A Study to Enhance Total Productivity in Building Industry by Material Waste Management

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Abstract - **In Construction industry Material, Manpower, Money, and Machine play a crucial persona. They are called 4Ms. There are many problems in the construction industry to enhance total productivity such as material waste. This paper delineate the consequence of research studies carried out in Pune (Maharashtra) that investigated the loss of total productivity due to happening of material waste at five building sites located in different locations of the Pune in Maharashtra. From this it is reasoned out that total productivity can be enhanced by efficient & strict control over supervision of site labours, supervisors and flow of construction materials. Material waste has been acknowledged as a major issue in the construction industry. The main reasons for loss in total productivity is the wastage and essential remedial measures for reducing wastage and enhancing total productivity it are discussed in this paper.**

Keywords— *Productivity; Waste; Construction Material; Building*.

I. INTRODUCTION

This research work is based on the study to enhance total productivity by material waste management in building construction. Through this dissertation work, effort is to find out the reasons of wastage in construction industry and the way it can be reduced to enhance total productivity.

Depending on the form of the housing project, building materials account for about 65 to 75 % of the cost of the project approximately. Through the function of material waste management, we can minimize the overall project cost by waste minimization or utmost usage and apportionment of material resources to enhance total productivity.

But practically it is very difficult enhance total productivity by evaluating all wastes in the construction industry; overtone examines from different countries have confirmed that waste constitutes a relatively eminent ratio of production costs. A broad range of measures have been used for monitoring the waste, such as surplus material consumption and repair and maintenance costs, accidents, and unproductive time.

Wastage in the construction industry is vital not only from the view of efficiency, but also from environmental perspective. This kind of waste generally accounts for about 15 to 30% of urban waste.

Measuring waste is an effective way to assess the performance of production systems. This is because it usually allows pointing out areas of potential improvement and the identification of main causes of inefficiency. Equated to the ceremonious economic measures, waste measures support to enhance total productivity by management more effectively.

II. SCOPE

1. Only applicable for residential buildings projects
2. As well applicable for materials such as steel, cement, sand, coarse aggregate which is commonly used in major work such as RCC, masonry & plaster work in which the wastage is heavy.

III. RESEARCH METHODOLOGY

1. The Site visit to versatile construction projects for data accumulation.
2. Find out symmetry of wastage by examining data.
3. Study the effect of wastage on cost of the project.
4. Determine the reasons of wastage by experience & discussion with builder/consultant/contractor/engineer.
5. How to enhance total productivity of the project.

IV. DEFINITIONS

1. WASTIVITY: Wastivity of any system is defined as the ratio of the waste to input.
Hence, Wastivity = Waste/ Input
Depending upon the level of waste under consideration, Wastivity may be categorized as Gross Wastivity and Net Wastivity.

2. GROSS WASTIVITY: The Gross Wastivity is defined as the ratio of total waste generated by a particular system to the total input to that system".
Hence, Gross Wastivity = Total waste generated / Total Input
However, fraction of total waste generated is recycled. Thus, net waste to be disposed of or reused in other system is less than the gross waste generated.
Hence, Net Waste = Total waste generated – Waste recycled within the system.

3. NET WASTIVITY: The Net Wastivity is defined as the ratio of net waste to be disposed of the total input to that system.
Hence, Net Wastivity = Net waste generated / Total Input
The net Wastivity depends on the extent of recycling.

4. PRODUCTIVITY: The Productivity of any system is defined as the ratio of the desired output to input.
Hence, Productivity = Output / Input or 1-Gross Wastivity
Most of the productivity measures at present compare the total output to individual inputs, viz. Labour, Material, Energy capital, etc.

V. PRODUCTIVITY IN THE CONSTRUCTION

Apart from building materials, reduction in the cost of construction may be achieved in a variety of ways such as avoiding the wastage, adopting appropriate technology, achieving efficient construction management, effective programming of the work, improving labour skills, on-line monitoring etc. All these techniques may be clubbed as "productivity measures" although there is no complete agreement on the true meaning of productivity, it may be defined as the Output–Input ratio with a time period with due consideration for quality. It can be expressed as follows:

$$\text{Productivity} = \frac{\text{Output (O)}}{\text{Input (I)}}$$

The Formula indicates that Productivity can be improved by:

(1) Increasing outputs with same inputs
(2) Decreasing inputs but maintaining the same output or
(3) Increasing outputs and decreasing inputs to change the ratio favourably.

Construction projects use several kinds of inputs, such as labour, material and capital.

The highest site productivity is obtained by producing the required quantity of construction, of the specified quality, within the budgeted time and by the best & cheapest method. To achieve this target, management employs construction planning and control, the tool that coordinates all construction activities. The management combine various resource input to carry out project economically and expeditiously. In large projects, a management team will share numerous specialist activities such as the site management at the various level, materials handling, plant deployment and maintenance, financial control and so on. But in small projects, all management activities might carry out by one person.

The productivity of the construction process, therefore, is made complex by the type of environment in which it exists, and the process must also produce a clearly defined solution at technical level of design and construction and also for the fluctuations in the supply of raw materials.

VI. CONCEPT OF WASTE

Waste is any unnecessary input to or any undesirable output from any system encompassing all type of resources. Waste includes both the incidence of material losses and the execution of unnecessary work, which generate additional costs without adding any value to the product (Koskela 1992). Therefore, waste should be defined as any losses reduced by activities that generate direct or indirect costs but do not add any value to the product for the client which leads to the loss of productivity.

Classification of waste helps to understand the wide range of possible corrective measures related to its prevention. Regarding the possibility to control the occurring of waste, this study admits that there is a tolerable level of waste, which can only be reduced through a significant change in the level of development of technology. Thus, waste can be classified into two types:

1. **Unavoidable Waste** or **Natural waste:** It is the waste in which the investment necessary to its reduction is higher than the economy produced.

2. **Avoidable Waste:** When the cost of the waste is significantly higher than the cost to prevent it. Although waste is usually identified during the production stage, it can be originated by processes that precede production, such as materials manufacturing, training of human resources, design, materials supply, and planning. The main classification of waste proposed in this study is by its Nature, since it helps managers to understand the different forms of waste, why they occur and how to act in order to avoid them to enhance total productivity.

Cause of Waste Generation:

There are numerous causes responsible for the generation of waste in the different system. However, some general causes of waste generation at different stage have been perceived. Causes of waste generation as below:

General

- Lack of material management system
- Change in design and specification
- Untrained labour
- Non-use of left over materials
- Theft and pilferage
- Improper handling
- Loss during transportation and application
- Poor housekeeping & storage condition
- Poor quality control
- Adhoc procurement
- Contractors negligence
- Unconcerned supervisory staff

Specific

- Excess mortar/concrete preparation for cement, sand and aggregates
- Misuse of various grade of metal
- Non-utilization of cut piece of steel
- Mishandling of cement bags
- Wrong use of various grade of metal
- Silt content in sand
- Improper cutting of steel
- Use of dry cement

Relationship of Waste Management and Resource Management
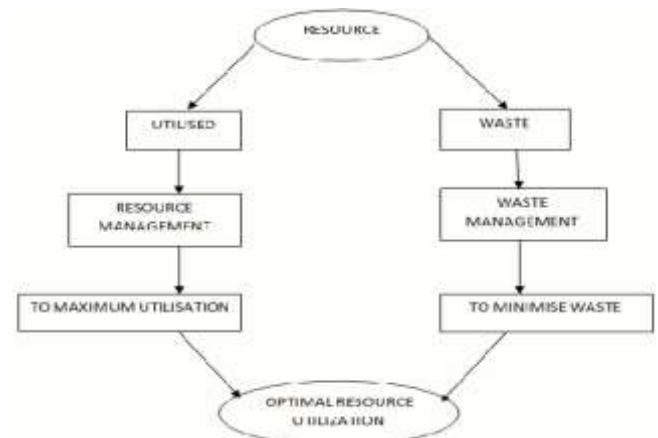
Flow Chart: Reduction of waste

STAGE WISE WASTE REDUCTION : AS SYSTEMATIC APPROACH
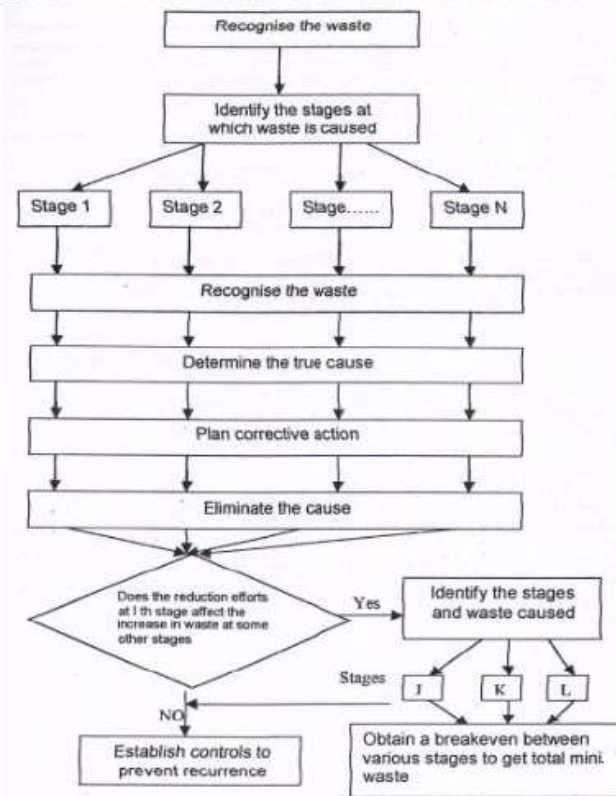
Reasons of Loss of Productivity

- Delay in approvals from government authorities
- Problems in contract administration
- Poor coordination of activities of contractors and consultants.
- Delay in procuring technical expertise
- Non availability of power, water and other infrastructural facilities.
- Adverse climatic condition
- Law and order problems
- Contractors and Labour problem
- Delays in the preparation and receipt of drawings from consultants.
- Lack of planning
- Delay in approval of design and specification
- Change in designs, specifications and materials
- Errors in project planning
- Unrealistic labour planning

Enhance of Total Productivity through below mention point:

- Towards Zero wastage
- The design stage
- Standardization
- Codification
- Site management

Overview of Project

Our aim is to find the causes of Loss of Productivity due to material wastage on construction site of multistoried buildings & how it can be minimized. So, overall project cost can be reduced or productivity can be maximized.

My research study is conducted in Pune district and it is limited to residential buildings only.

The data on estimated and actual consumption of major materials such as Cement, Reinforced Steel, Sand and Coarse Aggregate are collected. Negative variance or wastage worked out for each projects. From this wastage, which will effects more on the productivity of project is calculated.

VII. STUDY RESULT

Table 1: Cement

Project No.	Total Consumption		Wastage (Bags)	Wastivity (%)
	Estimated (Bags)	Actual (Bags)		
1	8652	8710	58	0.67
2	7280	7426	146	2.0
3	11500	11590	90	0.78
4	6650	6876	226	3.4
5	26250	26660	410	1.56

Table 2: Sand

Project No.	Total Consumption		Wastage (CFT)	Wastivity (CFT)
	Estimated (CFT)	Actual (CFT)		
1	14380	15472	1092	7.59
2	12100	12901	801	6.62
3	17219	18836	1617	9.39
4	11053	12202	1149	10.39
5	43630	47312	3682	8.44

Table 3: Reinforced Steel

Project No.	Total Consumption		Wastage (Kg)	Wastivity (Kg)
	Estimated (Kg)	Actual (Kg)		
1	104690	106450	1760	1.68
2	86250	88650	2695	3.12
3	135795	137240	1445	1.06
4	77115	80235	3120	4.04
5	337487	347182	9695	2.87

Table 4: Coarse Aggregate

Project No.	Total Consumption		Wastage (CFT)	Wastivity (CFT)
	Estimated (CFT)	Actual (CFT)		
1	30181	30757	576	1.90
2	25395	26146	751	2.96
3	36139	37112	983	2.72
4	23197	24041	844	3.64
5	91570	94707	3137	3.42

Table 5: Productivity

Project No.	Gross Wastivity	Productivity
1	1.6	98.4
2	2.9	97.14
3	1.3	98.7
4	3.8	96.2
5	2.6	97.4

$$\text{Wastivity (\%)} = \frac{\text{Wastage}}{\text{Estimated Consumptiont}} \times 100$$

$$\text{Gross Wastivity (\%)} = \frac{\text{Total Wastage}}{\text{Estimated Cost of major Material (Rs.)}} \times 100$$

Productivity = 100 - Gross Wastivity.

Suggestion for enhancing total productivity:

- Improving material quality
- Improving storage facilities.
- Good line of communication between top management and workers.
- Imposing conditions to minimise wastage when negotiating workers/sub contractors
- Establishing proper method of measuring sand, aggregate purchasing.
- Improving transport system.
- Strict supervision and control of materials
- Creating an awareness of consequences of waste and educating staff.
- Correct material planning and ordering.
- Intensifying security
- Effective site management
- Introducing incentive schemes.

VIII. CONCLUSION

In construction industry, there are various constraints e.g. Men, Machine, Location, Environment, Space in the construction industries. So, no loss of productivity due to waste is almost impossible for any kind of project.
By using computer application like ERP (Highrise), CPM, estimation related software etc. new techniques like Decorative concrete, precast units, modular coordination etc., new construction materials like high grade materials, polymer materials, wastage can be minimised to great extent.

In construction, numbers of parties are involved at execution stage. So, proper coordination between the party's emphasis on completion of project within time as well as estimated cost. However, in some organization due lack of coordination between same departments subordinates, creates wastage of time and other resources which lead to loss of productivity.

To compare the material wastage on different construction of project at Pune and also give the necessary suggestion for reduce waste at site.

REFERENCES

[1] Agopyan, V., Souza, U. E. L., Paliari, J. C., and Andrade, A. C. (1998). Alternatives for reducing waste of materials in building sites: final report, EPUSP/FINEP/ITQC, in Portuguese.
[2] Bossink, B. A. G., and Brouwers, H. J. H. (1996). "*Construction waste: Quantification and source evaluation.*" Journal Construction Engineering. And Management, ASCE.
[3] Books, N. D. Vora, "*Total Ouality Management*".
[4] Carlos Torres Formoso and Eduardo luis Isatto "*Method for waste control in building Industry*" University of California, Berkery, CA, USA, July 1999.
[5] Chandler Ian E; "*Material Management on Construction at Site*" Longman Inc; 78 Edition.
[6] Gavilan, R. M., and Bernold, L. E. (1994). "*Source evaluation of solid Waste in building construction*". J. Constr. Eng. Manage., 120(3)
[7] *Hong Kong Polytechnic and the Hong Kong Construction Association Ltd*. (1993). Reduction of Construction Waste: Final Report, Hong Kong.
[8] Indira Gandhi National Open University (IGNOU) "*Materials Management" Part Ms-5, Unit-6.*
[9] Shri Rakesh j. Hingu (2010) , "*Wastage of building materials during construction of structure*" Sardar Patel University, V.V. Nagar ,Dissertation report, June 2010.
[10] Skoyles, E.R., and Skoyles, J.R. (1987). "*Waste prevention on site*". Mitchell Publishing Company Limited. London.
[11] Vaid K.N. "Waste Control Of Building Materials' *NICMAR Course Materials In Construction Materials Management*, Octo'98.