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SUSTAINABLE CONSTRUCTION AND DEMOLISHING WASTE MANAGEMENT: A CASE STUDY IN PAKISTAN

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Abstract- Construction and Demolition waste management (CDWM) is an important topic nowadays as the world is moving towards more sustainable development. The social, economic, and environmental objectives will take into consideration as human health, safety, and quality of life is the main concern without compromising the sustainable future. In this paper, C&D waste is categorized, barriers against CDWM from different countries are analyzed and relate with CDWM in Pakistan. A case study is conducted in which a CDWM model is used to, minimize waste generation in the first place i.e. waste process management is implemented, reuse of demolished material. Suggestions are made by keeping the objectives of waste management in mind. As sustainability aims are crucial in CDWM, findings will help create some effective models of CDWM in Pakistan's construction industry.

Keywords- Waste management barriers, Construction and demolition waste management, CDWM in Pakistan, Sustainability

1 INTRODUCTION

Construction waste arise environmental problems so, it is important to develop new and effective strategies. Knowledge and awareness about waste are necessary to acknowledge in order to save the environment. The construction industry is the main source of solid waste all over the globe [1].40% of the total municipal waste in china is from construction industries. It is impossible to avoid waste generation in construction [2]. Although, there are different methods introduced in the past decade that minimize the waste to minimal level up to 1% i.e. DfMA and MiC. However, these methods are complex to understand. The waste has severe effects on the socio-environmental factors of sustainability, as the population increases results increase in pollution in different forms i.e. greenhouse gasses emission, water pollution, and uneven and unmanaged resources consumption [3] [4]. Human health and safety is the main concern of the based on sustainability factors. So, it is necessary to develop a sustainability model that assesses the construction and demolition waste management. Evaluation of the CDWM system becomes a crucial problem [5]**.**

This paper aims to introduce certain KPIs to control the waste at different stages of the project for different materials. Moreover, overall project success with respect to wastage needs certain KPI. This research will also encourage researchers from Pakistan to work on barriers against sustainable construction and sustainable development.

2 RESEARCH SIGNIFICANCE

This research will open a new area to develop the new CDWM models that are suitable for Pakistan's current condition. How can demolishing material be reuse and dispose of?

This paper will also provide a foundation for the researcher to work on barriers in implementation of new CDWM models in Pakistan.

3 RESEARCH METHODOLOGY

Pakistan, is one of the developing countries in the world, is facing many problems regarding population increase, urbanization, land scarcity, waste management, public health, environment, etc. given the waste management area priority over others can solve many of the problems. Most of the municipal waste comes from the construction industry

Within the cities, it is complex to sort out the construction waste into reuse, recycle, and dispose of small projects due to lack of awareness and knowledge about sustainability. In large projects, the construction waste is not sorted out as it has to. Most contractors and clients in Pakistan that work privately are not well educated and well aware of waste management. Moreover, the government did not put a check on local and private contractors or builders that causes a lot of construction waste generation.

In this paper, Hong Kong's construction and demolishing waste management strategies are studied, barriers, challenges, and suggestions are made to try to implement on Pakistan's waste management strategy to build a new and effective CDWM model.

A case study is done to show that how this CDWM model effectively implemented on construction project named SANA MALL in Bahria Enclave Islamabad Pakistan.

4 CONSTRUCTION WASTE MATERIAL

Construction waste is a by-product generated during the construction of civil engineering projects, demolishing of existing or renovation of old projects e.g. steel, concrete, blocks, bricks, wood, road waste, and many more [6] [7]. The construction waste is differentiated in inert and non-inert type. The non-inert materials are that are not suitable for land reclamation so they usually disposed of. The inert waste materials usually include steel, concrete type materials that are used to land reclamation. More than 80% of the construction waste material is inert [6] [8]**.** Concrete and asphalt can be used as engineering fill for site formation of the base before the plain concrete.

The C&D waste is categorize in five different categories. These types and their source of generation is given below in table 1 [9].

Table 1- Waste generation materials and their sources

Description	**Waste generating sources**
Concrete	Leakage in formwork
	Demolishing
Cement	Plastering
	Chiseling
	Over order
Blocks	Deformation during working
	Deformation during transportation
Timber	Leftover
	Deformation during working
Tiles	Deformation during working
	Deformation during transportation
	Design changes

In 1998, the government of Hong Kong establishes the committee on construction waste reduction comprising engineers, contractors, developers, specialists from the community, and government officials. The main focus of the construction waste reduction committee was managing the public landfills, introducing construction technologies, standards, and specifications and training, awareness regarding construction waste [10].

Currently, all the government work contractors need to prepare a waste management strategy and implement it according to specifications by the construction waste reduction committee. Certainly, the contractors need to sort out waste into different categories so that wastes go to the appropriate dumping site [1].

The Hong Kong government also introduces a "pay for safety and environment scheme" that helps contractors with financial incentives provoking them to implement the waste management and environmental improvement plans. In 2005, the government took the initiative that charge contractors on dumping waste at landfills. This as well compels the contractor to sort out the waste for reuse or recycling.

5 MAIN METHODS TO ASSESS CDWM PERFORMANCE

There are three methods to assess the CDWM performance upon which in this paper only the sustainability based methods will be studied; others are system thinking based method and life cycle thinking base method [11].

5.1 *Sustainability Based Method*

In CDWM sustainability have greater impact. Sustainability based methods are further divided into three types i.e. environmental, economic and social Sustainability based methods. A project will be in sustainable success if all three aspects are achieved.

An environmental sustainable method gives ecological activities priority irrespective of the other two pillars of sustainability. Matter of fact, all three methods are connected in certain ways depending on project nature i.e. Socio-economic, socio-environmental, and environmental-economic factors are being analyzed and implemented [12].

Almost 90800 projects are built on green construction methods that have all social, economic, and environmental aspects as 80 million tons of less waste generated and 41% less energy consumption. However, greenhouse construction projects have 4% more value in real estate than others. Green construction is a new method that more sustainable. For sustainable development, it is important that all three pillars of sustainability are touched which makes green construction more reliable.

6 BARRIERS AND SUGGESTIONS ON CONSTRUCTION AND DEMOLISHING WASTE MANAGEMENT

Based on previous studies, discussion and interviews on construction waste management in Hong Kong, this paper project the challenges and suggestions of construction industry of Hong Kong to Pakistan's construction industry. Construction industry and particularly waste management in both countries are much different. Topography, culture and many other variables that differentiate one's industry from another. Hong Kong on the other hand has much better condition regarding to sustainability aspects. Following are the suggestions and barrier in construction and demolition waste management in Pakistan

- For both Private and governmental contractors it is necessary to get a Pakistan engineering council license, so if contractor dump waste into unauthorized place there should be necessary action taken against them.
- Every contractor should submit their waste management plan to the municipal beside the construction approval document. Otherwise, the municipal have the authority to stop the work and fine them.
- Contractors should be charged against the dumping waste weight. This will encourage contractors to recycle, reuse waste, or use some other strategy before disposal.
- The government should make a law regarding construction waste management. Incentives should be given to contractors that fully manage the waste plan.
- Lack of technologies and new strategies is one of the main reasons for waste generation in the first place. So contractors should be well aware of new ways of construction that helps towards sustainable future
- Construction management is a very important skill. As more than one construction activities happen at the same time and many subcontractors' involve in this process. So, it is important for the construction manager to put strict checks on them against the time schedule and waste generation.

- In Pakistan's construction industry lack of site-supervision is a big issue. A usually unskilled and uneducated person found to be a site engineer that has practically no knowledge about waste management.
- One of the main barriers in Pakistan's construction industry is that contractors don't have enough knowledge about waste management. They should be educated about new and easy ways of CDWM.
- Tight time schedules are one of the causes that waste is not treated as it should be.
- Profit oriented stakeholders don't want to spend capital on waste management because of zero law reinforcement.
- Using CDW with lime or cement, low cost bricks with excellent physical properties.
- Suitable waste can be used as backfilling can be considered low quality recovery, as it replaces soil that have high environmental impact from its production.

7 KEY PERFORMANCE INDICATOR

Key performance indicators KPI are the main elements to measure progress of any project towards pre-defined goals and used critically in the decision-making process regarding any activity in the project. KPI's in waste management have economic value i.e. it gives indications about waste generation during the work done. Exceeding value of KPI tells about more waste generation and helps the construction manager to take proper actions. These KPIs vary from activity to activity, stage of the project, and organizational scope of work. In construction waste management the KPI's used for different activities are given bellow

Table 2 - KPI's for waste management

Activities	KPI	KPI Limit (A)	Actual value (B)	KPI value (B/A)	Remarks
Masonry	MSR	5%	7.2%	1.44	Not favorable
Plaster	PLT	2%	6.8%	3.4	Not favorable
Concrete	CTR	5%	3.7%	0.74	Favorable
Steel rebar	STL	5%	8.9%	1.78	Not Favorable

KPI's are important to control the project in different aspects. In waste management, above KPI indicates projects performance at any stage. At the end of project a general KPI's introduced in order to get one single figure that represent all the wastage during the activities.

8 CASE STUDIES

Sana mall is located in Bahria Enclave Islamabad. Due to change in architectural drawings after the completion of the grey structure results in demolishing of concrete and block masonry. Sana mall has 3 stories: basement, ground floor, and first floor. The total area of concrete to demolish was 10,000 square fit. 400 tons of concrete was demolished and transported into different sites. The 45 tons of steel later used in making drains. Transportation of wastage was a difficult task. Keeping all three aspects of sustainability in mind following are the KPI are used to assess the performance of CDWM.

Table 3- Demolished materials and respective costs

Description	Quantity	Amount (Rs)	Demolishing cost (Rs)	Transportation cost (Rs)
Concrete	10,000 cft.	4.5 million	12.5 million	0.9 million
Blocks	22000 sq. ft.	0.77 million	0.11 million	0.05 million
Steel	45 tons	0.292 million	0.1 million	0.05 million
Plaster	44000 sq. ft.	1.1 million	0.05 million	0.02 million
Total costs		**6.662 million**	**12.75 million**	**1.02 million**

The statistics shows that demolishing cost is greater than the actual construction cost. The KPI that was introduced have the economical factor i.e. total wastage used should be 95% of the total.

Table 4- Key Performance Indicators for reuse of demolished materials

Description of KPI	Material against KPI	Usage Location	Actual demolished material	Actual demolished waste usage	Expected demolished waste usage	Variance
STL	Steel	Drains Reinforcement	100	95%	97%	2%
CRT	Concrete	Foundation for walk ways	100	75%	96%	21%
BLK	Blocks	Foundation for walk ways	100	100%	100%	0%
PLT	Plaster	Dumped	100	100%	100%	0%

Almost all the KPIs show that due to demolishing, the project's wastage has good environmental and economic aspects. The excess material later disposed of in landfills. Demolished material has economic and environmental benefits; everything is used in different specific activities. In the walkway, a lot less new material used due to demolished concrete and block filling, steel is used in drains that result in saving huge amounts of capital, also less consumption of new resources that have a positive impact on the environment.

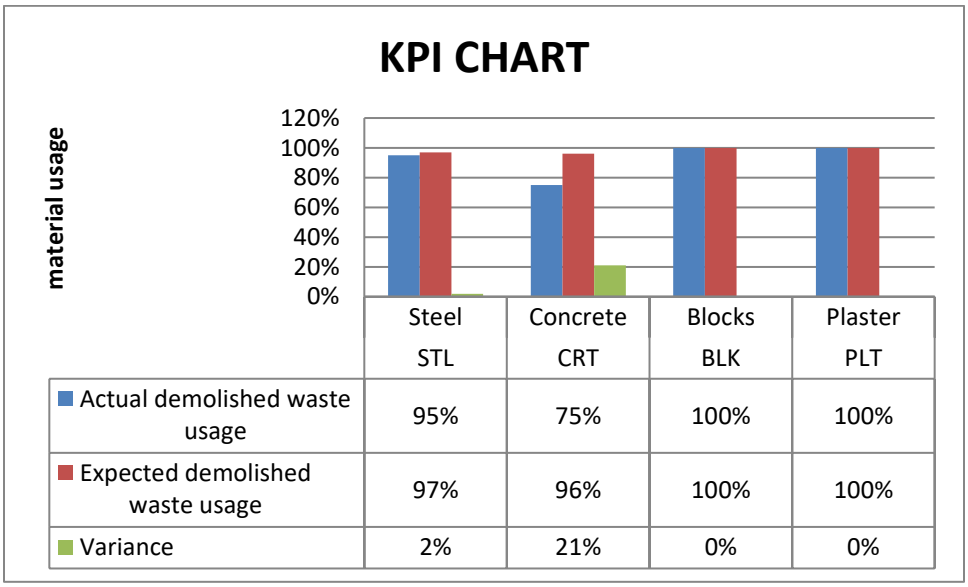

Figure 1: CDWM KPI's performance

9 PRACTICAL IMPLIMENTATION

The KPIs will help contractors to understand earned value from construction and demolishing waste materials. It is easy to implement all C&DW strategies on-site e.g. the main component in CDW is concrete which after crushing used as a sub-base in foundations [13]. It is very important to make new strategies regarding CDW because Pakistan is facing a bigger problem related to demolishing waste as more buildings already crossed their designed life span that will cause the creation of huge demolished materials. So, to sustainable development, it is necessary to reduce construction waste and use demolished waste wisely and sustainably.

10 CONCLUSION

This paper analyzes the current challenges to Construction and demolishing waste management in Pakistan by analyzing Hong Kong's waste management barriers. Suggestions are given in an effort towards better future planning. Lack of education and awareness in the construction industry in Pakistan: the country with a fast-growing population causes a huge and unmanaged consumption of resources results in land scarcity both for new projects and material waste landfills. The government should take initiative towards green construction as Pakistan is facing many issues related to energy, water, and climate change. However, without the participation of Architects, engineers, and contractors, all initiatives would be ineffective. No doubt, minimizing construction and demolishing waste management will be a new area of research in Pakistan.

The government of Pakistan needs to evaluate its waste management strategies. Hong Kong is a city with a relatively small area than the whole country. However, the District Municipal authorities in Pakistan have a hold on a specific small area that makes the implementation of the above-discussed CDWM system easy. A sustainable future for the next generation would be our main concern. The case study in this paper will help contractors to pay some attention to waste that it could be useful in different ways and as it has economic value.

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