International Journal of Future Generation Communication and Networking
Vol. 13, No. 4, (2020), pp. 4330–4336

Review of Waste Reduction Strategies for Civil Construction Projects

Nawanath Pandharinath Phadtara---

PHD Student Shri Venkateshwara University, Gajraula, UP.

Dr. Akeelahmed Khan ---
P*HD Guide Shri Venkateshwara University, Gajraula, UP.*

ABSTRACT

In construction and manufacturing industries, the direct waste is described as complete loss of raw materials that is they are irreparably damaged or simply lost. Here, the wastage usually needs to be removed from the site. In contrast, indirect waste has no physical loss of materials and cause only monetary loss. In this research we aim: 1) to analysis the status of Construction and Demolition (C&D) wastes 2) to study and anlyze the existing waste reduction methods 3) to estimate the fore-seeable difficulties 4) to present more effective waste minimizion methods. For the thorough investigation of the efficacy of existing waste reduction techniques, the telephonic interviews with recyclers, site visits to C&D sites and the recycling plants are carried out. We have observed that the recyclable material quality was poor and investment costs were higher. Along with these, the more demolition periods and limited spaces are also main barriers. Hence, we have suggested the following recommendations: 1) proposal for higher landfill charging schemes 2) setup for a centralized plant to recycle the wastes 3) collecting the support from government for the provision of land for these recycling plants 4) implementation of novel demolition techniques 5) allowing some locations for an easy access to drop-off recyclable materials 6) to allow some flexible demolition periods 7) setup for mobile recycling plants 8) reusing few material as donations to charitable organizations 9) providing higher flexibility in collecting concrete wastes 10) balancing the supply and demand of recycled materials.

KEYWORDS: *Construction, Construction waste; Waste reduction; Waste management, Civil Construction Projects.*

1. INTRODUCTION

There is a tremendous and continuous growth in the construction of infrastructure and buildings throughout the world. The waste generated through these constructional activities has severe impact on the productivity and environment. In most of construction projects, the actual quantity of the waste generated exceeds the envisaged quantity leading to unnecessary utilization of natural and human resources [1]. There is a wide scope for enhancing the project productivity by minimizing the waste generated from construction, which indirectly saves the extraction of natural resources [2].

It has been reported that, about 5% to 27% of total materials procured for construction is being wasted during execution. Since construction industry involves the participation of major industries for supply of raw materials and finished products, eliminating the waste generation could lead to huge cost savings to the company. Due to the increase in demand for power, the construction of Thermal, Nuclear and Hydro Electric power projects has increased throughout the globe. In India, presently the Power generation is at a level of 135GW against the target requirement of 435GW for 2017 (Powering in India – The Road to 2017 – McKinney& Company). Implementations of new power projects require various resources like men, materials, machinery etc [3].

Construction of any Power Plant requires huge quantities of construction materials like

ISSN: 2233-7857 IJFGCN

cement, reinforcement steel, structural steel etc. The cost of such basic materials constitutes 65% to 70% of the total project cost depending on the capacity of the Power Plants [4].

Since these materials that are required for construction have major cost investment, it would be more appropriate to minimize wastages in an efficient and feasible way for minimizing the loss. Due to increase in construction activities, lack of material resources and limited funding, waste generated from construction becomes a serious concern in India and yet no attention has been paid in this regard [5].

People involved in the construction often fail to identify and control waste generated during execution because of the absence of appropriate tools for measuring it. From the reported literatures it can be seen that, limited studies have been carried out in India on the types, composition and quantities of waste generated during construction of power plants. The main aim of this research is to make an attempt to study the present situation with regard to generation of construction waste from power plant projects in India [6] - [8].

The reasons behind generation of waste during construction of power plants in India have been explored in this research. The research is mainly focused on construction of nuclear and thermal power plant projects. The necessary data required to understand the different stages in construction are collected in detail from actual sites, research archives, personal interviews and group discussion [9].

The entire set of data for further analysis is collected by a structured questionnaire. All major construction stages and activities are covered in the survey questionnaire. The questionnaire is developed by taking into consideration various factors related to the construction of power plant projects. The questionnaire is circulated among the site officials, management staff and supervisors for their feedback [10].

The actual project site practices and processes are recorded using the structured questionnaire. The primary focus is on the reasons behind the generation of waste during the construction of nuclear and thermal power plant projects. The construction activity involves many stages like planning, design, procurement, material storage, execution etc., this research is conducted by grouping the various stages into two major groups [11].

The research highlights the major causes for material wastage in construction of power plant projects and suggests appropriate measures to be adopted to minimize wastage. The findings of this research lead to enhanced project productivity and resulting in cost savings to the extent of 1.67% to 1.94% of total project cost. This would also help in minimizing the extraction of natural resources [12].

2. CONSTRUCTION WASTE PROBLEMS

Waste is characterized as any material by-product of human and industries that doesn't have any value [25]. Approximate;ly 38percent of wastage is produced from C&D activities, around 6 thousand tons of wastage for each year are produced from construction activities. In 2001, the amounts of the ferrous metal of about 45.5percent with 8 lakh tons of the all recyclable materials and about 37.7percent with 6.6 lakh tons from wood and paper. Non-ferrous metal has the higher estimations of recyclable volumes, in which it esteemed as one thousand million dollars. For the total recyclable materials, ferrous metal, non-ferrous metal, wood and paper incorporated to about 87.1percent of the all out amount of traded recyclable materials and about 87.2percent of the overall estimations of the materials. Thusly, it is important to decrease the waste produced from those materials to protect the environment.

Because of a lot of wastages generation in the construction industries, a construction wastage management is necessary at the construction sites. Subsequent to recognizing the reasons for

ISSN: 2233-7857 IJFGCN

construction wastes, it is critical to structure approaches to limit it. Also, it should be made mandatory that each construction firm ought to authorize construction wastes management plans to it's specific method of business. As a result, every personnel from the administration to the operational level can make a beeline for a similar objective. Aside from reduction techniques, monetary issues in construction wastes management and contractual implications likewise assume a huge job.

3. CONSTRUCTION WASTE RECYCLING

Most construction waste are transported to landfills. There are many opportunities for the industry to minimize waste [5] to prolong the life of landfill sites, minimize transport needs and to reduce primary resource requirements (mineral and energy).

Although there are many material recycling schemes recommended by the government with some practical examples listed in Table 5, the actual administering of C&D waste recycling is limited to a few types of solid waste. When considering a recyclable material, three major areas should be taken into account [26]: i) economy; ii) compatibility with other materials; and iii) material properties. From a purely economic point of view, recycling C&D waste is only attractive when the recycled product is competitive with the corresponding natural resources in relation to cost and quantity. Recycled materials will be more competitive in regions where shortage of both raw materials and landfilling sites exists.

4. LITERATURE SURVEY

This section deals with the review of the research carried out in recent years related to managing the construction material waste generated during various stages of execution of the projects is presented in this section. Literatures pertaining to various types of construction projects are also presented.

A study was conducted by Ekanayake and Ofori to develop the building waste assessment score model for assessing building designs [16]. Because recovering of construction waste is not yet prevalent, the primary environmental concern should be the reduction of the generation of construction waste. It is necessary that to propose a yearly improvement plan that the primary target for ''controlling solid waste'' is to ''reduce the amount of waste generated'' [10]. In order to prevent the generation of construction waste, it is important to first determine the reasons for the generation of waste.

If waste generation could not be prevented or only prevented to a certain degree, the next step should be to ensure that the construction waste is reused and recycled as much as possible. An analysis has shown that recovery reduces the amount of waste and Green House Gas (GHG) emissions, saves energy, and reduces the use of raw materials [17]. Recovery also reduces the cost of disposal and the amount of waste in the landfills.

The Regulation on the control of excavation, construction and demolition wastes contains also the Rules regarding the recovery and use of excavation, construction/demolition wastes [12]. However, because this regulation has not yet been implemented, an effective study regarding recovering has not been made.

Because the necessary organizations that can recycle construction waste have not developed, large economic losses occur. However, the reuse of construction waste does occur at certain levels albeit quite irregularly. The collected used building materials are sold in open and semi-open markets that could be named as ''used building materials outlets.'' At these outlets, wood and PVC doors and windows, kitchen and bathroom components (closet, wash-bowl, kitchen sink, kitchen counter and cupboard), strips, tiles, plastic pipes, asbestos roofing sheets, wooden lath, etc., various materials and items that are in good and bad shape that can be reused are sold mostly to low income wage earners or those building squatter homes. Although the collecting and selling of materials from

ISSN: 2233-7857 IJFGCN

modifications by collectors is a positive application of reuse, it is not a system that functions at an efficient level [24].

The economic and environmental benefits to be gained from waste minimization and recycling are enormous [27], since it will benefit both the environment and the construction firms in terms of cost reduction. The economic benefits of waste minimization and recycling include the possibilities of selling specific waste materials and the removal from site of other waste at no charge or reduced cost, with a subsequent reduction in materials going to landfills at a higher cost [28]. Therefore, this can increase contractors' competitiveness through lower production costs and better public image. However, very few contractors have spent efforts in considering the environment and developing the concept of recycling building materials [29]. Because contractors rank timing as their top priority, their effort is always focused on completing the project in the shortest time, rather than protecting the environment [23,24]. Managing building material waste can in fact achieve higher construction productivity, save time and improve safety [30-32] while extra waste take extra time and resources for disposal that may slow down the construction progress.

Table 5: Recycled Materials for Construction Industry [4]

Recycled Materials	Applications	Local Examples
Aggregates	Sub-base materials for road construction, hardcore for foundation works, base / fill for drainage, aggregate for concrete manufacture and general bulk fill	Pilot studies carried out by Works departments
Asphalt	Aggregate fill and sub-base fill	Under investigation by Highways Departments
Excavated Materials	Filling materials	Housing Department's building projects
Public Fill	Land reclamation	Land formation of public filling areas
Pulverized Fuel Ash	Manufacture of concrete products, used in fill and reclamation, highway constructions and reinforced soil structures	Construction of Chek Lap Kok Airport, using structural concrete for foundation works in the Housing Department's building projects
Metal	Manufacture of new metal	Widely practiced in the local construction industry
Glass	Substitute for sand and aggregates as pipe-bedding material, gravel backfill for walls, crushed stone surfacing, backfill and bedding	Nil
Plastic	Synthetic materials in form of plastic lumber for landscaping, horticulture and hydraulic engineering	Used at some public recreational facilities such as garden furniture
Rubber	Manufacture of rubber slate tile use in roofing and sport / playground surface mat	Used at some public recreational facilities such as playground surface mats
Expanded Polystyrene	Manufacture of lightweight concrete for non-structural works	Used in manufacturing lightweight concrete in Housing Department's building projects

In the examination on the current situation on waste management and recycling in the construction industry, telephone-interviewing with recycling firms, interviewing with representatives and site visits to six local C&D sites are conducted. Their difficulties encountered in waste

ISSN: 2233-7857 IJFGCN

management and recycling practice are highlighted.

5. IMPROVING THE CURRENT STATUS IN RECYCLING MARKETS

There are several ways in improving the current status of recycling market as follows:

Waste minimization can only be achieved with a concerted effort. Design, construction, waste hauler, government and the supply chain of materials need to be coordinated. The government should be acted as an important role in the process by enacting necessary regulations, setting a higher landfill cost, cultivating the waste management culture, encouraging formation of recycling plants, mandating the use of recycled products, ensuring steady supply of all kinds of wastes for recycling and balancing the supply and demand of materials for recycling.

Likewise, the developers should be encouraged to use the selective demolition scheme to increase the recyclable waste, provide longer demolition contract duration to allow sufficient time for the salvage contractors to remove the recyclable items and mandate the implementation of the waste management plan during construction.

Designers should be educated to adopt more recyclable materials and energy such as the application of life cycle assessment of materials at the design stage, extending the design and technical life of building by improving its quality and durability, or extending the functional life through flexible or multifunctional building designs, using low waste designs and technologies such as reducing the use of on-site wet trades, wider adoption of prefabrication (e.g. facades, staircases and semi-precast floor slabs). The prefabricated elements being produced under a controlled factory environment can reduce the production waste and encourage the use of recycled materials such as recycled aggregate and asphalt, pulverized fuel ash and etc.

Most importantly, the above efforts need to be coordinated by a centralized and authoritative organization including the setting up the legal and practical framework, funding research and development in recycling practices and technologies, delineating clear responsibility and liability between stakeholders, encouraging investment on environment, and fostering an environment-concerned culture in the industry.

6. CONCLUSION

As environmental protection has been pressing hardly around the world, the pollution generation from construction activities seems difficult to control; while waste is the major element in the pollution generation. For controlling the waste generation in the construction industry, reuse, recycling and reduce construction materials have been encouraged. However, the existing waste recycling methods did not encourage various recycling parties and encountered difficulties from various directions. Therefore, some recommendations are suggested: i) proposing a higher landfill charging scheme; ii) setting up a centralized centre for recycling materials; iii) the government should be supported in the provision of land for recycling plants; iv) implementing innovative demolition methods; v) allowing some locations in town for residents' easy access to drop-off recyclable materials; vi) allowing flexible demolition periods; vii) setting up recycling plants in the form of mobile installations; viii) reusing the reusable components as donations to charitable organization; ix) providing higher flexibility in receiving concrete waste and x) balancing the supply and demand of recycled materials through legislations or incentive schemes.

REFERENCES

[1]. Poon, CS, Yu, ATW & Jaillon, L 2004, 'Reducing building waste at construction sites in Hong Kong Construction Management and Economics', vol. 22, no. 5, pp. 461-470

[2]. Hoe, L.K. (2005). Causal Model for Management of Subcontractors in Waste Minimization (Unpublished PhD Thesis). Department of Building, National University of Singapore,

ISSN: 2233-7857 IJFGCN

Singapore.

[3]. Berg, R. & Hinze, J. (2005). Theft and Vandalism on Construction Sites. Journal of Construction Engineering and Management, 131 (7): 826-833.

[4]. Begum, RA, Siwar, C, Pereira, JJ & Jaafar, AH 2007, 'Implementation of waste management and minimization in the construction industry of Malaysia', Resources, Conservation and Recycling, vol. 51, no. 1, pp. 190-202.

[5]. Forsythe, P. & Mate, K. (2007). Assessing Brick Waste on Domestic Construction Sites for Future Avoidance. Proceedings of 41st Annual Conference of Australia and New Zealand Architectural Science Association (ANZAScA), James Coulson, Dirk Schwede, Richard Tucker, (eds) Geelong: Deakin University.

[6]. Alan, M 2009, 'Creating value: a sufficient way to eliminate waste in lean design and lean production', Lean Construction Journal, pp. 13 – 23

[7]. Enshassi, A., Mohamed, S. & Abushaban, S. (2009). Factors Affecting the Performance of Construction Projects in the Gaza Strip. Journal of Civil Engineering and Management, 15(3): 269–280.

[8]. Zainul Abidin N (2010) "Investigating the awareness and application of sustainable construction concept by Malaysian developers" Habitat International Vol 34: pp. 421-426

[9]. Lam, PTI, Chan, EHW, Chau, CK, Poon, CS & Chun, KP 2011, 'Environmental management system vs green specifications: How do they complement each other in the construction industry?', Journal of Environmental Management, vol. 92, pp. 788-795

[10]. Koshy, R & Apte, EM 2012, 'Waste minimization of construction materials on bridge site (cement and reinforcement steel)—a regression and correlation analysis', International Journal of Engineering and Innovative Technology, vol. 2, no. 1, pp. 6-14

[11]. Mehdi Rashid & Gholamreza Heravi 2012, - A Lean Management Approach for Power Plant Construction Projects - Wastes Identification and Assessment

[12]. Shrivastava, S & Chini, A 2012, 'Using building information modeling to assess the initial embodied energy of a building', International Journal of Construction Management, vol. 12, no. 1, pp. 51–63

[13]. Peng, CL, Scorpio, DE, Kibert, CJ (1997), Strategies for successful construction and demolition waste recycling operations, Journal of Construction Management and Economics 15, 49-58.

[14]. Edwards, B (1999), Sustainable architecture: european directives and building design (Oxford: Architectural Press.

[15]. Coventry, S (1999), The reclaimed and recycled construction materials handbook (London: Construction Industry Research and Information Association.

[16]. Hong Kong Government - Environmental Protection Department (2006), Environmental Report 2006 (Environmental Protection Department, Hong Kong government.

[17]. Construction Industry Research and Information Association (1993), Environmental issues in construction: a review of issues and initiatives relevant to the building, construction and related industries (Construction Industry Research and Information Association, London.

[18]. Hill, R, Bowen, P (1997), Sustainable construction: principles and a framework for attainment, Construction Management and Economics 15, 223-239.

[19]. Ofori, G (1992), The environment: the fourth construction project objective?, Construction Management and Economics 10, 369-395.

[20]. United Nations Centre for Human Settlements (1993), Development of national capacity for environmental sound construction (United Nations Centre for Human Settlements,

ISSN: 2233-7857 IJFGCN

Nairobi.

[21]. Brown, L, Flavin, C, Kane, H (1996), Vital signs 1996: The trends that are shaping our future (Norton Co and Worldwatch Institute, New York.

[22]. Lenssen, N, Roodman, DM (1995), Making better buildings in state of the world 1995 (Worldwatch Institute, New York.

[23]. United Nations Centre for Human Settlements (1990), People, settlements, environment and development (United Nations Centre for Human Settlements, Nairobi.

[24]. Worldwatch Institute (1995), State of the world 1995 (Norton, New York.

[25]. Ferguson, J, Kermode, N, Nash, CL, Sketch, WAJ, Huxford, RP (1995), Managing and minimizing construction waste: a practical guide (London.

[26]. Sealey, BJ, Phillips, PS, Hill, GJ (2001), Waste management issues for the UK ready-mixed concrete industry, Resources, Conservation and Recycling 32, 321-331.

[27]. Craven, EJ, Okraglik, HM, Eilenberg, IM (1994), Construction waste and a new design methodology, in: C.J. Kilbert (Ed.), Sustainable Construction: Proceedings. Of the 1st Conference of CIB TG 16 (89-98.

[28]. McDonald, B (1996), RECON waste minimisation and environmental program, in: Proceedings of CIB Commission Meetings and Presentations (RMIT, Melbourne, Australia, 14-16.

[29]. Rogoff, MJ, Williams, JF (1994), Approaches to implementing solid waste recycling facilities

[30]. Environmental Protection Department (2001), Hong Kong Environment 2001 (Hong Kong Government.

[31]. Construction Materials Recycling Association, in: (2005).

[32]. Hendriks, CF, Pietersen, HS (2000), Sustainable raw materials: construction and demolition waste (RILEM Publication, Cachan Cedex, France.

ISSN: 2233-7857 IJFGCN