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Application of 3R and Lean Practices in Construction Materials for a Better Environment

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ABSTRACT

Construction is the second largest activity after agriculture. Building and infrastructure projects consume nearly 50-60% of the materials in their total cost. Various construction materials are from natural sources, such as soil, stones, wood, water, coal, etc. Many composite construction materials are formed and used in building construction from these basic materials. During the use of these materials in the construction process, wastage does take place to the tune of 10%. The waste or wastage of the building materials in the construction can be minimized by applying 3R (Reuse, Reduce and Recycle) and lean practices. Systematic study of the different construction processes and executing the improved versions save the building materials, helping in a sustainable environment.

***Key words**: Construction, Wastage control, 3R, Lean practices.*

Introduction

Construction problems are well known, such as low productivity, poor quality, safety issues, and inferior working conditions. Even the construction industry deploys a large portion of the nation's total employment and makes a large contribution to revenue as a whole. With the adaptation of lean management tools in construction, new construction practices are laid on the conversion and flow process concepts. Therefore, construction project performance improvement is addressed by adopting waste identification and reduction strategies. This paper highlights the construction case undertaken to identify the source of wastes for the selected construction task and relate them to the waste identified in local construction projects therebyimproving the efficiency of the project by reducing and eliminating the wastes as classified under lean construction.

Literature Study

The Last Planner System (LPS), one of the tools of lean management, applies common sense in planning, focuses on smooth workflow, and considers the independencies between activities. It helps move from a push to a pull system and supports construction tasks with its resource planning involving much more than the due dates and the sequence of prior tasks (Katarzyna Cwik, 2017). Construction projects and manufacturing plants differ in many ways, which might explain why lean production theories and practices do not fully fit the construction sites. Though many lean construction tools and elements are still in an embryonic state.Lean tools in construction are gaining popularity because they can affect the bottom line of projects (Salem *et al.,* 2006). Industries like manufacturing or service sectors have greatly increased their quality, safety, productivity and performance levels. Most construction activities

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are based on traditional methods, attended by supplychain deficiencies and high defect rates, resulting in wasted materials and manhours. Estimates indicate that upto 30% of construction costs are due to methods or work in efficiencies, errors in installations or handling,work delays, and poor communication or coordination (Lincoln and Syed, 2010). In construction projects, the term 'wastage' refers to the negative variance between the estimated and actual consumption of building materials. Thus, wastage in the use of building materials can be deduced from detailed engineering drawings and the methodology of the work execution. The term wastage may be differentiated from the term 'waste,' as the latter refers to extravagant or ineffectual use of input and is seldom accounted for as an estimate (Vaid and Tanna, 1997). Carlos *et al*. (1999) developed a method to control thewaste resultingfrom building projects. The main focus of using the concepts of lean management is to establish waste minimization as part of site practices on a routine basis, using a pull learning rather than a push system approach and emphasizing the principle of procedure transparency by using Lean Construction tools through the application of some of its principles on the construction project.

Akinkurolere and Franklin (2005) report that in construction projects, building materials are vital on project sites, but not all the materials delivered are used for the purposes for which they have been ordered, and the subsequent disappearance of these materials constitutes part of the waste. The investigation revealed that material wastage brings about additional costs to the construction project and a reduction in the contractor's profit, considering the cost of storing and transporting construction waste along with the loss of revenue from not reclaiming waste. Also, most waste that occurs on construction sites is due to poor management and a lack of awareness of effective waste management. The recycling and reusing of construction waste are a viable option in construction waste management, and material wastage can be reduced by giving incentives to the workers for good handling of materials and by having trained personnel to supervise the works.

Joseph Laquatra (2009) elaborates on the alarming issue in building construction that the building structure of a single-family home typically generates between three and four tons of debris during its demolition, the majority of which is used in landfills of the low lying areas, despite the fact that 80 percent of this has recycling potential. Construction and demolition (C&D) waste also have significant recycling potential. C&D debris combined comprise 24 percent of municipal solid waste, which is leading to increased costs and regulation. Some municipalities now ban C&D waste from landfills so that it can be recycled appropriately. Some progress is being made in diverting such waste from landfills to be reused in the appropriate construction.

Concrete wastage is mainly due to over-order and loss due to concreting, steel reinforcement, and formworks getting wasted due to unscientific cutting, and bricks and blocks getting wasted due to improper cutting and damage during transportation. The structures with complicated shapes and different sizes lead to a high waste of materials. Training on-site staff, creating awareness among workers and implementing the best procedures will lead to a significant reduction of waste (L Y Shen *et al.,* 2000).

Construction Project Case

Data is collected from construction project managers who have been working on sites for more than five years using questionnaires and structured interviews.

Some of the causes of wastages resulting on construction sites reported by the project managers are as listed below:

- Excess preparation of mortar/concrete,
- Use of dry cement,
- Misuse of different grades of metals,
- High silt content in fine aggregates,
- Unplanned cutting of steel bars and non-utilization of cut pieces,
- Mishandling of materials and multiple movements on site,
- Poor workmanship and quality of materials,
- Poor housekeeping at the site,
- Cosmetic and non-essential design by the architect,
- Lack of coordination amongst planning, design and construction teams,

Wastage generated in construction sites is mainly due to its large out-door construction activities, the temporary nature of its organization structure, labour intensive, and moving construction machinery/equipment and indeed, those construction peculiarities and variables will restraint the efficiency of the construction processes compared to those stationary & well controlled manufacturing processes,

but all of those peculiarities and variables can be overcome with the application of new flow design and improvements as well as new technologies adoption. Use of lean management tools like Last Planner System (LPS), Value Stream Mapping (VSM), Just-in-time (JIT), Visual Management (VM) and 5S (Sort, Set in Order, Shine, Standardize, and Sustain). Even though the construction is slow in adopting the technology, it is observed that JIT, 5S and VSM are practiced (shown in Fig 1) to provide a methodology for organizing, cleaning, developing, and sustaining a productive work environment.

Due to tough competition in the construction business,and to remain in this field, one has to follow efficient and effective methodologies for better profitability. Select practices adopted during construction executions (Fig. 2), such as Store management at the site, Reuse of the material, recycling what cannot be used, design for deconstruction and demolition adopted for wastage reduction at the site.

In Indian cities, many of the residential houses are old-styled and designed as per the requirement of that time, i.e., 4-5 decades older ones. Due to the growth of the cities, land demands have increased many folds. Today'sutility units in the houses have become smaller and multi-level to accommodate many families in the same building; such construction projects are categorized as redevelopment construction projects. Construction materials collected from the demolition for the redevelopment are recycled in construction. Building materials like

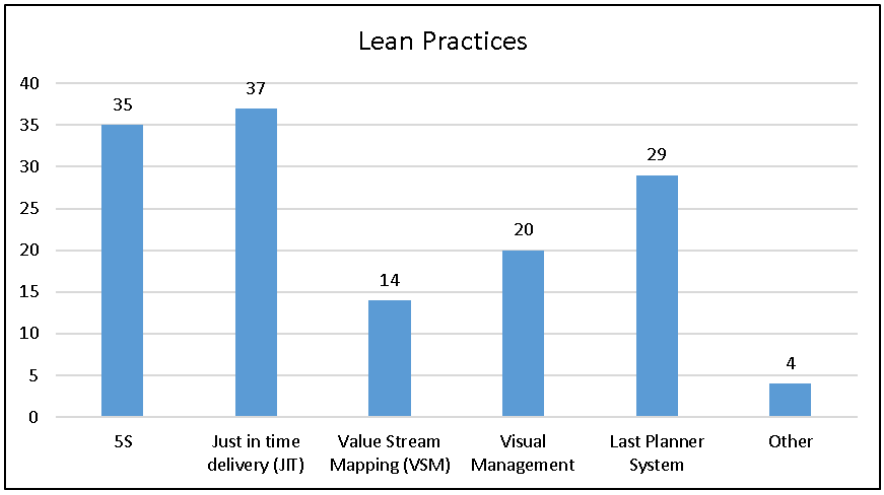

Fig. 1. Popular Lean Tools Used by Respondent

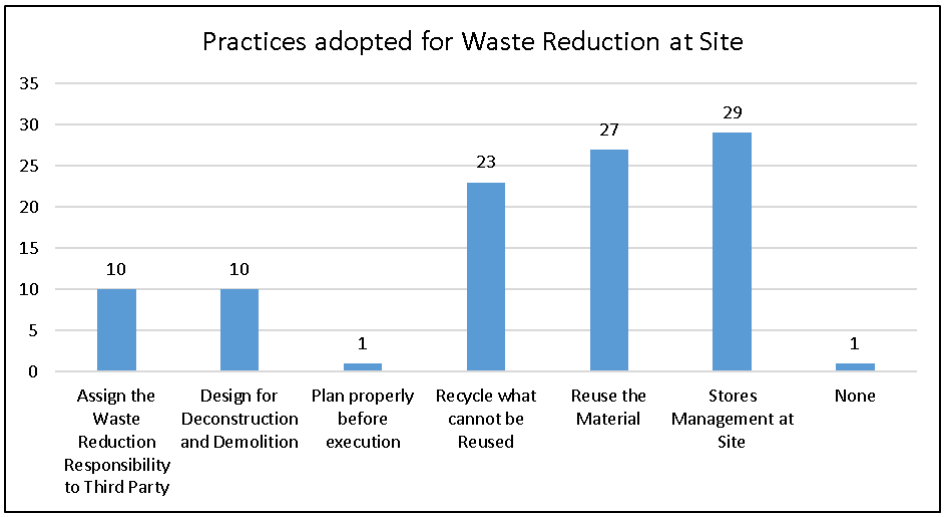

Fig. 2. Frequency and Types of Waste Reduction at Site

wooden doors and windows are used in the furniture; bricks are used in wall masonry, and concrete with some processing is used in the concreting of non-structural elements.

Construction material wastageis accounted for due to the numerous factors depending on the site. A list of these factors cited by the project managers isthe procurement of materials, handling of materials, the culture of an organization, construction methods, delivery methods, delivery Schedules, purchase of inadequate materials, no return policy, poor advice from suppliers, damages during transportation, In-appropriate storage, poor product knowledge, equipment breakdown, in-appropriate handling, lack of awareness, lack of incentives, lack of management support, lack of training, lack of will to work, poor workmanship/skill, design, rework and variation, inexperienced staff, poor communication/coordination, site and climatic condition etc. In order to achieve sustainable construction, companies can adopt a variety of materials and methods for reducing wastage of these materials using the application of technology evolving innovative designs, efficient construction management, efficient programming of work, improved skills of labour force, online monitoring etc. Some important aspects that need to be considered while minimizing waste are durability and the design life of construction structures.

Conclusion

Lean management and 3R are used in industries these days; many challenges are faced in implementing like - lack of awareness and knowledge about these tools in construction practices. Lack of trained professionals, lack of support from the organization or not willingness to adopt these techniques, and also due to the issues of contracts we see implementing them in an organization becomes difficult. We have benefits of implementing tools of lean management like it saves time, resources and cost. The planning of a project becomes predictable—less variability in the workflow of the project. The use of lean tools makes all the members-engineers, contractors, and managers come together and collaborate for effective results. Though many challenges are faced in implementing lean management, the use of lean management can be seen as increasing. The challenges that are faced can be managed, and it not fatal. However, if the challenges faced in the organization are solved, it will actually lead to increased usage of lean within the organizations, and the value of lean management will increase. Efforts will be required to plan in detail to take advantage of lean management. The planning becomes more reliable with lean implementation, and the project's effectiveness increases.

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