Feasibility of Utilizing Wastage Material in Construction Site

K. Selvakumar, R. Babu, R. Jegadeesan, V. Pavithra, S. Gokul Raj and A. Madhavan

Abstract--- Huge amount of construction waste generate annually and affecting our environmental. Construction activities increases construction waste problem around the word. Construction waste gives a negative impact to the environment, cost, time, productivity and social economy Vigorous literature review identified 81 factors for causing construction waste and clustered in 7groups of factors namely Design, Handling of Materials and Equipment, Workers, Management, Site Condition and Procurement and External. A structures questionnaire designed based on these factors was surveyed and interviewed among 25 experts in construction industry. Respondents need to ranks the factors and also to conform whether the factors belong to the assigned group. T–test statistical technique of comparing means was used in the analysis of data with SPSS version 23.0 software to the major construction waste generation attributes. A construction waste management system that can provide data on waste quantities, identify area that are problematic in waste generation, and be able to analyze the cause of these wastes is recommended. Diverting materials from disposal to reuse or recycling.

Keywords--- Waste Generation, Waste Management, Reuse or Recycle

I. INTRODUCTION

The building industry is consuming a considerable amount of resources, from the most common material sand to the valuable natural assets like timber. If the life cycle of the material on site, from its transportation and delivery to the end fate, is closely examined, it is generally known that there is a relatively large portion of the materials being wasted because of poor material control on building sites. There are two main kinds of building construction waste, structure waste and finishing waste. Concrete fragment, reinforcement bars, abandoned timber plate and pieces are generated as structure waste during the course of construction. Finishing waste (including a wide range of waste materials) is generated during the finishing stage of a building. Broken raw materials like mosaic, tiles, ceramics, paints and plastering materials are wasted because of careless use. The packaging of public and household facilities such as gas cookers, bathtubs, washtubs and window frames are also parts of the finishing wastes. The strategy to manage C&D materials comprises three major tasks: reduce, reuse and recycle. In this paper, it will concentrate on reducing building waste through better materials control.

II. OBJECTIVES OF THE STUDY

Material waste has been recognized as a major problem in the construction that has important implications both for the efficiency construction and for the environmental Impact of construction projects. The aim of this study is:

- To determine the important waste materials at construction site
- To study wastage level at different types of projects.

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- To Reason out causes of excessive wastage on site.
- To recommend ways of minimizing wastes on construction sites.
- To suggest effective measures of waste management on construction sites.

III. CONSTRUCTION WASTE

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

A. Physical Waste

Physical construction waste is 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. However, some defined directly to solid waste: the inert waste which comprises mainly sand, bricks, blocks, steel, concrete debris, tiles, bamboo, plastics, glass, wood, paper, vegetation and other organic materials. Another way to understand the physical waste or construction debris can be seen in construction site.

B. Non Physical Waste

The Non-physical waste normally occurs during the construction process. By contrast with material waste, non-physical waste are time and cost overrun for a construction projects. Similarly, researchers from Indonesia defined waste as not only associated with waste of materials but also other activities such as repair, waiting time and delays. Besides that, the waste can be considered as any inefficiency that results in the use of equipment, materials, labor and money in the construction process. In other words, waste in construction is not only focused on the quantity of materials on-site, but also overproduction, waiting time, material handling, inventories and unnecessary movement of workers. From the interview it was found that least attention was given for this type of waste in construction industry.

IV. METHODOLOGY

General

From the literature review the methodology chart is created. Methodology refers to step- by- step plan for achieving some desired result. Methodology provides details on how the works are carried out. The methodology chapter discusses the technical and managing approach in finding the needed resources for the project.

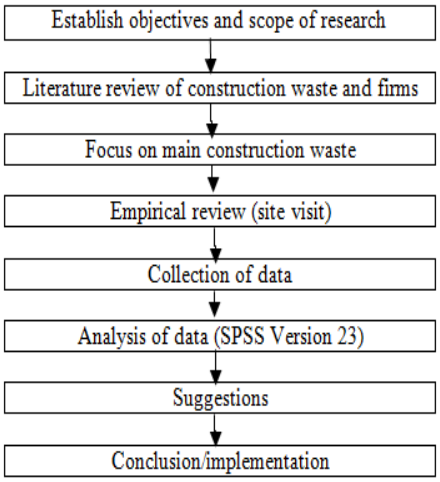

Fig. 1: Flow Chart of Methodology

V. EXPLANATION OF METHODOLOGY

A. Establish Objectives and Scope of Research

The study process should begin with a definition of the problem the construction industry faces and the establishment of specific objectives. The major difficulty here is converting a series of ambiguous construction problems into achievable research objectives. The objectives are drawn with reference to the work time available and the ease with which the same can be done.

B. Literature Review of Construction Waste and Firms

A literature review can be just a simple summary of the sources, but it usually has an organizational pattern and combines both summary and synthesis. A summary is a recap of the important information of the source, but a synthesis is reorganization, or a reshuffling, of the information. They have also conducted works on the waste minimization techniques of the technical fields of engineering. The literature collected is from the American Society of Civil Engineers (ASCE) journals which have International approval. This forms the main frame for the project.

C. Focus on Main Construction Waste

In this process, identification of major elements of construction waste and quantification and sources of construction waste are studied. These sources are derived from the literary works done by the previous researchers. The waste attributes are identified through literature review from previous studies on waste categorization.

PART 1: Causes of material wastage due to project management.

- Design and Documentation attributes
- Site management and practices
- Procument attributes
- Material Storage and Transportation
- Environmental and other condition

The material waste attributes are identified through literature review from previous studies on waste categorization.

PART 2: Causes of material wastage on construction Sites

- Steel Reinforcement
- Premixed concrete
- Timber Formwork
- Cement
- Sand lime and premixed motar
- Aggregate
- Ceramics Tiles
- Bricks and blocks

PART 3: Measures to minimize material wastage

The Questionnaire has been devised to suit the above criteria. The total Number of Questions in the Questionnaire is 121.

D. Collection of Data

The study will be conducted using structured survey questionnaire. A structured questionnaire focusing on major parties (i.e. construction material) involved in construction project. A structured questionnaire will be developed and distributed in Construction Company in India. The questionnaire where collected by direct visitations to the respective firms.

The Questionnaire is of Objective type. For a given population of 22, confidence level of 95% and degree of accuracy as 0.05, a sample size of 22 was required to represent contractor. 22 Construction companies were directly interviewed for the Questionnaires and of those were successfully completed and collected which represent 100% response rate.

Respondents were requested in the questionnaire to identify the major waste attributes in waste generation on sites by responding on a 5-point rating scale as: 5 – most significant, 4 – more significant, 3 - significant, 2 - less significant, 1 – not significant.

The next part of Questionnaire had the same 5 responses, but the rating points are as follows: 1 – very low influence, 2 – low influence, 3 - Moderate influence, 4 – high influence, 5 – very high influence.

E. Data Analysis

Using SPSS version 23 software, the responses were analyzed using one sample t – test to determine the major waste attribute and the causes of material waste. The mean score and the standard deviation were calculated to rank waste causes and material waste. The common major waste attributes in both were determined based on ranking of waste variables using one sample t-test and 95% confidence interval. Test value 5 was used to compare means. Those with mean value of 3 and above were considered as major waste attributes and the material waste and those waste attributes found to have mean scores less than 3 were considered insignificant and were left out.

F. Implementation

The most frequent waste categories will be identified which affecting in construction projects, identify the types of waste occurring on the top waste categories affecting in construction and determine their possible causes, and recommend guidelines to be applied in projects and reduce waste. To implement an efficient waste reduction program in construction projects is necessary to identify construction waste and its causes.

VI. RESULT AND DISCUSSION

A. Analysis of Result

The collected data has been analyzed by using SPSS software and the questionnaire focus on three major parts (Part-1 Causes of material waste due to project management, Part-2 Causes of material wastage in construction site, Part-3 The possible measures that contribute to the minimization of material waste).

$$t = \frac{M - \mu_m}{S_m}$$

Where $S_m = \frac{s}{\sqrt{N}}$

$$s = \sqrt{\frac{\varepsilon(x-M)^2}{N-1}}$$

M = Sample mean

S_m = estimated standard error mean

s = Standard deviation

x = variable

VII. CONSOLIDATED RANK WISE RESULTS

Table 1: Consolidated Ranking of Part-1

Rank	Major contributor of project management in construction	Mean	SD
1	Design And Documentation Attributes	4.22	1.04
2	Procument Attributes	3.78	0.82
3	Material Storage And Transportation	3.02	0.93
4	Environmental And Other Conditions	2.98	1.08
5	Site Management And Practices	2.54	0.82

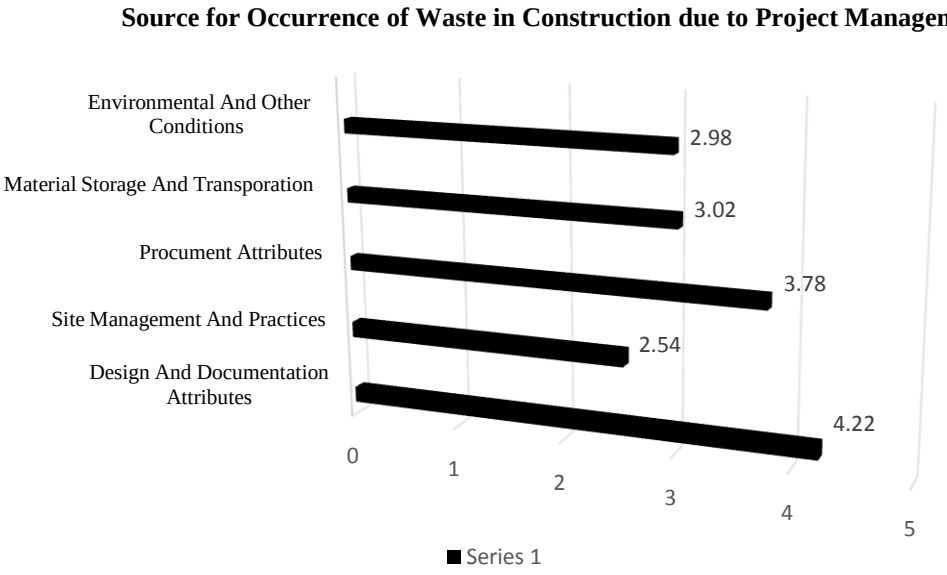

Fig. 1: Variables Significant in Causing Wastage

Table 2: Consolidated Ranking of Part-2

Rank	Major contributor of material wastage in construction	Mean	SD
1	Timber	4.22	1.04
2	Premixed Concrete	4	0.82
3	Ceramic Tiles	3.9	0.93
4	Cement	3.86	1.08
5	Steel Reinforcement	3.77	0.65
6	Aggregate	3.66	1.95
7	Sand Lime And Premixed Mortar	2.81	0.82
8	Bricks And Blocks	2.09	0.87

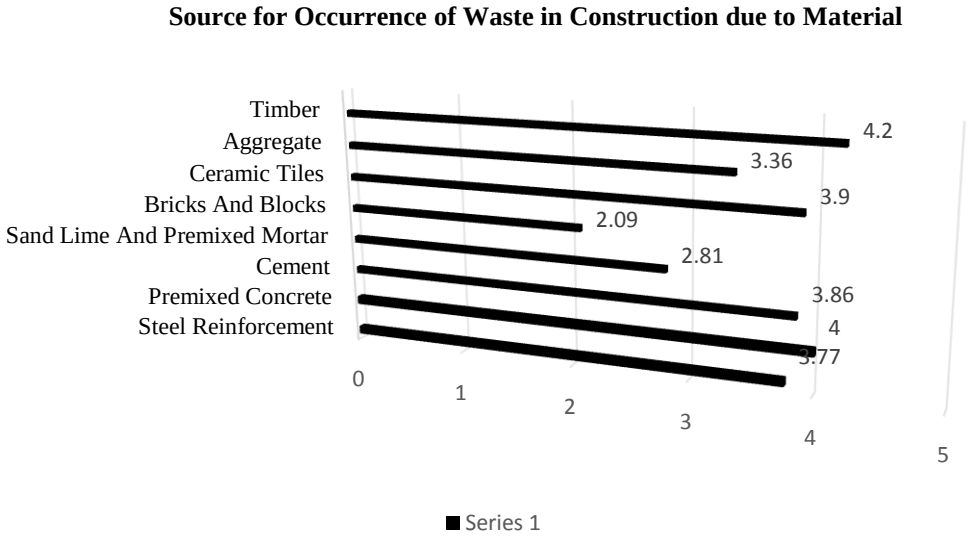

Fig. 2: Variables having Significant Influence in Material Wastage in Construction Site

Table 3: Internal Ranking of Part-3

Rank	Major contribute to the minimization of material wastage	Mean
1	Waste management officer or personal employed to handle waste issues	4.40
2	Good construction management practices	4.30
3	Weekly programming of works	4.30
4	Training of construction personnel	4.25
5	Mixing, transporting and placing concrete at the appropriate time	4.25
6	Proper storage of material on site	4.20
7	Minimizing design changes	4.00
8	Just in time operations	4.00
9	Checking materials supplied for right qualities and volumes	4.00
10	Use of more efficient construction equipment	4.00
11	Vigilance of supervisors	4.00
12	Good coordination between store and construction personnel to avoid over-ordering	3.85
13	Change of attitude of workers towards the handling of materials	3.85
14	Regular education and training of personnel on how to handle	3.80
15	Accurate and good specifications of material to avoid wrong ordering	3.80
16	Early and prompt scheduling of deliveries	3.70
17	Careful handling of tools and equipment on site	3.65
18	Recycling of some waste materials on site	3.25

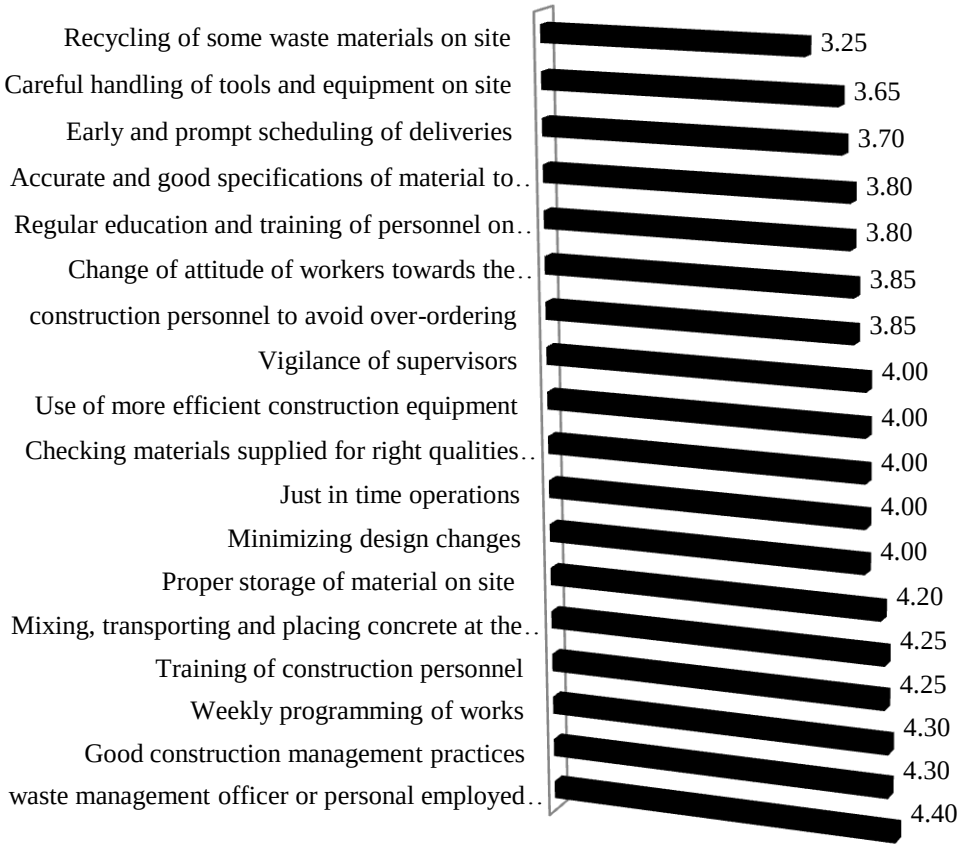

Fig .3: The Possible Measures that Contribute to the Minimization of Material Waste

VIII. DISCUSSION

The result in Tables1 indicate that Changes made to design while construction in progress, Selection of low quality products, Error in the contract document, In complete contract document at commence of project, Rework that don't fulfil with drawing and specification, Lack of attention paid to dimension coordination of product , Designer's in experience in methods and sequence of construction , Complexity of detailing in drawing, Lack of attention paid to the standard size available on the market Designer's unfamiliarity with alternative products, Waiting for designer document and drawing were ranked in the first positions as the most significant waste attributes on project management in their respective categories.

Timber wastage in various kinds of element formwork where ranked as the first in major materials in the construction site, the major timber waste is due to the non-optimized cutting of timber boards. In large project timer usage work there should proper planning for the cutting and making of element the new element which have been made for should be marked and used for the same size of elements in next coming elements, those should not be dismantled and used for other purpose. Breaking of time during the de shuttering of leads to the major damage and waste, and using of timber boards for other purpose also leads to great wastage

Inadequate stacking and insufficient storage on site can result from materials are stacked without pallets such as bricks/blocks, bags of cement, gypsum, lime etc., exposing materials to rainy weather such as steel bars which rust and may get damaged; unpacked supply of materials like bricks, glass and tiles often increase wastage during transportation due to their easily broken nature. From journals also found that inadequate stacking and insufficient storage of material was one of the major material waste factors. These results clearly indicate that there is need for training of both management and site staff in the planning and provision of the appropriate material storage and handling facilities on sites.

IX. CONCLUSION

The construction industry has been found to be a major generation of waste. The generation of construction waste also contributes to the reduction of raw materials using in the construction industry.

The result indicated that Changes made to design while construction in progress, Selection of low quality products , Error in the contract document, In complete contract document at commence of project , Rework that don't fulfil with drawing and specification, Lack of attention paid to dimension coordination of product, Designer's in experience in methods and sequence of construction, Complexity of detailing in drawing, Lack of attention paid to the standard size available on the market Designer's unfamiliarity with alternative products, Waiting for designer document and drawing are most five signifying sources of construction waste during the construction process.

From the result of construction material waste it is indicated that Non optimized cutting of timber boards, Excessive cutting of blocks, Cutting the tiles in great quantities, Poor storage of sand, Wrong storage of cement, Non optimized cutting of steel bar, are most six high influence causes of material wastage on construction sites. And it indicated that Timber formwork, Block, Tiles, Sand, and Cement are major five material wastage in construction sites.

From recommending result it indicate that Waste management officer or personal employed to handle waste issues, Good construction management practices, Weekly programming of works, Training of construction personnel, Mixing, transporting and placing concrete at the appropriate time, Proper storage of materials on site, and Minimizing design changes are most significant possible measures that can contribute to the minimization of material waste will be

the top most management practices needed for reduction of the material waste.

Therefore the application of method of waste identification is required urgently within the construction industries to assist construction managers to identify waste and eliminate it within construction process. And it is clear that the responsibility of eliminating of waste depends on all individual, the client, consultant manager, suppliers, foremen and worker.

Contractors' responsibilities are to assign qualified staff and workforce in construction projects and if required the staff should be trained according to any new project. And there should be a waste management plan to minimize the waste. He should work with all suppliers to reduce waste on a project by asking them to buy back unused product. There should be perfect planning for delivery of materials on site, their stacking in suitable places and their distribution to the workplaces.

REFERENCES

[1] B.A.G. Bossink and H.J.H. Brouwers, "Construction Waste: Quantification and Evaluation", Journal of construction engineering and management, Vol. 122, No. 1, Pp.55-60, 1996.

[2] Carlos T. Formoso and Lucio Soibelman, "Material Waste in Building Industry: Main Causes and Prevention", Journal of construction engineering and management, Vol.128, No.4, Pp. 316-325

[3] Cristiano R. CasteloBranco, "An Effective way to Reduce Residential construction waste: A Case Study in Texas", 2007.

[4] Jing Zhang and Danelle L. Eastham, "Waste – Based Management in Residential Construction". Journal of construction engineering and management(ASCE), Vol. 131, No. 4, Pp.423-430, 2005.

[5] Lee chin foo and Ismail Abdul Rahaman, "Classification and quantification of construction Waste at Housing Project Site", Vol.1, No.1, Pp. 1-4, 2013.

[6] L. Muhwezi, L.M. Chamuriho and N.M. Lema, "An investigation into Materials Wastes on Building Construction Projects in Kampala-Uganda", Scholarly journal of engineering research Vol. 1, No.1, Pp.11-18, 2012.

[7] C.S. Poon, Ann T.W. Yu and L. Jaillon, "Reducing building waste at construction sites in Hong Kong", Construction Management and Economics, Vol 139. No.5, 2004.

[8] Sasitharan Nagapan and Ismail Abdul Rahman, "Identifying Causes of Construction Waste – Case of Central Region of Peninsula Malaysia", International journal of integrated Engineering, Vol.4, No.2, Pp. 22-28, 2012.

[9] Said sakar Al – Moghany, Managing and minimizing construction waste in Gaza strip, 2006.