in South Africa, enlisted participation from construction professionals, with Quantity Surveying representing the largest contingent (31.4%), followed by Construction Management (24.1%), Engineering (22.2%), and Architecture (3.7%). Predominantly, respondents (83.3%) held bachelor's degrees, while 3.7% and 13% possessed master's and certificate degrees, respectively. Notably, respondents reported an average work experience of 12.3 years in the field, indicating significant professional experience. These findings suggest that the study's target demographic, construction professionals, were adequately represented and equipped with the requisite educational backgrounds to engage with the survey questions [34], thereby reflecting a wealth of professional expertise.

Moreover, mean, standard deviation, and a one-sample *t*-test were utilised to evaluate the significance of specific constraints among respondents. The mean rank of each constraint was compiled to provide a comprehensive insight into respondents' viewpoints. Significance was established at a 95% confidence level, adhering to established standards [35]. A constraint was deemed significant if it achieved a *p*-value less than or equal to 0.05 and a mean rating of 3.5 or higher on the five-point Likert scale. Table 1 outlines the constraints identified regarding clients' acceptance of recycled construction materials, presenting both the mean data and standard deviations. In cases where multiple constraints shared identical means, priority ranking was assigned based on the constraint with the lowest standard deviation [36]. Refer to Table 1 below for detailed one-sample statistics and *t*-test outcomes.

**Table 1.** One-Sample Statistics and Test of Constraints.

| Constraints | T | Df | Sig. (1-Tailed) | Mean | SD | Mean Diff. | 95% Confidence Interval of the Diff. | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Lower | Upper |
| Lack of recycling facilities | 9.956 | 109 | <0.001 | 4.25 | 0.795 | 0.755 | 0.528 | 0.950 |
| Resistance to change | 7.913 | 109 | <0.001 | 4.22 | 0.952 | 0.718 | 0.500 | 0.919 |
| Absence of appropriate technology | 8.098 | 109 | <0.001 | 4.20 | 0.907 | 0.700 | 0.717 | 1.165 |
| Limited availability of recycled materials | 7.759 | 109 | <0.001 | 4.20 | 0.946 | 0.700 | 0.460 | 0.871 |
| Lack of information about recycled products | 7.768 | 109 | <0.001 | 4.18 | 0.921 | 0.682 | 0.319 | 0.715 |
| Lack of proper standards | 7.788 | 109 | <0.001 | 4.16 | 0.894 | 0.664 | 0.722 | 1.173 |
| Negative perception from clients | 7.453 | 109 | <0.001 | 4.16 | 0.934 | 0.664 | 0.457 | 0.867 |
| Lack of awareness | 7.453 | 109 | <0.001 | 4.16 | 0.934 | 0.664 | 0.526 | 0.946 |
| Limiting standards and specifications | 7.453 | 109 | <0.001 | 4.16 | 0.934 | 0.664 | 0.463 | 0.877 |
| Distrust on technical feasibility of recycled materials | 7.152 | 109 | <0.001 | 4.13 | 0.920 | 0.627 | 0.558 | 0.984 |
| Lack of government support | 7.003 | 109 | <0.001 | 4.11 | 0.912 | 0.609 | 0.525 | 0.944 |
| Uncertainty of quality | 5.471 | 109 | <0.001 | 4.07 | 1.098 | 0.573 | 0.321 | 0.720 |
| Availability of raw materials | 7.037 | 109 | <0.001 | 4.07 | 0.854 | 0.573 | 0.460 | 0.873 |
| Low supply and demand | 5.512 | 109 | <0.001 | 4.02 | 0.986 | 0.518 | 0.554 | 0.977 |
| Cost influence/cheaper and easy to landfill | 5.083 | 109 | <0.001 | 4.00 | 1.032 | 0.500 | 0.530 | 0.952 |
| Fear of legality issues associated with the use of recycled materials | 3.447 | 109 | <0.001 | 3.87 | 1.134 | 0.373 | 0.497 | 0.912 |

SD: standard deviation; DF: degree of freedom; T: *t*-test value.

According to the *p*-values (significance (1-tailed)) presented in Table 1, respondents collectively agreed that all factors listed are significant constraints to clients' acceptance of recycled construction materials. The results show that the lack of recycling facilities is the highest-ranked and the most significant constraint to clients' acceptance of recycled construction materials. Resistance to change follows this. The absence of appropriate technology, limited availability of materials, lack of information about recycled products, and lack of proper standards are other top significant constraints to clients' acceptance of recycled construction materials.

Furthermore, to assess variations in responses among participants based on their respective construction occupations, a Kruskal–Wallis test was performed. The analysis revealed no statistically significant differences among participants' responses regarding the constraints to clients' acceptance of recycled construction materials within the South African construction sector, such as uncertainty of quality, lack of information about recycled products, and lack of recycling factories. For others, such as lack of proper standards, negative perception from clients, and distrust of the technical feasibility of recycled materials, there were statistically significant differences among participants' responses. Table 2 provides detailed findings.

**Table 2.** Kruskal–Wallis Test Showing *p*-values for Constraints.

| Constraints | *p*-Values |
|---|---|
| Uncertainty of quality | 0.167 |
| Lack of information about recycled products | 0.212 |
| Lack of recycling facilities | 0.136 |
| Lack of government support | 0.201 |
| Lack of proper standards | 0.013 |
| Absence of appropriate technology | 0.257 |
| Availability of raw materials | 0.051 |
| Negative perceptions from clients | 0.004 |
| Cost influence/cheaper and easy to landfill | 0.047 |
| Lack of awareness | 0.067 |
| Distrust on the technical feasibility of recycled materials | 0.003 |
| Low supply and demand | 0.154 |
| Limiting standards and specifications | 0.513 |
| Limited availability of recycled materials | 0.007 |
| Resistance to change | 0.121 |
| Fear of legality issues associated with the use of recycled materials | 0.380 |

## 6. Discussion

From the study's findings, the lack of recycling facilities ranked first as the constraint to clients' acceptance of recycled construction materials. This was further corroborated by the Kruskal–Wallis test conducted, as the four (4) groups of construction professionals who participated in the study agreed to the ranking. This finding corroborated the results of [2,28], that there are no specialised factories available locally that can be used to perform the extraction and separation processes; hence, this negatively influences clients' perceptions of recycled construction materials. It is important to note that without accessible recycling facilities, the supply of recycled construction materials may be limited or inconsistent. This scarcity could lead to challenges in meeting project requirements and timelines, potentially resulting in delays and increased client costs. Consequently, clients may hesitate to incorporate recycled materials into their projects if they cannot reliably source them. Furthermore, the quality assurance of recycled construction materials may be compromised without proper recycling facilities. Without appropriate processing and quality control measures, there may be concerns about the durability, performance, and consistency of recycled materials compared to conventional alternatives. Clients may be unwilling to risk using inferior materials that could compromise the integrity of their construction projects. Also, the lack of recycling facilities may contribute to perceptions

of uncertainty and scepticism among clients regarding the suitability and reliability of recycled materials. Clients may question whether recycled materials can meet their specific project requirements, regulatory standards, and performance expectations without the support of a robust recycling infrastructure.

The study's findings further revealed that resistance to change ranked second among the constraints to clients' acceptance of recycled construction materials. This was further corroborated by the Kruskal–Wallis test conducted, as the four (4) groups of construction professionals who participated in the study agreed to the ranking. This finding corroborated the study of [30] that clients may resist using recycled construction materials due to inertia from the traditional practices they are familiar with. Again, clients may hesitate to use recycled materials if they are unfamiliar with them or lack trust in their performance. Traditional materials have a long-established track record, while recycled materials may be perceived as untested or unproven. Also, clients often have specific aesthetic preferences for their projects. Recycled materials may not always align with these preferences compared to traditional materials, leading to resistance based on concerns about appearance and visual appeal. Clients may resist using recycled materials if they perceive them as aesthetically inferior or incompatible with their design vision. In addition, the absence of appropriate technology ranked second as the constraint to clients' acceptance of recycled construction materials. This was further corroborated by the Kruskal–Wallis test conducted. This finding corroborated the results of [1,28], that technology is crucial for safe and efficient waste recycling, and the absence of it will impede clients' acceptance of recycled construction materials. The absence of appropriate technology may limit the ability to blend recycled materials with traditional construction materials effectively. This can result in compatibility issues that compromise the performance or appearance of the finished structure, leading clients to prefer conventional materials that are easier to work with.

The construction professionals who participated in the study collectively agreed that all factors listed are significant constraints to clients' acceptance of recycled construction materials. Addressing the constraints requires a multifaceted approach that considers various factors influencing clients' decisions. Firstly, it is crucial to educate clients about the benefits of using recycled materials, such as cost savings and reduced environmental impact [37]. Providing case studies and examples of successful projects utilising recycled materials can help alleviate concerns about performance and durability. Secondly, addressing quality control concerns is essential. Clients may hesitate to use recycled materials due to perceptions of inferior quality or inconsistency. Implementing strict quality control measures throughout the supply chain, including testing and certification processes, can help ensure that recycled materials meet or exceed industry standards. Also, offering incentives or subsidies for using recycled materials can encourage client acceptance. Government initiatives, tax incentives, or rebates for incorporating recycled content into construction projects can incentivise clients to prioritise sustainability. Collaboration among stakeholders, including architects, engineers, contractors, and material suppliers, is crucial. By involving clients in early-stage discussions and decision-making processes, they can better understand the benefits and feasibility of using recycled materials in their projects.

## 7. Conclusions

This study examines the constraints to clients' acceptance of recycled construction materials in a bid to understand clients' unwillingness to accept recycled construction materials in their construction projects. The constraints were discovered after a survey of the available literature, which was then presented to construction professionals. The study results show that the most significant constraint to clients' acceptance of recycled construction materials is the lack of recycling facilities. Resistance to change, absence of appropriate technology, limited availability of materials, lack of information about recycled products, and lack of proper standards are some of the other significant constraints. Although all constraints were considered significant, there was no agreement between the professions regarding constraints such as the lack of proper standards, negative perceptions

from clients, cost influence/cheaper and easy to landfill, distrust of the technical feasibility of recycled materials, and limited availability of recycled materials. Based on the study's findings, it is obvious that addressing logistical challenges, such as the availability and accessibility of recycled materials, is essential. Developing robust recycling infrastructure and supply chains and increasing awareness of local recycling facilities and resources can help overcome these constraints. Hence, research and development efforts focused on improving the performance and durability of recycled materials should be a priority and can further enhance client acceptance. Investing in innovation and technological advancements in recycling processes can also lead to developing high-quality, cost-effective recycled materials that meet clients' diverse needs in the construction industry. Finally, the current study evaluates the constraints to clients' acceptance of recycled construction materials; the findings could inform construction actors and stakeholders of these constraints and encourage them to take significant steps towards putting the necessary measures in place to facilitate clients' acceptance of recycled construction materials, which could help solve environmental issues. Finally, the study was conducted in South Africa. A similar study should be conducted in other developing nations to provide a more robust discussion on the subject matter.

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