

A Review of Construction Waste Cause Factors

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Abstract

Rapid growth in construction activities increases construction waste problems around the world. Construction waste gives a negative impact to the environment, costs, time, productivity and social of country. To reduce these negative impacts, it needs a comprehensive understanding of the construction waste generation and management. This paper identifies various causative factors of construction waste existing in construction field activities. The common causes of construction waste were identified from past research papers. The causes of construction waste are matrix and found that 63 waste factors existed in construction activities. The waste causes were grouped into the seven categories: Design, Handling, Worker, Management, Site condition, Procurement and External. The frequency of the causative factor in each category was determined based on the deduction from past research works that were considered. The highest frequency as indicated by most researchers is a frequent design change that contributes to large generation of construction waste. Meanwhile, factors from each category are also determined. Through identifying the important causes, construction industries players can avoid and alert about how the waste was generated. It will gives a great benefit for country in term of economic, social and protection of the environment.

Keyword: Construction waste, Causes of waste, Mapping Matrix

1.0 Introduction

Waste is one of the serious problems in construction industry. Many researchers and practitioners indicate that there are many wasteful activities during design and construction process. Wahab and Nawal [11] described waste emanates during different stages of construction which are during planning, estimating and construction stage. Furthermore, Ekanayake and Ofori [4] shows waste occur during design, operational, procurement and material handling. The majority of these consuming time and effort without adding value for the client thus resulting losses in material, delay times and execution of unnecessary work. Waste has direct impact on the productivity, material loss and completion time of project which resulting in loss of a significant amount of revenue. The physical waste contributes a significant part of landfill, and studies show that 13-26% of landfill is construction waste which emphasis on the need of a systematic and efficient waste minimization method to control the generation of waste at different level [10]. The construction industry produces large amount of waste, equal to four times produce in households and more than 50% deposited in landfill [21]. Therefore, to avoid the waste generation, need to find out the root cause of the waste. The causes that contribute to the generation of construction waste are various. The purpose of this paper was to analytic review of construction waste causes from beginning to the end of construction activity. This information will help researchers and construction industry players to identify the main causes of construction waste which contribute to generate waste.

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2.0 Construction Waste

Waste is a product or material that is unwanted [22]. Waste is also can be defined as any materials by product of human and industrial activity that has no residual value [15, 25]. Construction waste can be clustered into two groups namely the physical and non physical waste.

2.1 Physical Waste

Physical construction waste can be defined as a mixture of inert and non-inert materials arising from construction, excavation, renovation, demolition, roadwork and other construction-related activities [23]. Similarly defined by Shen et al. [24] and Kofoworola and Gheewala [28], construction and demolition waste is generally defined as waste which arises from construction, renovation and demolition activities including land excavation or formation, civil and building construction, site clearance, demolition activities, roadwork, and building renovation. But some defined as solid waste and consists of concrete debris, different types of bricks and blocks, various kinds of tiles, steel reinforcement, wood, plastic materials and paper, as well as gravel and soil [31]. Research has also interpreted in physical construction waste as waste origins and can be found in [29, 30].

2.2 Non Physical Waste

On the other hands, waste can be defined as non-value adding works. The term non value-adding activity is used to differentiate between physical construction waste found on-site and other waste which occurs during the construction process. This type of waste also mentions by other researcher as intangible waste, in-directs waste or non-physical waste. Womack and Jones [26] describe waste as any human activity that absorbs resources but creates no value, such as mistakes that require rectification, production of items no one wants, process steps that are not needed, unnecessary movement of employees, and people waiting for the conclusion of upstream activities. Furthermore, Koskela [27] also describe waste as any inefficiency that results in the use of equipment, materials, labour or capital in larger quantities. In other words, waste in construction is not only focused on the quantity of waste of materials on-site, but also related to several activities such as overproduction, waiting time, material handling, processing, inventories and movement of workers [16]. Similarly, researcher from Indonesia defined waste is not only associated with waste of materials in the construction process, but also other activities that do not add value such as repair, waiting time and delays [8].

3.0 Matrix of Causative Factors

Mapping of factors is to give preliminary idea on what past researchers had discovered the factors that contributed to construction waste generated. This matrix analysis can identify the severity of each factor based on the frequency of the factors identified by past researchers around the world. There are 20 scholarly research papers selected for this study and 63 causative factors of construction waste generation were found in the study. These factors are grouped into 7 categorized. Table 1 shows the mapping of the causative factors taken from research articles around the world. These can be the input for developing the questionnaire to determine the relevancy of these factors to local environment.

Table 1 – Matrix of the Causes of Construction Waste

GROUP	CAUSE OF CONSTRUCTION WASTE	REFERENCES																				F	%
		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]		
DESIGN	Frequent design changes	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	20	1.6	
	Design errors	1		1		1	1		1		1		1			1		1	1	1	11	0.9	
	Lack of design information				1	1	1	1	1	1						1					7	0.6	
	Poor design quality								1	1			1		1						5	0.4	
	Slow drawing distribution					1	1		1	1											4	0.3	
	Complicated design				1	1															2	0.2	
	Inexperience designer				1						1										2	0.2	
	Interaction between various specialists					1		1													2	0.2	
																					$\Sigma=4.2$		
HANDLING	Wrong material storage	1		1	1			1	1	1	1	1	1	1		1	1	1	1	14	1.1		
	Poor material handling	1		1	1	1		1	1	1		1	1			1	1	1	1	13	1.0		
	Damage during transportation				1			1			1	1	1	1		1				8	0.6		
	Poor quality of materials								1	1	1		1	1	1	1			1	8	0.6		
	Equipment failure			1	1						1		1						1	6	0.5		
	Delay during delivery					1			1	1			1			1				5	0.4		
	Tools not suitable												1	1					1	3	0.2		
																					$\Sigma=4.5$		
WORKER	Workers' mistakes			1	1	1		1			1		1	1		1	1	1		10	0.8		
	Incompetent worker					1			1	1			1			1				6	0.5		
	Poor attitudes of workers				1			1					1	1	1					5	0.4		
	Damage caused by workers				1	1					1							1		4	0.3		
	Insufficient training for workers							1						1		1				3	0.2		
	Lack of experience								1	1				1						3	0.2		
	Shortage of skilled workers					1			1							1				3	0.2		
	Inappropriate use of materials								1	1	1									3	0.2		
	Poor workmanship	1																	1	2	0.2		
	Worker's no enthusiasm												1							1	2	0.2	
	Abnormal wear of equipment							1												1	0.1		
	Too much overtime for workers								1											1	0.1		
																					$\Sigma=3.4$		
MANAGEMENT	Poor planning	1	1		1	1		1	1	1		1			1	1			1	11	0.9		
	Poor site management			1	1			1				1	1	1	1		1			9	0.7		
	Poor controlling		1			1		1			1		1		1	1	1		1	9	0.7		
	Poor supervision								1	1			1		1	1	1			7	0.6		
	Inappropriate construction methods					1			1	1		1				1	1		1	7	0.6		
	Lack of coordination among parties					1			1	1	1					1			1	7	0.6		
	Poor information quality		1						1	1	1				1	1	1			7	0.6		
	Late information flow among parties		1			1			1	1	1					1				6	0.5		
	Scarcity of equipment					1			1	1			1			1	1			6	0.5		
	Resources problem		1						1				1			1				4	0.3		
	Rework					1		1				1							1	4	0.3		
	Waiting periods						1	1					1			1				4	0.3		
	Communication problems				1									1						1	3	0.2	
	Outdated equipment							1	1	1										3	0.2		
	Lack of waste management plans					1			1		1									3	0.2		
Non availability of equipment												1			1				2	0.2			
Lack of environmental awareness														1					1	0.1			
																				$\Sigma=7.4$			
SITE CONDITION	Leftover materials on site	1		1						1			1			1				5	0.4		
	Poor site condition							1	1			1				1				4	0.3		
	Waste resulting from packaging	1									1			1						3	0.2		
	Congestion of the site												1			1				2	0.2		
	Lighting problem													1						1	0.1		
	Crews interference														1					1	0.1		
																				$\Sigma=1.3$			
PROCUREMENT	Ordering errors	1		1	1	1		1			1		1	1		1	1	1		11	0.9		
	Error in shipping			1										1					1	3	0.2		
	Mistakes in quantity surveys				1	1													1	3	0.2		
	Ignorance of specifications							1								1				2	0.2		
	Waiting for replacement					1														1	0.1		
																				$\Sigma=1.3$			
EXTERNAL	Effect of weather	1	1	1	1	1	1		1	1	1	1	1		1			1		13	1.0		
	Accidents	1		1	1	1					1								1	6	0.5		
	Pilferage	1			1				1			1								4	0.3		
	Vandalism							1				1								2	0.2		
	damages caused by third parties								1	1										2	0.2		
	Festivities															1				1	0.1		
	Unpredictable local conditions					1														1	0.1		
Lack of legatitive enforcement														1					1	0.1			
																				$\Sigma=2.3$			

4.0 Results and Discussion

Based on table 1, the factor that has the highest frequency is the frequent design changes. This factor is acknowledged by 18 out of 20 articles considered in this study. This significant factor is in the category of design which has eight factors. The significant factors for other categories are as in table 2.

Table 2 - Significant factors that contributes to construction waste generation based on category

Category of factors	Significant factor determined
Design	Frequent design changes
Handling	Wrong material storage
External	Effect of weather
Management	Poor planning
Procurement	Ordering errors
Worker	Workers' mistakes
Site condition	Leftover materials on site

4.1 Frequent Design Changes

The 'Frequent design changes' was found the most dominant cause for generating construction waste with highest frequency among others factors. These problems arise because of the last minutes client changes during the construction activities. This becomes an issue due to lack of communication between contractors, designers and the clients during design work. At the design stages, the client must sit together for getting the final decision before contractor undertaking the construction projects. This is vital part after the drawing stage. Whenever changes occurs after the construction, to rebuild according to new drawings need a lot of rework and its time taking. Therefore, to overcome this problem, more attention should be given in waste reduction during design phase. The parties, who involve in any construction projects, should always have a good communication with clients to avoid the last minutes changes.

4.2 Wrong material storage

Wrong material storage, was the second highest key cause of construction waste generation. It's also ranked first place in the Handling Group. This problem always connected with the improper storing methods due to handling activities. For example, the wrong handlings method used for bricks during construction leads to cracks. This material is brittle and must handle with very careful. The problems always occur because of human error. Apart from this, wrong storage is also occurs because of inappropriate protection strategy. For examples, cements have to store under a shade and save place. But workers wrongly store it under bridge or at any open space. At last, the materials expose to weathers such as direct sun light and rain. Without proper protection, the materials end up as waste. Proper storage of material are very necessary for avoid the construction waste generation. Store keepers have to monitor the storing method by workers. This may reduce the damages of material at site. Besides that, a very comprehensive and good storage technique should be adopted for better protection of materials at site.

4.3 Effect of weather

The Effect of weather is an important factor in External group. Weather becomes the most influential factors causing delays waste. Some of the site works, such as concreting and excavation works have to stop due to heavy rain and storm. This severe weather condition taking lots of time and cause delayed. For construction projects, time play an important element. Many constructions have to rescheduling their site works due to this problem. Weather or climate change is one of the factors cannot be control by human and it is natural effect. For examples, some researchers believe the weather changes cause by act of God. Thus, the waste due to weather can be avoided with good decision making and management skills. Construction waste could be minimized with proper planning by the management players.

4.4 Poor planning

Poor Planning is the highest frequencies score in the Management group with the percentages of 7.4 %. The management group is the most dominant group for generating construction waste. The act of management plays an important role in contributing to waste generation. Less attention paid to workers during material handling on site causing waste. This problem occurs due to poor planning skills by the management site. The project managers need to assign a good and dedication supervisor at the site. The incompetent supervisor and project manager, lead to poor workmanships and improper material handling done by workers. Furthermore, the wrong planning methods applied by management generate to construction waste. Before planning, the management must bear in mind about the resources, such as how many workers and supervisor need for the construction projects; what type of equipment and how many tools needs for the specific works. Thus, proper planning is the key managerial function that should be used to be effective in eliminating these waste causes. All management leaders should be paying more attention towards this cause.

4.5 Ordering errors

In procurement aspects, ordering error score the highest frequency. The ordering errors such as over ordering and under ordering become the main issues during the ordering process. For example, the excessive of brick and concrete mixture at construction site was due to over ordering. On the other hand, if under ordering, fewer materials available at site during construction process and lead to stoppage of works. Another example, if lack of concrete premix during concreting activities, this can cause delay and need wait time for the material supply. Apart from this, sometimes poor ordering of materials does not fit in terms of quality, type and dimensions for the actual works at site. This type of mistakes happen and at last ends up as material waste. Thus, proper material ordering plays an important part and helps to reduce material losses and damage for construction projects.

4.6 Workers' mistakes

Workers' mistakes is a very common key cause for generating construction waste. The cause is the highest frequency among other causes in the Worker group. The workers mistake occurs due to untrained labourers, lack of skills and poor working attitude. Such workers often make mistakes at work place. They always generated material waste such as bricks, light weight concrete, plaster and tiles. The mistakes can avoid by selecting a competent worker for site works. In addition, supervisor must always monitor workers during their works at site. This can make the workers alert and do their works properly. Workers should have a good working culture and must responsible to their daily works. If these steps taken positively by the workers, the waste generating can be minimize during construction.

4.7 Leftover materials on site

Leftover materials on site is one of the cause of construction waste and can see thru naked eyed after construction. This cause is ranked on the tops of the Site Condition group. This cause of waste also classified as physical waste on site. The leftover material at site commonly as cut of steel bar, used formworks and broken bricks. This leftover scarp always occurs at the end of construction project. The poor attitude of project manager and workers is the cause of this residual at side. They should clean up the site before leaving. The project manager should monitor and make sure to store the excessive materials in store room or ware house. They also can resell or recycle the leftover materials. This method will reduce the construction waste on site and also can save our environment.

5.0 Conclusion

Waste generation by construction activities has a significant impact in many countries. This review study of 20 research papers found out the most significant factor contributing waste is 'Frequent design changes'. Meanwhile Wrong material storage, Workers' mistakes, Poor planning, Leftover materials on site, Ordering errors and Effect of weather also causing for generating waste. In preliminaries stages, this on-going result will be used to find out a method or way to minimize the construction waste generation.

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