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Identifying the Barriers to Sustainable Management of Construction and Demolition Waste in Developed and Developing Countries: Case Studies in UK, KSA, Egypt and Ghana

Ali Alotaibi [1,*], Patrick Aaniamenga Bowan [2], Mahmoud M. Abdel daiem [3,1], Noha Said [3], Obas John Ebohon [4], Aasem Alabdullatief [5], Essa Alenazi [6], Greg Watts [7]

[1] Civil Engineering Department, College of Engineering, Shaqra University, Al-Dawadmi, 11911, Ar Riyadh, Saudi Arabia
[2] School of Engineering, Department of Civil Engineering, Wa Polytechnic, P. O. Box 553, Wa, Upper West Region, Ghana
[3] Environmental Engineering Department, Faculty of Engineering, Zagazig University, 44519, Zagazig, Egypt,
[4] School of Built Environment and Architecture, London South Bank University (LSBU), London, England, United Kingdom
[5] Department of Architecture and Built Environment, College of Architecture and Planning, King Saud University, 11451, Ar Riyadh, Saudi Arabia
[6] General Administration for Investment and Privatization, Ministry of Education, Ar Riyadh, Saudi Arabia
[7] School of Science, Engineering and Environment, University of Salford, United Kingdom

* Correspondence alialotaibi@su.edu.sa; Tel.: (00966 505117740)

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Abstract: The construction industry is a vital part of every nation's economy. Construction activities influence the social, environmental, and economic aspects of sustainability. There are numerous barriers to sustainable construction and demolition waste management (C&DWM) globally. This study aims to identify sustainability barriers for effective C&DWM in developed and developing countries including UK, KSA, Egypt, and Ghana as case studies. To achieve the objective, 11 barriers have been selected and identified based on an excessive and comprehensive literature review. These barriers were further examined using a questionnaire survey for the selected countries. Ranking of the barriers for each country and all the countries were carried out using the Relative Importance Index (RI), and practical solutions were proposed to overcome the identified barriers. The overall ranking of barriers by RI indicates that insufficient attention paid to C&DWM, lack of law enforcement, lack of regulation, and financial constraints represent the four major barriers to sustainable C&DWM. The findings of this study and the proposed solutions can support decision-makers to develop strategies to tackle these barriers and achieve effective and sustainable C&DWM.

Keywords: Barriers, Sustainability, Construction and Demolition Waste, Waste Management, Relative Importance index.

1. Introduction

A rapid increase in global urbanization has increased the demands placed upon the construction industry. The construction industry now not only needs to meet this increasing demand for urban spaces but also effectively address all the negative ramifications associated with increased urbanization. This includes the large-scale clearance of agricultural land, high energy consumption, and rising environmental degradation [1]. The amount of construction and demolition waste (C&DW) generated by the industry is also increasing at a rapid rate. The construction industry is seen as a major generator of waste and pollution, as waste from construction activities significantly pollutes the environment [2, 3]. The proper management of this waste is a challenge in many countries, particularly, developing countries. C&DW mainly consists of inert and non-biodegradable materials such as concrete, plaster, wood, metal, broken tiles, bricks, masonry [4]. In some parts of the world, particularly in developing countries, the disposal of C&DW often creates additional hazards as it is disposed of via illegal dumping on any available space, including on the shoulders of major roads [5].

Despite construction activity having a vital role in developing cities, the industry's contribution to environmental degradation is not going unnoticed [6]. Infrastructural development inevitably leads to an increase in C&DW generation. The C&DW is considered the largest waste flows worldwide, that has reached 30–40% of the total solid waste [7–9], e.g. the European construction sector produces 820 million tons of C&DW every year, which is around 46% of the total amount of solid waste (SW) generated in Europe [10]. Effective management of C&DW is therefore of paramount importance to mitigate and reduce C&DW. However, there exists a gap in current literature around why effective management practices are not widely adopted when it comes to the management of C&DW, and what barriers exist to effective C&DW management, and more specifically, are these barriers influenced by geographical factors. A greater understanding of any geographical barriers that exist will aid the international management of C&DW and allow the development of effective strategies to target C&DW on a country by country basis.

From this background, the main objective of this study is to conduct an in-depth understanding the barriers to sustainable management of C&DW and any perceived barriers to the effective management of C&DW in different countries including United Kingdom (UK) as a developed country from Europe continent, Kingdom of Saudi Arabia (KSA) as a developing country with high developed economy from Asia continent, finally Egypt and Ghana as developing countries with lower-middle income economy from Africa continent. The revelation of these barriers and of geographical factors will serve to better inform policy decision makers as to how they can focus and implement strategies aimed at reducing C&DW that occurs as a result of infrastructure and construction works meeting the increasing demand or global urbanization.

2. Literature review

The construction industry encompasses the design, construction, maintenance and demolition of assets, buildings, engineering and infrastructure works. It involves the entire life cycle of buildings and infrastructure from concept and design, to development, use and ultimate demolition [11] and the importance of the construction industry to the economy of a country cannot be underestimated. It has been argued that a country's construction industry is vital for economic development and national growth [12] yet stakeholders are increasingly demanding construction companies take responsibility beyond their economic contribution to include their impact upon the wider environment and society [13]. Unlike many industries, the construction industry also operates almost wholly in the public eye and so is subject to a greater level of scrutiny over its practices, specifically around waste minimization, reuse and recycling practices. The construction industry involves several participants and stakeholders, their consciousness and commitment can have a major impact on effective construction and demolition waste management (C&DWM).

Construction and Demolition Waste Management (C&DWM) is considered the most important item for all environmental programmers worldwide. To attain effective and sustainable C&DWM, the creation of novel solutions and the understanding of different approaches will be required. For instance, increasing the recycling rate for non-hazardous C&DW can be an ambitious target in certain countries, which could contribute to the improvement the economic sector as well as environmental sector. Furthermore, the sharing of best practiced techniques, and barriers is an essential approach to support decision makers and stakeholders in the development of new policy and strategic frameworks for sustainable C&DWM.

Accordingly, many researchers have identified the barriers militating against effective C&DWM. Bufoni et al [14], recognized socio-political, technological, regulatory, financial, and human resources constraints as the barriers to effective C&DWM. This is supported by Menegaki and Damigos [15], who also identified the lack of regulatory and financial resources to be the hindrances to effective C&DWM. Similarly, Udawatta et al [16], recognized the barriers to effective C&DWM as the rigidity of construction practices, construction project characteristics, awareness, experience and commitment, and the nascent nature of waste management, human factors and technical factor.

Furthermore, the barriers to effective C&DWM are classified under 3 dimensions of behavioral, technical, and legal [17]. Huang et al [18] also acknowledge ineffective management system, immature recycling technology, under-developed market for recycled C&DW products and immature recycling market operation have been taken as barriers to C&DWM. The barriers to effective C&DWM may be similar or varied from country to country, as the generation rate and composition of C&DW are usually influenced by many factors, such as level of economic development, cultural norms, geographical location, energy sources, and climate [19].

3. Methodology

3.1. Identification of barriers

There are so many barriers that hinder the effective implementation of waste management in construction projects. Eleven barriers were identified and investigated through literature reviews, as shown in Table 1. All these barriers are well recognized and highly applicable in current context. The literature review focused mainly on two criteria for journal selection: indexed in Science Citation Index and publication focusing in waste management areas. Figure 1 shows the methodology for the current research.

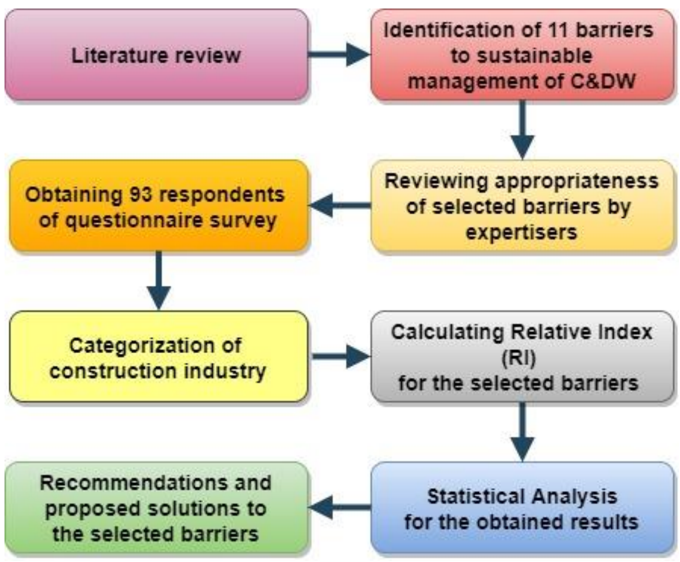


Figure 1. Research methodology scheme

Table 1. Barriers to effective C&DWM

Serial Number	Barriers to Effective C&DWM	References
B1	Institutional Fragmentation	[16,18,20–26]
B2	Lack of Fundamental Data on C&DW	[16,17,21,27–30]
B3	Lack of Law Enforcement	[8,17,18,29,31–34]
B4	Insufficient Attention Paid to C&DWM	[8,16,22]

B5	Socio-political	[14,25,31,35]
B6	Technological	[14–17,20–25,27,30,35]
B7	Lack of Regulation	[8,14,15,18,21,22,24,28–34,36]
B8	Financial	[8,14,15,18,21,23,31,35–37]
B9	Human Resources Constraints	[14,16,17,20,32,33]
B10	Construction Project Characteristics	[16,25,31,38]
B11	Rigidity of Construction Practices	[16,39,40]

B1: Institutional Fragmentation

Several institutions are involved in waste management, including C&DWM in most countries, which often lead to many institutions reneging on their responsibility on a C&DWM problem, thinking that another institution would tackle the problem, as there is usually confusion about who is responsible [25,26,41]. Institutional fragmentation is particularly a major challenge to effective C&DWM in most developing countries, where the institutional arrangements for waste management are weak [42–44].

B2: Lack of Fundamental Data on C&DW

Sound waste management requires reliable data on generation rates and composition of the waste. However, the fundamental data on C&DW that will inform effective planning for sustainable C&DWM is absent in many developing countries and woefully inadequate in some developed countries [16,30]. Notwithstanding this, C&DW comprises the largest waste stream in most developed countries and is also increasing at alarming rates in the developing world, due to rising urbanization [45].

B3: Lack of Law Enforcement

Many countries have a long history of safeguarding the environment, including attempts in ensuring proper C&DWM and have enacted appropriate legislation; nonetheless, the enforcement of legislation is a challenge in many countries [42]. The non-enforcement and non-compliance with laws governing C&DWM have significantly contributed to poor C&DWM in many countries [17,32].

B4: Insufficient Attention Paid to C&DWM

Stakeholders in the construction industry usually focus more on completing the project within budget, expected time, and to the desired quality, to the detriment of the waste that emanates from the construction activities [8,16,22,46]. This has given a bad image to the construction industry, as the improper disposal of C&DW results in far-reaching environmental consequences.

B5: Socio-political

The construction industry like other industries is characterized by cultural and socio-political differences across firms' types, age and size. Consequently, studies are rife linking the construction industry's culture with its waste intensiveness [47]. Therefore, understanding these cultural and socio-political patterns of construction firms, could help in planning for effective C&DWM [14,25,31,35].

B6: Technological

C&DW technology and management choices in many countries have become very complicated, especially when concentrations for greenhouse gasses reduction and avoidance, landfill-minimization and land reclamation are involved [20,23]. The C&DW sector has become a specialized industry, with high technological standards, therefore, engagement with the sector requires in-depth experience, thorough research and engineering expertise [15,17,21,23–25,30,35].

B7: Lack of Regulation

The regulation of the environment, including C&DWM, is essential to ensuring good environmental governance. However, weak enforcement of environmental regulations in many countries, allows construction firms to flout regulations on C&DWM without sanctions [29,30,33].

B8: Financial

Financial and other resources are critical for effective waste management; however, these are generally scarce in many countries [14,23]. Poor national economic policies, coupled with extreme poverty and infrastructure deficit, make financial consideration one of the obvious constraints to developing appropriate C&DWM system in most developing countries [15,21,48].

B9: Human Resources Constraints

Human resource is essential for effective waste management, especially, the daily operations of C&DWM. Nonetheless, many countries do not have the human resource with the requisite expertise required for the effective functioning of a C&DWM system [14,16,17,20,32,33].

B10: Construction Project Characteristics

Several construction project characteristics have the potential of influencing C&DWM, which include: the complexity of the project, size of the project, location of the project, type of project, the importance for the project to be completed on time, the form of contract, project funding, etc. [16,25,31,38].

B11: Rigidity of Construction Practices

Many stakeholders are involved in the construction industry who play varied and crosscutting roles. The effectiveness of a C&DWM system in a particular location/country depends on the performance of these stakeholders in terms of their flexibility or rigidity in their practices [16,39,40]. With high public awareness about the problems posed by inadequate C&DWM, broad consultation and involvement of all stakeholders are needed for the development of workable C&DWM strategies.

In addition, the study adopted Relative Importance index (RI) to identify and rank critical barriers that militates the effective implementation of waste management. The RI has been extensively used in construction management researches to identify barriers, level of importance, and degree of implementation of various construction projects by using Equation (1) below [49,50].

$$\text{RI}=\sum(\text{ax})\times\frac{100}{7} \tag{1}$$

Where: a = constant (weight) 1 to 7, x = n/N, n = Frequency of responses, N = Total responses.

3.2. Data Collection

A questionnaire survey was distributed amongst various stakeholders within different organizations to investigate barriers to effective waste management implementation in the construction industry. Two-steps procedure was adopted to assess its appropriateness and rationality. In the first step, the questionnaire was assessed by 15 persons having expertise in construction projects, to ensure clarity and technical applicability. The second one, the reviewed questionnaire was sent to respondents to identify and rank the frequency (i.e., 1 = Never, 2 = Rarely, 3 = Occasionally, 4 = Sometimes, 5 = Frequently,6 = Usually and 7 = Always) of the eleven barriers.

The distribution was conducted across various countries mainly UK, KSA, Ghana and Egypt. Due to ongoing COVID-19 pandemic, technological circumstances such as Google form was followed. A convenience sampling approach was adopted to select participants from each country; 93 valid responses were received and considered for analysis. All results were reported descriptively with the aid of Statistical Package for Social Sciences (SPSS), Microsoft Excel and Relative Importance Index (RI).

4. Results and discussion

The results discussed under this section are based on the extensive literature review that produced the barriers to effective C&DWM and the responses to the questionnaire by experts from UK, KSA, Egypt and Ghana. Thus, the responses of 93 experts in the construction industry are discussed.

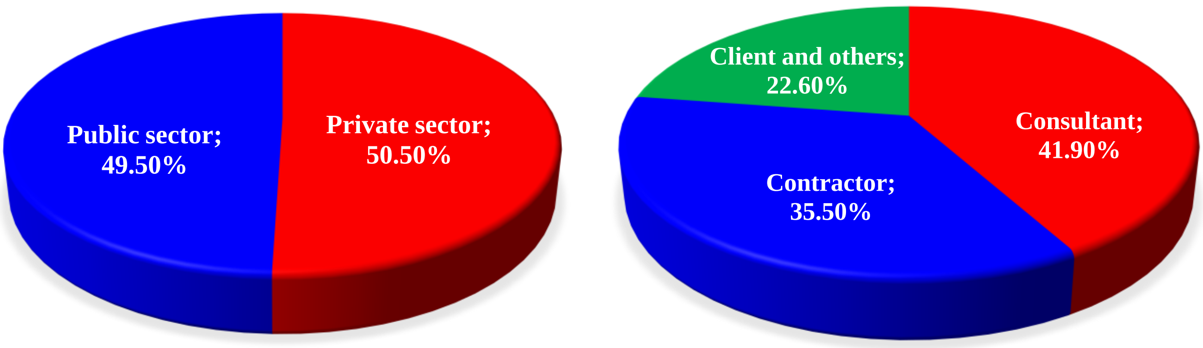
4.1. Categorization of the Construction Industry

The researchers categorized the construction industry in the study countries in terms of ownership (public or private), type of the organization, size of the organization, role of the respondent in the organization, and experience of the respondent in the construction industry. Figure 2 a) shows the classifications of respondents in relation to ownership of the organizations. 49.5% of the respondents were from the public sector, whereas, 50.5 % were working in the private sector. Thus, there was virtually equal number of respondents from the public and private sectors.

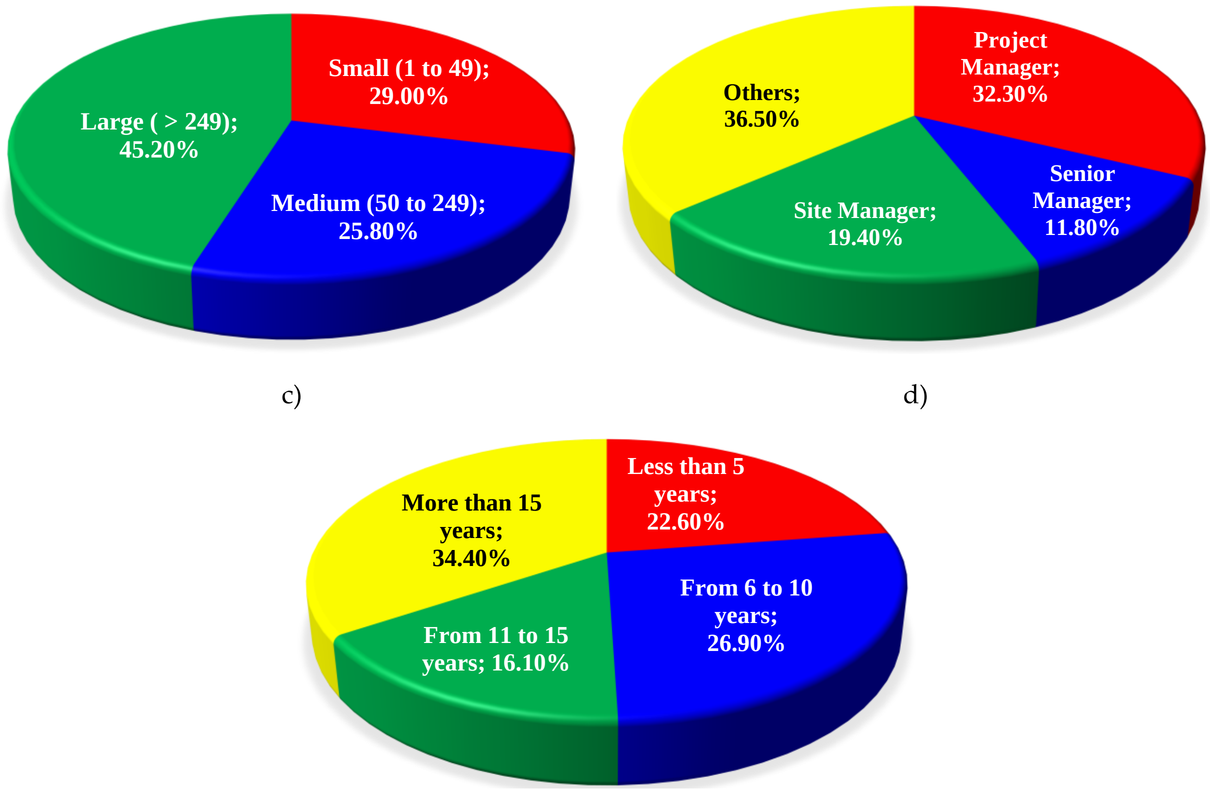
Also, on the type of construction industry, majority of the respondents (41.9 %) were from consultancy firms and remaining were contractor, and client and other type of construction industry, as indicated in Figure 2 b). These represent the main actors in the construction industry and thus, provided a good picture of the industry in the four countries. Furthermore, Figure 2 c) indicates percentages of organization size based on the number of employees in the organization. The organization were categorized in sizes as: large organization (< 249 employees), medium organization (50 to 249 employees), and small organization (> 49 employees). The large size organization accounted for the highest percentage (45.2 %) of respondents.

In addition, the position of respondents in the organizations are classified in Figure 2 d). Project managers recorded 32.8 % that are better placed to assess the barriers to effective and sustainable C&DWM. The classification of respondents according to the years of experience is shown Figure 2 e). The category that has experience more than 15 years represented the highest contribution (34.4 %), followed by the category has experience from 6 to 10 (26.9 %).

It can be deduced from the categorization of the respondents that majority of the respondents were from consultancy firms, large organizations, project managers, and the category that has the highest years of experience in the construction industry.



a) b)



c) d)

e)

Figure 2. Categorization of the Construction Industry: a) Ownership of the organization, b) type of organization, c) size of organization, d) position in organization, and e) years of experience.

4.2. Organisations Engagement in Effective and Sustainable C&DWM

The result on organizations engagement in effective and sustainable C&DWM were obtained by asking the respondents "Why they think their organization should engage in effective C&DWM activities". The researchers found out that "to make a positive difference to society" was recognized as the greatest reason (69.9 %) for organizations adopting effective and sustainable C&DWM activities, as indicated in Figure 3. However, "to meet primary project objectives cost, time and quality" was not the least reason by the respondents for their organizations to engage in effective and sustainable C&DWM.

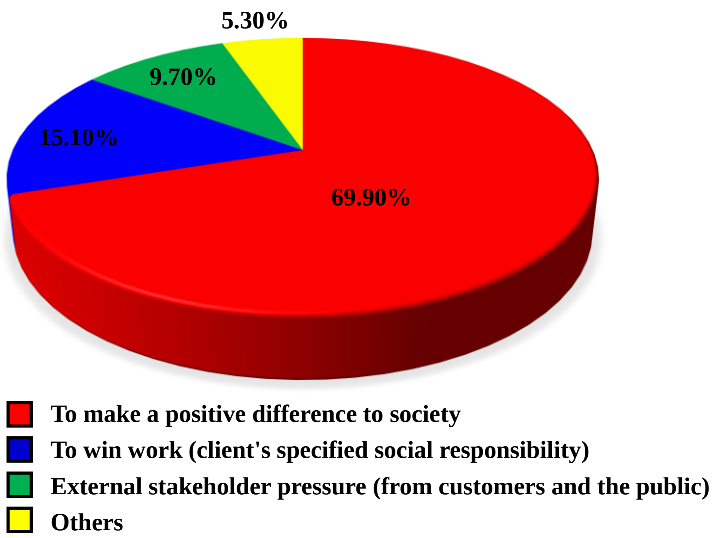


Figure 3. Reasons for organizations engagement in effective C&DWM

4.3. Evaluation of Barriers to Effective and Sustainable C&DWM

Based on the results obtained from the experts, the estimated RI values range from 0.45 to 0.70, as shown in Figure 4. These values were divided into three levels: strong barriers (0.60 - 0.70), moderate barriers (0.50 - 0.60), and weak barriers (< 0.50).

4.3.1. Critical barriers in UK

According to the questionnaire in UK, B4, B3, B7, B8 and B2 the five strongest barriers to the effective and sustainable C&DWM. Additionally, B1, B5 and B6 were regarded as moderate barriers to the effective and sustainable C&DWM. Notwithstanding these, the UK Government has been using a combination of regulation, economic instruments and voluntary agreements to meet targets of ethical, social and environmental performance in driving the waste management agenda [51,52]. Also, the UK implements legislative and fiscal measures which lead not only to construction waste reduction, but are directly related to the rising landfill tax, increasing cost for waste disposal, and compliance requirements with site waste management regulations 2008 [53,54].

4.3.2. Critical barriers in KSA

The experts in KSA indicated that the top seven barriers to sustainable C&DWM are B4, B3, B6, B7, B8, B5 and B1. Despite these barriers have moderate RI values (0.50-0.60), the plurality of them is a major challenge to adopt feasible approaches to tackle the barriers. Identification of these barriers can support decision makers in the Kingdom to meet their 2030 Vision. There is no data available on C&DW characterization [55]. Despite that contractors play an important role in collecting C&DW from their sites by licensed waste haulers who are subcontracted to perform this task, the subcontractors usually dump these wastes in unapproved sites or along roadsides resulting in contamination and roads blocks as well as undesirable views [41].

4.3.3. Critical barriers in Egypt

C&DWM challenges are not different in Egypt from the other countries studied, as C&DWM is a major problem in the construction industry. Consequently, experts who responded to the study questionnaire identified seven strong barriers to sustainable C&DWM. These barriers are B4, B11, B8, B7, B5, B3 and B6. The remaining barriers were regarded as moderate level barriers. Recently, Waste Management Law No.202 of 2020 has been adopted for waste management including construction and demolition waste in Egypt (EEAA, 2020). The main goals of the law are the development of an integrated of municipal, industrial, agricultural, C&DW management system; promote reuse; work to ensure the recycling, treatment and final disposal of waste, and manage waste in a way that reduces damage to public health and the environment. The achievement of these goals could help ensure effective and sustainable C&DWM in Egypt.

Notwithstanding this, Daoud et al. [56] posit that 5.8 million tons of C&DW is generated annually, which accounts for 6.4% of the total solid wastes generation in Egypt. However, this waste generation rate may be inaccurate due to the lack of data on solid waste generation and characteristics in Egypt [57]. Similar to C&DW disposal in the KSA, C&DW are also usually dumped on roads and in facilities which lack effective management. Moreover, contractors usually find it cheaper to transfer C&DW to a nearby illegal site and neglect paid-for disposal services at an approved legal site. There is legislation C&DWM in Egypt, however, the legislation is ineffective due to several reasons including the existence of construction operations without a permit, lack of regulations' enforcement, C&DW collection and disposal is carried out by limited number of local governments, and the 1% building permit fee is dedicated to other services rather than C&DWM [56].

4.3.4. Critical barriers in Ghana

The construction industry in Ghana has operated in a particular style for long period of time such as it presents itself as a sector which is traditionally very difficult to change especially with respect to construction methods practiced and building materials used [58]. The current study indicates B7, B3, B4, B8 and B6 have the highest range of RI (0.60-0.70) and represent the major barriers to effective and sustainable C&DWM in Ghana. The other barriers are considered as moderate barriers and only B1 is disregarded based on its factor. In this context, previous studies showed that the additional financial cost of providing measures to improve the sustainability of construction works, the government policies, legislation and government commitment, the management of the construction industry, the technical information on sustainable construction, the desire of stakeholder in the construction industry to be committed to change and congruent goals and objectives represented the main components for successful implementation of sustainable construction in the Ghanaian construction industry [58].

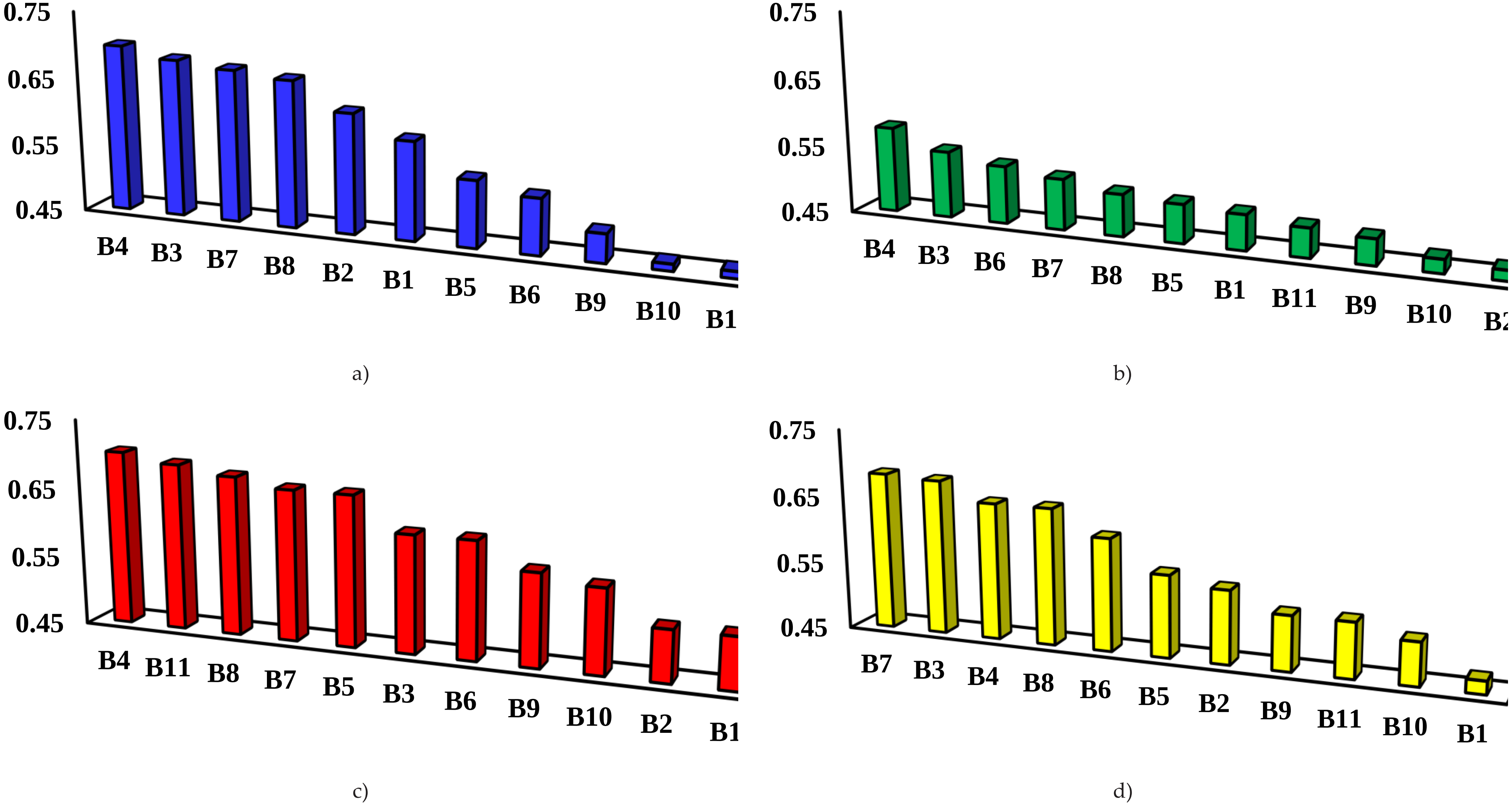


Figure 4. Variation of RI index for a) UK, b) KSA, c) Egypt, and d) Ghana

The data obtaining from respondents' opinions were integrated and analysed for all studied countries. Table 2 indicates the descriptive information for the results and the overall ranking of barriers by RI. Based on the experts' opinion, B4, B3, B7 and B8 represent strong and major barriers to sustainable C&DWM. However, the other barriers are considered as moderate barriers, with only B10 being considered as a weak barrier and can be disregarded due its low RI value (< 0.50). The correlation coefficients of the results have been also determined to get the relation between the different barriers. Table 3 shows the correlation coefficients, where the values between 0.5 and 1 indicate the closely related barriers. The strongest relation has been found between B10 and B11 followed by the relation between B9 and B10. The lowest one has been detected between B1 and B10. These barriers can be mitigated and managed by organizations through proper management and leadership.

Based on the evaluation of the barriers to effective and sustainable C&DWM in the four studied countries, practical solutions to overcoming barriers to effective and sustainable C&DWM have been proposed in Table 4. The proposed solutions to tackle the barriers to effective sustainable C&DWM include cooperation and collaboration among construction companies, providing fundamental data about the amount of C&DW and their composition, enforcing regulations on waste management, stakeholders involvement in C&DWM, application of sustainability policies in C&DWM, and adoption of integrated waste management.

Table 2. Descriptive statistics of the received data and RI index for the overall countries

Barriers to Effective C&DWM	N	Minimum	Maximum	Mean	Std. Deviation	Variance	Confidence Level (95.0%)	RI	Rank
B1	93	1	7	3.56	2.01	4.05	0.41	0.512	10
B2	93	1	7	3.69	1.79	3.20	0.37	0.536	7
B3	93	1	7	4.36	2.05	4.18	0.42	0.628	2
B4	93	1	7	4.45	1.85	3.41	0.38	0.642	1
B5	93	1	7	3.87	1.89	3.59	0.39	0.558	6
B6	93	1	7	3.99	1.81	3.27	0.37	0.573	5
B7	93	1	7	4.38	1.94	3.75	0.40	0.627	3
B8	93	1	7	4.30	1.95	3.79	0.40	0.611	4
B9	93	1	7	3.55	1.86	3.46	0.38	0.516	9
B10	93	1	7	3.42	1.62	2.61	0.33	0.496	11
B11	93	1	7	3.67	1.76	3.11	0.36	0.525	8

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Table 3. Correlation coefficients and P-values of the barriers for the overall countries

		B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
B1	Correlation		0.513**	0.460	0.219	0.453	0.346	0.374	0.330	0.168	0.143	0.224
	p- Value		< 0.001	< 0.001	0.019*	< 0.001	0.002	0.012	0.012	0.834*	0.529*	0.783*
B2	Correlation	0.513**		0.739**	0.590**	0.551**	0.508**	0.624**	0.393	0.169	0.271	0.269
	p- Value	< 0.001		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.011	0.774*	0.115*	0.130*
B3	Correlation	0.460	0.739**		0.692**	0.517**	0.509**	0.679**	0.450	0.220	0.281	0.270
	p- Value	< 0.001	< 0.001		< 0.001	< 0.001	0.020	< 0.001	0.011	0.315*	0.195*	0.268*
B4	Correlation	0.219	0.590**	0.692**		0.562**	0.540**	0.643**	0.596**	0.422	0.458	0.553**
	p- Value	0.019*	< 0.001	< 0.001		< 0.001	0.001	< 0.001	< 0.001	0.001	< 0.001	< 0.001
B5	Correlation	0.453	0.551**	0.517**	0.562**		0.652**	0.580**	0.485	0.216	0.176	0.282
	p- Value	< 0.001	< 0.001	< 0.001	< 0.001		< 0.001	< 0.001	< 0.001	0.479*	0.045	0.189*
B6	Correlation	0.346	0.508**	0.509**	0.540**	0.652**		0.668**	0.654**	0.290	0.265	0.260
	p- Value	0.002	< 0.001	0.020	0.001	< 0.001		< 0.001	< 0.001	0.075*	0.250*	0.507*
B7	Correlation	0.374	0.624**	0.679**	0.643**	0.580**	0.668**		0.684**	0.255	0.353	0.400
	p- Value	0.012	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001		< 0.001	0.285*	0.169*	0.024
B8	Correlation	0.330	0.393	0.450	0.596**	0.485	0.654**	0.684**		0.536**	0.483	0.494
	p- Value	0.012	0.011	0.011	< 0.001	< 0.001	< 0.001	< 0.001		< 0.001	0.001	< 0.001
B9	Correlation	0.168	0.169	0.220	0.422	0.216	0.290	0.255	0.536**		0.771**	0.663**
	p- Value	0.834*	0.774*	0.315*	0.001	0.479*	0.075*	0.285*	< 0.001		< 0.001	< 0.001
B10	Correlation	0.143	0.271	0.281	0.458	0.176	0.265	0.353	0.483	0.771**		0.775**
	p- Value	0.529*	0.115*	0.195*	< 0.001	0.045	0.250*	0.169*	0.001	< 0.001		< 0.001
B11	Correlation	0.224	0.269	0.270	0.553**	0.282	0.260	0.400	0.494	0.663**	0.775**	
	p- Value	0.783*	0.130*	0.268*	< 0.001	0.189*	0.507*	0.024	< 0.001	< 0.001	< 0.001	

** Correlation is significant and strong positive, * P-value is not significant

Table 4. Proposed solutions to barriers to effective and sustainable C&DWM

Barriers to Effective C&DWM	Proposed solution(s)	References
B1	The government, organizations, and individuals should establish effective communication tools to achieve cooperation and collaboration among construction companies. The government should have an appropriate framework to encourage and regulate companies' practices. Construction companies and their projects should realize the strategic importance of C&DWM and impalement it at organizational and project levels.	[42,59]
B2	Municipalities should provide fundamental data about the approximate amount of C&DW and their compositions based on the project type. Moreover, they should provide data about the protocols, procedures and alternatives for the available management of C&DW (reuse, recycle, reduction, and disposal).	[30,60]
B3	Implementation of waste management rules and regulations by enforcing the environmental regulations and penalties regarding C&DWM.	[17,41,42]
B4	Promote environmental awareness by organizing discussions, seminars, training, and workshops on sustainable construction and its importance for contractors, consultants, and stakeholders.	[8,16,41]
B5	Social awareness, change in culture and attitude by branding and use of social media as well as incentives such as tax reduction and applicable sustainability policies by government agencies can support sustainable C&DWM.	[58,60]
B6	Technical information in sustainable construction, advanced technologies and methodologies, production and distribution of technical guidance documents for best practices should be available.	[25,60]
B7	Government should review and evaluate existing legislations and suggest amendments in coordination with responsible regularity authorities. Moreover, government with the support of stakeholders should develop legislations, regulations, codes and standards relating to sustainable construction practices.	[41,58]
B8	Additional financial cost should be provided for sustainability management. Reduction in costs by improving quality and reusing materials or recycled products, determining the best routes and use of waste transportation and material recycling to achieve economic and environmental gains by reducing fuel consumption.	[58,60]
B9	Developing appropriate training for all levels of workers in order to develop their skills and knowledge	[41,59,60]
B10	The construction project characteristics should be provided to organize and achieve effective and sustainable C&DWM such as type, size, location, and complexity of the project, as well as, the importance for the project to be completed on time, contract form, and project funding.	[25,38]

B11	Creating and improving awareness and knowledge of sustainable construction amongst varies actors in the construction industry especially for stakeholders. Funded projects should include provisions that encourage and obligate the stakeholders and contractors towards proper C&DWM.	[39,40,60]

5. Conclusions

This study identified sustainability barriers to effective and sustainable C&DWM in four countries (UK, KSA, Egypt and Ghana). Eleven barriers (institutional fragmentation, lack of fundamental data on C&DW, lack of law enforcement, insufficient attention paid to C&DWM, socio-political, technological, lack of regulation, financial, human resources constraints, construction project characteristics, and rigidity of construction practices) have been identified and ranked by (RI). The overall ranking of barriers indicated that the insufficient attention paid to C&DWM, lack of law enforcement, lack of Regulation and financial constraints represent the four major barriers to effective and sustainable C&DWM. Consequently, practical solutions to tackle the barriers have been proposed. These findings can support decision makers to achieve effective and sustainable C&DWM.

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