
Factors Contributing to the Waste Generation in Building Projects of Pakistan

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ABSTRACT

Generation of construction waste is a worldwide issue that concerns not only governments but also the building actors involved in construction industry. For developing countries like Pakistan, rising levels of waste generation, due to the rapid growth of towns and cities have become critical issue. Therefore this study is aimed to detect the factors, which are the main causes of construction waste generation. Questionnaire survey has been conducted to achieve this task and RIW (Relative Importance Weight) method has been used to analyze the results of this study. The important factors contributing to the generation of construction as identified in this study are: frequent changes/ revision in design during construction process; poor scheduling; unavailability of storage; poor workmanship; poor layout; inefficient planning and scheduling of resources and lack of coordination among supervision staff deployed at site. Based on the identified factors, the study also has presented some suggestions for the reduction of construction waste in building construction projects of Pakistan.

Key Words: Construction Waste, Factors, Buildings Projects, Pakistan.

1. INTRODUCTION

Construction waste is the solid waste generated from the construction activities performed at site. The waste is generated from the breaking, renovation, earth works and the land clearance activities [1]. Construction waste is the by-product generated throughout different construction activities for fresh and renovation of building [2]. Construction industry widely contributes the large quantity of waste at site. The profit margin of the contractors reduces due to increase in construction waste at site. According to Ganesan [3], construction materials are utilized in large quantities during different stages of construction. The cost of construction

materials is about fifty to sixty percent of the overall cost of the project. Regrettably, the major portion of purchased materials is not consumed by the construction industry. Kwan, et. al. [4] reports that still there is extensive appreciation across the globe, traveling in the direction of significance prolong sustainability. The construction industry is famous for generating huge quantity of construction waste.

Construction waste affects overall economy of the country. Ballard, et. al. [5] expressed that the waste minimization contributes increase in the profit. Andy, et.

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al. [6] discovered that over 70 million tones of waste is generated from the construction industry yearly. According to Nagapan, et. al. [7] construction waste turns out to be a comprehensive problem faced by the construction professionals more or less all over world. The completion of project is more significantly affected by the generation of construction waste.

The vital role of construction industry in maintaining the economic growth contributes more in GDP (Gross Domestic Product) of the country. This industry is more human resource absorbing like other industries. According to Labour Force Survey Report Government of Pakistan 2008-2009 [8], construction industry shares 2.4% in the GDP and comprises of 6.62% of total employment. The construction industry is a major purchaser of manufactured products. However, at the same time it faces different problems. Due to disinclination towards adoption of latest technology and management system; construction industry of Pakistan is backward as compared to developed countries [9]. Increased economic growth and urbanization in developing countries has led to extensive construction activities that generate large amounts of wastes. Materials wastes on building projects have not only caused financial setbacks to contractors but also caused significant impacts on health, aesthetics and the general environment [10].

In past few decades, construction waste has received increasing attention worldwide. It has been determined that existing studies with respect to construction waste reduction are mainly carried out from a static perspective [11]. A significant amount of construction waste is witnessed as a result of rapid urbanization and large scale of construction activities [12]. Non value-adding activities, also known as wastes, have not been paid much attention in the current construction management. Previous studies have shown that significant amounts of project values were lost due to these wastes [13]. Various activities are observed in construction practices in a

research study carried out by Ha Duy, et. al. [14] and most of them were left unnoticed or unattended during construction.

The construction waste generated during different phases of construction is documented as the major problem in the construction industry. It has also a major impact on the efficiency of the construction sector. Waste is prominently generated by the construction sector in different activities at site, it has become severe problem everywhere in world especially in Pakistan. Hence, this study aims to identify most critical factors, which are the main cause of waste generation in construction industry. It also aims to suggest feasible actions towards reduction of construction waste at site. As the construction industry has remained a neglected sector in Pakistan, therefore the problems associated with this sector has been ignored and not addressed properly.

2. RESEARCH METHODOLOGY

For achieving the objectives of study, the work was divided into two phases. In the first phase of research, the main factors causing the generation of construction waste were identified through extensive literature review and unstructured interviews. The identified factors were grouped in to five main categories with their sub factors. The identified factors were shaped in to a set of questionnaire to get the response of the experts to make a priority table of the identified factors. RIW method has been applied to get the priority weights. In the second phase of the questionnaire mitigation measures were placed, which were worked out from literature review and unstructured interviews. The data of the second phase was also analyzed using RIW method.

3. DATA COLLECTION AND ANALYSIS

As discussed earlier, survey has been carried out to achieve the objectives of study. The details of data collection and analysis are given in following sections.

Factors were identified from literature and unstructured interviews. These factors were grouped in the five categories: “Design/Contract Document”, “Procurement”, “On Site Operation”, “Site Management and Practices” and, “Site Supervision”. The questionnaire was designed to obtain the opinion of professional engineers regarding factors contributing to generation of construction waste at site and its mitigation measures in public sector buildings projects of Pakistan. The respondents were requested to rank the factors on a five point likert scale ranging from 1-5 for significance of the waste generation factors and a three point likert scale for mitigation measures. RIW method has been successfully applied in various studies because of its appropriate results and simple working process [15-16]. The weights in RIW method are calculated using Equation (1).

$$RIW = \frac{\sum (a_i x_i)}{\sum x_i} \quad (1)$$

Where a_i is Constant expressing the weight given to I ; x_i is Variable expressing the frequency of the response for; i is 1, 2, 3, 4 and illustrated as follows, x_1 is Least Importance and corresponding to a_1 is 1, x_2 is Less Important and corresponding to a_2 is 2, x_3 is Important and corresponding to a_3 is 3, x_4 is Very Important and corresponding to a_4 is 4, x_5 is Most Important and corresponding to a_5 is 5.

4. RESULTS AND DISCUSSION

The questionnaire sets were distributed to 175 professional engineers working in the building sector projects in the construction industry of Pakistan. The response rate was 52%. Respondents experience level has significant effect on such qualitative studies. Hence, respondents experience has been given careful consideration for this research work. Fig. 1 shows the frequency of respondents based on work experience.

The respondents having up to 10 years experience is 42% in total, respondents up to 20 years are 52% in total, respondents up to 30 years are 5% in total and only 1%

with more than 30 Years experience but maximum questionnaires are filled by respondents having sufficient working experience in the construction industry.

The data has been processed using RIW method in MS Excel. Table 1 shows the results of the waste generation factors with the ranks.

The results show that unavailability of skilled workers, poor qualified staff assigned to the project, lack of waste management plan, lack of site supervision, poor workmanship and ineffective planning and scheduling of the project with their average mean weight score as 4.186, 4.164, 4.098, 4.087, 4.076 and 4.033 respectively are the major factors leading to generation of waste in the building projects in Pakistan followed by others as shown in Table 1.

The second phase questionnaire contained mitigation measures which were worked out from literature review and unstructured interviews from field experts. The

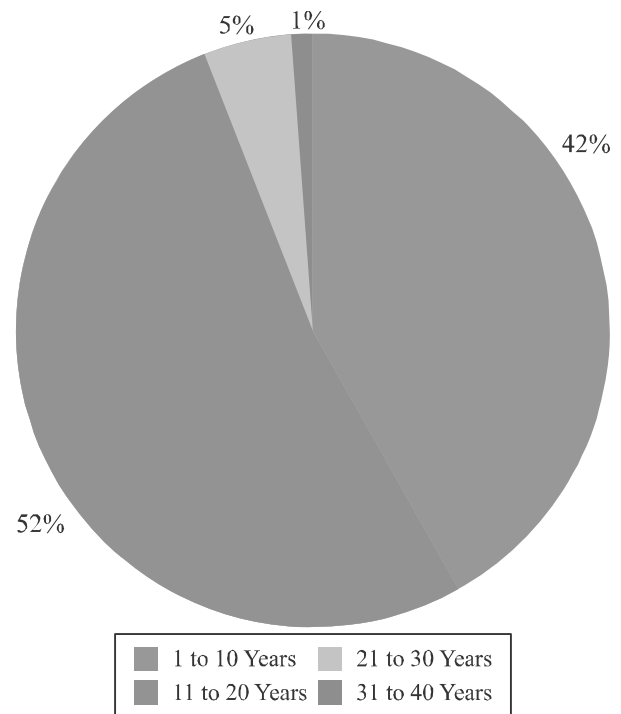


FIG. 1. RESPONDENTS EXPERIENCE

respondents were requested to highlight the relative importance of mitigation measures on another likert scale ranging from (1) Low, (2) Medium and (3) High.

The data of this phase was also processed using RIW method in MS Excel. Table 2 shows the results of the mitigation measures to reduce waste generation in construction industry of Pakistan with the ranks.

Changes in drawings should be avoided, Construction activities should be as per design changes /revision, Proper Layout of the Project, Vigilant Supervision Staff are found to be the most important mitigation measure to reduce the waste generation in building projects of Pakistan followed by others.

TABLE 2. MITIGATION MEASURES

No.	Mitigation Measures	Score
1.	Changes in drawings should be avoided	3.0
2.	Construction activities should be as per design changes /revision	3.0
3.	Proper layout of the project	3.0
4.	Vigilant supervision staff	3.0
5.	Provide detailed construction program of resources (weekly/monthly)	2.96
6.	Close coordination between all parties	2.96
7.	Proper material supply as per scheduled plan and specifications	2.96
8.	Experienced designer	2.93
9.	Proper construction methods	2.93
10.	Strong coordination and communication between contractor's site staff	2.90

TABLE 1. MEAN VALUE AND RANK OF FACTORS

Factors	Score	Rank
Design/Contract Document		
Poor specification or unclear/unsuitable specification	3.835	1
Required information is not provided in drawings	3.824	2
Ambiguity, mistakes and discrepancies in drawings	3.736	3
Frequently changes/revision in design, during construction work in progress	3.681	4
Lack of Coordination between designer and stakeholder (Client)	3.648	5
Procurement		
Ordering of material which doesn't fulfill requirements specified in design	3.868	1
Poor quality of materials supplied by the supplier	3.747	2
Over-ordering of material due to miscalculation of quantities	3.681	3
Over-sized materials supplied by the supplier	3.670	4
Improper materials storing methods	3.648	5
Site Operation		
Unavailability of skilled workers	4.186	1
Poor workmanship	4.076	2
Frequently changes/revision in design, during construction work in progress	3.901	3
Use of incorrect materials	3.758	4
Wrong selection of construction methods	3.736	5
Site Management and Practices		
Lack of waste management plan	4.098	1
Ineffective planning and scheduling of the project	4.033	2
Poor management for distribution of labour, materials and equipments	3.923	3
Poor site documentations	3.901	4
Poor site layout	3.890	5
Site Supervision		
Poor qualified staff assigned to the project	4.164	1
Lack of site supervision	4.087	2
Suspension of work	3.736	3
Delay of payment to the contractor	3.692	4
Poor coordination between site and supervision staff	3.681	5

5. CONCLUSIONS

This study explores the main factors, which are the major causes of generation of construction waste at site. These factors were grouped in following five main categories i.e. Design/Contract Document; Procurement; On Site Operation; Site Management and Practices and; Site Supervision. The comprehensive analysis of these factors was carried out using statistical methods. The most important factors contributing to the generation of construction waste are analyzed as frequent changes/revision in design during construction and poor scheduling for the procurement of materials. Apparently, it has been analyzed that poor workmanship and unavailability of skilled workers, poor site layout and lack of coordination between site and supervision staff also contribute significantly in the construction waste generation on site.

In the second phase, important mitigation measures were worked out considering the most critical factors causing the generation of construction waste. The most important mitigation measures required for the reduction of construction waste as identified in this study are:

- (i) Frequent changes in design during construction process have the significant effect on the generation of construction waste. Therefore, it is important to avoid changes in design during construction process and appointment of experienced and qualified design engineer is also important in this context. There should be close coordination between client and designer during design stage.
- (ii) It is important for the contractor to supply the materials at site according to scheduled plan and specifications.
- (iii) It is essential to provide proper storage of material. In addition to this, it is also important to use construction materials before expiry date.

- (iv) It is important to assign qualified staff and workers in construction projects so that proper workmanship and quality could be obtained.
- (v) It is important to have proper layout before starting activities so that re-work can be avoided.
- (vi) There should be close coordination between important stakeholders of the project (i.e. client, consultant and contractor) during construction process.

The findings of this study will not only be helpful in minimizing construction waste at site but it will also help in the improvement of environment. Besides this, it will have an impact on project cost reduction which is advantageous from public sector clients' perspective. It will also help the constructors to earn more profits by avoiding rework and reducing waste in construction projects.

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