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WASTE MANAGEMENT IN CONSTRUCTION PROJECTS OF PAKISTAN

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ABSTRACT: Construction waste generation of materials on site is a severe issue causing major environmental impact worldwide. There is a need to controlling construction waste generation and promote construction waste management methods. This study has recognized common construction waste strategies and management methods relevant to application in construction projects of Pakistan. Gathering of data involved survey from twenty-eight experience personnel from client, consultant and contractor firm involved in construction works. Analysis of the data with relative importance index revealed that reduce, reuse and recycle are reported as of high relevancy and use for effective waste management while prefabrication, value engineering and building information modeling are top three ranked methods useful and relevant for managing waste on site in construction projects on site.

Keywords: Construction Waste, Waste Management Methods, Waste Management Techniques.

INTRODUCTION

Over the last two decades, construction problems have drawn a significant interest from numerous researchers. One of the severe problems which have triggered attention of researchers is growing challenge of construction waste (CW). Over 10 billion tons of construction waste (CW) have been generated every year from which the United State (US) generates about 700 million tons, the European Union (EU) contribute 800 million tons (Ajayi *et. al.*, 2016), around 2300 million tons is generated from China (Zheng *et al.*, 2017) and roughly 20 million tons of physical waste is generated annually in Pakistan, with the annual growth rate of about 2.4% (Racheal, 2019). Karachi is the largest city of the country, which generates more than 9000 tons of physical waste daily (Iqbal, 2019), construction waste (CW) is a main point of solid waste generation in the Islamic Republic of Pakistan.

Construction Waste to unwanted building material during execution work, alteration and demolition activities which may have harmful ingredients giving bad effect on human beings and environment (Wu *et al.*, 2019; Akhund *et al.*, 2018). These effects (Kofoworola and Gheewala, 2019), deterioration of land, air pollution, dust and poisonous of construction is a high priority, there is a need emerging need to minimize construction management generation and reduce its effects on the friendly environment. There are several strategies and methods which can be very useful in management construction waste problem. Hence, this study has focused on unveiling various strategies and method relevance to use in construction industry of Pakistan for managing construction waste on site.

Construction waste management practices are very helpful in keeping environment friendly construction environment (Ali *et al.*, 2019). Several research works have been carried out to highlight various waste management strategies and methods which can be implemented in construction projects. It is stated that overall construction waste management practices are classified into five elements known as 5Rs which include recover, reduce, reuse, recycle and disposal. In few states of United State of America (USA) and Europe Union (EU), where resources of concrete are rare, recycling of construction waste (CW) is considered as preferred strategy and several concrete plants for recycling and sorting went into process (Wang *et al.*, 2019). Currently in relation of the overall global warming potential, the best eco-friendly environment method for treatment is the recycling (Ulubeyli *et al.,* 2017; De-Magalhães *et al.*, 2017; Dinesh *et al.*, 2017) while in many European Union (EU) countries, recycling is comparatively a new technique (Zheng et al., 2017; Wang et al., 2019). On the contra cry some of the researcher argues that waste management strategies can be classified as 3Rs which comprise of reuse, reduce and recycle. In order to identify common waste management strategies adopted globally, numerous previously published research papers were reviewed and summarized as in table 2 below.

Besides these strategies, there are several advanced methods which have been proved effective for waste management such as lean construction. Lean construction is a philosophical tool for avoiding waste through continuous improvement (Saieg *et al.*, 2018, Zhang and Chen 2016). Another method which is popularized in eliminating waste is prefabrication. In (Bajjou and Chafi, 2018) pointed out that with prefabrication methods; construction waste reduction was

achieved by 52%. By considering prefabrication and industrialization technologies, now the professionals have adopted Industrialized Building System (IBS). IBS is considered waste controlling technique during the construction execution works. More recently BIM is getting popularity in construction sector (Ahmed, 2018; Hoseini *et al.*, 2017). A review of various published research articles resulted in identifying 7 common and relevant methods applicable for waste management in construction industry as in table 2.

Table 1: Waste Management Strategies.

S. No	Waste Management Strategy	References
1	Reuse	Huang *et al.*, (2018), Ghisellini *et al.*, (2018), Ismail *et al.*, (2018), Wang *et al.*, (2019), Ghafourian *et al.*, (2017), Arshad *et al.*, (2017), Esa *et al.*, (2017), Esa *et al.*, (2019)
2	Recycle	Huang *et al.*, (2018), Ghisellini *et al.*, (2018), Ismail *et al.*, (2017), Wang *et al.*, (2019), Ghafourian *et al.*, (2017), Arshad *et al.*, (2017), Esa *et al.*, (2017), Esa *et al.*, (2019)
3	Reduce	Huang *et al.*, (2018), Ghisellini *et al.*, (2018), Seige *et al.*, (2018), Arshad *et al.*, (2017), Esa *et al.*, (2017), Esa *et al.*, (2019)
4	Landfill	Huang *et al.*, (2018), Wu *et al.*, (2019), Wu *et al.*, (2019)
5	Incineration	Huang *et al.*, (2018), Wu *et al.*, (2019), Wu *et al.*, (2019)
6	Recover	Arshad *et al.*, (2017), Esa *et al.*, (2017),
7	Avoid	Arshad *et al.*, (2017)
8	Treat	Esa *et al.*, (2019)

Table 2: Construction Waste Management Techniques.

S. No	Waste Management Strategy	References
1	Lean Techniques	Esa *et al.*, (2017), Bajjou and Chafi (2018), Wu *et al.*, (2019), Mesa *et al.*, (2019), Dinesh *et al.*, (2017)
2	Industrialized Building System (IBS)	Esa *et al.*, (2017), Bajjou and Chafi (2018), Wu *et al.*, (2019), Mesa *et al.*, (2019), Dinesh *et al.*, (2017)
3	Building Information Modelling (BIM)	Esa *et al.*, (2019), Ahmed (2018), Hoseini *et al.*, (2017), Esa *et al.*, (2019)
4	Prefabrication	Bajjou and Chafi (2018), Mesa *et al.*, (2019)
5	Value Engineering	Bajjou and Chafi (2018), Mesa *et al.*, (2019)
6	Modular Design	Bajjou and Chafi (2018), Mesa *et al.*, (2019)
7	Green Procurement	Bajjou and Chafi (2018), Mesa *et al.*, (2019), Aadal et al., (2013)

MATERIALS AND METHODS

Data collection was conducted through quantitative method with questionnaire survey. Survey form was prepared based on Construction Waste Management (CWM) methods and strategies identified through review of previous published research works at global level. Data collection involved seeking perception of the experienced personnel working in construction projects. A five (5) point Likert-scale was adopted to evaluate the level of relevancy of each parameter considering as 1= Not related (NR); 2= Slightly Related (SR); 3= Moderately Related (MR); 4= Very Related (VR) and 5= Extremely Related (ER). Relative Importance Index (RII) formula adopted from (Rooshdi *et al.*, 2018; Akhund et. al. 2019) was used to analyze the as fellows.

$$RII = \frac{(1X_1+2X_2+3X_3+4X_4+5X_5}{(A*N)*100} \quad (1)$$

where
X_1=No of respondent weight for Not Relevant (NR);
X_2=No of respondent weight for Slightly Relevant (VR);
X_3=No of respondent weight for Moderately Relevant (MR);
X_4=No of respondent weight for Very Relevant (VR);
X_5=No of respondent weight for Extremely Relevant (ER);
A = Height weight;
N = Total number of respondent' sample

RESULTS AND DISCUSSION

28 respondents are parts of this survey given in table 3.

Table 3: Statistics of the respondents.

Organization	Frequency	%age	Cumulative percentage
Client	12	42.86	42.86
Consultant	9	32.14	75.00
Contractor	7	25.00	100.0
Experience of the respondents			
6 to 10 Years	3	10.71	10.71
11 to 15 Years	8	28.57	39.29
16 to 20 Years	5	17.86	57.14
20 to 25 years	3	10.71	67.86
Above 25	9	32.14	100.0

From above table 3 it is viewed that the respondents had sound experience of working in construction works and considered eligible to give proper feedback required for uncovering the research issues. Majority of the respondents' i.e. 25 of 28 have worked for

many years. The respondents represented all three major stakeholders which are clients, consultants and contractors. RII values for construction waste management strategies and techniques were computed using Microsoft Excel Software application where table 4 shows the RII values with ranking.

Table 4: Ranking of the Waste Management Strategies.

Construction Waste Management Methods	NR	SR	MR	VR	ER	N	RII	Rank
Reduce	1	1	3	16	7	28	79.29	1
Reuse	0	2	7	11	8	28	77.86	2
Recycle	1	3	5	11	8	28	75.71	3
Avoid	2	5	7	6	8	28	69.29	4
Landfill	4	2	9	13	0	28	62.14	5
Recover	2	10	7	5	4	28	59.29	6
Incineration	7	6	10	2	3	28	51.43	7
Treat	7	6	11	4	0	28	48.57	8

Table 4 above depicts that most of respondents agree that the waste generation must be reduced at sites and thus the strategy "reduce" has got 1st rank amongst all the strategies. At second position the strategy of "reuse" is placed with consent of 77.86% of the respondents participating in data collection. Treat has been placed at the last rank with 48.57% response which shows that the participants try to avoid treating the wasted material. This might be possible because of several reasons such as the type of waste and required treatment might be expensive & time consuming, also chemical treatment may not be environmental friendly. The respondents were also asked to rate the advance methods used for construction waste management. Calculated RII value and ranking for waste management method based on collected responses is presented in table 5.

From Tab.5, 73.57% highlighted that prefabrication can be very useful technique for waste management on site by placing this technique at 1st rank. 2nd ranked method of waste management is value engineering as mentioned by 70.71% respondents. Value engineering is considered very useful in avoiding waste generation during the execution work while Building Information Modeling (BIM) is placed at 3rd place as considered by 70% of the respondents. Though the respondents considered that BIM is very useful method but in Pakistan still it is new and emerging method.

Table 5: Ranking of Construction Waste Management Methods.

Construction Waste Management Methods	NR	SR	MR	VR	ER	N	RII	Rank
Prefabrication	1	5	4	10	8	28	73.57	1
Value Engineering	2	5	6	6	9	28	70.71	2
Building Information Modelling (BIM)	1	5	8	7	7	28	70.00	3
Lean Techniques	2	6	4	12	4	28	67.14	4
Industrialized Building System − IBS	2	3	12	7	4	28	65.71	5
Green Procurement	4	6	8	7	3	28	59.29	6
Modular Design	3	10	7	8	0	28	54.29	7

Conclusion: This study investigated various strategies and method adopted for managing construction waste generation on sites. Study was carried out by collecting the perception of the experienced personnel handling large construction project in Pakistan. Statistical analysis with RII formula was carried out for collected data. The results of the study indicated that majority of the respondents are of the opinion that the construction waste generation must be reduced but if it is generated then it is preferred to reuse and recycle. Effective waste management can be achieved by implementing different waste management methods. Among these methods prefabrication is reported as most relevant method for reducing waste generation on site. Value engineering and BIM are reported as 2nd and 3rd ranked major methods for managing construction waste effectively.

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