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Study of Construction Material Wastage, Its Causes, Amendment and Financial Impacts

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Abstract – All over the world, the construction industry has gained very rapid growth in recent decades. The creation of garbage has expanded dramatically as infrastructure and industrialisation have grown. Bulk generators and retail or small generators are the two main sources of construction waste materials creation. The construction projects must be well planned and must be properly executed to minimize the construction wastes. The amount of construction practices has been almost doubled considering last decade and will keep on increasing day by day. As the construction practices are increasing day by day, large number of masses are getting involved in the activity of cons. There is huge amount of mismanagement caused on site in various aspects of construction such as scheduling, material management, labour management etc. The aim of this research paper is to explore and formulate strategies and measures for effective construction management and reduction in material wastage. To learn more about the best practices for reducing and managing construction waste, we conducted semi-structured interviews and focus groups. The prospective short-, medium-, and long-term plans are the key contributions of this research work. Financial rewards to stakeholders, governmental regulations that facilitate garbage sorting, the creation of a mature recycling industry, and education are the five key solutions advocated. This research paper majorly focuses on waste-age caused during the process of construction activities due to various reasons as like natural calamities, human error, false calculations etc. The financial impact caused by such wastages are also formulated taking into consideration certain sites.

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1. INTRODUCTION

CONSTRUCTION SCENARIO IN INDIA

The Indian economy relies heavily on the infrastructure industry. The sector plays a critical role in accelerating India's overall growth, and the government places a high priority on enacting regulations that will assure the country's timely building of world-class infrastructure. The infrastructure sector includes power, bridges, dams, roads, and urban infrastructure development. In India Construction has accounted for around 40 per cent of the development investment during the past 50 years. Around 16% of the country's working population relies on building for a living.

BUILDING MATERIAL

Building material is any material used for construction purpose such as materials for house building. There are a wide variety of building materials used in the construction of structures. For building projects, they are the most cost-effective options. Many naturally existing materials have been used to create structures, including clay, sand, wood, and rocks, as well as twigs and leaves. Many man-made items, some more synthetic than others, are used in addition to naturally existing materials. Building materials manufacturing is a well-established sector in many countries, and its use is often divided into speciality crafts such as carpentry, plumbing, roofing, and insulation work. This reference deals with habitats and structures including homes.

MATERIAL WASTAGE IN CONSTRUCTION INDUSTRY

The new production philosophy defines waste as any inefficiency that leads in the use of more equipment, materials, labor, or capital during the building of a project than is believed necessary. Extra expenses are generated by the execution of work that does not add any value to the final product, such as material losses. Thus, waste should be defined as any losses saved due to actions that generate direct or indirect costs but do

not add value to the product from the customer's perspective. In addition to having a firm grasp on the broad notion of waste, categorizing trash into distinct groups can assist clarify the wide variety of potential preventative measures. When it comes to waste management, there is a certain amount of trash that can be reduced only by a significant change in technological progress. When the expenditure required to reduce trash is more than the economic output, it is classed as unavoidable waste (or natural waste), while waste that may be avoided occurs when waste generation costs are greater than the investment required to prevent it.

2. AIM

The strategy of adjusting and optimizing wastage, using systems and procedures so as to reduce requirements while holding constant or reducing total costs of producing the output from these systems

3. PROBLEM STATEMENT

This study attempted to determine how the wastage of construction material caused during and through the course of construction activity leads to a minor but significant financial impact to the cost of project. This cost related to wastage can be curtailed and kept into limits using and applying various techniques thus keeping efficiency in the profits. The wastage caused also in turn leads to wastage of natural resources and decreases the efficiency of sustainability.

4. OBJECTIVE OF STUDY

1. To Determine the types of materials used in construction, tracking the consumption of different construction materials, identifying the reasons for wastage of material caused by analysing different methods used for processing, stacking and use of different construction material.

2. Analysing the cause of wastage and proposing appropriate counter-measures to curtail and reduce wastage caused whilst stacking and execution.

3. Supervising a certain site to analyse the causes, rectification and financial impact caused due to wastage of material.

4. Calculating the financial impact caused on the project cost due to the amount of wastage caused and providing solutions to keep the impact to minimum.

5. REVIEW OF LITERATURE

5.1 Bossink, B.A.G. and Brouwers (1996)

The building and construction sector is responsible for a large portion of the garbage generated. As a result, the Dutch government's integrated chain management strategy prioritizes the reduction of building waste. By reducing trash output, construction organizations save money on deposition charges and the cost of procuring new materials. The key policy areas of the Dutch government with regard to sustainability are described in an overview. Construction waste reduction is in line with this strategy.

5.2 Agyekum, K., Ayarkwa, J. and Adinyira, E (2012)

The goal of this research is to determine which building material is the most wasteful during construction. Any improvement in the management of building materials on construction sites might have a positive impact on the performance of the construction industry, saving money, and increasing efficiency. There will also be an evaluation of various subcontracting options in terms of the amount of material waste they generate, the percentage of the project cost overrun that is attributable to material wastage, and a look at the factors that contribute to the waste of building materials on construction sites. A survey design was used in the study. Descriptive and inferential statistics were used to analyze responses from 56 site-based professionals, which accounted for 70% of the respondents.

5.3 Akanni, P. O.

An investigation of construction material waste on building sites in Nigeria's South is the focus of this study. The goal is to measure the amount of waste that is created on construction sites and compare it to the amount of waste that is allowed in estimates. For six months, data was gathered from 30 ongoing public building projects. A one-way ANOVA was used to evaluate waste values between states in the zone based on percentages of total garbage. A paired t-test was used to determine the significance of the difference between the actual and permitted levels of waste.

5.4 Ajayi, O.M., Koleoso, H.A., Soyingbe, A.A. and Oladiran O. J. (2008)

This paper reports on the findings of a substantial literature review investigated the needs, promises and barriers of adopting offsite manufacturing in Nigeria. Despite several efforts, Nigeria still has a housing shortage of 17 million. There are a number of factors that contribute to this problem, including high building prices, a lack of skilled workers, a sluggish rate of development, inadequate

infrastructure, and a lack of housing stock. Offsite manufacturing has been suggested as an innovative solution to these concerns. Thematic analysis and Nvivo software were utilized to code and analyze the research data from seminal literature on offsite construction and the Nigerian construction sector.

5.5 Formoso, C. T., Isatto, E. L., and Hirota, E. H. (1999).

The paper presents the preliminary results of an ongoing research project which aims to develop a method for controlling waste on building sites. The main focus of the method is to establish waste control procedures as part of site management on a routine basis, using a pull learning approach and emphasising the principle of process transparency by using qualitative and quantitative data collection techniques. The study also intends to make some contributions for the consolidation of the Lean Construction theory, through the application of some of its principles in practice.

5.6 Teo, S.P, Abdelnaser, O. and Abdul, H. K. (2009)

Pre-contract and post-contract stages of a project are examined in this article to determine the link between material waste and cost overruns. Construction waste has grown to be a severe issue that requires immediate response, yet cost overruns are a problem that impacts 90% of all finished projects worldwide. For the past 70 years, people have debated how to stop projects from running over budget due to material waste on the job site. The paper is given using a desktop methodological approach. Experts analyze the causes of both waste and budget overruns in the literature to determine whether there is a correlation.

5.7 Shen, L. Y, Tam, V. W, Tam, C. M, and Drew, D, (2004)

The free-flow mapping presentation approach is used to map out six real-world building sites in Hong Kong to analyze how garbage is handled during the development process. The paper is given using a desktop methodological approach. Experts analyze the causes of both waste and budget overruns in the literature to determine whether there is a correlation. To efficiently manage construction waste, there are a number of measures that need through be taken, from the time of creation to the time of final disposal.

5.8 Shen, L. Y., Tam, V. W. Y and Tam, C. M., (2002),

This paper investigates the profile of waste generation from applying different types of building materials to different types of construction projects. Hong Kong's building and demolition operations create thousands of tons of solid garbage each year, making it the city's primary source of solid waste. The increasing generation of construction wastes has caused significant impacts to the environment and aroused growing public concern in the local community. Construction waste reduction has so become a top priority. According to some estimates, the volume of trash generated by various construction projects depends on the type of building materials used.As a result, this article aims to examine how waste creation and the use of building materials to various projects are linked together.

5.9 Ekanayake, L L and Ofori G (2004)

According to the literature, the design has a significant impact on waste generation. Construction waste generation models were developed as part of this research to identify the most significant sites in Singapore that produce significant amounts of site trash, and to use those models to assess various building designs. Singapore's largest building contractors were surveyed for this study. As a result of this study, it was discovered that four predetermined design, operation, and material handling qualities all contributed significantly to site waste. BWAS was developed using the multi-attribute value approach based on respondents' assessments on a 5-point Likert scale that created weights for the building subsystems. The BWAS model was constructed using a modified version of the Building and Construction Authority of Singapore's building design evaluation system.

6. METHODOLOGY

1) To find out the variables non-value-added activity for wastes in terms of material, time and efforts generated in construction activities are mainly due to its large fieldwork component by observation from project site visits.

2) To prepare waste identification matrix is meant for identification of waste in various operations involved in execution of an activity.

3) To collect all the data regarding the particular activity and component and analyze.

4) Apply the lean technology and the principles of lean technology to minimize the non-value-added activity or wastage and increase the productivity of the construction industry.

5) To verify and re-evaluated the status of existing productivity and performances on construction activities and processes for construction industries.

6) The cost-benefits of design are made up of costs of value-adding activities and waste.

The waste in the design process is formed by:

- Rework (due to design errors detected during design)
- Non-value-adding activities in information and work flows

7) Proper relation flow is made for heavy equipment and for critical situation.

8) Minimize physical and process waste.

7. DATA COLLECTION AND ANALYSIS

The study involved the project site of a newly constructed, G+5 residential building with almost 9750 Sq.Ft of per floor space. The project site is located in Kondhava near ISCON temple, Pune. The project site was selected because it involved conventional building and construction activities. Data was collected through Google form survey with project quality surveyor and site engineer at the project site. For detailed study we sent Google form to different site supervisor.

Among 50 questions only 30 questions were considered for survey. The questionnaires were distributed through various electronic media platform to a variety of respondent working around the construction projects. About 40 people have responded to the questionnaire survey.

The respondents were asked to indicate the positions they held in the respective companies and the duration for which the company is in operation. They were provided with options to choose from. About 26.7% of the respondents who participated in the study are from Top management background, 40% were from middle management, while 33.3% were serving as a lower management as shown in the Fig. These respondents are well conversant with effect of construction waste management.

The material mentioned below was ordered according to the requirement as per site condition. The construction site is projected to be completed in a period of two year. Thus, as per the scheduling of project the material was ordered.

The cost incurred for the material ordered is mentioned in the following table

Sr. No.	Item	Quantity	Unit	Cost per unit	Amount in Rs.
1	Bricks	25,832	Nos.	18	4,64,976
2	Cement bags	4,825	Nos.	350	16,88,750
3	Steel	37,645	Kg	72	27,10,440
4	Aggregate	420.83	Cum	900	3,78,747
	Total				52,42,913/-

According the scheduling of project the foundation was completed in the first 2 months of the project period. It was followed by plinth and ground floor. Then the construction of first floor to fifth floor was carried out and eventually the lift room and terrace was completed.

During the course of execution, the quantity of material used as per the stages of project is demonstrated in the table below:

Sr. No.	Project stage	Bricks (Nos.)	Cement (Bags)	Steel (Kg)	Aggregate (Cum)
1	Foundation and ground floor	4,305	832	5,457	72.21
2	First floor	3,562	770	5,150	65.31
3	Second floor	3,666	780	5,280	64.23
4	Third floor	5,730	768	5,273	66.53
5	Fourth floor	3,689	776	5,300	64.80
6	Fifth floor	3,660	765	5,243	65.93
7	Others	1,220	134	5,942	21.82
	Total	25,832	4,825	37,645	420.83

During the entire course of project, the material usage was kept in check, it was observed that the material used during the execution work was higher than that of the design. The quantity according to the design is stated as follow:

Sr. No.	Project stage	Bricks (Nos.)	Cement (Bags)	Steel (Kg)	Aggregate (Cum)
1	Foundation and ground floor	4200	800	5100	70
2	First floor	3400	700	5000	64
3	Second floor	3400	700	5000	64
4	Third floor	3400	700	5000	64
5	Fourth floor	3400	700	5000	64
6	Fifth floor	3400	700	5000	64
7	Others	1200	80	5000	17
	Total	22,400	4,380	35,100	397

The cost incurred for the losses caused due to the wastage is calculated in the following table and a theoretical view to the material wastage is given stating the cost of wastage.

Sr. No.	Item	Quantity	Unit	Cost per unit	Amount in Rs.
1	Bricks	3,432	Nos.	18	61,776
2	Cement bags	445	Nos.	350	1,55,750
3	Steel	2,545	Kg	72	1,83,240
4	Aggregate	23.83	Cum	900	21,447
	Total				4,22,213/-

As per data the total cost of material needed for the construction is 52,42,913/- and considering the wastage the total cost that represents wastage turns out to be 4,22,213/-.

The above-mentioned numbers show a clear loss of **8.05%** of the total material cost, which is considerably higher for a lower project cost. If the project cost is scaled up then this percentage of loss could do a considerable damage to the project budget.

The following table shows percentage of loss occurred in respective type of construction material.

Sr. No.	Type of material	Percentage of wastage occurred
1	Brick	13.28 %
2	Cement	9.22 %
3	Steel	6.76 %
4	Aggregate	5.66 %

8. SUMMARY

The concept of this paper is to determine the wastage of construction material caused before and during the construction duration. The construction industry in India is increasing day by day, as a result during this construction activities a lot of material wastage is encountered. These wastages are generally caused due to material mishandling, improper inventory control, flaws in design, excess material orders etc. In order to avoid these kinds of errors proper training is needed to be provided to the working staff, inventory control should be done precisely, proper design estimation must be done, etc. This paper also provides an overview of financial impact caused due to the wastage of material. Such impact can be huge for the projects costing large tender amounts.

9. CONCLUSION

The Study is established from the following:

1. Study of research papers based on material wastage during construction.
2. Study of case papers, literature reviews & future scope of the research papers.
3. Providing optimum solutions to curtail the wastage of construction material during the course of project.

10. REFRENCES

1. Bossink, B.A.G. and Brouwers, H. J.H. (1996), “Construction Waste Quantification andSource Evaluation”, ASCE Journal of Construction Engineering and Management, 122(1), pp55-60.
2. Bossink, B.A.G. and Brouwers, H. J.H. (1996), “Construction Waste Quantification and Source Evaluation”, ASCE Journal of Construction Engineering and Management, 122(1), pp55-60.
3. Agyekum, K., Ayarkwa, J. and Adinyira, E.(2012). “Consultants’ perspectives on materials waste reduction in Ghana”, Engineering Management Research, 1(1), pp138-150.
4. Akanni, P. O. (2007). “An empirical survey of the effect of materials wastage on contractors’ profit level in construction projects”, The professional Builders, pp35-46.
5. Ajayi, O.M., Koleoso, H.A., Soyingbe, A.A. and Oladiran O. J. (2008), “The practice of waste management in construction sites in Lagos state; Nigeria”, The construction and building research conference of the Royal Institute of Charted Surveyors, Dublin Institute of Technology 4-5 September.
6. Formoso, C. T., Isatto, E. L., and Hirota, E. H. (1999). “Method for waste control in the building industry”, In Proceedings IGLC (Vol. 7, p. 325).
7 Yu, A. T., Poon, C. S., Wong, A., Yip, R., and Jaillon, L. (2012), “Impact of Construction Waste Disposal Charging Scheme on work practices at construction sites in Hong Kong”. Waste Management. pp 138–146
8 Shen, L. Y, Tam, V. W, Tam, C. M, and Drew, D, (2004), ‘Mapping Approach for Examining Waste Management on Construction Sites’, Journal of Construction Engineering and Management, Vol. 130, No. 4, July/August 2004, pp. 472-481

9 Shen, L. Y., Tam, V. W. Y and Tam, C. M., (2002), Material Wastage in Construction Activities – A Hong Kong Survey, Proceedings of the CIB W107 1st International Conference: Creating a Sustainable Construction Industry in Developing Countries, 11 – 13 November, Stellenbosch, South Africa.

10 Ekanayake, L L and Ofori G (2004) Building waste assessment score: design-based tool. Building and Environment, 39, 851–61.

11 M T. Phani, S V. Mathew and S. Roy, Material Management in Construction – A Case Study, International Journal of Research in Engineering

12 K.V. Patel, C.M. Vyas, Construction Material Management on Project Construction sites, National Conference on Recent Tends in Engineering and Technology, 2011

13 Lingard, H, Graham, P. and Smithers, G. (2000) 'Employee Perceptions of the Solid Waste Management System Operating in a large Australian Contracting Organisation: Implications for Company Policy Implementation', Construction Management and Economics, Vol. 18, pp. 383.

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