

Waste Management in Indian Construction Industry

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Abstract

Waste results due to inefficiency in the use of construction equipment, materials, labour, or capital in larger quantities than those required or considered as necessary in the construction of a building or infrastructure. Waste in construction includes both the incidence of material losses and the execution of unnecessary work produced by activities. Both generate additional costs (direct cost and indirect cost) but do not add value to the building from the point of the client. Efforts to reduce, reuse and recycle construction waste through a significant change in the level of technological development may save money, reduce liability, keep job sites cleaner and safer, conserve valuable landfill space and help in successful implementation of viable affordable housing project. A classification for waste in the construction industry is reported in Garg (Ref: 2). It is necessary to classify the waste in different categories to understand why they occur and for taking corrective actions to prevent or avoid the waste. Waste can be classified in unavoidable waste or natural waste and avoidable waste. The percentage of unavoidable waste in total waste will depends on job site, on company and level of construction technology involved. This paper aims to highlighting the importance of waste management, identifying the causes of waste, their reduction through change in construction material and process and to propose guidelines for waste control at building sites in Indian construction Industry.

Introduction

In 1998, the U.S. Environment Protection Agency (EPA) estimated that 25% to 40% national solid waste is of building-related construction & demolition (C&D) material waste in the U.S. The composition of generated C & D waste materials varies significantly with type of project. The waste materials from older buildings is likely to contain plaster and lead piping, while from new construction, it contain significant amounts of drywall, laminates, and plastics. EPA estimates the overall percentage of building C & D waste materials falls within the following ranges (Ref. 7)

Table 1 : Range of Building C & D Materials Waste (EPA Estimate)

Concrete and mixed rubble	40-50%
Wood	20-30%
Drywall	5-15%
Asphalt roofing	1-10%
Metals	1-5%
Bricks	1-5%
Plastics	1-5%

Waste management should be an integral part of projects development. Each of the principle projects participants-the owner, the architect, the contractor and the subcontractors- should engage and contribute in waste management throughout the project. The owner must

establish waste reduction goals and define what levels of diversions are achievable and reasonable under the project conditions. The Contractor is responsible for defining the means, methods, techniques, sequences and procedures of construction for waste reduction.

Origin or Causes of Wastages

The following construction work are found the major waste producing construction work in a survey at different construction sites in India.

- 1) Form work
- 2) Finishing work
- 3) Masonry work
- 4) Concrete work
- 5) Material handling
- 6) Scaffolding and
- 7) Hoarding

Factors leading to wastages are shown in Fig.1

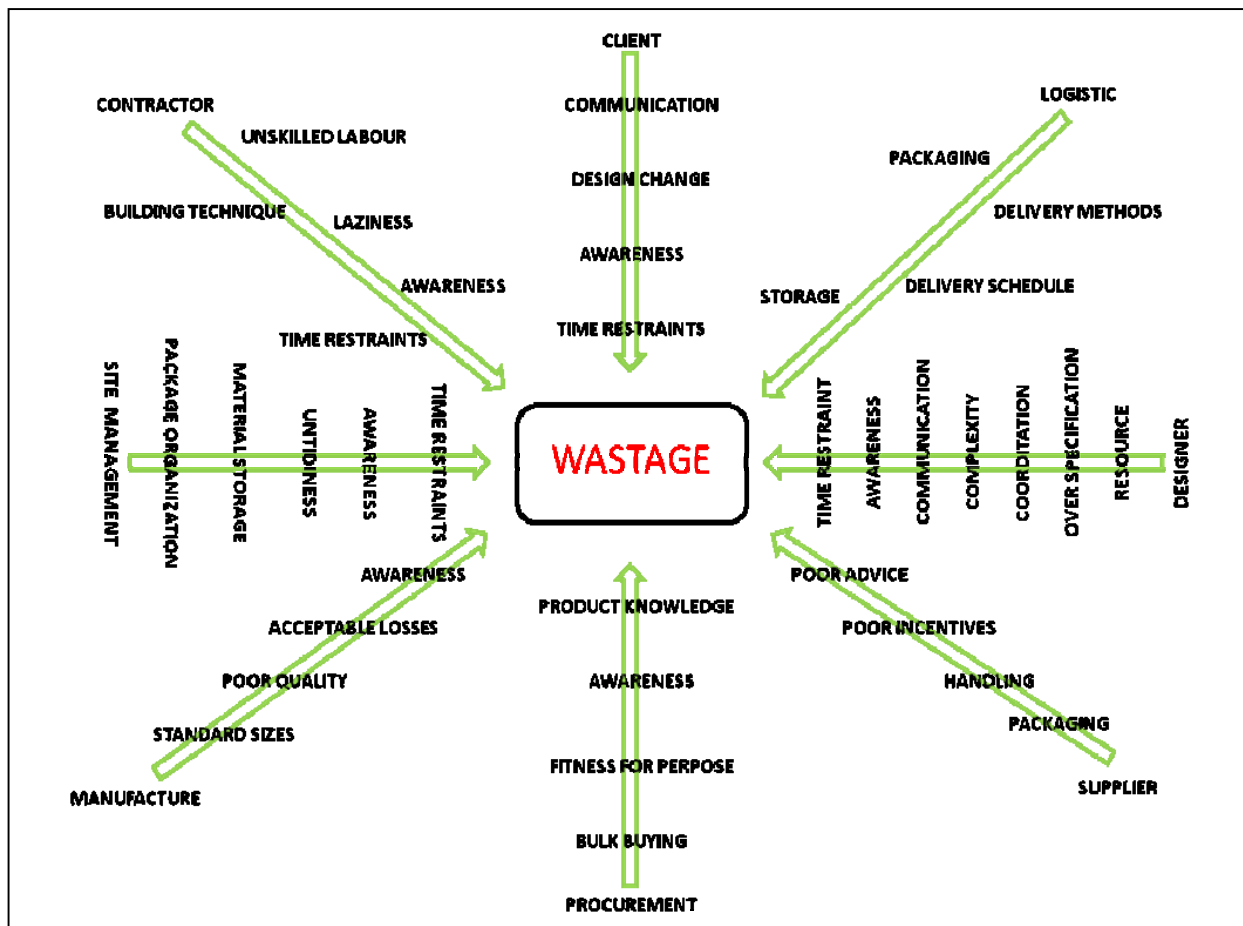


Figure 1. Factors responsible for the generation of wastages in construction.

Waste Management Techniques

Much of the site waste is harmful to the environment and costly to business. The following waste management technique will help in managing site waste more effectively, reducing potential harm to the environment and human health.

1) By developing a Construction Waste Minimization Program

To develop a successful Construction Waste Minimization Program, a Contractor should evaluate each of the following steps and determine the best and most cost-effective approach for waste minimization.

i) Design to Prevent Waste

Paying attention to waste potential in the

building's design stage can lead to less waste on the site. Some issues to consider in the design phase of a building are:

- Be efficient in area and volume. If less material is required by the design, less waste is generated at the jobsite.
- Optimize building dimensions to correspond to standard dimensions.
- Modify framing layouts & details to optimize lumber use and reduce waste and costs when ordering.
- Order drywall in optimal dimensions to minimize cut-off waste. Drywall is available in different lengths, and designed dimensions should correspond to standard sizes.
- Minimize the number of blueprints and reproductions necessary during the design and construction.

ii) Plan For Waste Prevention

- Estimate the types and quantities of waste the project will generate and determine a schedule of when the wastes will be developed.
- Work with all suppliers to reduce waste on a project by asking them to buy back unused product.
- Ask suppliers to deliver supplies using sturdy, returnable pallets and containers. Then have the suppliers pick up the empty containers when delivering new building materials.
- Ascertain if storage and handling practices prevent loss from weather and other means and make revisions as needed.+

iii) Prevent Waste On-Site

Waste generated on site mainly are Wood, Drywall, Cardboard and Siding.

- Store lumber on level blocking and under cover to minimize warping, twisting and waste.

- Use lumber and plywood/oriented strand board (OSB) cut-offs as fire blocking, spacers in header construction and in other ways.
- Use clean sawdust in compost piles or around planting areas. Avoid sawdust that might contain painted or treated wood.
- Use large drywall scraps as filler pieces in small hidden areas.
- Reuse joint compound buckets for tool or material storage by clients or crews.
- During construction, collect, stack and cover brick and other masonry materials to prevent soiling or loss.
- Clean concrete chunks, old brick, broken blocks and other masonry rubble can be used as backfill along foundation walls.
- Use returnable containers and packing materials and give away non-returnable materials.
- Install leftover insulation in interior wall cavities or on top of installed attic insulation if it cannot be used on another job.
- Branches and trees from site clearing can be chipped for use on the site as landscaping mulch.
- Vinyl and metal siding cut-off waste can be returned to a waste collection area for recycling.

iv) Purchase to Prevent Waste

- Avoid excessively packaged materials and supplies. Packaging should be adequate to prevent damage and waste.
- Minimize waste by ordering only the quantity needed in building specific lengths.
- Evaluate estimating procedures to make sure that excess material is not delivered at site.

v) Document Waste Prevention Savings/Costs

- Keep accurate project records of the costs and savings associated with waste prevention and the corresponding environmental impacts.
- Develop a list of suppliers and recycle contacts for easy reference and use in future projects.

2) **By proper utilization of Construction & Demolition (C&D) Waste Materials**

C & D waste materials are landscape and land clearing debris, Asphalt pavement, Gravel and aggregate products, concrete, masonry scrap and rubble, metals (ferrous and non ferrous), clean wood, plastics, Asphalt/bituminous roofing, insulation materials, glass, doors and window assemblies, carpet and carpet pad, fibrous acoustic materials, ceiling tiles, plumbing fixtures and equipment, lighting fixtures and electrical components, cardboard packing and packaging and others. The possible utilization of some of the C&D materials is:

- **Wood:** as a fuel, mulch, bulking agents for composting, manufactured wood products, alternative wood fibre-based materials.
- **Metal:** reuse by salvagers, various metal feed stocks
- **Glass:** reuse of windows and mirrors, inert granular material additive, fibreglass.
- **Concrete:** road base, fill material, aggregate for new ready-mix, lime for a neutralizing agent, riprap for harbours.
- **Asphalt Pavement:** asphalt patch for roads (cold-mix), on-site processing into hot-mix for roads, road base or fill material
- **Drywall:** soil amendment (gypsum), cement additive (gypsum), new drywall (gypsum), paper fibre feedstock (paper), animal bedding (paper)

- **Rubble:** aggregate for fill or road base, construction entrance roads, drainage bed material, landfill cover material.

3) **Construction contract requirements for waste management**

The Owner and their Architect/Engineer must determine how their waste management requirements are represented in the contract documents and incorporated into the project. There are essentially three ways to represent waste reduction requirements in the contract documents:

- Describe the waste reduction goals and rely on the Contractor's own initiative to achieve them. This may be effective if the Owner and Contractor share a good working relationship, and encouraging the Contractor is sufficient for them to "do the right thing."
- Specify definitive minimum waste and debris diversion criteria.
- Incentives to reward the Contractor.

The Contractor can contribute to waste reduction in the following ways:

- By performing multiple functions with one material rather than requiring multiple materials to perform one function.
- By using standard material and product dimensions. Locate features "on module" to the extent possible to reduce cutting which creates scrap.
- Where possible, select construction systems that do not require temporary support, shoring, construction aids, or other materials that will be disposed of as debris during and after the project.
- Where possible, select materials that do not rely on adhesives, which require containers and create residue and packaging waste.

- Where possible, reduce requirements for applied finishes, laminates, coatings, adhesives, and the associated scrap, packaging, and waste. Select materials with integral finishes.

4) By Designing Best Site Waste Management Plan (SWMP)

A successful SWMP requires careful planning and preparation. There are nine important steps to producing a best Site Waste Management Plan (Ref. 4 & 5) as shown in Fig. 2.

- It help in making cost savings by better managing of material supply, materials storage & handling & better managing the waste for recovery or disposal.

Waste management hierarchy given by Kibert & Lanquell (Ref. 3) for waste management is shown in Fig. 3.

Guidelines for Controlling Waste

The following guidelines should be established for strengthen the continuous process control and improvement necessary

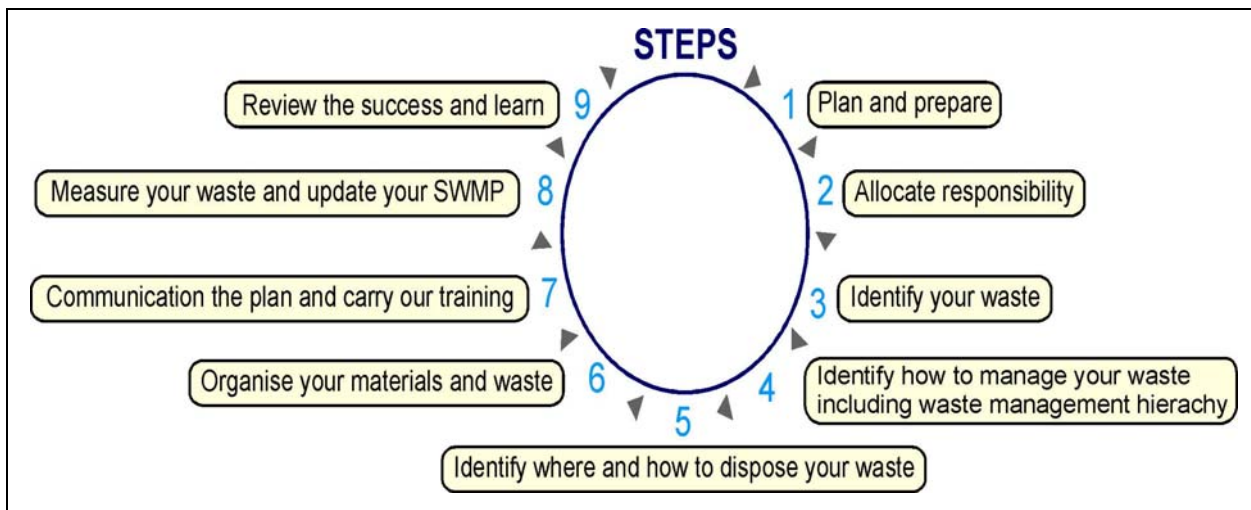


Figure 2. Steps in producing a best Site Waste Management Plan (SWMP).

Benefits of SWMP:

- Better control of risks relating to the materials and waste.
- Better dealing with any queries from environmental regulators regarding waste arising at site.
- It helps in demonstration to the client how you manage waste & minimize costs & risks.
- It help in fulfilling the requirement of Quality Management System (QMS) & Environment Management System (EMS).

for waste control at site.

1. Monitoring: The following data should be monitored

- Data on productivity of workers from production chart.
- Usage of materials and man hours spent in the process are collected from resource usage chart.
- A periodical inventory survey to monitor the physical quantity of materials stored on site.

- Efficiency of construction processes.
- Quantify and show the variability of productivity, production and waste rates using control charts.

2. Evaluating: It must be quick and flexible enough so as to motivate people and to make feasible the intervention in the process before it finishes. Whatever the

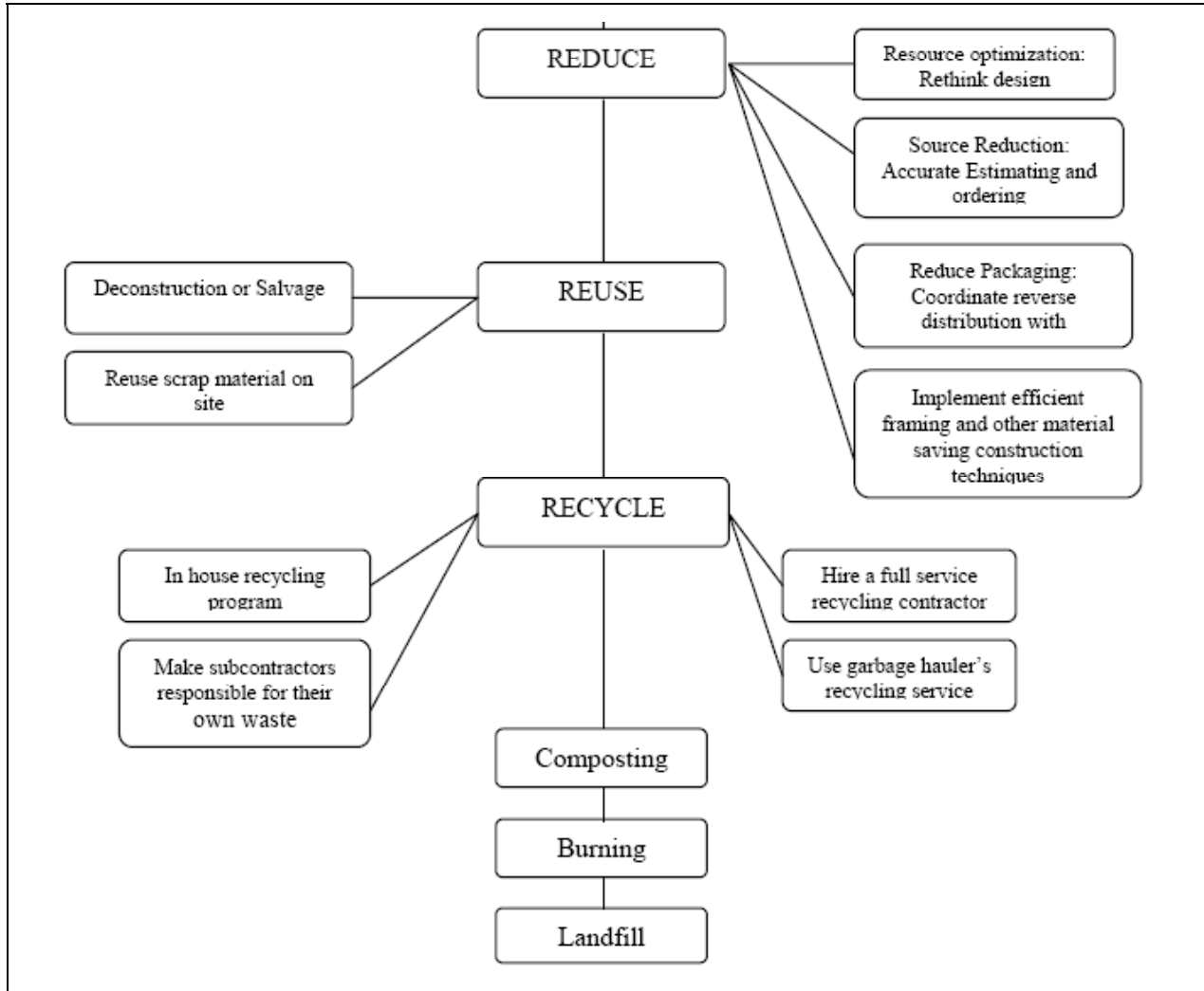


Figure 3. Waste Management Hierarchy.

Feedback data during monitoring from the site must be much more transparent as possible and the people directly involved in the construction process must be the first ones to see the results. As a consequence, those people could learn from their own experiences and commit themselves to the reduction of waste in the construction process.

data collected it must be useful for improving the process and avoiding further waste.

3. Auditing: The tools used in the audit may be

- A check list about Site-condition and Process Performance Evaluation: It enables a qualitative evaluation of the process performance and work

environment. It also points out improvement opportunities.

- Process Chart: It is used for registering improvements in the process
- Videotapes and Photos: It helps in documentation of the process and the work environment in order to improve transparency for the people involved in the improvement of the process.
- Additional indicators such as plastering thickness, concrete slab thickness etc. It provides additional quantitative data, which help in identifying the nature of waste. Identification of problems or causes by using audit tools must be followed by the proposal of simple and flexible solutions.

One of the important step in this method are discussions involving the 'owners of the process' aiming to motivate them to learn causes of waste and possible corrective actions by process improvement.

Conclusions

The other non-technical reasons found for waste generation at construction sites by Indian construction Industry are as follows:

1. The waste of building materials is far higher than the nominal figures assumed by the companies in their estimates.
2. There is a very high variability of waste indices from site to site. Furthermore similar sites might present different levels of wastes for the same material. This indicates that a considerable portion of this wastage can be avoided.
3. Very few companies have a well-defined material management policy and a systematic control on material usage.

4. Waste is because of flaws in the management system and not only because of lack of knowledge, qualification and motivation of workers. Also waste is usually the result of a combination of factors like inadequate design, lack of planning, flaws in the material supply system etc. rather than originated by an isolated incident.
5. Time and cost are the most important factors in the selection of construction methods or technologies for building projects. The reduction of construction and demolition (C & D) waste is the least important factor in the minds of the contractor. This can be attributed to the availability of relatively inexpensive means of waste disposal and the generally low environmental awareness of the construction industry in India.
6. There is relatively little involvement of people from the company in waste control processes.
7. The lack of integration of waste control with the planning and control process.
8. The practice of only verifying and not to monitoring.

Waste management is a valuable marketing tool bidding on projects. Efforts to prevent waste, to recycle, and to use recycled-content materials on a project can help in earning points towards qualifying for LEED or any other national programs. Waste prevention by reusing building materials, using new innovative materials and small changes in construction methods not only cut garbage and recycling collection costs but also reduces materials expenses and add up to significant savings to the builder, the homebuyer and environment. It can increase contractors competitiveness through lower production costs, better public image, higher construction productivity, save in time and improvement in safety. The extra wastages

take extra time and resources for disposal that may slow down the construction progress.

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Biography

Dr. A. K. Garg (akgarg@nicmar.ac.in) is a Professor and Head, Research at the National Institute of Construction Management And Research, India. He received his Doctor of Engineering in Civil Engineering from Kyoto University and Master of Engineering in Water Resource Engineering from Asian Institute Technology (AIT). His current research focuses on the innovative building material and construction method, energy & environmental management in infrastructure and buildings, construction project management and water resources management.