EVALUATION ON BUILDING CONSTRUCTION WASTE MANAGEMENT PRACTICE IN KURDISTAN REGION OF IRAQ

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ABSTRACT

In the construction industry, material waste contributes to a major problem, and it is vital to manage material waste. The main objective of this research was to determine the significant factors contributing to construction wastes in the Kurdistan region of Iraq, particularly in the city of Sulaymaniyah. The construction industry provides a foundation for future construction projects; thus, it is significant to avoid and eliminate the causes of material waste in the construction process. The study's objective is to investigate the practice of material waste in the building construction sector to motivate the performance of managing construction projects in Iraq's Kurdistan region. The survey questionnaire was the main technique used for conducting and collecting primary data from relevant governmental bodies and construction companies with a study sample of 50 respondents. The result of the analysis demonstrated that the conventional construction method was the most common method utilized for construction. Also, the result illustrated that the main sources and causes of material waste were weak strategy for waste minimization, lack of staff awareness of waste management practices, and poor materials storage system. The most wasteful materials, including formworks (from timber/wood), tile, sand, and concrete, were also determined. Apart from that, the result found that possible measures that might contribute to minimizing material waste included implementing effective site management and supervision techniques, employing skilled labour, and appropriate on-site material storage.

Keywords: Management, Material, Waste, Construction

1.0 INTRODUCTION

In the majority of developing countries, the construction industry plays a crucial role. It enhances people's quality of life by providing infrastructure, for instance, highways, hospitals, schools, and other essential necessities. Despite the advantages gained from this industry, its activities produce rising amounts of waste, resulting in a negative reputation for the industry and the exhaustion of limited natural resources (Luangcharoenrat et al., 2019). Saidu and Shakantu (2016) posit that the construction industry produces a wide range of waste, the quantity, and type of which varies depending on factors, for example, construction stage, type of construction work, and on-site practices. The Central Organisation Statistics of Iraq (2016) stated that the entire volume of construction and demolition waste was recorded 11,235,478 tons per year.

Consequently, the construction industry is the main source of landfill-bound controlled waste (Osmani, 2012; Udeaja et al., 2013). Insufficient storage and safety, bad stock control, meager or multiple handling, lack of site management, over-ordering of materials, deficiency of training, and destruction of materials throughout delivery are all factors that often lead to waste creation on construction sites (Oladiran, 2018). The construction materials waste quantity in the majority of Iraqi projects has surpassed the allowable limit (Iraqi Ministry of Construction and Housing, 2018).

Among the many studies that have been published around the world, only a limited number of research addressed the management of construction material waste in Iraq. The literature has yet to reveal any regarding the contributing causes to the generation of building construction material waste in the Kurdistan region or ways to improve waste management in the specified location, for that matter. Furthermore, most of the literature concentrates on managing on-site materials and does not address stages before procurement to mitigate future wastage. Therefore, to fill this gap, the present study attempts to examine the sources of construction material waste that increases in the lifecycle of a project as well as identify significant methods to manage and minimize material waste in building construction projects in the region of Kurdistan. The objectives of the paper are as follows:

1. To determine the significant contributing factors to the production of material waste;
2. To classify the most wasteful materials generated in construction sites; and
3. To formulate a possible strategy to minimize and manage material waste.

This paper follows the dissertation that the author has presented for academic purposes in Master of Science in the Building Services Engineering, Kulliyyah of Architecture and Environmental Design, IIUM, Malaysia (Agha, 2021).

2.0 LITERATURE REVIEW

In the life cycle of construction, waste can arise at any stage. Inappropriate materials ordering for a project in terms of type, quality, and quantities to consequence in material waste is a concern among contractors and some consultants. This situation can ascend from incorrect information flow, the deliberate selection of low-quality materials to diminish costs, or incorrect/insufficient project advisor requirements (Agyekum et al., 2012; Oladiran, 2018). Therefore, waste management must first contemplate the various waste sources and the form of waste they produce and then take opposite steps to mitigate them from the root.

2.1 Causes of Material Waste

In most cases, sources and factors of material waste depend on the type of construction methods utilized, particular materials being used, and the construction stage itself. Nwachukwu et al. (2016) pigeonholed waste by its source, the phase at which the root causes of waste befall. They supplementarily clarified that waste emanates not only from the usage and application of materials in the construction work site but also from the previous construction process, such as the manufacturing of materials, the supply of materials, design, and planning. Table 1 illustrates the contributory factors of waste generation in Iraqi construction projects according to Alajeeli and Kaabi (2016).

Table 1 The degree of impact of the causative factors on waste production in Iraq

No.	Causative Factors	Effect Degree
1	Lack of supervision and management	Very High
2	Design errors	High
3	Design revisions	High
4	Mistakes in execution	High
5	Technical workers experience is lack	High
6	An incorrect planning	High
7	Lack of quality control	High

8	Inefficiency of subcontractor	High
9	Lack of materials storage	High
10	The project's work site is insufficiently large	Medium

Source: Alajeeli & Kaabi (2016, Pg. 89)

Low priority for waste minimisation and management programs in Iraq result in the annual production of large volumes of construction material waste. Project cost overrun and illegal landfill disposal are two significant problems impacting the sector, all related to construction waste (Khaleel & Al-Zubaidy, 2018). Table 2 shows participants' responses to the causes of wastage together with the ranking of factors that cause materials wastage in Iraqi construction projects. On-site planning and management ranked first because most construction companies, except large contracting companies, which have few numbers in the country, do not have a plan for managing the materials. These approaches are represented in managing material purchasing, material stocking, material supply, handling, and transporting materials.

Table 2 Factor groups and ranking of materials waste in Iraq

Factor Group	Ranking
On-site planning and management	1
Operation of site	2
Storage	3
Design and document	4
Procurement	5
External factors	6
Handling of materials	7

Source: Mahdi (2019, Result and Discussion, para. 1)

2.2 Types of Material Waste

Bekr (2014) alienates waste into two types, firstly, direct waste, which is the loss of materials resulting from destruction during site application or handling or lost through the building process, and secondly, indirect waste that is not an outcome of direct waste (i.e., materials' physical loss) but has financial implications nevertheless. Skoyles and Skoyles (1987) and Park et al. (2020) defined direct waste as the waste that can be avoided and includes actual material loss or removal as well as replacement. The cost of direct waste is generally not included in the material cost but is followed by the disposing and removing cost (Seneviratne et al., 2015). Construction waste is described as waste ascending from construction, renovation, and destruction activities, including excavation or creation of land, civil and building construction, clearing of sites, roadwork, and renovation of buildings. Nevertheless, some are directly classified as solid waste or sluggish waste consisting mainly of tiles, bricks, sand, blocks, steel, glass, bamboo, concrete debris, wood, paper, plastics, vegetation, and other organic materials. Since those materials are irreparably damaged or simply vanished, this form of waste comprises a total loss of materials. Generally, the waste is moved from the site to landfills (Akhund et al., 2019).

2.3 Construction Waste Management and Minimization

Waste management is a comprehensive term that traditionally refers to collecting waste materials produced by human activities and transporting them to the location for disposal or being used (Aleksanin, 2019). Rabea (2016) states that construction waste management (CWM) is characterized as eliminating waste materials when there are no alternatives, recycling waste materials when

possible, and reusing materials that would otherwise become waste if not reused. The primary objective of waste management in construction is to implement solutions as far as possible in order to achieve substantial management of materials, waste, and resources that may include time and labour. The significance of CWM implementation is that waste materials are disposed of in landfills in the majority of countries according to laws and regulations and in areas where it is illegal to dispose of building and demolition waste (Agency, 2012; Fikri Hasmori et al., 2020).

2.4 The Three "Rs" of Waste Minimisation in Construction

The three "Rs" for minimizing materials waste in building construction are founded on three principles: reduction, reuse, and recycling (Hadi, 2015). Reduction of waste or sources means stopping waste production in the initial place. It is one of the fundamental philosophies of a sustainable building (Hocking, 2006; Fikri Hasmori et al., 2020). The most widely correlated components within the integrated management of solid waste are avoidance of waste, reduction of waste, reuse of materials, recovery of material from waste streams, materials recycling, burning with the recovery of energy, burning without recovery of energy, and landfill disposal (Ng et al., 2018). As illustrated in Figure 1, current methods of evaluating waste management expand "Reduce, reuse, recycle" into the waste hierarchy. The waste hierarchy emphasizes that preventing materials from entering the waste stream in the first place "reduce" is the most preferred method to manage waste.

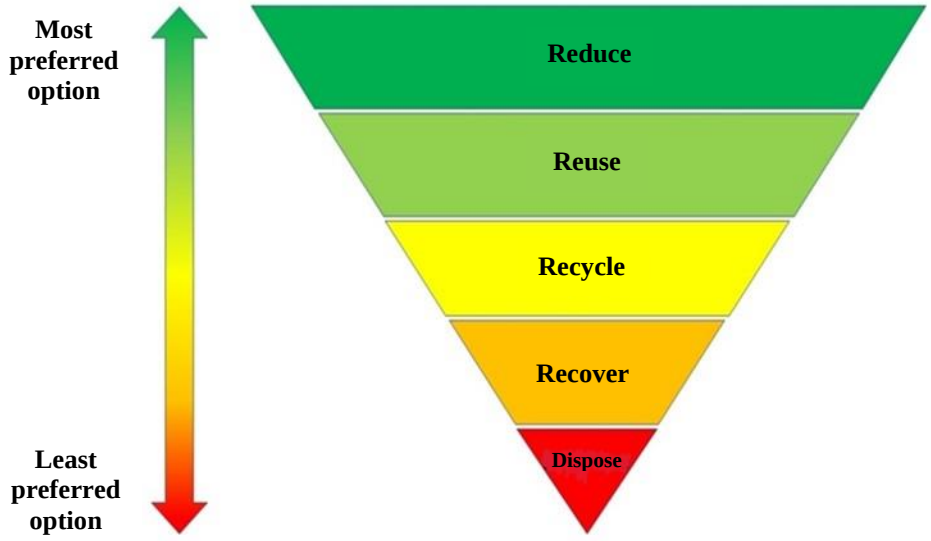

Fig. 1: Waste hierarchy
Source: (European Environment Agency, 2020, https://www.fmlink.com/articles/missing-link-sustainable-reuse-recycling-building-products/)

3.0 METHODOLOGY

The data for this study was gathered using a structured questionnaire. The survey questionnaire was implemented to obtain feedback on the respondents' views about material wastage on construction sites. The quantitative method was pursued since this study's wide sample was chosen. Thus, this study relies on a quantitate analysis to understand and clarify the topic. The questionnaire is divided into four sections. The first section is concerned with the demographic data of the respondents. Engineers, quantity surveyors, project managers, and contractors are all requested to respond to the

questions relating to their specialized field and experiences in building construction projects. Section two includes a list of the sources and factors that contribute to construction material waste, and section three contains a list of the identified types of building materials wasted during construction. The last section comprises a list of measures to minimize and manage material waste during construction. The variables were measured on a five-point Likert scale.

This method was deemed suitable as the Likert scale is the most common method for collecting data. Further, it is straightforward, easily understandable, and an effective measure after receiving feedback. Furthermore, the five-point rate has the advantage of allowing the respondents to answer the questions with persistency, improving the data quality (Scales, 2020). For data collection in this study, the target population for the survey is those consultancy companies (quantity surveying and architectural) as well as building construction companies in the Sulaymaniyah city in the Kurdistan region of Iraq. The targeted sample size was set at a minimum 50 respondents. However, due to the current global pandemic which is Covid-19 affecting this study at the time of writing and fieldwork, an online questionnaire was utilized in order to adhere to the standard operating procedure (SOP) in keeping physical distance.

3.1 Data Analysis

In this study, completeness, accuracy, and readability of the completed questionnaires were reviewed. After the data had been checked, it was organised in a way that allowed for easy analysis. The Statistical Package for Social Science (SPSS 23.0) software was used to code quantifiable data from the questionnaires for analysis. This was further supported by Microsoft Excel to analyse the data in a swift, methodical, reliable, precise and advanced method. Behavioural and social science-based researchers often use the SPSS (Beddo & Kreuter, 2004). Investigation in quantitative research begins with a descriptive analysis. Therefore, the goal of the descriptive analysis in the current study is to identify the demographic profile of the respondents through the statistical analysis method which is the mean score. Besides, the mean is used to calculate central tendency. A high mean relevance rating donates the significance of the factor under consideration.

3.2 Reliability Analysis

A significant criterion in evaluating a measuring instrument's quality and adequacy is its reliability. If the measurements of an instrument correctly represent the "true" measure of the attribute under examination, it can be said as reliable. The reliability coefficient theoretically has a value of -1.00 to +1.00. Reliability coefficients greater than 0.70 are considered satisfactory for most purposes (Polit & Hungler, 1999; Wadhwa, 2019). Table 3 shows that the Cronbach's value for all the scales is more than 0.7, indicating that the scales are accurate and reliable for further analysis. More specifically, the types of materials that are wasted in construction activity has the highest α value of α=.934. In contrast, measures to material waste minimisation scored the lowest α value with α=.918.

Table 3 Reliability analysis

Variables	Cronbach's α	*N* of items
Sources and reasons of construction material waste	.928	12
Types of materials that are wasted in construction activity	.934	10
Measures to material waste minimisation	.918	10

4.0 RESULT AND DISCUSSION

4.1 Respondents' Demographic Background

In terms of the respondents' position, Figure 2 indicates that the majority of them work as an engineer and a quantity surveyor with 64% and 18%, respectively. This is crucial for the result of this research since the problems are investigated in the context of actual practice. A total of 12% of the respondents are project manager, and 6% work as a contractor which is the minority in this study.

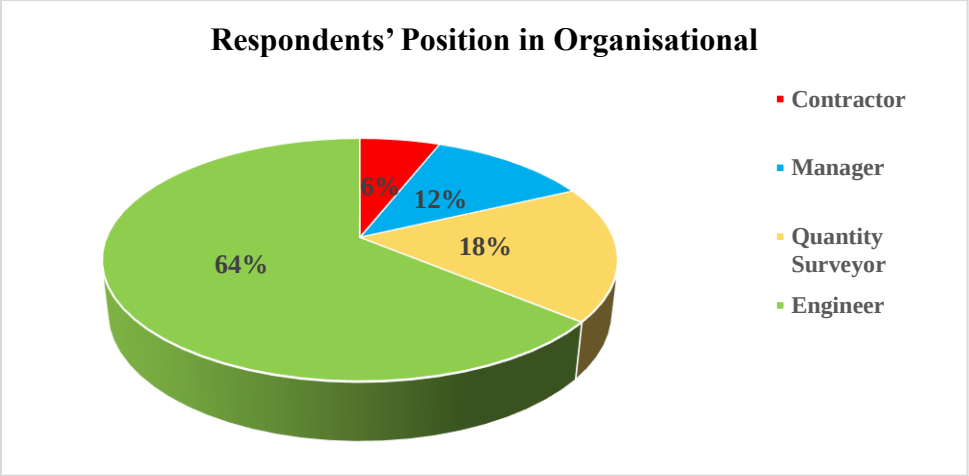

Fig. 2: Respondents' organisational position

In terms of the respondents' specialties relating to construction projects, Figure 3 illustrates the types of construction projects carried out by the various respondents. Residential building is the highest ranked type of construction project carried out by the respondents which account for 58% of all projects. The result further shows that 18% of the respondents work for institutional construction projects, followed by 14% in commercial building, and just a small percentage of respondents (i.e., 10%) are involved in industrial construction projects.

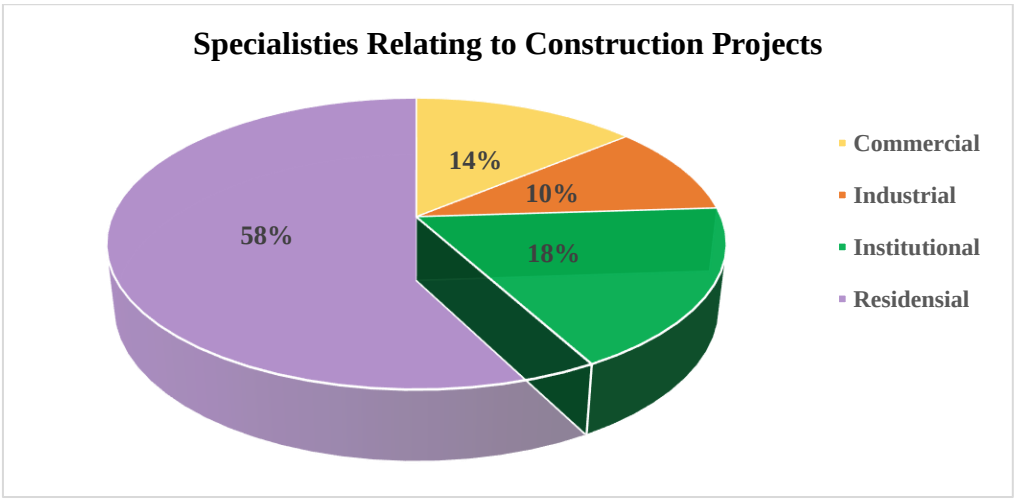

Fig. 3: Specialties relating to construction projects

Figure 4 demonstrates the respondents' working experience (in years) in construction projects. The chart shows that respondents with 11-15 years of experience in working in construction form the highest percentage and consist of 36%, followed by 32% of respondents who own more than 15 years of working experience in the construction field. A significant number of respondents have extensive experience with building construction and materials, which contribute to the expectation that they will be reliable sources of information. On the other hand, respondents who have worked in construction for 6-10 years constitute 20%. Moreover, only a minority of respondents (i.e., 12%) have working experience for 0-5 years. This means that most respondents were eligible to respond to the survey based on their prior experience.

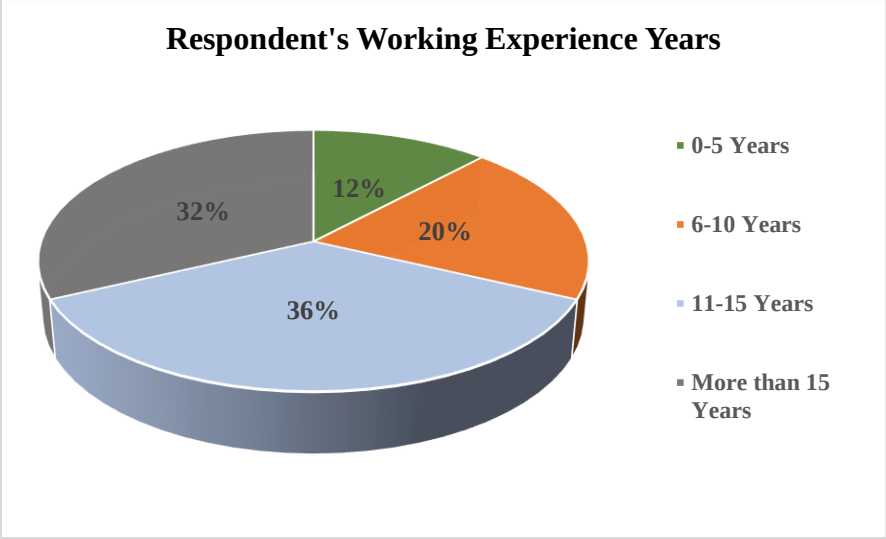

Fig. 4: Respondents' working experience (in years)

4.2 Determining Factors of Material Waste

This section provides the mean value and ranking of the data which was tabulated in Table 4 that was obtained from the respondents' input on the sources and factors of construction material waste.

Table 4 Sources and factors of construction material waste

Factor	Mean	Ranking
Weak strategy for waste minimisation	4.26	1
Lack of staff's awareness on waste management practices	4.20	2
Poor materials storage system	4.06	3
Unskilled labour is used	3.98	4
Lack of procurement management (incorrect purchasing order – quantity, quality, order time)	3.70	5
Design (frequent design changes and poor design)	3.06	6
Poor site security	3.02	7
Poor packaging, delivery, and transport	2.96	8
Poor materials handling on site	2.86	9
Time pressure	2.80	10
Exposed weather	2.78	11
Poor site materials schedule	2.56	12

Weak strategy for waste minimization ranked first in the hierarchy of 12 factors that contribute to material waste. Apparently, there is an absence of a proper strategy to minimise material waste in Kurdistan construction industry. Although some sort of waste minimisation strategy has been employed by contractors at the source level, a huge quantity of materials waste goes to landfill, which is the worse system for material waste management. This is due to the lack of an existing strategy to reuse and recycle, except for steel recycling factories. One of the main barriers hindering material recycling is cost. To clarify, because of the availability of natural resources (i.e., trampled stone and river gravel), the expense of obtaining natural aggregate is low in Kurdistan. In comparison, recycled aggregate expenses from construction and demolition wastes may not be cost defective due to the energy required costs regarding construction and demolition waste processing and transportation (Maruf, 2017).

The lowest factor ranked as a producer of material waste was poor site materials scheduling. According to the respondents, this factor did not have a significant effect on material waste generation in Kurdistan construction projects. Nevertheless, this problem, should it persist, is mainly due to the lack of resource planning or bad supervision. Therefore, construction sites must be managed by expert and trained site supervisors.

4.3 Classifying Construction Material Waste

In this section, the respondents were asked to evaluate the most wasted material in a construction activity. The mean value and ranking of each type of material waste are presented in Table 5 that include ten types of waste materials. The classification of materials that have a high rate of waste showed that the most common construction material wastes produced were formworks (from timber or wood) and tiles. Besides that, sand and concrete were determined to contribute significantly to construction waste, while steel, paint, and pipe are rare waste materials.

As revealed in the analysis of the data, timber recorded the highest construction of waste generation. This is because timber is not utilised as a permanent support, particularly for the project employing conventional construction method. In the conventional method, which is a common method in Kurdistan construction projects, a large number of timbers is used as a transitory support mainly for concreting work (Samih, 2017).

Table 5 Types of construction waste materials

Material	Mean	Ranking
Formworks (from timber / wood)	4.18	1
Tiles	4.12	2
Sand	4.10	3
Concrete	4.04	4
Sandcrete brickwork and blockwork	3.94	5
Mortar for rendering/plastering	3.56	6
Cement	3.36	7
Steel	2.70	8
Paint	2.64	9
Pipes	2.54	10

Another reason for timber's highest ranking in the waste production hierarchy is the nature of timber which easily decays. According to John and Itodo (2013), the wastage of timber formwork in

foundation work contributes more than 20 percent because of the wet nature of the foundation work level. Moreover, the timber lifespan regarding reuse relies on the quality of the material utilised in the construction project. On the other hand, pipes were the lowest material waste reported in this research. Pipes are damaged when equipment is moved through them. Also, small unusable pieces are created when pipes are cut. These are two of the most common sources of pipe waste. Poor planning in the material distribution while pipes are cut leads to the production of unusable short pipes that do not promote cutting optimization (Saker Al-Moghany, 2006).

4.4 Formulating Strategy for Waste Management

In this section, the respondents determine possible measures that contribute to the minimisation of material wastes during construction works. Ranking of the ten measures are illustrated in Table 6 and below.

Table 6 Possible measures for material wastes minimisation

Waste Minimisation Measure	Mean	Ranking
Implementation of effective site management and supervision techniques	4.54	1
Employing skilled labour	4.50	2
On-site material storage that is appropriate	4.28	3
Use construction equipment that is more efficient	4.20	4
Recycling of some waste materials on site	4.16	5
Buying raw materials that are just sufficient	4.12	6
Encourage reuse of waste materials in projects	4.04	7
Identify each type of material waste level	3.96	8
Minimising design changes	3.54	9
Just in time operations of works/delivery of materials	2.24	10

The findings identified the seven most effective measures to minimise material waste. They were the implementation of effective site management and supervision techniques, employing skilled labour, appropriate on-site material storage, efficient use of construction equipment, recycling of some waste materials on-site, purchasing sufficient raw materials, and encouraging waste materials reuse in projects. These measures recorded mean values above the number four in terms of minimising material waste in construction sites. The respondents further rated the least, but nevertheless important measures, to minimise material waste which were identifying each type of material waste level, minimising design changes, and just in time operations of works/delivery of materials.

In the analysis of the data, implementation of effective site management and supervision techniques ranked as the most important strategy to minimise material waste. Site management and supervision plan are needed from a concern over cost and environmental protection. To reduce material waste in construction sites, there must be strict materials control and supervision. Further measures that were deemed necessary included increasing staff members' knowledge and training on waste consequences and management, and intensifying security.

The least crucial strategy to minimise waste was just in time operations of works/delivery of materials. This result indicates that the significance of this strategy is yet to be appreciated and understood in the context of Kurdistan's construction industry. This strategy plays a crucial role in which it ensures the procurement and delivery of materials at every stage of construction to the work

site. This helps to avoid uncertain quantities estimations which can lead to wastage from losses and deterioration due to insufficient on-site stock.

This study thus makes several recommendations based on study by Saker Al-Moghany (2006), relating to the third objective (i.e., to reduce the quantity of material waste generated in construction projects) as follows:

- In each phase of construction, the hierarchy of waste management should be carried out. They include the conceptual phase of the project, initial design and planning phase, stage of procurement and tendering, and stage of pre-construction and construction itself.
- In order to avoid cutting-to-fit during design, dimensioning of materials as well as elements should be carried out carefully.
- Timely as well as efficient communication regarding design changes to all parties involved.
- In the process of implementation, high-tech equipment is required.
- Hiring experienced and trained supervisors as well as labour is crucial.
- At the construction stage, specifications of the project must be reviewed by the contractor in order to detect detailing, design, and other errors.

6.0 CONCLUSION

The construction industry has been identified as a significant source of waste generation. The reduction of raw materials utilised in the construction industry is also aided by the production of construction waste. This research has presented the outcome of the study on the waste management practiced in Kurdistan Region of Iraq. The purpose of this research was to minimize material waste by determining the sources of waste and the severity of each cause in construction projects in Kurdistan. Therefore, the research was based on primary data and the online questionnaire was self-administrated and distributed through social media to people who are working in public and private building construction sites. In lieu of the findings, this study therefore recommends a necessity to establish a new department of construction waste by the municipalities and ministries. Such effort is expected to enhance policies of waste management and improve effective strategy implementation to minimize construction material waste.

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