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Strategies to Reduce the Impact of Resource Consumption in the Ghanaian Construction Industry

Augustine Senanu Komla Kukah[1]*, Andrew Victor Kabenlah Blay Jnr[2], Alex Opoku[3]

[1]*Department of Construction Technology and Management, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana*
[2]*Department of Management Studies, University of Education, Winneba, Ghana*
[3]*Department of Architectural Engineering, University of Sharjah, Sharjah, United Arab Emirates (UAE)*

*Corresponding author's email: augustinekukah@gmail.com

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Abstract

With a growing priority on resolving environmental issues and managing resources more effectively in line with Sustainable Development Goal 12, this research aims to assess solutions to minimize resource consumption in the Ghanaian construction sector. In the Ghanaian cities of Accra and Kumasi, questionnaires were utilized to solicit responses from construction stakeholders. Mean score ranking was used to rank these techniques. A reliability analysis using Cronbach's alpha coefficient found a high level of internal consistency. A high level of agreement was found after testing using Kendall's concordance. A one-sample t-test was also employed to examine the relative importance of the variables. Properties should be built to be disassembled; sections of existing building structures should be reused; prefabricated components should be utilized for on-site assembly; demolition components should be re-used or recycled, and existing buildings should be renovated to prevent destruction. This research is valuable because it adds to a checklist of measures for minimizing the effect of resource consumption in the Ghanaian construction sector, as well as to the achievement of the SDG goal. Project managers, architects, engineers, subcontractors, and other key stakeholders are encouraged to use innovative approaches to decrease resource consumption.

Keywords: Strategies, reduce, resource consumption, SDG 12, construction industry

1.0 INTRODUCTION

The construction industry globally is noted for consuming more raw materials regularly, culminating in natural resource scarcity and environmental consequences (Laiblova et al., 2019). Every year, thousands of tons of garbage are generated by construction materials across the planet. The high embodied energy of these construction materials results in large CO2 emissions. Steel contains roughly 32 MJ/Kg of embodied energy, whereas cement has about 7.8 MJ/Kg (Lomite & Kare, 2009). The largest carbon dioxide-producing substance is cement, and a large amount of carbon dioxide is created during the production and transportation of building materials (Hossain & Marsik, 2019). Annual cement output is expected to surpass 5 billion metric tons by 2050, resulting in roughly 4 billion tons of carbon dioxide (CO2) emissions (Ding et al., 2019; Liu & Gao, 2016).

Construction material usage rises in lockstep with population growth. Even yet, the only method to cut down on building materials used is to recycle and reuse them. In the stage of recycling and reusing construction materials, several trends and regulations have been adopted (Alghamdi et al., 2019; Hossain & Marsik, 2019).

Implementation of sustainability tenets in the construction sector might significantly facilitate the achievement of several SDGs, including SDG2 (End Hunger), SDG3 (Good Health & Well-Being), SDG4 (Quality Education), SDG6 (Clean Water & Sanitation), SDG7 (Affordable & Clean Energy), SDG8 (Decent Work & Economic Growth), SDG9 (Industry, Innovation & Infrastructure), SDG10 (Reduced Inequalities) (Opoku, 2016, 2019). To acquire the competitive edge necessary to thrive in this present economic climate, Opoku and Fortune (2011) reckoned that sustainability concepts and practices should be included in organizational learning in the construction sector.

In their respective studies, Chávez (2006) and Lauber et al. (2005) revealed that the current level of sustainability awareness in developing nations is undoubtedly a key factor contributing to the architectural inclination and high resource consumption now observed in emerging regions. This consumes a lot of energy and adds a lot of money to the construction process because it necessitates the importation of supplies and specialized labor.

Previous research has been done on resource consumption reduction measures. The literature, however, still has certain gaps. Shu et al. (2017) investigated resource utilization during project design. The flaw is that they did not pay attention to project phases other than design.

Park et al. (2009) also concentrated on manufacturing energy consumption techniques. The study's flaw was that it was limited to the industrial sector, with solely energy-related solutions. Blay et al. (2022) investigated competing techniques for increasing sustainability and decreasing resource use. Their study, however, has a limitation in that it only looks at SDG 12. A systematic and all-encompassing endeavor to synthesize and incorporate all of these current strategies in the Ghanaian construction sector has received very little attention. Even though such studies are critical to industry and academia, they are limited in developing nations. With a growing focus on environmental issues and more efficient resource utilization in line with Sustainable Development Goal 12, this research aims to assess options for reducing resource consumption in the Ghanaian construction sector. The first objective of this work is to fill a knowledge gap in the field of resource consumption and sustainability, especially for emerging economies. The findings are also useful for key stakeholders and the government in their efforts to reduce resource consumption and promote sustainability in the building sector. The introduction is the first portion of the document. The second section discusses the literature review. Subsequently, the methodology section follows. The data gathering, analysis, and discussion are all covered in the fourth section. The conclusion and policy suggestions are the last sections.

2.0 LITERATURE REVIEW

2.1 Ghanaian Construction Industry

Construction projects managers, designers, structural engineers, cost engineers, contractors, and craftspeople are all part of Ghana's construction sector (Sutton & Kpentey, 2012). Presently, there is no national authority overseeing and regulating the industry's operations (Owoo & Lambon-Quayefio, 2018). The diverse segments of the sector have their controlling structures in the dearth of this authority. The Ministry of Works and Housing is in charge of overseeing all construction and civil engineering works in the country, while the Ministry of Roads and Highways is in charge of overseeing the activities of those involved in the construction and infrastructure such as roads, highways, railways, airports, and other structures. As a result, these two ministries are collectively authorized for contractor certification and categorization in the sector. Despite this, there is no national database of industry actors that includes information on the members' sizes and skills (Owoo & Lambon-Quayefio, 2018).

In both the housing and roads and civil works subsectors, contractors are ostensibly classified based on their economic resources, human resource capacity, and degree of technology (i.e. the type and efficiency of equipment used) (Darvas & Palmer, 2014). Contractors are classified differently in the housing and road subsectors.

Depending on the value of the project to be performed, contractors in the housing subsector are grouped into four groups, numbered 1 to 4. Class 1 (D1K1) contractors can complete projects costing more than $500,000; class 2 (D2K2) contractors can complete projects worth up to $500,000; class 3 (D3K3) contractors can complete projects worth up to $200,000; and class 4 (D4K4) contractors can complete projects worth up to $75,000. According to the Ministry of Works and Housing, the majority of construction firms in Ghana (approximately 60%) fit into class 3, with just around 10% and 20% falling into the first two categories, respectively. The remaining items are classified as fourth-class citizens (Government of Ghana, 2015). These categories have direct ramifications for the sorts of projects that firms in the industry can tender on, with various levels of competition amongst them. Class 1 looks to be more oligopolistic due to the lesser concentration of contractors. The degree of competition looks to be higher in the class 3 category, where there are more firms concentrated (Ackah et al., 2014).

2.2 Sustainable Development Goal 12

Sustainable Development Goal 12 asks for sustainable consumption and production, basically divorcing economic expansion from inappropriate resource usage and emissions while also addressing hazardous material and waste management (Blok et al., 2015). Sustainable consumption and production (SCP) are identified as "the use of goods and services that meet basic requirements and improve quality of life while significantly reducing the use of natural resources, dangerous substances, and waste and pollution emissions over the life span, so as not to endanger the need of posterity" (Norwegian Ministry of the Environment, 1994; Clark et al., 2016). The incorporation of sustainable consumption and production as SDG 12 (SDG 12 Sustainable Consumption and Production) relies on the Stockholm Declaration's early awareness of the need for sustainable natural resource usage (refer to Stockholm Declaration on the Human Environment in 1972). It also draws on the growing sustainable development curriculum, which emphasizes the importance of changing consumption and production patterns as a precondition for more sustainable growth (United Nations, 2012).

The worldwide economy depends on both consumption and production. Production and consumption activities are nearly totally responsible for anthropogenic damage to the environment and human health (Steinbach et al., 2018). Food security, poverty reduction, healthcare, infrastructure, welfare, and services are all dependent on productive activities and the income they create at the same time. As a result, SDG 12 is inextricably tied to the majority, if not all, of the SDGs (Lipinski et al., 2017).

2.3 Strategies to Reduce the Impact of Resource Consumption in the Construction Industry

The investment appraisal stage, the conceptual design, the tendering phase, the construction phase, the operational stages, and the maintenance and disposal phase are the six phases most commonly used to categorize construction projects (Asdrubali et al., 2013). The investment choice phase, design phase, and bidding phase, on the other hand, have comparatively modest environmental implications (Robati et al., 2017).

To lessen the effects of resource use, a variety of measures can be implemented. These can have an impact on the interconnected variables of material use, inherent energy and pollutants, infused water, and landfill waste (Alghamdi et al., 2019; Hossain & Marsik, 2019). Unquestionably, repurposing and renovating existing structures and infrastructure to minimize demolition and new development should be explored (Pullen, 2010a). The least harmful course of action will be determined by the age, condition, and adaptability of the buildings and infrastructure. Reusing existing building structure elements (such as structural frames and facades) as an alternative will save material consumption and embodied energy use. It is recommended that new developments be planned and built to be robust, long-lasting, and adaptable in structure and operation (requiring little maintenance and renovation) (Cuenca-Moyano et al., 2019). Greater spans between load-bearing frame structures and higher floor-to-ceiling heights may be required. Modular components should be used as much as possible for on-site assembly to reduce on-site waste associated with shaping in-situ construction parts. Structures should be designed with disassembly in mind, allowing materials and components to be recycled rather than discarded when their useful lives are over (Pullen et al., 2012). Materials generated during disposal activities should be processed and reused or recycled as much as possible on-site. Specific materials, such as concrete or masonry, may need to be transported to recycling centers for further treatment and decomposition into an aggregate (for concrete) or roadbase, which can then be reused on the job site or other future construction sites. Finally, if reuse or recycling are not viable options, the items should be disposed of in a landfill (Pullen, 2010b).

Qian and Chan (2010) compared measures in the United Kingdom, the United States, Canada, and China to minimize resource use and enhance energy efficiency. After that, they developed a conceptual model of the approaches. In their conceptual model, some of the techniques included funding from the government for strengthening energy efficiency technology research and development (R&D), financial and non-financial rewards, low-cost loans for strengthening energy efficiency incorporation, product descriptions, and evaluation, and enhanced policing of established standards (Chan et al., 2018; Qian & Chan, 2010). In Utrecht, the Netherlands, and Valencia, Spain, van Doren et al. (2016) studied techniques to speed the scaling up of energy-saving programs. They highlighted building and enforcing regulatory systems as examples of tactics.

For a few years, there has been an ecological and financial motive to dematerialize economies, sometimes known as 'do more with less' (Allwood et al., 2013). In their earlier work on resource efficiency, Allwood et al. (2011) detailed several resource consumption techniques. Recycling old components, making long-lasting goods, and designing things with less material are just a few of these tactics. These are congruent with the United Nations Environmental Program's (UNEP) philosophy of reducing, reusing, and recycling, with the most advantageous being a reduction in material usage and consumption (Marteau, 2017).

Better regulation, improved public awareness and rewards, and more efficient management systems are proposed by Esa et al. (2017) as three essential measures in Malaysia to stimulate the usage of building and demolition waste reduction methods. Environmentally, economically, and socially sustainable buildings should be assessed for their lifespan costs as well as their environmental, economic, and social advantages (Darko et al., 2017). To encourage long-term adoption, the government must give financial help. The government should establish green technology research institutes and centers, as well as encourage universities to conduct sustainable construction research (Darko & Chan, 2018).

According to Li et al. (2014), the three most important strategies for increasing stakeholders' ecological consciousness, boosting sustainable technology research and design, and passing sustainable building legislation in China are increasing stakeholders' ecological consciousness, boosting sustainable technology research and design, and passing sustainable building legislation.

Table 1 below provides a summary of strategies to reduce the impact of resource consumption in the construction industry.

Table 1 Summary of strategies to reduce the impact of resource consumption in the construction industry

Strategy	Author(s)
Parts of an existing building structure can be reused	Lomite and Kare (2009)
Existing structures should be renovated rather than demolished	Cuenca-Moyano et al. (2019)
Use designs that are long-lasting, flexible, and durable	Opoku (2019)
Examining and thinking about the life cycle	Laiblova et al. (2019); Lomite and Kare (2009)
Disassembly should be considered while designing buildings	Darko and Chan (2018); Yilmaz et al. (2019)
The reusable-sections market is up and running	Alghamdi et al. (2019); Lomite and Kare (2009)
Optimal utilization of natural resources	Hossain and Marsik (2019)
Materials that are both sustainable and local are used	Liu and Gao (2016)
Procurement and sourcing that is environmentally friendly	Cuenca-Moyano et al. (2019); Lomite and Kare (2009)
For on-site assembly, prefabricated components are used	Lomite and Kare (2009)
The materials left over during demolition should be recycled	Alghamdi et al. (2019); Laiblova et al. (2019)
Using a landfill to dispose of items	Pullen (2010b)
Imposing a pollution levy on materials that pollute the environment	Yilmaz et al. (2019)
Financial inducements to encourage recycling	Yu et al. (2021)
Adopting a zero-waste strategy	Cuenca-Moyano et al. (2019); Opoku (2019)
Green grading systems should be used	Chan et al. (2018)
The availability of an institutional framework for successful resource consumption reduction	Pullen (2010a)
Green construction policies and standards must be mandatory	Alghamdi et al. (2019); Blay et al. (2022)
More media attention (television, radio, newspapers) on resource utilization is needed	Darko et al. (2017); Pullen et al. (2012)
Improved research and development (R&D) in the field of sustainable construction	Chan et al. (2018)

3.0 METHODOLOGY

The study was conducted quantitatively. Questionnaires were the primary method of data collection. This is because quantitative researchers choose questionnaires as a data collecting approach (Sarantakos, 2005). In the social sciences, questionnaires are also the most common form of data collection (Creswell, 2005).

All industry practitioners with expertise and awareness of sustainable building in Ghana made up the population. The sample was non-probability since there was no sampling frame for this investigation (Zhao et al., 2015). To get a representative sample, the non-probability sampling approach can be used (Patton, 2002). When a truly random sample approach cannot be utilized to pick respondents from the entire population, it is reasonable to select respondents based on their desire to participate in the study (Chan et al., 2018; Wilkins, 2011). Purposive and snowball sampling strategies were used in this study regarding its design, goal, and realistic inference on this research issue. Purposive sampling targeted respondents based on their expert understanding of the topic issue. These respondents were then asked to propose individuals who were competent in the field and fit the study's criteria. The criterion for selecting these responders was that they are well informed about sustainable building and have at least three years of construction industry experience. This resulted in the collection of a representative sample of seventy (70) respondents. Following the field survey, 68 questionnaires were collected and analyzed. Respondents were chosen from government organizations, consulting businesses, and construction enterprises participating in sustainable construction initiatives.

The questionnaire was pre-tested and piloted before the actual field survey. According to Oppenheim (1992) and Creswell (2005), doing pre-testing and piloting surveys before the main survey is critical in maintaining and establishing organizational and comprehensive consistency in data gathering (Yin, 2009). Pre-testing questionnaires were used to analyze the design instrument's comprehensiveness, clarity, and feasibility, as well as the survey's overall viability. It also wanted to know how long respondents took to complete the surveys. Three building project specialists with in-depth knowledge and characteristics of expected respondents have been invited to pre-test the questionnaires. These three people were requested to look at the research instrument (RI) for ambiguity, clarity, and the amount of time it took them to complete the surveys. They were also supposed to provide information that would help enhance the accuracy of the surveys. According to the feedback obtained, the questions were extremely easy to understand and were quite likely to provide relevant responses in the main survey. The piloting feedback was utilized to make a few changes and fine-tune the questionnaires for the main survey. Before the actual field survey, the designed questionnaire instruments were pre-tested and piloted. As stated by Oppenheim (1992) and Creswell (2005), pre-testing and piloting surveys being conducted before a main survey are very crucial to uphold and establish an organizational and complete consistency in the collection of data (Yin, 2009). The purpose of pre-testing questionnaires was to assess the extensiveness, clarity and viability of the design instrument and the whole survey. It also sought to note the time taken to answer the questionnaires by respondents. Three experts working in construction projects with insightful expertise and having characteristics of anticipated respondents were asked to pre-test the questionnaires. These three respondents were asked to check the research instrument (RI) for ambiguity, clearness and time used to finish answering the questionnaires. They were also tasked to give insights which will improve the preciseness of the questionnaires. Feedbacks received indicated that the questionnaires were very clear to comprehend and were very likely to get pertinent answers in the main survey. Comments from the piloting were used to make a few additions and fine-tuning of the questionnaires for the main survey.

The main survey lasted six weeks and asked respondents from Accra and Kumasi to score the techniques for reducing the impact of resource consumption in the construction sector on a Likert scale of 1 to 5 (where 1 is not significant and 5 is extremely significant). Accra and Kumasi were chosen as the study's focus because they are the Ghana's two largest cities and are home to the majority of building projects, resulting in a high concentration of specialists.

Cronbach's alpha was used to conduct the reliability test. The techniques were ranked using a mean score ranking based on mean values and standard deviation. On a statistical data set, standard deviations represent the amount of variability and consistency associated with respondents' interpretation of variables (Field, 2009; Kukah et al., 2022b). It is considered crucial in terms of statistical credibility and data dependability (Field, 2009; Motulsky, 2003). Small standard deviations (less than 1.0) associated with mean values being assessed indicate strong consistency and minimal diversity in interpreting variables across respondents (Field, 2009; Motulsky, 2003). Large standard deviations (over 1.0) indicate low consistency and diversity in the interpretation of variables among respondents (Field, 2009; Motulsky, 2003).

4.0 FINDINGS

4.1 Respondents' Profile

The demographics of the respondents are shown in Table 2. Assessing the respondents' demographics, according to Hallowell and Gambatese (2009), helps offer background information on the study respondents and analyze their competence to lend credibility to the replies and overall conclusions of the research.

33.9 percent of those polled work for government entities involved with environmental issues. 42.6 percent of those polled work for consulting businesses that focus on sustainable building projects. Finally, 23.5 percent of respondents work for construction companies that specialize in sustainability-related projects. Respondents in this study work in a variety of industries and businesses that are involved in building projects and are familiar with the operations of sustainability-related construction endeavors. As a result, the study's dependability is assured.

Participants in the survey were also asked to state how long they had worked. With 3-5 years of experience, 30.9 percent of respondents are qualified. 5-10 years of experience is represented by 25.0 percent of those surveyed. With 11-15 years of experience, 17 responses (25.0%) have it. 17.6% of workers have 16-20 years of experience, while 14.7 percent have more than 20 years. In Ghana, having at least six years of work experience qualifies a worker for the position of senior management, according to traditional work practices and the actual view of employment practice. Furthermore, a worker who has worked for at least 10 years is qualified for a senior management job. As a result, it is reasonable to conclude that the respondents to this survey had sufficient industrial experience. In conclusion, their replies to this study appear to be trustworthy and genuine.

HND was possessed by 10.3 percent of those polled. BSc degree was the qualification of 29.4 percent of the respondents. Furthermore, 57.4 percent have a master's degree, whereas just 2.9 percent have a doctorate. In terms of the practical aspects of the teaching and training courses supplied by various experts in the Ghanaian sector, the results show that the majority have completed higher education, with a BSc degree being the minimum need. This study implies that the respondents had a good educational background and hence have a better understanding and interpretation of the factors. As a result, their comments are expected to be credible and consistent.

Table 2 Respondents' profile

		Frequency	Percentage
Category of firm of respondents	Government Agency	23	33.9
	Consulting Firm	29	42.6
	Construction Firm	16	23.5
	Total	68	100.0
Years of working experience	3-5 years	21	30.9
	5-10 years	17	25.0
	11-15 years	8	11.8
	16-20 years	12	17.6
	Above 20 years	10	14.7
	Total	68	100.0
Educational level of respondents	HND	7	10.3
	BSc	20	29.4
	MSc	39	57.4
	PhD	2	2.9
	Total	68	100.0

4.2 Reliability Test

Cronbach's alpha was used to verify the data's dependability and internal consistency before proceeding with the detailed analysis. According to Norušis (2005), Cronbach's alpha reliability must be more than 0.70 to be considered dependable. According to Table 3, the study's Cronbach's alpha is 0.812. This means that the data in this study is credible and reliable.

Table 3 Reliability statistics

Cronbach's alpha	Cronbach's alpha based on Standardized Items	N of Items
.812	.812	20

4.3 Strategies to Reduce the Impact of Resource Consumption in the Construction Industry

The purpose of this study was to identify strategies for reducing the impact of resource use in the construction sector. Respondents were asked to rank the strategies on a scale of 1 to 5 where 1=Not Significant; 2= Moderately Significant; 3= Significant; 4= Very Significant; 5= Extremely Significant. From this Likert scale, mean values greater than 3.00 were considered to be significant.

The findings are shown in Table 4. Based on the mean scores, three variables had meant more than 4, indicating that they were highly significant. The top five motivators are listed below, along with their standard deviation values. With a mean of 4.26 and a standard deviation of 0.765, 'Buildings should be designed with disassembly in mind' was placed first. With a mean of 4.13 and a standard deviation of 0.841,' re-use of parts of existing building structure' was rated second. With a mean of 4.09 and a standard deviation of 0.643, 'Use of prefabricated components for on-site assembly' was rated third. With a mean of 3.97 and a standard deviation of 0.596, 'Materials resulting from demolition activities should be re-used or recycled' was ranked fourth. Renovation of existing buildings to avoid demolition was ranked 5th with a mean of 3.97 and a standard deviation of 0.667.

All of the components in the table had mean values that were higher than the population mean (3.0). It can be deduced that all of these aspects are important in terms of methods to lessen the effect of resource consumption in the building sector. Based on the data, it is also clear that all of the standard deviation numbers are less than 1.0. This shows that respondents correctly comprehended and evaluated the variables, as well as that data variability is small and respondents are very consistent. This increases confidence in the study's findings and interpretations.

Table 4 Strategies to reduce the impact of resource consumption in the construction industry

Strategies	Mean	Std. Deviation	Ranking	Significance Level
Buildings should be designed with disassembly in mind	4.26	0.765	1	Very Significant
Re-use of parts of existing building structure	4.13	0.841	2	Very Significant
Use of prefabricated components for on-site assembly	4.09	0.643	3	Very Significant
Materials resulting from demolition activities should be re-used or recycled	3.97	0.596	4	Significant
Renovation of existing buildings to avoid demolition	3.97	0.667	5	Significant
Use durable, long life, flexible designs	3.83	0.695	6	Significant
Use of sustainable and local materials	3.82	0.912	7	Significant
Dispose of materials as landfill	3.81	0.942	8	Significant
Adopting a zero-waste approach	3.79	0.807	9	Significant
Efficient use of natural resources	3.77	0.902	10	Significant
Financial incentives to promote recycling	3.75	0.612	11	Significant
Mandatory green building policies and regulations	3.73	0.843	12	Significant
Life cycle assessment and thinking	3.72	0.896	13	Significant
Enhanced research and development (R&D) on sustainable construction	3.70	0.827	14	Significant
Sustainable procurement and sourcing	3.69	0.768	15	Significant
Use of green rating systems	3.65	0.664	16	Significant
More media publicity (television, radio, newspapers) on resource consumption	3.63	0.879	17	Significant
Availability of institutional framework for effective minimization of resource consumption	3.59	0.984	18	Significant
The functioning market for reusable sections	3.55	0.682	19	Significant
Imposing pollution tax on materials that are prone to pollution	3.51	0.874	20	Significant

4.4 Kendall's Concordance Analysis

Kendall's concordance analysis was used to determine how well different respondents agreed on their strategy rankings based on mean values within a group. An acceptable degree of unanimity among the respondents was indicated if Kendall's coefficient of concordance (W) was statistically significant at a pre-defined significance level. Table 5 presents Kendall's concordance analysis test findings for each stakeholder group at a significance test value of 0.05. W values vary from 0 to +1, with a value greater than 0 indicating a high degree of consistency in factor rankings within each group (Sheskin, 2011). The results show that within each category, the ranks are consistent: (government agency, consulting firm, and construction firm).

Table 5 Test results of Kendall's coefficient of concordance

Firm	Government agency	Consulting firm	Construction firm
Number of survey respondents (N)	23	29	16
Kendall's Coefficient of Concordance (W)	0.562	0.499	0.461
Chi-Square	87.299	92.078	85.013
Asymp. Sig.	0.000	0.000	0.000

4.5 One-Sample T-Test for Strategies to Reduce the Impact of Resource Consumption in the Construction Industry

To determine the relative significance of the variables, one-sample t-test was utilized. This is used to determine if a sample mean deviates considerably from a postulated mean (Ahadzie, 2007). The hypothesized mean in this study was fixed at 3.5. This is because if 3=moderately is important and 4=important, then a variable should have a mean greater than the neutral point of 3.5 for it to be regularly deemed agreed upon. All of the means that are more than 3.5 were unanimously agreed upon by the study's participants. In agreement with the risk thresholds, the significance level was established at 95%.

According to Table 6, all of the components showed positive t-values (test strength), suggesting that their means were greater than the anticipated mean of 3.5. All of the components have a p-value (test significance) less than 0.05, indicating that the means of these variables are not substantially different from the hypothesized mean of 3.5. Furthermore, the 95 percent confidence level interval quantifies the difference between the mean weight of the population and the test value.

Table 6 One-sample t-test for strategies to reduce the impact of resource consumption in the construction industry (theoretical mean = 3.5; Df=67)

Strategies	t-value	p-value	CI (Inf)
Buildings should be designed with disassembly in mind	14.032	0.000	2.996
Re-use of parts of the existing building structure	13.922	0.000	3.173
Use of prefabricated components for on-site assembly	13.205	0.000	3.142
Materials resulting from demolition activities should be re-used or recycled	11.421	0.000	2.945
Renovation of existing buildings to avoid demolition	10.258	0.000	2.868
Use durable, long life, flexible designs	9.965	0.000	3.182
Use of sustainable and local materials	8.424	0.000	3.161
Dispose of materials as landfill	7.082	0.000	2.934
Adopting a zero-waste approach	6.354	0.008	3.092
Efficient use of natural resources	5.470	0.000	2.884
Financial incentives to promote recycling	4.345	0.000	2.891
Mandatory green building policies and regulations	3.938	0.000	2.552
Life cycle assessment and thinking	3.829	0.000	2.613
Enhanced research and development (R&D) on sustainable construction	2.844	0.000	2.611
Sustainable procurement and sourcing	2.915	0.000	2.721
Use of green rating systems	1.654	0.000	2526
More media publicity (television, radio, newspapers) on resource consumption	0.991	0.000	2.562
Availability of institutional framework for effective minimization of resource consumption	0.857	0.010	3.002
The functioning market for reusable sections	0.356	0.000	2.980
Imposing pollution tax on materials that are prone to pollution	0.113	0.100	3.451

Df=Degree of freedom; CI=Confidence interval

5.0 DISCUSSION

The outcomes of the study are consistent with previous similar studies. Analyzing energy and material flows at the size of cities has the benefit of providing insight into whether progress toward higher sustainability is truly being made (Kukah et al., 2022a). The modeling of the rehabilitation of an established Adelaide, South Australia area, where older houses were eventually substituted with contemporary energy-efficient buildings, is an example (Pullen, 2010a). The savings in energy consumed by the new energy-efficient houses were surpassed by the increased energy required in the fabrication of the new construction materials at faster rates of demolition and replacement. To reduce the embodied energy and emissions of new houses, one strategy to combat this phenomenon is to employ more re-used and recycled materials. According to early calculations, this is effective for demolition and reconstruction rates ranging from low to moderate (Li et al., 2014).

As non-renewable resources are removed from the environment and utilized in the human economy, their stocks are inexorably depleted (Alghamdi et al., 2019). This is because non-renewable materials are limited in number and do not replenish after being extracted. Recycling can extend the economic life cycle of some non-renewable resources, notably metals. This method entails gathering and processing discarded industrial and home items to recover reusable resources like metals and plastics (Hossain & Marsik, 2019).

Research and development (R&D) was scored highly as a cost-cutting strategy. Several affluent nations have made substantial progress in resource consumption research and development (Chan et al., 2018; Li et al., 2014). Ghana would benefit from engaging with developed nations and learning from their experiences to reduce resource use through R&D. To promote interest and demand for sustainable construction, all R&D discoveries should be communicated through channels such as development tours, the media, academic and industrial publications, seminars, and workshops to educate industry practitioners and the general public (Chan et al., 2018).

To reduce waste associated with producing in situ construction parts, prefabricated elements should be used as much as possible for on-site assembly. Structures should be designed with disassembly in mind, allowing materials and parts to be reused rather than ending up in landfills at the end of their useful lives (Pullen et al., 2012). Materials generated during demolition activities should be reused or recycled as much as possible, and if possible, used on-site. Some components, such as concrete and another masonry, may need to be transported to recycling centers for further refining and downgrading into aggregate (for concrete) or roadbase, which may then be reused on the construction site or in subsequent construction projects. Finally, if re-use or recycling is not an option, the items should be discarded in a landfill (Pullen, 2010b).

Doan et al. (2017) and Li et al. (2017) found that developing green building certification systems is crucial to lowering resource consumption and improving sustainability after examining the literature on the subject. Environmentally, economically, and socially sustainable buildings should be evaluated for their lifetime costs as well as their environmental, economic, and social benefits (Darko et al., 2017; Kukah et al., 2021). To promote long-term adoption, the state must give help. Green technology research institutes and centers should be established by the government, and educational departments such as universities should be encouraged to do sustainable building research (Darko & Chan, 2018).

Whilst the goal of this research is to provide a generic list of strategies for minimizing the repercussions of resource consumption in the construction sector, it is worth noting that the relevance of these strategies depends entirely on a variety of factors, including the type and scale of projects (e.g., government- or privately-funded projects), the sector under consideration (e.g., residential or commercial sectors), and firm characteristics (e.g., the residential or commercial sectors).

6.0 CONCLUSION

The most significant strategies based on the mean score ranking were: buildings should be designed with disassembly in mind; re-use of parts of the existing building structure; use of prefabricated components for on-site assembly; materials resulting from demolition activities should be re-used or recycled; and renovation of existing buildings to avoid demolition. After testing Kendall's concordance, a high level of agreement was observed. One sample t-test also determined the relative significance of the identified strategies.

This research adds to the body of knowledge about sustainable building by examining important techniques for reducing resource consumption in the construction sector in a developing country. In addition, the findings of this study will help policymakers, industry stakeholders, and activists better understand the important measures for reducing resource use and promoting SDG 12. This research is useful to academics since it contributes to the body of knowledge, particularly on the most important ways for reducing resource consumption in the Ghanaian construction sector. The widespread adoption of methods and tactics to reduce the environmental effect of resource construction would need a shift in attitudes and culture among all stakeholders involved in building construction.

When evaluating and generalizing study findings, keep in mind that there are limitations. The scope of this research was limited to construction players in Ghana. Because professional competence and experience differ around the globe, there is a chance that the research findings will differ. The industries in emerging nations, notably in Sub-Sahara Africa, are theoretically comparable. As a result, the aforementioned constraint will not affect the validity of the findings or their future use in these emerging nations. Furthermore, the findings' consistency with the literature adds to the findings' credibility and trustworthiness. The development of norms and standards that describe appropriate industry practices for the re-use of materials and components in the building is proposed.

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