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A Review of Construction Material Management and Waste Control in the Construction Industry

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ABSTRACT
These days, civil engineering projects may take use of a plethora of building materials. Materials alone may account for as much as 60% of a construction project's overall budget, depending on the specifics of the undertaking. A well-managed inventory of building supplies is essential to a project's successful completion. The construction sector also faces the significant issue of construction waste. Construction generates a wide variety of waste materials at every step, each with its own unique properties. When it comes to environmental concerns, the construction industry is mostly to blame. Minimising building waste is essential for both the economy and the environment. This article offers a comprehensive overview of the current state of construction management and construction waste in the industry, as well as a survey of the methods used to comprehensively investigate these topics.

Keywords **-** Material Management, Construction Waste, Management techniques, Economic relevance, Existing Situation.

INTRODUCTION

Spending in India's construction sector is the country's biggest economic expenditure. The eleventh five-year plan lists it as the country's second-biggest economic driver, just after agriculture. Project management isn't complete without materials management. A well-managed procedure for building materials is essential to a project's success. As project complexity has increased throughout the years, it has undergone continuous evolution and development. Knowing where materials management practices came from and how they compare to practices in other sectors is crucial. A significant portion of the building industry's budget goes on materials. Depending on the project type, level of mechanisation, and plant used, the total cost of materials may account for 60% or even more of the entire cost of a construction project (K V. Patel et al. 2011). To keep waste to a minimum—which would inevitably impact the organization's performance—such a massive expenditure requires meticulous planning and supervision. Planning and directing the flow of materials is the responsibility of materials management, a coordinating activity. Improper handling of building materials is a key cause of project delays. An major problem of material management is ensuring a timely flow of materials. Any excess or deficit of supplies can cause the project to be delayed or even halted, thus it is crucial to carefully control the procurement of these materials. Because of this, it becomes more difficult to keep a steady stream of product components, which impacts the total

project. Materials Management is the practice of ensuring that a company has access to the products and services it needs to purchase, store, and transport materials in order to accomplish its goals. The core functions of material management include inventory tracking, planning, purchasing, warehousing, receiving, and distribution. Making ensuring the correct resources are available in the appropriate amounts at the right time is what material management is

all about. Large quantities of construction trash are produced by the many building activities that have resulted from the increasing economic expansion and urbanisation. The yearly global waste production from building materials is in the millions of tonnes. Among the many major issues plaguing the building sector is waste. Any discrepancy between an item's actual consumption and its projected use is known as waste. The authorities must verify compliance with safety regulations and limits before approving the transfer of certain hazardous items. The importance of properly managing waste products from building sites cannot be overstated. Reusing things that may otherwise end up in the trash is an important part of waste management, as is reducing waste wherever possible. From initial site preparation to destruction of old buildings and the final product, a wide variety of waste products with distinct characteristics are generated during the whole construction process. The precise amount and make-up of debris from building projects created during the projects are always evolving because of the ever-changing nature of the building operations, making them difficult to identify. Construction trash varies in content and kind depending on the stage of the project. It is possible to anticipate the amount of construction trash that will be generated by carefully planning the building's layout and acquiring the necessary supplies. At different points in the building process, the kind of trash that accumulates may change. It is necessary to identify and quantify the waste that is generated during the various phases of construction in order to minimise this wastage.

I. Management of Construction Materials

Inadequate material management during site operations is a major component negatively impacting construction project performance (N B. Kasim. 2008). Any building project's material is the most important part. Consequently, a large variation in project costs might result from poorly handled materials in building projects. Taking corrective steps towards the cost variation that occurs in the project may help keep the overall cost under control. (Veronika et al., 2006; T. Phani Madhavi et al., 2013). C H. Caldas et al. (2014) cite research from the Construction Industry Institute (CII) that indicated materials and installed equipment might account for 50–60% of the overall project cost and 80–% of the project timeline. S. V. Desale et al. (2013) observed that diverse building organisations have discovered substantial expansion in infrastructure within the previous several years. The aspects taken into account while designing and laying out a site in order to facilitate effective material management are illuminated in Fundamental Principles of Site Material Management. A lot of projects have inefficient material management techniques, which lead to a lot of wasted time and money. References: (H. Randolph et al. 2005, Pauline Jeruto Keitany et al. 2014). In order to run a productive and economical facility, effective material management is crucial. For any given project, a materials management system is in place to guarantee that the correct materials, in the right amounts, are chosen, bought, transported, and handled securely on site—all within the allotted time frame and budget. (G. Kamodozhi et al., 2014; S. Donyavi et al., 2009). In order to effectively execute projects, each business must use materials management strategies. Methods for building, storing, identifying, retrieving, and transporting materials are all part of material management. Safety, productivity, and meeting deadlines are all dependent on the aforementioned factors. When combined with engineering, materials management is an essential component of project management that, according to Kini (1999), guarantees a final product that satisfies the needs of the customer.

also saves money. Materials management has evolved into an integral part of any well-executed construction project. (Georgekutty et al., 2012; Carlos H. Caldas et al., 2014). In order to implement and track material management plans effectively, there has to be a centralised team that coordinates between the site and the organization. While there are certain shared concepts in construction materials management, there is a great deal of variation in the finer points of application. In material planning, the sequence of on-site material requirements is taken into account (S V. Desale et al. 2013). Preventing material shortages or excess inventory on construction sites requires careful planning and execution of material procurement and storage (G.Kanimozhim et al. 2014). Deficits in the supply and flow of construction materials were frequently named as significant causes of productivity degradation and

financial losses. Construction materials vary from industrial materials in that they are more varied, less standardised, and less uniform, and they also have distinct demand characteristics. Material planning and scheduling should be considered at every level of material management. The source is A. R. Patil et al. (2013).

Part II: Managing Materials
A method

First, planning; second, procurement; third, logistics; and last, on-site execution are the five main steps that make up materials management. Dealing with 5.Waste control procedures. Quantifying, ordering, and scheduling are all part of materials planning. Micro and macro levels of planning are possible for companies. Simply said, procurement is the process of acquiring goods and services from other parties. C. H. Caldas et al. (2014) and N. Kasim (2011). The six steps of a typical purchasing process are as follows: (1) material indent; (2) vendor enquiries; (3) vendor comparisons; (4) vendor selection and negotiations; (5) purchase order; and (6) vendor evaluation. The many components of a receipt system are 1.Payment from third-party vendors

2.Receipts from internal divisions. Two methods exist for conducting inspections. 1. Checking before shipment 2. on-site examination. There are three different ways to check something: 1. One, visual; two, tactile; and three, statistical. The notion of logistics centers on the transportation of commodities. Moving raw materials, WIP, or completed items around a building site is essentially all part of materials handling. (K. V. Patel et al. 2011; G. Kanimozhi et al. 2014). The most crucial aspects of materials management for efficient management are (I) fundamental functions, which include achieving the main goals. The main functions of materials management assigned tasks such as materials needs planning (MRP), buying, inventory planning and control, determining and managing material flow and supply, material quality control, and departmental efficiency. (II) The secondary functions include forecasting and planning, material coding and categorisation, making and buying choices, and standardisation and simplification. In 2011, K. V. Patel and colleagues published... Site Materials Management, Materials Management for Operations and Maintenance, Subcontracting, Expediting, Supplier Quality Management, and Project Acquisition Strategy are some other tasks related to material management. (Carlos H. Caldas and colleagues, 2014). First, determine what materials are needed on site. Then, place an order for those materials from the store. After that, create an invoice. Next, check the store's availability. After that, check for any remaining items. Then, choose a vendor from the approved list. Finally, inspect the materials from the stock that was received. Finally, issue the materials to the department. The study was conducted by Ashwini R. Patil and colleagues in 2013. More efficient and effective on-site material control with less human effort is possible with the use of information technology (IT) integrated into materials management. N.B. Kasim et al.(2005) and (2014) list the following IT implementations: a system for planning construction materials, an adviser to help choose material handling equipment, an exchange for building supplies, and a bar-code system. Site and management analysis, inventory control analysis, buying process analysis, procurement and tracking analysis, and cost analysis are all experimental approaches that may be used for construction material management. Madhavi et al. (2013), T. Phani.

section three: the material's current state in charge of According to research conducted by Pauline Jeruto Keitany et al. (2014) and K V. Patel et al. (2011), the cost of building materials and equipment might exceed 70% of the entire cost of a typical construction project. Currently, the construction sector in India is using labour-intensive, imprecise, and error-prone manual materials management techniques and control systems, which are not sufficient. Construction projects go behind schedule, workers are less productive, and there is no up-to-date, real-time information available because of all these factors. Looking at the methods and technologies utilised for materials management thus far, it seems that the majority are still in the research and development stages, with just a small number having found commercial usage. (Note added by Kasim et al. 2012). Radio, barcode scanners, and wireless communication systems are some of the new, upcoming technologies.

Construction projects make good use of radio frequency identification (RFID) technology to speed up material monitoring and management, reduce human error, and improve overall project management. (Kasim et al. 2013; T. P. Madhavi et al. 2013, 2013). G.Kanimozhi et al. (2014) revealed that in the UK, 40% of government-contracted construction projects had schedule delays owing to inadequate material management, while 50% of these projects in India did the same. Currently all over the globe the main reason in cost variance and

problematic management of material are due to overstocked materials because of improper planning, damaged materials due to logistics, handling or in application, loss of materials because of improper supervision, waiting of the materials to arrive in location due to improper tracking systems, frequent moving of materials due to improper site layout, inflation, material changes in buying/purchasing situation starting from the prepared cost estimation, bulk construction material, the shortages and changes of construction materials quantity required, materials inefficiency on site, stealing and loss of construction materials, material shipment, work repairing, delay in updating/posting storage system on site, inaccurate measurement of work locationon construction projects, material off- take, inaccurate estimation of shipment quantity of materials, uneconomic order quantity of materials, poor shipping time, inadequate tools/equipment needed on site, increasing transportation cost of materials, material over usage in location of project, choosing the wrong materials for construction, the increasing storage cost of materials, the poor buying ability of managers, delay of payment for materials, and the poor policy in purchasing the materials (Alin Veronika et al. 2006, N. Kasim et al. 2013). Three percent are attributable to administrative factors, which have an impact firsthand, and five percent are attributable to material shortages caused by poor material management. The "A" group accounts for 70% of the entire cost, even though it only accounts for 10% of the total materials used in construction. Reference: (T. Phani Madhavi et al. 2013). According to studies, the majority of a construction project's budget can go into materials and handling equipment. Companies with an effective material management system are 35% more efficient overall. In 2011, K. V. Patel and colleagues published.Part Four: Construction Debris in charge of Unwanted materials generated by the building or industrial processes are collectively known as construction waste. According to A. Harikumar et al. (2014), each time building or demolishing a structure occurs, trash is created.

Various construction activities, such as site excavation or formation, civil and building construction materials, site clearance waste, demolition activities waste, roadworks waste, building renovation waste, rubble, earth, concrete, steel, timber and mixed site clearance construction materials, all contribute to construction waste. L. Y. Shen et al. (2004), C. S. Poon et al. (2013), Siti Akhtar Mahayuddin et al. (2013), and many other nations throughout the globe face the environmental challenge of managing building trash. Project design, material and equipment handling, construction workers, project management, site conditions, and procurement of materials and external items were found to be seven of the 81 factors that contribute to construction waste, according to a thorough literature review (Ismail Abdul Rahmana et al. 2013). When discussing building projects, the word "wastage" is used to describe any discrepancy between the actual and predicted consumption of individual items or the overall factor consumption of all inputs. There is widespread agreement that material waste is a big issue in the construction industry, with serious consequences for industry efficiency and project environmental effect. (Jing Zhang et al., 2005; S. V. Desale et al., 2013). An effective waste management system is necessary for waste control and management throughout a construction project, from the first stages to the last touches (M D. Meghani et al. 2011, K R. Kareem et al. 2013). Furthermore, as a useful tool for evaluating the efficiency of production systems, waste assessment is an integral part of their administration. According to Carlos T. Formoso et al. (2002), building project management now includes waste management as a crucial role in response to the growing concern about the environmental implications of construction waste. Recognising that construction waste considerably contributes to environmental pollution, there has been a push for better waste management practices in the industry (L. Y. Shen et al. 2004). Existing research and practices have generated a variety of techniques to managing construction waste. These approaches may be broadly categorised into three areas: waste management strategies, disposal technologies, and waste categorisation. Negative environmental impacts are often associated with construction operations, which include taking land and other resources for development, creating waste, and polluting in many ways (Tam et al. 2005, 2006, Carlos T. Formoso et al. 2002, S. Nagapan et al. 2012). Other According to Siti Akhtar Mahayuddin et al. (2013), some of the negative effects on the environment include waste creation, ecological imbalance, changes in the living environment, sewage, decrease of environmental resources, and energy use. In order to lessen this effect on the environment, construction professionals should identify the main causes of trash before beginning any project (Ismail Abdul Rahmana et al. 2013).

II. Control of Construction Waste

Having a mindset of zero waste, making the right choices during the design phase, managing the site effectively, standardising building supplies, and codifying all of the above are all ways to reduce waste (S. Sanmath 2011). Additionally, including a

waste management system into a project may help cut down on construction waste. All members of the construction crew are responsible for reducing the amount of trash produced by the project by carefully planning its operations at each step (J. Thomas et al. 2013). Better material handling, lower waste rates, and increased productivity are all possible outcomes of using a waste rate estimating approach (A. Al-Hajj et al. 2011, M. D. Meghani et al. 2011). The 4Rs—reduce, reuse, recycle, and recover—are also useful concepts that may help lessen the amount of building materials that go to waste. All stages of a product or service's lifetime may benefit from these (K R. Kareem et al. 2013, J. Thomas et al. 2013, Nitish Bagdi et al. 2013). If researchers want to learn more about how construction sites handle garbage, they may use the free-flow mapping presentation method. This method has been shown to be useful for expressing process flows in a clear, concise, and logical manner (L. Y. Shen et al. 2004). While a structure is being constructed, its components may be used to estimate the anticipated flow of garbage (Siti Akhtar Mahayuddin et al. 2013). Reducing the input of mixed construction waste at landfills, increasing reusing and recycling, and reducing waste output are all strategies that may be utilised to effectively decrease material waste in the construction industry. There has been an effort to promote green building practices, such as the use of big panel systems on all sites, the efficiency of prefabrication components, and the reduction of wet trade (L. Y. Shen et al. 2004). An effective public filling program with enough facilities and accessibility should also be a part of any plan to handle construction trash. Reuse and recycling resources to the greatest extent feasible, improving design and construction efficiency to reduce waste, sorting mixed building trash instead of merely disposing of it in one location, etc. The study was conducted by A. Harikumar and colleagues in 2014. A few more methods for cutting down on demolition and construction waste include design standardisation and stock management.

environmental education for employees, reducing instances of overordering, etc. (N. Bagdi et al. 2013). Construction and demolition waste producers may be financially incentivised to reduce, reuse, and recycle via a government-implemented construction waste disposal charge system (CWDCS). On the job site, waste may be reduced by the use of government interventions such as landfill taxes, increased taxes on virgin building materials, tax incentives for recycling, and so on (C. S. Poon et al. 2013, Mansi Jain 2012).

III. Existing Situation of Construction Waste

There is an annual deluge of material waste in India's building sector because proper site waste minimisation and management methods are not given the attention they need. J. Thomas et al. (2013) found that most nations currently have low levels of knowledge about resource-efficient building procedures. There are currently very few rules and regulations in place in India that address the reuse and recycling of building debris, either at the national or regional level (Mansi Jain. 2012). Currently, private companies haul this trash to low-lying areas, their own properties, or, more often, they dump it illegally along highways or other public spaces in the area (A.Harikumar et al. 2014). The present amount of solid waste creation in India is 48 million tonnes per year, with 25% of that amount coming from the construction industry (A.Harikumar et al. 2014, B.Prakash Rao et al. 2014). New research has shown that China produces over 40% more trash than Spain, with 39.27 million tonnes of trash produced in Spain alone. The problem of unlawful dumping has lately become increasingly severe across the nation, affecting both Singapore and Malaysia. Seventy percent of construction and demolition (C&D) waste in Hong Kong consists of soft, inert materials that are only suitable for use as fill in reclamation and earth filling projects, according to official figures (C. S. Poon et al. 2013). According to Market (2009), over 11% of India's GDP is invested in the building industry. Total building activity for five years, from 2006 to 2011, is comparable to $847 billion, according to a report by the Technology Information, Forecasting and Assessment Council (TIFAC). That being said, the amount of money wasted due to building material waste is likewise substantial. The majority of trash collected by landfills worldwide consists of materials from construction and demolition (C&D), which may account for as much as 30 percent of the total. Source: Mansi Jain (2012). It has been shown that building and demolition debris, as per the European Topic Centre on Resource and Waste Management (EIONET, 2006), constitutes around 25% of the total garbage produced. There was no way that Indian structures didn't produce above 53 million tonnes in 2013. Estimates range from 300 to 500 kilogram per square metre from building demolitions (TIFAC. 2013). There has been a lot of study on recycling construction industry waste, including concrete, masonry, bricks, bituminous, and other materials, in countries including the US, Japan, UK, France, Germany, and Denmark, among others. The results of this research point to the potential of recycling building debris as a new material. Most demolition and recycling methods are often straightforward to execute and regulate, and it is economically possible to recycle up to 80-90% of the entire quantity of building debris in most European nations today (J. Thomas et al. 2013, M. Jain 2012).

IV. CONCLUSION

A more efficient and effective use of materials on the job site may be achieved via a transformation of materials management systems, according to the systematic literature study. All four metrics—time, money, quality, and productivity—are negatively impacted when building materials are not handled properly. Further study is needed in this area to provide practical methods for whole project cost management, as is evident from the literature review. The acquisition of building supplies is not well-organised. This sheds emphasis on the fact that acquiring materials and doing thorough pre-planning are of equal importance in keeping project costs in check. The importance of minimising materials waste during construction cannot be overstated in order to prevent financial loss. It has come to light that a lot of studies have looked at certain methods of building waste management at certain points in time. Rather than focusing on non-value-adding activity as an intangible waste, much research on building activities has focused on material loss. If you want to know how well your construction waste management is doing, one good metric to use is the trash generation rate.

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