A Study of Various Propositions to Manage Waste in Construction: A Value Engineering Perspective.

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ABSTRACT

Construction process is known to generate waste due to its very nature of evolution of building inputs to its transformation to final form for use. At various stages of construction, the inputs gets deformed, discarded, disowned, discarded, discouraged, discounted, disgraced, diseased, disfigured, disintegrated and hence categorized and termed as waste. While it known that "energy can neither be created nor destroyed". The embodied energy in such 'waste' materials needs to be used for creativity, creatively.

A project has plenty of inputs; optimum use of these inputs to achieve project objectives needs effective management system and utilization of all resources. It is known that resources when utilized to its optimum would results in high in efficiency and performance. Construction projects in its execution phase are disorderly. The project teams are so absorbed in meeting project deadlines that optimum usage of resources is of reduced priority.

This paper lists the experiences of the author intended to create Waste Management system as an important knowledge area. The study intends to focus on areas that needs focus and creation of a wastage management system in projects.

KEYWORDS – waste management, value engineering, green building, optimization

INTRODUCTION

In Indian scenario, use of construction activity's waste is synonymous to landfills. One cannot immediately imagine any other mode of disposal of construction wastage. In our country, there is space for any quantum of wastage generated by construction industry. But, one has to pause and

ponder if generation of waste is necessary and waste which is a byproduct of construction, landfill is only the place of landing.

In today's world the hum word is 'green construction'. The intention of going green is that reduction, reusing and recycling, in order, will result in a sustainable and greener construction. If wastages are to be minimized, then optimizing consumption shall be infused in first steps of construction, the planning. Execution of activities, a phase where actual waste is generated, needs plans to reuse of discarded material. However at the end of this phase some of the materials are either in excess due to project changes or leftovers due to deliberate planning as risk mitigations, needs reuse and not discarded. As a byproduct of execution phase, some materials are not fit for reuse due to deformity and applicability for consumption will have to necessarily discontinue from the supply chain. Such materials need careful and meticulous planning on its recycle. After recycle it should get associated to the supply chain of the same project, when possible.

Planning being most important phase in a project, seldom has plan for managing waste integrated into it. Though it is a known fact that wastes are generated during construction phase of a project, project teams don't envision the generation of waste, its quantum, and its subsequent use. Further to envisioning, its reuse and recycle also needs planning.

While managing projects, rigorous monitor and control is necessary to guide implementation of the plans and revise it based on performance values. The changes encountered in projects and subsequent change in plans, implementation of revised plan and acceptability of the output generated, then, drives the efficiency and performance of the project as a whole.

A project has definite targets, defined quantum of inputs and performance parameters. For a project to be called as a success, adherence to all its objectives is necessary. Shortfall in any one of the parameter would defy its purpose. Besides post construction, efficiency and performance of project parameters during construction also very crucial for construction team. This is greatly driven by ratio of output to inputs of all resources.

For efficiency of a project to be at its desired maximum, the difference between the inputs and outputs needs to be minimal. This implies that:

1. the input to the project shall be nearly equal to requirement of output
2. the output shall also confirm to the acceptable standard, for optimum utilization of inputs

If both the above points have to be adhered to, it would lead to better efficiency, acceptability, performance, thereby reducing wastage. Our focus is directed to these two areas while we move on to look at inputs optimization for a Wastage Management system.

PREPOSITIONS TO REDUCE WASTAGE IN CONSTRUCTION

Out of the five phases in construction, increasing order of waste generation is initiation, planning, close, monitoring and execution (IPCME). It is one of the project's characteristic that, it elaborates while it progresses from initiation to close (IPEMC). In case of waste management, this order is distinctly different. Ideally, in wastage management too this order of progression has to be followed. This will enhance the chances of reduction of waste. Hence, focus and work needs to be in the areas of 'execution' and 'close. Two of them should switch their positions in the order, resulting in reduced waste.

The reasons why this phase of execution generates maximum quantum of waste needs retrospection. Starting to look at the concept of green construction and sustainability here, first in the series is '*reduce'*, optimization of input for a given output is the key. Source reduction – using less material in the first place, using less packaging, or using materials more efficiently, eliminates wastes. In order to reduce the gap of output and input, planning phase need to include the following on the inputs:

1. Materials utilization –
    a. the dimensions of the building units will have to be in the multiples of material availability. e.g., the toilet sizes can be in the multiple of available tile sizes.
    b. material procurement will have to be in the dimensions as required by the project. e.g. procurement of prefabricated reinforcing steel for structure would reduce wastages at site.

c. combine several building units and procure them as one large single unit. e.g., use of prefabricated structural elements, toilets, doors & window units all reduces wastage in construction

2. Machinery deployment –

   Choice of material as input would drive the use of material, yet any use of devises and technology has always resulted in reduced activity time. E.g. erection of prefabricated toilets is definitely faster than doing a toilet bit-by-bit, thereby reducing wastage of materials.

3. Manpower usage –
   a. when above suggested examples of value additions on materials are heed to, the quantum of requirement of manpower for construction, fabrication and erection is reduced – resulting in reduction of wastage.
   b. supervision of these building units would lessen – reduced wastage of manpower too
   c. in project cost, tradeoff between incremental increase in material and decrease in manpower, and cost to quality would have improved benefits on wastage too.

4. Expenditure of Monies – Optimization of threesome of material, machinery and manpower, with intent on wastage reduction too, would also result in decreased project duration and increased quality. Conversion of time and quality to cost will definitely result in cost benefits when performance and serviceability is also in focus. Cost-benefit is the cornerstone in commencing and implementing a wastage management plan.

5. Efficient use of Information – Collections of facts for drawing up of conclusions and facilitate decision making for optimization of material, manpower, monies and energy is the essential for reduction in wastage.

Next in the series of concept of green construction is '*reuse'*. The wastage generated in the execution phase –

a. *deforms* due to errors such as improper handling and staking, abuse, alteration, destruction and reconstruction,
b. *is discarded* as its use in the project ceases or its use will not yield desired results,
c. *is disowned* as its use in project deliverable is no more envisioned,
d. *is discarded,* though some materials has no self-life, its need is not ascertained for the project,

e. *is discouraged* as materials used would be harmful to the project deliverable's performance,
f. *is discounted* as the efficiency of product using such materials would be reduced,
g. *is disgraced* as use of such materials is obsolete,
h. *is diseased* due to omissions as such materials has exceeded its self-life,
i. *disfigure* due to wear &tear, or mishandling or exposed to unfavorable environment,
j. *disintegrate* as it is exposed to abrasion and abused.

While the reasons for generation of wastage are known aplenty in the execution phase, plans to reuse of such materials in alternative forms, shape, size, or properties need mention and implementation in wastage management plan.

When rehabilitation and repairs of structures are undertaken for its deterioration due to environmental factors, requirements on revised and updated usage, enhances performance & efficiency levels, often materials that are released and discarded as waste. These materials have embodied energy in them. Use of existing properties of such discarded materials within the project is challenge to the designers and engineers. Such challenges are required to be pursued to reduce the impact on internal and external environment.

There has been extensive reuse of one single material in construction, the reinforcing steel. The success of experimentation, standard practices, and designs has increased the potential of use and reuse of steel by engineers and designers to maximize its output. Here, one of the prime reasons for focus on the reuse of material is high cost of the raw material and recycle. A material next in the line that is found overly reused is timber. Timber's value in supply chain and ones already used structure, is high. Initial use of timber after it is obtained from the source is delayed due to requirement of seasoning. This process of seasoning is fast tracked with use of kilns, which enhances the cost of this material. Higher and raising cost of this material forces users to reprocess, reuse and reutilize it. Hence, higher costs of raw materials at source forces reuse. This should be the case for all materials irrespective of its value or price.

Several materials for construction are derived from the natural resources which are not abundantly available in all regions and are also seasonal. When available in scarce, it is transported from other regions at an additional input costs. It is this reason that the reuse of other building materials has nil or naught importance. Restriction on use of natural resource will facilitate reuse of materials in a project.

Demolition of structure is source of good quantum of construction waste. Financial subsidy and tax havens for reuse of materials obtained from demolition will encourage project teams to plan and reuse them without compromising the performance and efficiency parameters. For every material that can be re-used in a job, recycling isn't even necessary.

Thirdly, *recycling* of materials which has changed properties and are absolutely not usable in its current form needs recycling to transform it to be fit to use and perform. Recycling is only one of several ways to conserve resources and materials in construction and renovation.

'Sustainable building' is a national catchphrase. Onsite recycling also earns LEED points on green buildings. Economics of recycling too works out well for large developments. Such initiative by the project sponsor is visible to every worker, vendor and passerby leading to momentum on sustainable construction closer to reality. Perhaps most importantly, on a lifecycle basis, recycling produces usable materials at much less environmental cost than materials from primary sources. That is, in addition to conserving raw materials, recycling conserves energy and water, and reduces the production of greenhouse emissions and other pollutants. On and off the job site, recycling is one of the most significant commitments that can be made to sustainable building. So for many reasons – environmental, economic, LEED-practical, and environmental compliance – recycling is, and should be, at the center of sustainable building.

Demolition and renovation projects are different from new construction, and often need some extra planning. Planning is the keystone in waste management plan. For instance, excess quantity of waste generated, high value of waste, certain waste may be contaminated with hazardous

substances, automated demolition equipment won't allow segregation of materials, tight and inflexible schedules render segregation process to almost impossible.

Contracting language for recycle and use of recycle needs inclusion in specifications. It is important that sponsors and architects understand these recycled materials as commodities and not waste. The project teams should be familiar with recyclable materials, procedures, and markets and should be able to suggest options and solutions while managing projects. Recycling falls apart if there are no markets for the materials that are diverted from the waste stream and the best way to assure strong markets is to specify the use of recycled products wherever possible.

There are barriers to this concept of recycle of materials and its reuse. Thoughts on slowing the process of construction, safety issues, performance and serviceability perceptions, process complications, cost of segregation, recycling capex costs, additional burden on logistics etc., often loom large over project teams. Training and knowledge sharing sessions would be necessary to propagate the benefits of recycling.

The characteristics of materials requiring recycling are important. Major material like cement, steel, bricks and blocks, rubble, cement plaster, stones like marble and granite, timber and wood in its various forms needs recycling based on their properties. Minor materials like, conduits, pipes, electrical fixtures, wooden panels, tiles and glass panes are also available for recycling.

Storage, segregation or sorting at source of generation increases the chances of reuse in the project itself, else facilitate transportation for resale and recycle. Logistic plan in projects shall include movement of these materials else would result as a hindrance to the progress of project work.

Monitor and control phase which supervises the phase of execution too generates waste due to non-retention of works executed. The responsibility again falls back to the execution phase to complete deliverables 'first time right', to requirements, specifications, standards, practices and procedures. Implementation of quality assurance and control to the tee and without prejudice will generate no waste due to monitor and control phase.

CONSTITUENTS OF WASTAGE MANAGEMENT PLAN

The root of this elephantine problem of generation and disposal of waste is in planning. Meticulous planning of reduction at source, readopting left over materials and reacceptance after recycle should be the cornerstone of this wastage management plan.

As any plan, waste management plan shall consist of various processes addressing the following areas:

1. Plan
    - *a.* identifying the areas of wastage generated,
    - *b.* alternates to minimize wastage,
    - *c.* categorize waste generated,
    - *d.* segregation procedures of waste,
    - *e.* procedures to identify of landfills and approvals
    - f. procurement process to finalize vendors for disposal
    - *g.* initial plans on
        - *i.* reduce, reuse and recycle,
        - *ii.* solid waste reuse plan
        - *iii.* solid waste recycle plans
        - *iv.* cost benefit analysis of recycling Vs disposal
    - *h.* roles and responsibility of individuals in the project team on :
        - *i.* material handling,
        - *ii.* quality control and
        - *iii.* creation of acceptance criteria for fresh products, recycled commodities and project deliverables
        - *iv.* stringent monitoring of material requirement plan
2. Execution of plan
    - *a.* waste management implementation and follow-up meeting agendas, highlights and decisions taken for actions
    - *b.* logistic details of handling waste,
3. Monitor and Control
    - a. integrate outputs to other management areas with specific thrust to cost, resources, logistics, quality and time

b. gather information on yielded waste, costs incurred and compared to initial projects and variations analyzed, suitable modifications to plans to take it forward for implementation

CONCLUSIONS

When we hear of recycling of general home use items we can envision what happens to the recovered materials. Generally, paper gets converted into newspaper; aluminum cans is broken down to make new aluminum products, plastic is melted and molded into new plastic products. The same is true of materials from construction materials.

Concrete, rebar, Asphalt, tiles, gypsum boards, carpets, suspended ceilings elements, all these materials are found on almost every job site, and they're generated by ton or the thousands of square feet. But it is critically important that they do come back to construction supply chain. Recycling amounts to nothing unless there's a reliable chain for the recycled material: a recycling process, a recycled product, and ultimately, most importantly, a market for recycled product.

Construction industry is one of the largest waste generators in the country. It is also one of the largest consumers of raw materials and manufactured products. If the construction industry demands and (re)uses products with recycled content – particularly products with content that comes direct from other job sites, then project economics and affordability can improve for better. Additionally, if demand for recycled products increases, the demand for the recycled raw materials at sites would raise. That will drive demand for reuse and recycling costs even lower, and further enhance the economic benefits to be gained from reuse and recycling.

Costs are competitive to reduce, reuse and recycle than the costs of the material itself. Preparation of a waste management plan, successful implementation and passing over the lesson learnt to many other projects would need several trials and attempts. To engage in waste

management plan is clarity in the intent and goal, understanding the properties of thousands of materials that are the components of construction, and alternative analysis.

Waste management needs its due importance in projects. This management area needs to be developed as any other management knowledge area and the benefits of this area towards environment, sustainability, cost-benefits, speed of construction, needs distribution.

It is value engineering efforts coupled with technical insights, sound planning, and envisioning which can yield a successful waste management system.

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