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Severity of Causative Factors to Construction Waste Generation: Iraq Construction Industry

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Abstract

Objectives: Construction and Demolition (C and D) wastes affect negatively to environment and economic of Iraq. This paper presents the severity of 78 identified factors contributing to C and D waste generation in Iraqi construction industries. **Methods/Statistical Analysis:** The structured questionnaire survey amongst contractors, consultants and clients was conducted and a total of 208 valid response data was collected for the analysis purpose. Descriptive analysis employing average score index was used for collected data. **Findings**: The results indicate severity of each factor toward the C and D waste generation and also the severity ranking. It was found that poor site management, lack of experience, rework, design errors and lack of environmental awareness are ranked as five most sever factors to C and D waste generation in Iraqi construction industry. **Application/Improvements:** Benefit from this study will be shared amongst researchers and also construction community to ensure the minimization of the (C and D) waste generation in Iraq.

Keywords: Construction and Demolition Waste, Construction Waste Causes, Factors Contributing C and D, Iraqi Construction Industries Causing C and D, Ranking and Severity of C and D Waste

1. Introduction

Construction industries play a significant part for improving socio-economic condition of any country. The impact on economic, the advantages of investment and assistances to employment are extremely tremendous in construction industries. The construction industries predict the overall direction of an economy and by this mean, it often designated as a prominent economic sector[1,2]. Construction industry has a dynamic capacity in most developing countries and for this reason; it is among the most prosperous sectors in the globe and remains so with the continuation of the development of any country[3,4].

Undeniably, the advancement in the living standard, the congenital population growth and modifications in consumption behaviors cause to escalation of construction activities and led to progression to the Construction Waste (CW) and such witnessed considerably during last two decades[5,6]. Currently, construction industry is confronting numerous hindrances and issues related with unbelievable generation of CW amount[7,8]. The quantification of such CW generation through numerous construction activities is being the foremost need of most environmental organizations. However; still developed and developing countries generate tons of CW through

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Table 1. List of volume of total C and D waste generated in 20 countries

Country	Quantity	Reference
U.S.A	584 million ton/year	EPA, (2018)[9]
European Union	2 billion ton/year	Defra, (2007)[10]
Honk Kong	1,152,670 ton/year	EPA, (2008)[11]
UAE (Dubai's)	27.7 million tons/year	Al-Hajj, (2011)[12]
Malaysia	9,344,000 ton/year	Zulhabri et al. (2016)[13]
India	14.7 million ton/year	Gupta, (2018)[14]
Iraq	11,235,478 ton/year	Central organization statistics of Iraq,(2016)[15]
Thailand	1.1 million ton/year	Kofoworola and Gheewala, (2009)[16]
Brazil	68.5 million ton/year	John et al., (2004)[17]
U K	70 million ton/year	Tam et al., (2018)[18]
China	2 Pillion ton/year	Wang, et al., (2019)[7]
Bulgaria	44 million ton/year	Coelho et al., (2013)[19]
Czech Republic	24 million ton/year	Husnain et al., (2017)[20]
Denmark	14 million ton/year	Kozlovska et al., (2013)[21]
Germany	364 million ton/year	Akhar et al., (2011a)[22]
Estonia	19 million ton/year	Low et al., (2014)[23]
Ireland	20 million ton/year	Coelho et al., (2013)[19]
Greece	69 million ton/year	Kofoworola et al., (2016)[16]
Spain	138 million ton/year	Kozlovska et al., (2013)[21]
Austria	35 million ton/year	Kozlovska et al., (2013)[21]

construction activities and Table 1 shows the amount of waste in the several countries.

In developing countries, disposing off C and D wastes to landfills without recycling remains the commonplace treatment method[24]. Because of the inadequate landfill spaces; harmful gas emissions and building demolition wastes, water pollution, energy consumption has grown into a major problem for sustainable urban development[25]. All such evidences are alarming the urgency of reducing and or recycling C and D wastes so as to relief the landfills pressure and to provide better options for the waste diversion.

Table 2. Groups of factors by previous researchers

No. of groups	Reference	Name of classified groups
4	Lingard et al., (2010)[27]; Ekanayake and Ofori (2000)[34]; Polat and Ballard (2004)[28]; Mostafa et al., (2017)[35]	Procurement, Culture, Handling and Operation
5	Teo, et al., (2001)[29]; Urio & Brent (2006)[30]; Adnan (2012)[36]	Design, Procurement, Operation, Handling and Site Operation
6	Bossink and Brouwers (1996)[37]; Alwi et al. (2002a)[38]; Nazech et al. (2008)[39]; Guerrero et al. (2012)[40]; Husnain et al., (2017)[20]	Management, Design, Procurement, Operation, Handling, Others
7	Nagapan et al., (2012)[41]; Akter et al. (2011a)[42]; Ismail et al., (2015)[31]; Polata et al., (2017)[43];	Design, Management, Site Condition, Handling, Procurement, Workers and External Factor
8	Ilhaq (2010)[44]	Design; Contractual; Transportation, Procurement; Material storage; Site Operation; Material Handling; Planning; Onsite management and Others
10	Osmani et al. (2008)[45]; Shant et al., (2014)[32]; Gupta et al., (2018)[33]	Design, Contractual, Transportation, Procurement, On-Site, Storage Of Material, Management And Planning, Handling, Residual, Site Operation, Other Factors

2. Construction Waste Causative Factors Group

The rapid growth in construction activities during the last few decades has brought huge amount of waste generation world widely. Most of such waste is not recycled nor reused but subsequently transferred to landfills[2,26], consequently exerts massive pressure on the landfill depletion and harms adversely our surroundings and the environment. Improper and illegal CW dumping depends on many factors during the construction activities. In[27] categorized such factors into four groups: design; procurement; handling of materials; and operation. In[28] stated that CW generation is not just a technical problem, but a behavioristic one also. In[29,30] also supported this statement and there are many factors for contributing the Construction Waste.

As[27] categorized these factors under four categories like "design", "procurement", "handling of materials" and "operation". While the fifth major factor "workers" added by[29,30]. In[31] supported the researchers' findings on the sources of waste generation, and added "site condition" and "external factors" as two more categories. While others[32,33] increase the sources of waste to 10 as shows in Table 3, proposed groups of factors by previous researchers.

Table 3 presents several groups effects of Construction Waste generation found by previous research which carried out in different countries.

3. Construction Waste in Iraq

In Iraq, after (2003), the cost of wasting the construction materials have already crossed the allowable limits as standardized by the Iraqi Ministry of Construction and Housing (MOCH), and is increasing expeditiously[6]. For that reason, it is mandatory to take steps for reducing such kind of cost and need to encourage the professionals to

Table 3. C and D waste generated for 2015, 2016 and 2017, in Iraq[50]

City	No. of Municipals	2015		2016		2017	
		C and D waste (ton / year)	Total waste (ton / year)	C and D waste (ton / year)	Total waste (ton / day)	C and D waste (ton / year)	Total waste (ton / day)
Baghdad [*centre*]	15	583,890.5	4,118,259	3,500.8	3,838,237.4	59,766.4	2,522,159.9
Baghdad [*outskirt*]	16	15,001.5	321,273	95,201	634,245	117,424	680,777
Karbala	7	214,255	563,633	436,950.4	867,130.8	331,769.6	794,741.4
Babil	16	73,182.5	347,298	356,308.2	785,437.2	186,884.8	575,874,8
Salah al-din	18	22,520.5	269,480	462,321	825,806	823,911.5	1,556,554
Maysan	15	126,472.5	645,284	93,568	430,123	46,364	401,919
Muthanna	12	184,982	348,977	179,220.8	357,869.8	60,435.2	219,077.2
Wasit	17	61,320	364,015	232,194	606,506	219,078	539,544
Qadisiyah	15	134,247	452,345	167,080	579,244	236,712	554,659
Diyala	22	26,243.5	354,306	85,128	409,928	74,223.2	440,158.2
Anbar	-NA-	-NA-	-NA-	-NA-	-NA-	2,073,483	2,954,364
Kirkuk	7	7,482.5	377,155	99,297.6	385,298.67	86,412.8	384,420.8
Dhi Qar	20	6,0663	226,997	80,924.8	620,201.8	95,707	701,822.5
Najaf	9	285,101.5	902,098	341,587.7	895,451.2	490,947	1,168,301
Ninewa	-NA-	-NA-	-NA-	-NA-	-NA-	3,210,299.4	3,899,283.8
Basrah	15	433,547	1,647,647	2,120,484	3,310,214	2,249,905.6	3,276,539.6

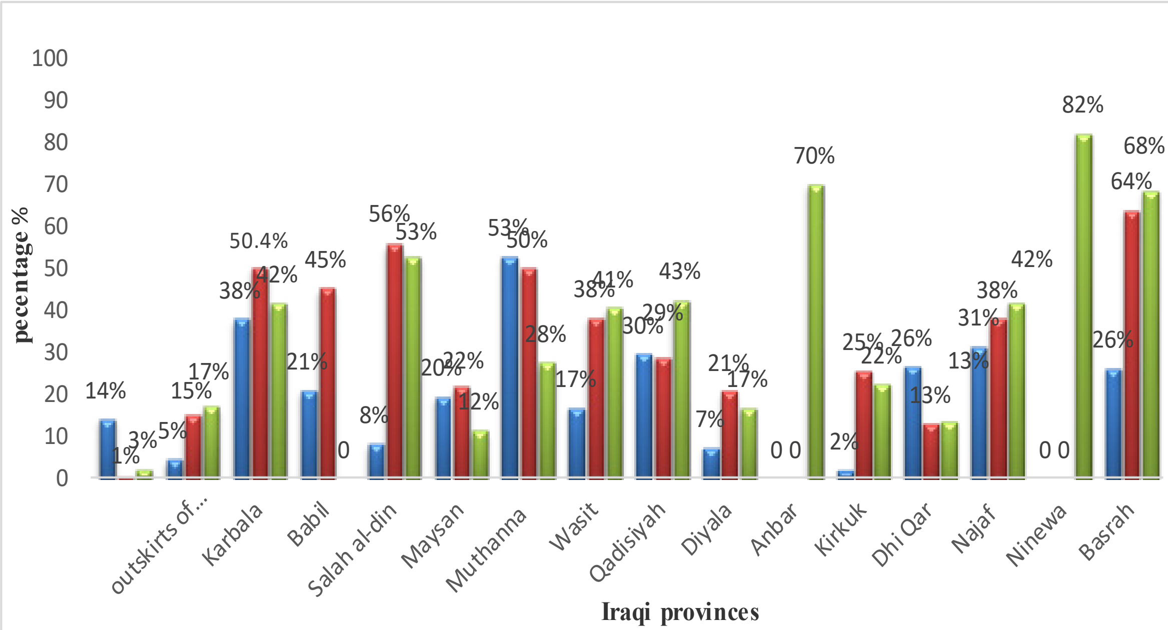

Figure 1. Percentage of C and D waste for Iraq cities[50].

develop the significant CW management system at project sites on expeditious basis and moreover to analyze the influencing factors that contribute to cause the CW. Thus, to overcome this problem, proper steps must be taken and introducing the effective waste management practices[46]. In[46] concluded that effective waste management implementation will guarantee the construction material flow in a closed loop so as to minimize the CW generation, decrease the need for landfills demanded and more than that will preserve natural resources but prior to those, the causes of waste generation are compulsory to find.

Iraq is a developing country and currently facing problem with the CW which has brought many illegal dumping sites[6,48] but at the same time, many organizations are working to finding out the source causes of CW and the effective practices for relieving from such problems[48]. Table 2 illustrates the volume of (C and D) waste and total waste for Iraqi governorates for the last three years.

Table 3 indicates that Iraq construction industry also producing huge amounts of (C and D) waste generation. Figure 1 shows the percentage of the resulting of (C and D) waste generation to total (C and D) waste generation for Iraqi cities except Anbar and Ninawa[50].

Figure 4 illustrates the percentage of C and D waste compared to total waste of each city in Iraq for 2015, 2016 and 2017, respectively.

4. Data Collection

This study was carried out in three phases: In the first phase, identified 78 important factors affecting Construction Waste generation through literature review and designed questionnaire survey. In the second phase, a pilot study was carried out to identify the factors effecting Construction Waste generation. The third phase, actual study was carried to calculate the mean score and the ranking of factors by importance. Also analyses the current views of the participants in the construction industry in Iraq on the generation of Construction Waste.

The structured questionnaire contains mainly two parts: The demographic data sample of the participated respondents and identifies the 61 factors that mainly contributed to the C and D waste generation. All such factors had been categorized into 7 groups. The study involved 38 experts selected from contractors, consultants and clients who are experienced in handling construction projects in Iraq. The participants were invited to give correct rating as per the Likert scale: 1–5 points (from the lowest to highest level) for each factor to check the relative importance for considering in CW generation.

4.1 Respondents Demography

Actual survey involved bigger samples to give better representation of construction practitioners in deciding the outcome of this survey. The actual survey was accomplishing to define the ranking based on mean score value of the causative and effective factors. In the meantime, the survey was conducted using the developed questionnaire based on the findings from pilot survey. Questionnaire sets were distributed among construction practitioner randomly selected in Iraq.

Two hundred twenty (220) sets of questionnaire were circulated for the collection of data, a total 208 completed questionnaire sets were received back within a time period of 3 months with respond rate of 95%. The respond rate is acceptable as it is around 20-30% response rate is considered as normal in construction research[51,52].

Table 4 shows the summary of statistics for collected samples.

In Table 5, it can be seen that most of the questionnaires were collected through in person/site visit. The percentage of questionnaires received from the respondents through in person/site visit is 140 out of the 140 questionnaires received with percentage 100%.

4.2 Organization

Respondents involved in the survey were engaged in different types of organization. The results of respondents based on the type of organization are presented in Figure 2.

From the Figure 2, it is obvious to see that the majority of respondents are working as a contractor: 133 experts with 63.94%, followed by consultants as 61 experts with 29.28% and clients/developer were 14 experts with 6.73%. Since majority of the respondents are from the contractor side, then the input from them are meaningful for this survey as they are the one that spend most of the time at the construction site.

4.3 Knowledge and Experience

Respondents involved in the survey have immense practice in managing several kinds of projects in Iraq. The details of projects handled by the respondents are summarizing in Figure 3.

According to Figure 3, 208 of respondents have experience more than 10 years in managing infrastructure projects. Most of the respondents have experience more

Table 4. Survey statistics

Mode of Survey	Sets of Questionnaire Involved	Questionnaire Received	Valid Responses	percentage
Visit the office or visit the site	140	140	140	100%
By other ways	80	80	68	72.5%
Total	220	220	208	95%

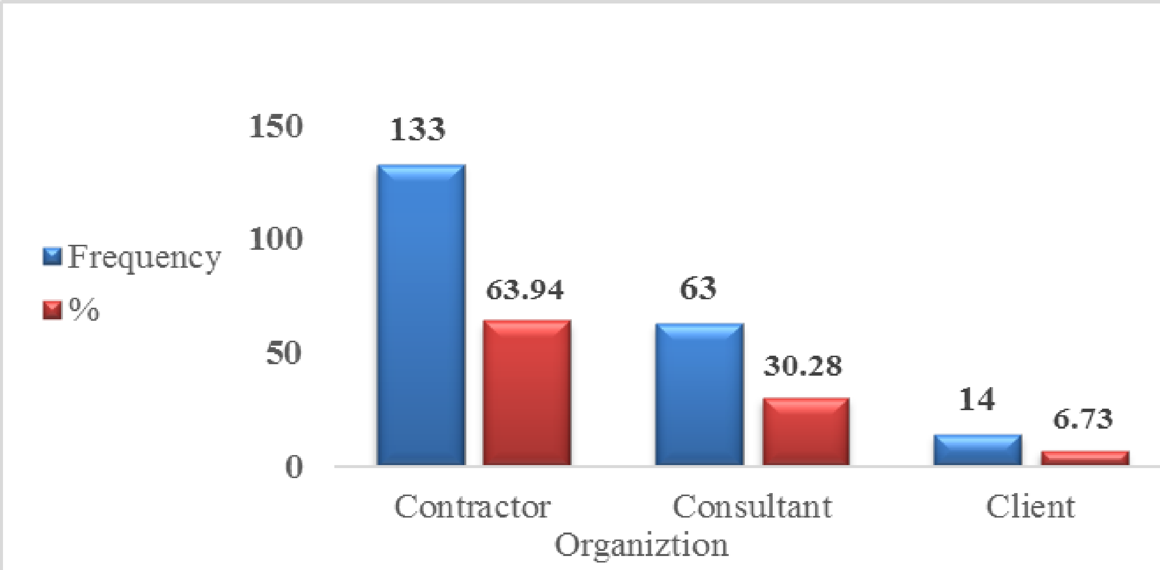

Figure 2. The type of organization is presented.

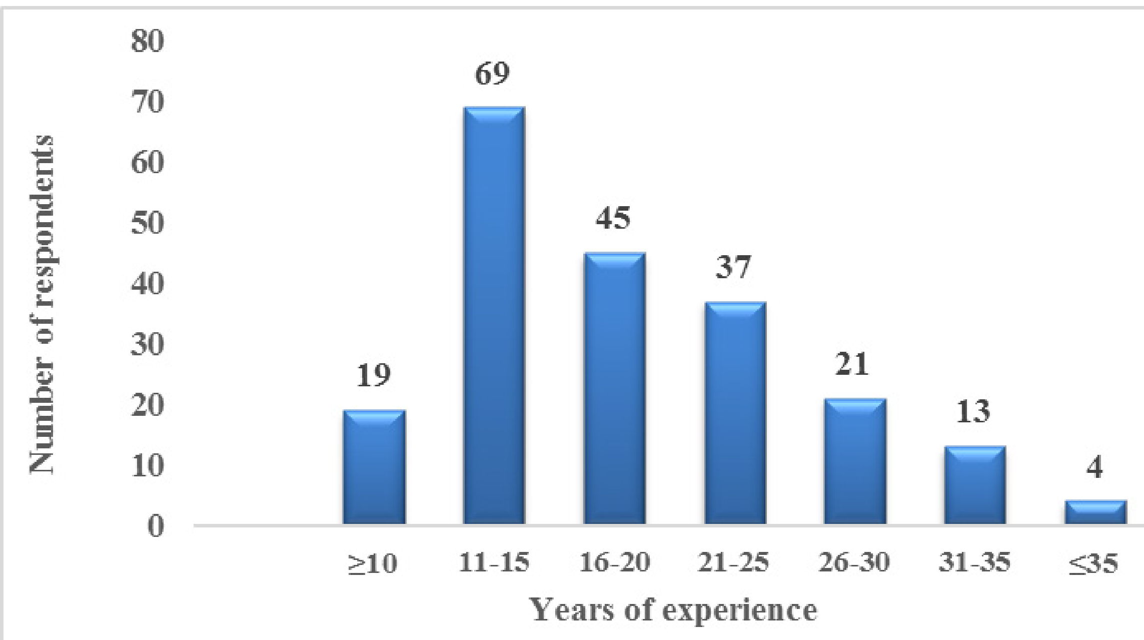

Figure 3. Experience of respondents involved in actual study.

than 15 years' practice in construction industry projects and only 4 of respondents are involved in construction industry have more than 35 years.

4.4 Qualification

For expert's academic background, most of them have the qualification of university degree; some even have master and PHD degree as presented in Figure 4.

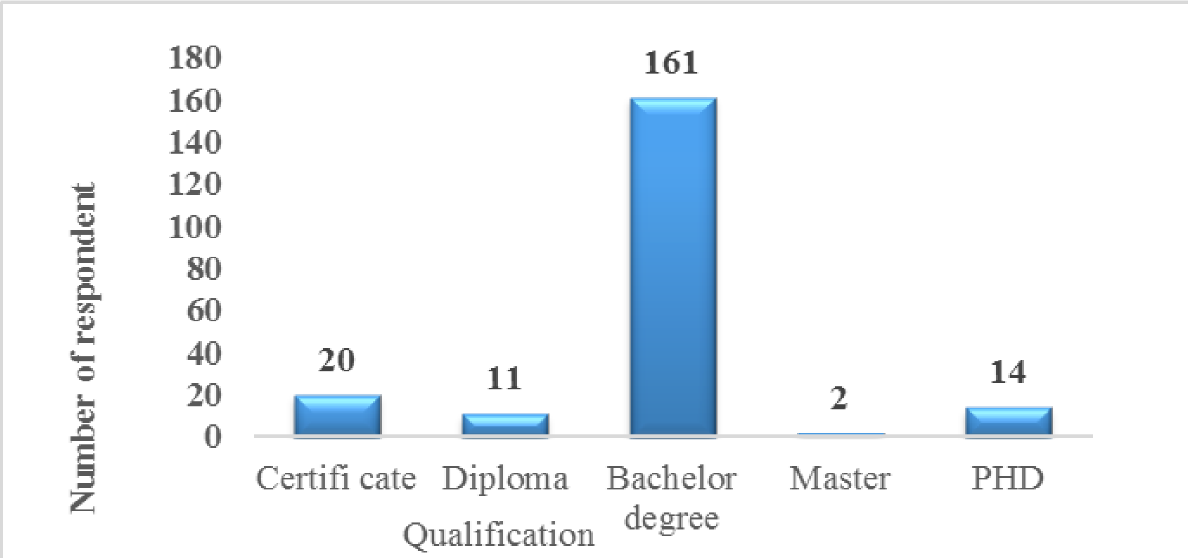

Figure 4. Shows the summary of the respondent's qualification.

Respondents' knowledge was measured based on their academic qualification and working experience in the construction industry. Academic qualification and working experience are an essential point and plays important role in understanding any problems at sites. The respondents' knowledge is considered in this questionnaire as to ensure that they have the ability to understand and answer the questionnaire swiftly.

5. Ranking of Causative Factors

The overall data gathered from 208 respondents for significance level of 61 factors causing Construction

Table 5. Results of reliability test

No.	Groups	Gronbach alpha	No. of items
1	Design (DESG)	0.980	11
2	Handling (HAND)	0.993	7
3	Workers (WORK)	0.993	10
4	Management (MANA)	0.894	15
5	Site Condition (SITE)	0.919	4
6	Procurement (PROC)	0.991	8
7	External (EXTE)	0.972	6
8	Overall	0.985	61

Waste were analyzed statistically using frequency analysis and average index obtained through SPSS V 24 software package. Reliability analysis was used to check the consistency of the collected data. The indicator used for checking the consistency is Cronbach's alpha value. The Cronbach's alpha value consistency degree is varying from 0 and 1 and on the basis that the higher values represent a higher degree of internal consistency of the data[53]. As per[54], the reliability is considered low if Cronbach alpha value is less than 0.3 and the data cannot be accepted, whereas, consistency of data will be high if the Cronbach alpha value is more than 0.7 and such will be acceptable. A total of 208 valid collected data from the actual survey were analyzed for its consistency using SPSS software to get the Cronbach's alpha values for each group of factor and the overall factors. All the generated value of Cronbach alpha is reorganized as in Table 5.

Table 5, shows the value of Cronbach alpha for each group of the factors. The values of Cronbach alpha are in the range of 0.894 to 0.993 for all groups while alpha value is 0.974 for overall data which is ≥ 0.70 as a cut-off

Table 6a. Rank of the design group factors

Code	Item names	Severity 5-points Likert Scale					AI	STD	SI Rank
		1	2	3	4	5			
GS1-1	Design errors	0	36	68	57	47	3.55	1.02	R1
GS1-2	Lack of design information	0	39	68	64	37	3.48	1.00	R2
GS1-3	Frequent design changes	0	36	80	50	42	3.47	1.00	R3
GS1-4	Inexperience designer	0	39	74	54	41	3.47	1.01	R4
GS1-5	Poor design quality	0	47	67	49	45	3.44	1.07	R5
GS1-6	Incomplete contract document	0	37	84	49	38	3.42	0.98	R6
GS1-7	Complicated design	0	37	87	45	39	3.41	1.00	R7
GS1-8	Slow drawing distribution	0	39	89	40	40	3.39	1.00	R8
GS1-9	Last minute client requirements	0	36	90	47	35	3.39	0.96	R9
GS1-10	Error in contract documentation	0	37	92	43	36	3.38	0.97	R10
GS1-11	Interaction between various specialists	0	41	96	41	30	3.29	0.94	R11

*Note: NS-Not Strong, LS- Less Strong, N- Neutral, S- Strong, VS-Very Strong.

value[38]. Thus, the collected data is considered reliable to carry out further analysis.

The factors ranked based on average index value. The results of frequency for level of significance, average index and rank of severity for each causative factor of design categories are shown in Table 6a.

Table 6a, shows there are 11 factors in design group arranged based on the average index score of severity of each factor contribute to Construction Waste generation. Result from this table indicates that three severest factors are design errors, lack of design information and frequent design changes. This finding concur with the study conducted by[45] where the most sever factors are design errors, lack of design information and frequent design changes.

Table 6b. Rank of the of management group factors

Code	Item names	Severity 5-points Likert Scale					AI	STD	SI Rank
		1	2	3	4	5			
GS2-5	A poor site management	0	20	40	64	84	4.02	0.97	R1
GS2-2	Rework	0	20	61	60	67	3.84	0.99	R2
GS2-1	Poor supervision	0	20	67	61	60	3.77	1.03	R3
GS2-9	Poor planning	1	28	68	45	66	3.71	0.94	R4
GS2-3	Lack of environmental awareness	0	31	71	51	55	3.63	0.99	R5
GS2-6	Long project duration	0	26	98	47	37	3.46	0.93	R6
GS2-8	Waiting periods	0	31	86	62	29	3.43	0.92	R7
GS2-7	Lack of knowledge about construction	0	31	105	40	32	3.35	0.91	R8
GS2-11	Poor information quality	5	33	91	45	34	3.34	1.07	R9
GS2-12	Non availability of equipment	4	38	88	40	38	3.34	0.97	R10
GS2-4	Poor controlling	0	37	98	41	32	3.33	1.01	R11
GS2-10	Inappropriate construction methods	2	38	89	49	30	3.32	1.04	R12
GS2-14	Resources problem	1	43	93	42	29	3.26	0.98	R13
GS2-13	Lack of waste management plans	4	39	96	38	31	3.25	0.96	R14
GS2-15	Lack of influence of contractors	3	36	109	31	29	3.23	0.94	R15

Management group involves the largest numbers of factors (15 factors), that contribute to C and D waste generation and the result of ranking is as shown in table 6b.

From Table 6b, it is found that the most significant factor is "Poor site management", thence "Rework". This finding is concurrent with the findings from other countries such as in Ghana, a similar study conducted

Table 6c. Rank of the of handling group factors

Code	Item names	Severity 5-points Likert Scale					AI	STD	SI Rank
		1	2	3	4	5			
Si3-5	Wrong material storage	3	41	84	41	39	3.35	0.96	R1
Si3-6	Poor material handling	6	35	82	53	32	3.34	0.95	R2
Si3-3	Poor quality of materials	1	45	92	34	36	3.28	1.01	R3
Si3-1	Damage during transportation	5	33	105	37	28	3.24	1.02	R4
Si3-7	Tools not suitable used	11	31	98	37	31	3.22	1.04	R5
Si3-4	Delay during delivery	4	47	89	37	31	3.21	1.02	R6
Si3-2	Equipment failure	4	41	94	46	23	3.21	1.04	R7

Table 6d. Rank of the site condition group factors

Code	Item names	Severity 5-points Likert Scale					AI	STD	SI Rank
		1	2	3	4	5			
Si4-3	Waste resulting from packaging	23	112	41	31	78	4.83	0.90	R1
Si4-2	Leftover materials on site	29	86	51	42	167	4.71	0.97	R2
Si4-1	Lack of experience	17	101	48	42	173	4.27	0.45	R3
Si4-4	Poor site condition	46	74	46	32	113	4.29	1.10	R4

by[49] found that majority of respondents participating in survey agreed that poor site management is the major factor of Construction Waste generation. In a study related to Construction Waste generation in India highlighted that poor site management factor is major reason of waste generated[55]. Result of the handling group factors are shown in Table 6c.

Based on the ranking results, 2 factors have importance level for C and D waste generation. These factors are "Wrong material storage and Poor material handling". This finding is concurrent with the findings from other study by[28], found that majority of participating agreed that wrong material storage is the main factor of Construction Waste generation. The result of site condition for each factor is as presented in table 6d.

From Table 6d, it was found that "waste resulting from packaging" is the main contribute factor[56]. In another study[57] pointed out the waste resulting from packaging significant factor that contribute C and D waste generation.

Table 6e shows the highest severity score in this phase is "mistakes on quantity surveys", subsequently "Ordering errors" this result similar study conducted by[28], found that majority of the respondents participating that agreed that mistakes on quantity surveys is the major factor of C and D waste generation. According to[34], in their study related

Table 6e. Rank of the procurement group factors

Code	Item names	Severity 5-points Likert Scale					AI	STD	SI Rank
		1	2	3	4	5			
Si5-2	Mistakes on quantity surveys	2	47	34	76	49	3.59	1.11	R1
Si5-1	Ordering errors	6	53	28	90	31	3.42	1.11	R2
Si5-3	Frequent variation orders	3	60	48	56	41	3.35	1.16	R3
Si5-4	Items not in compliance with specification	4	62	57	41	44	3.28	1.21	R4
Si5-5	Different methods used for estimation	3	78	48	41	38	3.16	1.09	R5
Si5-6	Wrong material delivery procedures	1	77	56	42	32	3.13	1.16	R6
Si5-7	Error in shipping	6	68	59	45	30	3.12	1.14	R7
Si5-8	Supplier errors	8	87	43	32	38	3.02	1.11	R8

Table 6f. Rank of the workers group factors

Code	Item names	Severity 5-points Likert Scale					AI	STD	SI Rank
		1	2	3	4	5			
Si6-2	Lack of awareness among the workers	1	93	31	51	32	4.59	1.02	R1
Si6-3	Too much overtime for workers	1	82	31	66	28	4.50	1.15	R2
Si6-6	Incompetent worker	1	71	45	51	40	4.49	1.11	R3
Si6-4	Shortage of skilled workers	11	65	10	79	43	4.44	1.26	R4
Si6-8	Damage caused by workers	9	72	33	53	41	4.28	1.18	R5
Si6-7	Poor workmanship	5	77	38	43	45	4.26	1.14	R6
Si6-1	Lack of experience of workers	0	58	67	53	30	4.24	1.22	R7
Si6-5	Workers' mistakes during construction	1	75	18	73	41	4.16	1.24	R8
Si6-9	Inventory of materials not well document	2	87	36	42	41	4.09	1.20	R9
Si6-10	Insufficient training for workers	4	94	31	47	32	4.00	1.17	R10

Table 6g. Rank of the external group factors

Code	Item names	Severity 5-points Likert Scale					AI	STD	SI Rank
		1	2	3	4	5			
Si7-3	Lack of legislative enforcement	0	58	60	53	37	3.33	1.01	R1
Si7-1	Effect of weather	6	57	50	54	41	3.32	1.19	R2
Si7-2	Pilferage	5	77	44	38	44	3.19	1.33	R3
Si7-4	Wars	18	48	67	44	31	3.11	1.22	R4
Si7-5	Accidents	6	82	31	65	24	3.09	1.42	R5
Si7-6	Vandalism	16	67	46	51	28	3.04	1.33	R6

to C and D waste generation, highlight that mistakes on quantity surveys is the major reasons of C and D waste generation. The results for worker's group are shown in Table 6f.

Table 6f illustrates the highest mean score in the workers group is "lack of awareness among the workers", thence, "Too much overtime for workers", this finding similar to study that conducted by[33]. The result of ranking for external group is shown in Table 6g.

In the external group, most of these factors are difficult control. From Table 6g, it was found that "Lack of legislative enforcement" then "Effect of weather" as the main contributes factors for C and D waste generation[56] and found that majority reason of the huge waste generation was lack of legislative enforcement and effect of weather. In[58] claimed that lack of legislative enforcement, as one of the causative factors to C and D waste generation.

6. Conclusions

From this investigation, a superior comprehension of the sources and reasons for CWs and the existing waste control practices on construction sites in Iraq was accomplished. The quantity of CW and the generation of waste material at construction projects rely upon different factors. "A poor site management", "Rework", "Poor supervision", "Poor planning" and "Lack of environmental awareness" are the major factors for contributing waste generation as witnessed through the value of degree of importance severity waste index. However, "lack of regulations, enforcement and guidelines" observed in some Iraq construction industry are also aspects that contributed to the generation of CW and could be considered as influencing factors. It is concluded on the basis of results achieved in this research would provide attentiveness to all Iraq construction industries to adopt and follow sustainable CW standards in line with standards originated by numerous international agencies. However; in continuation to this research work, further investigations will be conducted for documentation of the better practices for controlling and minimizing the CW waste and along with minimizing the barriers for that on construction sites in Iraq.

7. References

1. Chakkrit L, Singh I, Vachara P, Wandee S. Factors influencing Construction Waste generation in building construction: Thailand's Perspective. Sustainability. 2019; 11(13): 3638. https://doi.org/10.3390/su11133638.
2. Guerra B, Bakchan A, Leite F, Faust K. BIM-based automated Construction Waste estimation algorithms: The case of concrete and drywall waste streams. Waste Management. 2019; 87:825–32. PMid: 31109587. https://doi.org/10.1016/j.wasman.2019.03.010.
3. Osmani ., Villoria-Saez P. Chapter 19 - Current and emerging Construction Waste management status, Trends and Approaches, Waste . 2nd Ed. 2019. p. 365–80. https://doi.org/10.1016/B978-0-12-815060-3.00019-0.
4. Durdyev S, Maksat O, Ismail S. Causes of delay in residential construction projects in Cambodia. Cogent Engineering. 2017. https://doi.org/10.1080/23311916.2017.1291117.
5. Mahpour A. Prioritizing barriers to adopt circular economy in construction and demolition waste management. Resources, Conservation and Recycling. 2018; 134:216–27. https://doi.org/10.1016/j.resconrec.2018.01.026.
6. Khaleel T, Al-Zubaid A, Major factors contributing to the construction waste generation in building projects of Iraq. MATEC Web of Conferences; 2018. 162:02034. https://doi.org/10.1051/matecconf/201816202034.
7. Wanga J, Wu H, Tam VWY, Zuo J. Considering life-cycle environmental impacts and society's willingness for optimizing construction and demolition waste management fee: An empirical study of China. Journal of Cleaner Production. 2019; 206(1):1004–14. https://doi.org/10.1016/j.jclepro.2018.09.170.
8. Asgari A, Ghorbanian T, Yousefi N. Quality and quantity of construction and demolition waste in Tehran. J Environ Health Sci Eng. 2017; 15(14):1–8. PMid: 28649387 PMCid: PMC5479027. https://doi.org/10.1186/s40201-017-0276-0.
9. Environmental Protection Agency 2018. Advancing Sustainable Materials Management: 2015 Fact Sheet Accessed on Sep. 6th, 2018. https://www.epa.gov/sites/production/files/201611/documents/2014_smmfactsheet_508.pdf.

10. Defra. Key facts about: Waste and recycling. London: Department for the Environment, Food and Rural Affairs. 2007.
11. EPA U. S. Environmental Protection Agency EPA Construction and Demolition (C and D) Debris, Basic Information. 2008. File://G.\ EPA Construction.
12. Al-Hajj A, Hamani K. Material waste in the UAE construction industry: Main causes and minimization practices. Architectural Engineering and Design Management. 2011; 7(4):221–35. https://doi.org/10.1080/17452007.2011.594576.
13. Nurzalikha S, Zulhabri I, Maisarah M, Emma MAZ. Implementation of Malaysian government initiatives in managing Construction Waste. Jurnal Teknologi. 2016; 78(5-2):1–6. https://doi.org/10.11113/jt.v78.8490.
14. Gupta S, Malik RK. The impact of C and D waste on Indian environment: A critical review. Civil Eng Res J. 2018; 5(2):555658. DOI: 10.19080/CERJ.2018.05.555658. https://doi.org/10.19080/CERJ.2018.05.555658.
15. Ministry of Planning - Central Statistics Organization (CSO) The Republic of Statistics Iraq, Ministry of Planning, Central Bureau of Statistics, Department of Environment, Iraq Environmental Statistics. 2016. www.cosit.gov.iq/.
16. Kofoworola OF, Gheewala SH. Estimation of Construction Waste generation and management in Thailand. Waste Management. 2009; 29(2):731–8. PMid: 18774703. https://doi.org/10.1016/j.wasman.2008.07.004.
17. John VM, Angulo SC, Miranda LF, Agopyan V, Vasconcellos F. Strategies for innovation in construction and demolition waste management in Brazil. Proceedings of the CIB World Building Congress, National Research Council of Canada, Toronto; 2004.
18. Tam VWY, Le,KN, Wang JY, Illankoon IMCS. Practitioners recycling attitude and behaviour in the Australian Construction Industry. Sustainability. 2018; 10:1212. http://doi.org/10.3390/su10041212.
19. Coelho A, Brito JD. Environmental analysis of a construction and demolition waste recycling plant in Portugal - Part I: Energy consumption and CO2 emissions. Waste Manage. 2013; 33(5):1258–67. PMid: 23422042. https://doi.org/10.1016/j.wasman.2013.01.025.
20. Husnain A, Muhammad Q, Muhammad J Th, Hamza FG. Quantification of material wastage in construction industry of Pakistan: An analytical relationship between building types and waste generation. Journal of Construction in Developing Countries. 2017; 22(2):19–34. https://doi.org/10.21315/jcdc2017.22.2.2.
21. Kozlovska M, Spisakova M. Construction Waste s generation across construction project life-cycle. Organization, Technology and Management in Construction an International Journal. 2013; 5(1):687–95. https://doi.org/10.5592/otmcj.2013.1.5.
22. Akter S, Ambra JD, Ray P. Trust worthiness in Health Information Services: An assessment of a hierarchical model with mediating and moderating effects using Partial Least Squares (PLS). J Am Soc Inform Sci Technol. 2011; 62(1):100–16. https://doi.org/10.1002/asi.21442.
23. Low SP, Ong J. Project quality management critical success factors for buildings. Singapore. 2014. p. 193–249. doi: 10.1007/978-3-8350-9333-1_7. https://doi.org/10.1007/978-3-8350-9333-1_7.
24. Ruoyu J, Hongping Y. Science mapping approach to assisting the review of construction and demolition waste management research published between 2009 and 2018. Resources, Conservation and Recycling. 2019; 140:175–88. https://doi.org/10.1016/j.resconrec.2018.09.029.
25. Sa'adi N, Ismail Z, Makmor M, Zawawi EMA. Implementation of Malaysian government initiatives in managing Construction Waste. Jurnal Teknologi. 2016; 78(5-2):55–60. https://doi.org/10.11113/jt.v78.8490.
26. Ajayia OS, Lukumon OO. Waste-efficient materials procurement for construction projects: A structural equation modelling of critical success factors. Waste Management. 2018; 75:60–9. PMid: 29426721. https://doi.org/10.1016/j.wasman.2018.01.025.
27. Lingard H, Graham P, Smithers G. Employee perceptions of the solid waste management system operating in a large Australian contracting organization: Implications for company policy implementation. Construction Management and Economics. 2010; 18(4):383–93. https://doi.org/10.1080/01446190050024806.
28. Polat G, Ballard G. Waste in Turkish Construction: Need for lean construction techniques. Proceedings of the 12th Annual Conference of the International Group for Lean Construction; 2004. p. 1–14.
29. Teo MMM, Loosemore MA. Theory of waste behavior in the construction industry. Constr Manag Econ. 2001; 19:741–51. https://doi.org/10.1080/01446190110067037.
30. Urio A, Brent A. Solid waste management strategy in Botswana: The reduction of Construction Waste. Journal of the South African Institution of Civil Engineering. 2006; 48(2):18–22.
31. Ismail AR, Sasitharan N. Book. Causative factors of Construction Waste generation in Malaysia. UTHM, Malaysia. 2015.
32. Shant AD, Daphene CK. Waste management models and their applications on construction sites. International

Journal of Construction Engineering and Management. 2014; 3(3):91–8. DOI: 10.5923/j.ijcem.20140303.02.
33. Gupta S, Malik RK. The impact of C & D waste on Indian Environment: A critical review. Civil Eng Res J. 2018; 5(2):555658. DOI: 10.19080/CERJ.2018.05.555658. https://doi.org/10.19080/CERJ.2018.05.555658.
34. Ekanayake LL. Ofori G. Construction material waste source evaluation. Proceedings of the Strategies for a Sustainable Built Environment; Pretoria. 2000. p. 23–5.
35. Mostafa AS, Mohsin AA, Ali LN. Management of solid waste in Baghdad, Iraq. World Academy of Science, Engineering and Technology. International Journal of Environmental and Ecological Engineering. 2017; 11(7):700–4.
36. Adnan NF. A study of Construction Waste generation at site project in Batu Pahat, Johor. Universiti Tun Hussein Onn Malaysia: [Thesis Master]. 2012.
37. Bossink BAG, Brouwers HKH. Construction Waste: quantification and source evaluation. Journal of Construction Engineering and Management. ASCE. 1996; 122(1):55–60. https://doi.org/10.1061/(ASCE)0733-9364(1996)122:1(55).
38. Alwi SK, Hampson KD, Mohamed S. Waste in the Indonesian construction projects. Proceedings of 1st International Conference of CIB W107 - Creating a sustainable Construction Industry in Developing Countries; South Africa. 2002. p. 305–15.
39. Nazech E, Zaldi D, Trigunarsyah B. Identification of Construction Waste in road and highway construction projects. Proceedings of the Eleventh East Asia-Pacific Conference on Structural Engineering and Construction; Taipei. 2008. p. 19–21.
40. Guerrero LA, Maas GJ, Lambert AJD, Troyo F. Construction Waste in Costa Rica. Proceedings of the ISWA World Solid Waste Congress; Florence. Italy. 2012.
41. Nagapan S, Ismail AR, Ade A, Aftab HM, Rosli MZ. Identifying causes of Construction Waste - Case of Central Region of Peninsula Malaysia. International Journal of Integrated Engineering. 2012; 4(2):22–8.
42. Akter S, Ambra JD, Ray P. Trustworthiness in health information services: An assessment of a hierarchical model with mediating and moderating effects using Partial Least Squares (PLS). J Am Soc Inform Sci Technol. 2011; 62(1):100–16. https://doi.org/10.1002/asi.21442.
43. Polat G, Damci A, Turkoglu H, Gurgun AP. Identification of root causes of Construction and Demolition (C and D) waste: The case of Turkey. Conference 2017 Procedia Engineering. 2017; 196:948–55. https://doi.org/10.1016/j.proeng.2017.08.035.
44. Ilhaq M. An investigation with the concepts of construction site waste minimization. University of East London. [Master Thesis]. 2010.
45. Osmani M, Glass J, Price AD. Architects 'perspectives on Construction Waste reduction by design. Waste Management. 2008; 28(7):1147–58. PMid: 17624757. https://doi.org/10.1016/j.wasman.2007.05.011.
46. Olugbenga OA, Lukumon OO, Saheed OA, Muhammad B, Hafiz AA, Hakeem AO, Omolola OA. Designing out Construction Waste using BIM technology: Stakeholders' expectations for industry deployment. Journal of Cleaner Production. 2018; 180(10):375–85. https://doi.org/10.1016/j.jclepro.2018.01.022.
47. Akinade OO, Oyedele LO, Ajayi SO, Bilal M, Alaka HA, Owolabi HA, Arawomo OO. Designing out Construction Waste using BIM technology: Stakeholders' expectations for industry deployment. J Clean Prod. 2018; 180:375–85. https://doi.org/10.1016/j.jclepro.2018.01.022.
48. Alajeeli HKB, Al-Kaabi SAM. A study of waste management reality in Construction Waste projects in Iraq. Journal of Engineering Science. 2016; 4(1):75–92.
49. Chen X, Lu W. Identifying factors influencing demolition waste generation in Hong Kong. J Clean Prod. 2017; 141:799–811. https://doi.org/10.1016/j.jclepro.2016.09.164.
50. Obaid MK, Abdulrahman I, Idan IJ, Nagapan S. Construction Waste and its distribution in Iraq: An ample review. Indian Journal of Science and Technology. 2019; 12(17):1–10. doi: 10.17485/ijst/2019/v12i17/144627. https://doi.org/10.17485/ijst/2019/v12i17/144627.
51. Sohu SK, Jhatial AA, Jaffar M, Lakhiar MT. Factors adversely affecting quality in highway projects of Pakistan. International Journal of Advanced and Applied Sciences. 2018; 5(10):62–6. https://doi.org/10.21833/ijaas.2018.10.009.
52. Abu El-Maaty AE, El-Hamrawy S, Akal AY. Success factors of highway construction projects in Egypt: AHP Approach. Journal of Construction Engineering and Project Management. 2016. http://dx.doi.org/10.6106/JCEPM.2016.12.4.007.
53. Taber KS. The use of Cronbach's alpha when developing and reporting research. Instruments in Science Education, Research in Science Education. 2018; 48(6):1273–96. https://doi.org/10.1007/s11165-016-9602-2.
54. Ursachi G, Horodnic IA, Zait A. How reliable are measurement scales External factors with indirect influence on reliability estimators. Procedia Economics and Finance. 2015; 20:679–86. https://doi.org/10.1016/S2212-5671(15)00123-9.

55. Neelanjali VR, Vyas GS. Optimization of labour productivity in elevated corridor metro site construction. 2018. https://ssrn.com/abstract=3375910.

56. Wang JY, Kang XP, Tam VWY. An investigation of Construction Waste s: An empirical study in Shenzhen. Journal of Engineering, Design and Technology. 2008; 6(3):227–36. https://doi.org/10.1108/17260530810918252.

57. Lu W, Webster C, Peng Y, Chen X, Zhang X. Estimating and calibrating the amount of building-related construction and demolition waste in urban China. International Journal of Construction Management. 2017; 17(1):13–24. https://doi.org/10.1080/15623599.2016.1166548.

58. Esin T, Cosgun N. A study conducted to reduce Construction Waste generation in Turkey. Building and Environment. 2007; 42:1667–74. https://doi.org/10.1016/j.buildenv.2006.02.008.