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# EVALUATION OF REDUCING WASTE MATERIALS IN CONSTRUCTION PROJECTS USING RANKING ANALYSIS

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## ABSTRACT

*This study focus on waste material identification in construction site, the waste can be majorly divided into two parts they are inert (sand, bricks, concrete) and non-inert (plastics, glass, wood, paper) by the combining both this mixtures construction waste will be obtained. Construction waste management has received globalized attention for some time. It results scientist started research and investigation widely on construction waste management (CWM). In CWM can make a drift in reusing, reduction or recycling construction waste the building owners and professionals should be educate about the strategies and beneficial reuse for separation and identification of waste material. The main aim of this paper is to collect the data related to waste material management in construction and to identify the high waste materials occurring during the construction, for this case questionnaire survey will be conducted, 40 questions prepared in that 37 questions related to waste management and three questions are related to personal opinion on waste materials in construction projects.*

**Keywords:** Construction waste material, analysis of data, reuse, recycle.

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# 1. INTRODUCTION

Indian construction industry producing very high level of construction waste material due to poor knowledge on effective utilization of materials, the construction and demolition produces 75% of solid waste in Indian majority of construction waste ends up with landfills, uncontrolled sites. This mainly causes pollution of air, surface water, underground water, public health and loss of natural recourse, so in order to decrease the pollution we need to use the construction waste as a recyclable material. For sake of the future generation we need to save the natural resources so the waste should be recycled and reused. Utilizing the recycled waste materials will reduce the construction cost. Construction and demolition waste can generate different types of waste materials, which includes bricks, concrete, rock, soil, timber, asbestos and vegetation. The construction and demolition waste materials can be recycled by using the recirculation methods, waste generated by construction actives, such as damage or spoiled materials, temporary and expandable construction materials and aids that are not included in the finished project, packaging materials, and waste generated by the workforce. Waste material measurement is one of the important issues in the management system due to its effective way to measure their performance, building material is complex to recycle, due to avoid the pollution and large degree of different materials mixed together and its requires more space to disposal in large city, this is major problem so in that case to utilize the waste material in construction materials by recycle methods. The waste can be produced by different categories like unnecessary movement of workers or employs, time waste in during the work for waiting of equipment to finish the work, less quality products used in projects, unnecessary processing of goods in that projects and unnecessary transformation of materials. Occurrence of waste materials in construction: -Concrete, Steel, Bricks, Timber, Glass, Granite, Tiles, PVC Pipes waste.

**Concrete**: Concrete wastage mainly caused due to improper planning and estimating quality of concrete for particular structural work, concrete waste can affect the project cost and time, to get rid of this problem there should be proper planning and supervision is required while mixing, transporting and placing of concrete. Site supervisor must explain to the labor about problems that are facing while placing concrete. The concrete waste will cause mainly in poor handling, over- sized foundation and other elements, poor storage, poor workmanship, transport method.

**Steel:** Preparation of bar bending schedule is very important before placing the steel bars, because it help to decrease the wastage up to 95%, remaining wastage of steel 5% is scrap. The steel waste mainly caused due to change in design, over ordering, low ordering, and damage during the transportation to site / on site, inappropriate storage leading to damage or deterioration, inclement weather conditions, lack of good storage location system. Steel waste can be recycled.

**Bricks:** Adopt just in time ordering and to ensure materials arrive on site when they are needed. Thereby we can avoid damages while storing on site and additional moving of materials, the protection of bricks must be important, in that case care should be taken in every movement, Dropped, spoiled or discarded materials during fixing, Bricks and blocks are the most common wailing materials, the main cause of bricks and block waste is forms during cutting. In time of delivery of materials, if they were Unpacked it may produce more wastage because of the fragile nature of materials. In most poorly performing sites, combinations of materials waste causes are related to the waste of bricks and blocks. Many of sites facing delivery of poor quality of materials and damaged materials and in this study further confirmed that 75% of the waste bricks are due to cutting and it was recommended that a change in design of bricks could reduce the amount of waste generation on site.

**Timber:** Safety measures should be taken while transporting timber from depots to the construction site, quality of timber should be check on and off site to avoid the accounting the errors, it must be order the pre-made framing for easy to handling and also avoid off-cut on site, while ordering specific dimension should be given. The wastage of timber mainly develops by natural deterioration and also from cutting. The timber waste occur mainly 20% in the foundation works. Due to wet nature in foundation high-level wastage will occur, by proper handling and storage in safe place can avoid waste. Wood based products produces major waste on construction site. The strength of timber manly gained by texture, grain, color and shape, the shrinkage problems can be mainly avoided by properly stored.

**Glass:** Glass materials can be handle carefully during the transportation to the site, due to its fragile nature handling of material should be careful while uploading and placing, it should be properly storage otherwise the breakage or damage will occur, placing of glass must be safe to avoid the unnecessary movements, in the construction the glass materials can be windows glass so they might be reusing on construction based on the deal with glass handling, storage, transportation form to site.

**Granite:** Granite roll off collection fleet is operated by trained and experienced operator to avoid the waste of granite use specialized equipment for preparation of customers' requirements, granite waste can be recycled. The collection of granite waste from the site should be removed by staff and also to take responsibility of collection and removing the waste seriously. At the time of moldings the waste can be developed and to maintain the proper storage handling should be careful at the site.

**Tiles:** Tiles waste can be produced at the time of preparation, and the tiles waste can mainly produce due to improper storages and handling, need to take safety measures at the placing on site. At the time of arranging for floor experienced works should be preferred to operate the materials, most of cases tiles waste can be developed by storage places and same as transportation time.Taking care at both times the waste can be reduced.

**PVC pipe waste**: PVC waste is less compare to other materials because of pipes are buying at required lengths only and waste of small pieces pipes can be produced by cutting at end point of fitting, the waste can be reduced by proper storage and handling. Long length pipes facing problems when the transportation of materials to site, to avoid that type of problems there is a chance of decreasing the wastage of pipes.

## 2. OBJECTIVE

1. Evaluation of waste materials in construction site.
2. To Analysis the reducing of cost related to waste in construction industry.

## 3. METHODOLOGY

- Identification of different type's waste material based on the collection of different papers and case study data.
- Prepare the questions related to waste material in construction site.
- Questionnaire survey conducted in construction companies and personnel interviews with project incharge and construction project managers.
- Analysis of data and questionnaire.
- Results and recommendation.

### 3.1. Data collection

Date collection done in two ways, first one is to collect the waste materials, which are produced in construction site, collection of latest published papers and research methodology, and second one is personal interaction with construction company officials, in personal interviews with project incharge, site engineers and labors. In that case we enquired that whether the company has following any waste reuse methods, recycling methods, or not, and also collected the data regarding waste recycling material list as we collected how much waste material can produces in construction site.

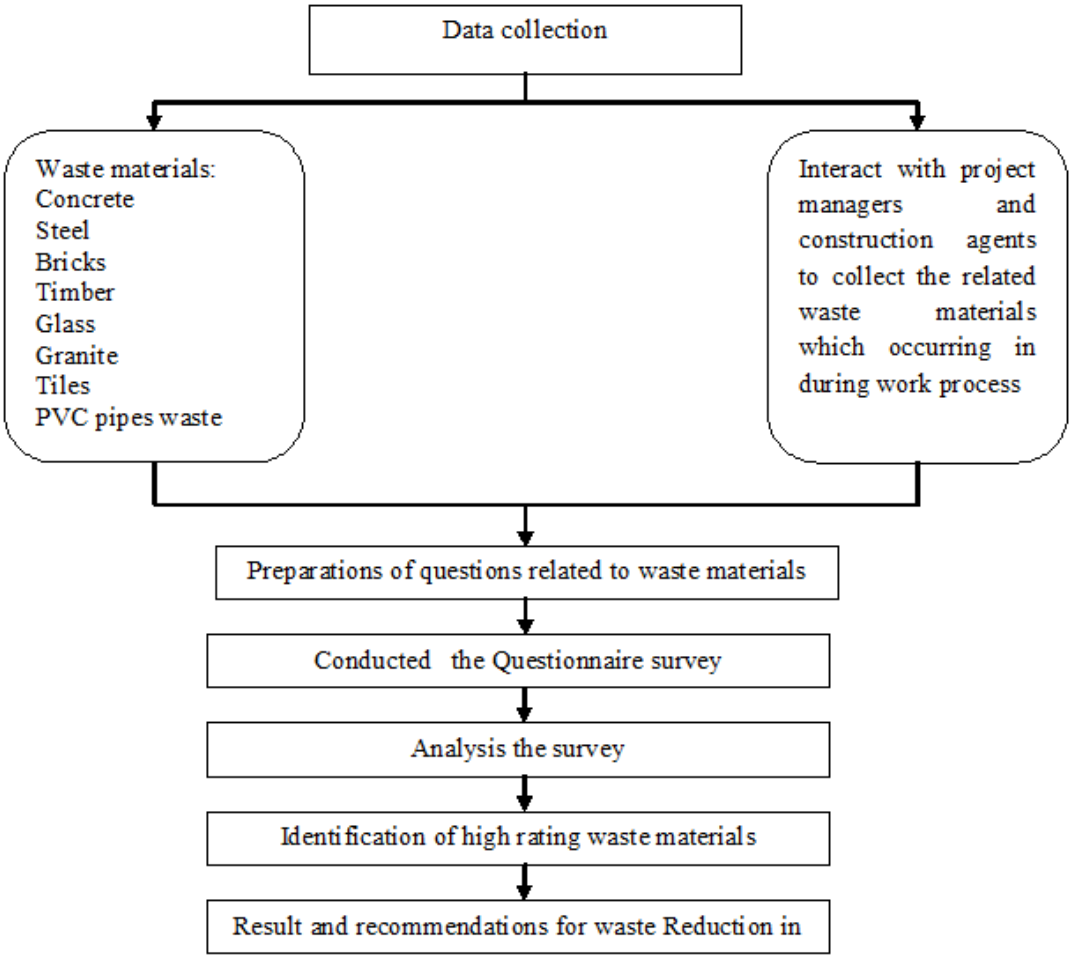


**Figure 1** Methodology Flowchart

## 4. RESULTS AND DISCUSSION

### 4.1. Analysis of survey

In this study we are conducting questionnaire survey. Total 40 questions are in that survey 65 responses are given out of 70 members. The survey mainly focus on the waste materials in construction site, we have identified the high rating waste materials and low rating waste materials, and also measure the causes of waste materials in construction site and to give the analysis which causes high priority to some questions related to the waste materials how they are used in construction site.

Table 2 Calculation for Questionnaire Survey

Ranking analysis = $\sum_{i=1}^{10} \frac{(Xi * Yi)}{N}$

Xi= Response rating

Yi= number of points (value from 1 to 5)

N= total number of responses

Example for calculation 1st question: [(1*6)+(2*5)+(3*3)+(4*10)+(5*45)]/69 =4.2

2nd question: [(1*5)+(2*14)+(3*20)+(4*15)+(5*14)]/69 = 3.2

**Table 1** Questionnaire survey on waste materials and their Ranking

| S.no | Questions waste materials | 1 | 2 | 3 | 4 | 5 | Rank |
|---|---|---|---|---|---|---|---|
| 1 | What is the rating concrete waste in construction during your project? | 6 | 5 | 3 | 10 | 45 | 4.2 |
| 2 | What is the rating bricks waste in your project? | 5 | 14 | 20 | 15 | 14 | 3.2 |
| 3 | What is the rating steel waste in your project? | 15 | 19 | 15 | 9 | 11 | 2.7 |
| 4 | What is the rating timber waste in your project? | 17 | 22 | 10 | 11 | 9 | 2.5 |
| 5 | What is the rating glass waste in your project? | 17 | 23 | 10 | 11 | 8 | 2.4 |
| 6 | What is the rating tiles waste in your project? | 15 | 10 | 28 | 11 | 5 | 2.8 |
| 7 | What is the rating cardboard waste in your project? | 6 | 14 | 28 | 10 | 11 | 3.0 |
| 8 | What is the rating pipes waste in your project? | 9 | 18 | 22 | 5 | 10 | 2.6 |
| 9 | What is the rating plastering waste in your project? | 20 | 18 | 15 | 10 | 6 | 2.1 |
| 10 | Construction companies perform well in the area of CWM | 6 | 14 | 28 | 10 | 11 | 3.0 |
| 11 | Construction companies have a waste management strategies | 10 | 18 | 17 | 15 | 9 | 2.8 |
| 12 | Cost of waste does not have much effect on project | 3 | 13 | 21 | 13 | 19 | 3.4 |
| 13 | Waste management is as important as other functions of construction management. | 3 | 13 | 18 | 19 | 16 | 3.4 |
| 14 | Attention of waste management in actual practice is not sufficient. | 9 | 11 | 24 | 13 | 12 | 3.1 |
| 15 | Waste management is worthwhile irrespective of the cost gains | 2 | 13 | 24 | 17 | 13 | 3.3 |


**Figure 2** Rank wise Graphical representation of waste materials in construction site

The above flowchart shows that concrete waste has got high rating compare to other materials. Glass waste has got least rating (2.4) and remaining materials almost have same rating, the produced waste rating ranged between 2.5 to 3.2. In that total analysis the material

waste can be mainly produced due to some causes of waste materials in construction site, table1 shows the ranking level of waste causes in ranking wise. The waste material in site mainly causes by improper planning of materials, usages and also many companies are not following the waste management techniques. In India 64% companies are not following the waste management rules, only 34% of companies follows the waste reuse and recycle process in construction.

**Table 2** Questionnaire survey for Causes of waste materials

| S.no | Questions | 1 | 2 | 3 | 4 | 5 | Rank |
|---|---|---|---|---|---|---|---|
| 1 | What is waste rating level in poor supervision? | 3 | 8 | 4 | 18 | 36 | 3.9 |
| 2 | What is the waste rating level in poor workmanship? | 3 | 20 | 14 | 18 | 14 | 3.2 |
| 3 | What are the waste rating level weather problems? | 3 | 13 | 21 | 18 | 19 | 3.4 |
| 4 | What is the waste rating level in material deterioration? | 9 | 11 | 24 | 18 | 14 | 3.16 |
| 5 | What is waste rating level in human errors? | 2 | 10 | 20 | 21 | 16 | 3.5 |
| 6 | What is the waste rating level in design errors? | 2 | 13 | 24 | 17 | 13 | 3.3 |
| 7 | What is the waste rating level in design changes? | 3 | 16 | 14 | 22 | 15 | 3.45 |
| 8 | What is the waste rating level in improper storage? | 9 | 17 | 19 | 10 | 14 | 3.0 |
| 9 | What is the waste rating level in poor storage facilities? | 3 | 10 | 15 | 22 | 17 | 3.7 |
| 10 | What is the waste rating level in improper handling? | 15 | 19 | 15 | 9 | 11 | 2.7 |
| 11 | What is the waste rating level in ordering errors? | 6 | 13 | 21 | 17 | 11 | 3.12 |
| 12 | What is the waste rating level in equipment malfunctions? | 8 | 23 | 15 | 15 | 5 | 2.9 |
| 13 | What is the waste rating level in without following the waste management? | 6 | 13 | 17 | 19 | 14 | 3.6 |

**Table 3** Analyzing the questionnaire survey of waste in construction site based on ranking.

| S.no | Causes of waste in construction site | Rating level | Rank |
|---|---|---|---|
| 1 | Poor supervision | 3.9 | 1 |
| 2 | Poor storage facilities | 3.7 | 2 |
| 3 | No waste management | 3.6 | 3 |
| 4 | Human errors | 3.5 | 4 |
| 5 | Design changes | 3.45 | 5 |
| 6 | Weather problems | 3.4 | 6 |
| 7 | Design errors | 3.3 | 7 |
| 8 | Poor workmanship | 3.2 | 8 |
| 9 | Material deterioration | 3.16 | 9 |
| 10 | Ordering errors | 3.12 | 10 |
| 11 | Improper storage | 3.0 | 11 |
| 12 | Equipment malfunction | 2.9 | 12 |
| 13 | Improper handling | 2.7 | 13 |

**As per the above table3**: Shows that the causes of waste material in construction site. Based on the survey poor supervision has high rating and its no.1 in ranking, many of construction companies in India having improper planning in maintaining of waste materials, the survey shows that causes of production waste in construction site. And not following the waste management, design changes and design errors give more waste of construction projects. Acquisition the bad quality of materials get effected on the entire project, in that case acquisition of best quality and quantity materials. In some conditions human errors,

equipment malfunction can also produce the waste materials, to maintain the proper planning at the starting of work to check the all conditions.

The results show that in every site works the waste can produce to some percentage by maintaining conditions like improper planning, human errors in site work, equipment malfunction and some other technical problems. In that case we need to follow the proper planning in every stage of work from initial stage to finishing stage of work progress must follow the waste management rules and conditions. If any waste can produced by mistake of any technical problems to reduce, reuse & recycle the waste materials. The following recommendations are made against the conditions of the research findings:

1. The government can provide the strict conditions to follow the waste management and introduce specific legislation governing the handling and disposal of waste.
2. To educate the sustainable construction in the curriculum of professionals in construction industry.
3. Government can provided the rewards firms who embrace waste management wholly.
4. If a project manager or contractors forecast and record the type of construction materials waste, which produced in a project, also aid in creating appropriate management action that reduces the amount of waste.
5. Illegal dumping of construction waste materials will damage the environment, to reduce this problem a dumping site, which separates the materials, based on inert and non-inert materials and it will be sent to their recycling factories to effective use of wastage.
6. Implementing reuse, recovery, and recycling by construction waste management plan will help on project cost.
7. Proper communication among all parties will reduce construction waste, who involved in a construction project, including customer, contractor, engineer, planner, subcontractor, labor and even the suppliers.
8. At the pre-planning stage of the project, proper material scheduling and material requirements at the right place and the right time will decrease the waste in constriction.
9. If some basic practices are mandatory in the construction process like anyone green building materials will be involved in construction will help in recycled material and construction cost.
10. If the government encourages the recycled or reused production materials to involve in government construction projects the economy of construction going to decrease.
11. If government provide free guidance and training courses for freely that helpful for low and medium projects to achieve the waste reduction, re-use and recycle the material to effective use and reducing construction cost.

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