



# Factors Affecting Material Management in Construction Industry

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**Abstract:** *Material cost is almost 50-60% of most construction projects. A better material management contributes to lesser cost for a project and also, sustainable use of available resources in the long run. This project aims to identify the major factors affecting material management in a construction project. The various factors at different stages of material management are identified and put in a form of a questionnaire. The responses to the questionnaire were obtained from the stakeholders such as architect, storekeepers, material managers, quantity surveyors, site engineers, project managers, and project engineers. The relative importance of each factor is arrived at based on the ranked response obtained from questionnaire survey. Among the factors identified, the factor 'unclear definition of roles and responsibilities' is ranked as the major factor that affects material management.*

**Keywords:** *management, materials, procurement, stakeholders.*

## I. INTRODUCTION

Materials are one of the main constituent of construction industry. The availability of materials of adequate quantity and appropriate quality, at the necessary time so as not to cause a delay in construction activity is material management. The activities in the construction cycle such as planning for the needed materials, identifying the source for procurement of materials at reasonable price, storing the materials without deterioration of quality and reduction in quantity and proper distribution of materials to the exact usage point constitute material management. A proper material management can prevent time over shoot, prevent cost overrun, ensure safety at site and lead to sustainable use of materials.

### A. Stages of Material Management

The following are the stages of material management [1],

- Material planning
- Vendor analysis
- Material purchasing
- Storing and inventory control
- Supply and distribution

Manuscript published on November 30, 2019.

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## II. LITERATURE SURVEY

Chan et al., (2004) [4] identified five independent variables and sub variables within the independent variable that are pivotal to project success. The main variables identified in the novel conceptual hypothesis were (i) project-related factors (ii) project procedures (iii) project management actions (iv) human related factors and (v) external environment. The authors also stressed the importance of finding key performance indicators (KPIs). Patrick et al (2007) [5] identified twenty crucial risk factors that affect a construction project from various stakeholders' perspective encompassing the whole life cycle of the project. Tight project schedule was identified as a most crucial factor affecting all stages of construction by the authors. Further, the authors opined that the stakeholder working together with adequate knowledge about construction and management is necessary for project success. Madhavi et al (2014) [3] identified causes and suggested ways to improve material management considering a case study of a particular organization. The study was focused on procurement and inventory control. The authors suggested modification in hierarchical structure of the organization and use of new technology to achieve better procurement and inventory control. Carstea et al., (2014) [2] opined that material management with focus on quality has an important bearing on the final product for any organization. The authors concluded that a change in material procurement process by ensuring the adequate quantity and quality of material from reliable source and cordial relationship with the vendor can make the organization competitive in the long run. Kostalova and Tetreva (2016) [6] studied the suitability and efficiency of the common project management tools for various types of projects namely, small, medium and large projects and also, for various stages of the project. The authors concluded that due prudence must be done while choosing the appropriate project management tool for a project based on size of the project and knowledge of the project team.

## III. OBJECTIVE AND SCOPE OF THE STUDY

The paper focuses on the following objectives:

- To identify the problems faced in material management.
- To identify the critical factors in various stages of material management.

The scope of this project is limited to small and medium scale residential projects which are being constructed in urban areas, where there is relatively better availability of materials, when compared to remote areas.

#### IV. PROBLEM IDENTIFICATION

Material management at site is always associated with certain risk factors which vary for each project. These risk factors contribute to the uncertainty of the project.

The following are the problems related to material management:

- Cost escalation of materials
- On-time delivery of materials
- Procuring good quality materials and maintaining the quality till construction and maintenance phase.
- Managing the risk related to materials, cost escalation of materials, inventory related risks, etc.
- Procurement problems like correct description of materials, insufficient storage area, too early receiving of materials, etc.
- Procedures and hierarchy problems and it leads to communication problem of material handling and movement

The factors affecting material management under the category of material management, vendor analysis, material purchasing, storage and inventory and supply distribution and onsite were identified and categorized into their dependency through literature study [2][3][4][5][7] presented in the Table-I, II, III, IV and V respectively.

**Table- I: Factors Identification – Material Planning**

Major Factors	Sub Factors
Cost	<ul style="list-style-type: none"> <li>Waste from uneconomical shape of material</li> </ul>
Communication	<ul style="list-style-type: none"> <li>Misunderstanding of owner's requirements by design engineer</li> <li>Insufficient instructions about handling materials onsite.</li> <li>Unclear and inadequate details in material specification</li> </ul>
Human resource	<ul style="list-style-type: none"> <li>Poor use of advanced softwares</li> <li>Poorly defined roles and responsibilities</li> </ul>
Procurement	<ul style="list-style-type: none"> <li>Impossibility to order small quantities</li> <li>Locating source of procurement</li> <li>Forecasting materials price in market</li> <li>Storing materials in faraway stores</li> <li>Poor store layout</li> </ul>
Risk	<ul style="list-style-type: none"> <li>Severe weather conditions</li> </ul>

**Table- II: Factors Identification – Vendor Analysis**

Major Factors	Sub Factors
Quality	<ul style="list-style-type: none"> <li>Manufacturing defects on materials.</li> <li>Rework due to poor material quality used before.</li> <li>Time lapse in testing and inspection</li> </ul>
Stakeholder	<ul style="list-style-type: none"> <li>Financial condition of the company</li> <li>Poor coordination and communication among the contractor and material supplier</li> </ul>
Cost	<ul style="list-style-type: none"> <li>Competitiveness of price</li> </ul>

Major Factors	Sub Factors
Time	<ul style="list-style-type: none"> <li>Timeliness of delivery</li> </ul>

**Table- III: Factors Identification – Storage and Inventory**

Major Factors	Sub Factors
Procurement	<ul style="list-style-type: none"> <li>Project delay due to slow delivery of materials.</li> <li>Lack of materials (due to closure).</li> <li>Ineffective control of storage.</li> </ul>
Risk	<ul style="list-style-type: none"> <li>Local issues causing material delays and unavailability</li> </ul>
Time	<ul style="list-style-type: none"> <li>Too early receiving of materials</li> </ul>
Integration	<ul style="list-style-type: none"> <li>Usage of materials without systematic control</li> </ul>
Communication	<ul style="list-style-type: none"> <li>Communication to previous stages</li> </ul>

**Table- IV: Factors Identification – Material Purchasing**

Major Factors	Sub Factors
Human resource	<ul style="list-style-type: none"> <li>Shortage of skilled labour for handling</li> </ul>
Quality	<ul style="list-style-type: none"> <li>Poor storage of materials.</li> </ul>
Risk	<ul style="list-style-type: none"> <li>Burglary, theft and vandalism</li> </ul>
Scope	<ul style="list-style-type: none"> <li>Burglary, theft and vandalism</li> </ul>
Communication	<ul style="list-style-type: none"> <li>Shortage of skilled labour for handling</li> </ul>

**Table- V: Factors Identification – Supply, Distribution and Onsite**

Major Factors	Sub Factors
Risk	<ul style="list-style-type: none"> <li>Damage of material onsite</li> </ul>
Quality	<ul style="list-style-type: none"> <li>Use of incorrect material</li> </ul>
Integration	<ul style="list-style-type: none"> <li>Using excessive quantities of materials</li> <li>Lack of onsite materials control.</li> <li>Existence of unnecessary materials onsite.</li> </ul>

#### V. DATA COLLECTION

Data was collected through questionnaire survey. It is a data gathering tool with a series of question with provisions for responses either in the form of yes/no or hierarchical ranking or open ended opinion. The questionnaire used in the study had hierarchical ranking as the response option. It is reliable way to get the relative importance of factors.

Developing a reliable questionnaire for this project is very important for identifying the correct factors regarding material management. Initially the design of the questionnaire was developed based on the review of the existing literature.

In this research, a five-point Likert scale was used as a simple method to identify the factors in construction site. The questions in the questionnaire survey are provided to identify the factors affecting the material management process. A series of questions pertaining to the identified factors and sub factors were posed to all the personnel in the project such as architects, sponsors, storekeepers, material managers, quantity surveyors, site engineers, project managers, and project engineers.

## VI. RESULT AND DISCUSSION

The data received from questionnaire survey was recorded. Relative Importance Index (RII) was calculated and used for ranking of factors using Microsoft Excel [7].

### A. Relative Importance Index (RII)

Relative Importance Index (RII) can be used to hierarchical rank the factors based on the ranked response from the questionnaire survey. It helps in comparing the significance of the one factor with respect to the other factors. The maximum value of RII can be 1 indicating highest importance ranked by all respondents. RII can be used for ranking within the sub-factors and also for overall ranking. The expression for calculating RII is given in (1).

$$RII = \frac{\sum W}{A \times N} \quad (1)$$

Where, W is a weight or index as stated by the respondents in the questionnaire and can range from a low value of 1 to a high value of 5, A is the highest rank or weight or index given to a factor by any respondent and N is the total number of respondents.

**Table- VI: Ranking Criteria**

Not Applicable	Sub Factors	moderate	high	very high
A1	A2	A3	A4	A5
1	2	3	4	5

**Table- VII: Material Planning**

Major factor	Sub factors	RII	RANK
HR	Poorly defined roles and responsibilities	0.8667	1
Procurement	Storing materials in faraway stores	0.8533	2
Procurement	Poor store layout	0.8367	3
Procurement	Forecasting materials price in market	0.7567	4
Communication	Unclear and inadequate details in material specification	0.73	5
Cost	Waste from uneconomical shape of material	0.71	6
Communication	Insufficient instructions about handling materials at site	0.6333	7
Procurement	Locating source of procurement	0.5567	8
Communication	Misunderstanding of owner's requirements by design engineer	0.5533	9
Procurement	Impossibility to order small quantities	0.5267	10

Major factor	Sub factors	RII	RANK
Risk	Severe weather conditions	0.5033	11
HR	Poor use of advanced software	0.46	12

The ranking criteria is presented in Table VI. A1 represents number of respondents selected not applicable, A2 represents number of respondents selected low, A3 represents number of respondents selected moderate, A4 represents number of respondents selected high, and A5 represents number of respondents selected very high. Table VII shows the various factors considered in the material planning phase and their RII value along with their ranking.

Table VIII shows the various factors considered in the vendor analysis phase and their RII value along with their ranking.

**Table- VIII: Vendor Analysis**

Major factor	Sub factors	RII	RANK
Stakeholder	Poor coordination and communication among the contractor and material supplier	0.9067	1
Quality	Rework due to poor material quality used before	0.8733	2
Time	Timeliness of delivery	0.8467	3
Stakeholder	Financial condition of the company	0.7833	4
Quality	Time lapse in testing and inspection	0.73	5
Quality	Manufacturing defects on materials	0.73	6
Cost	Competitiveness of price	0.68	7

Table IX shows the various factors considered in the material purchasing phase and their RII value along with their ranking.

**Table- IX: Material Purchasing**

Major factor	Sub factors	RII	RANK
Risk	Local issues causing material delays and unavailability	0.8933	1
Procurement	Lack of materials (due to closure)	0.8767	2
Time	Too early receiving of materials	0.86	3
Integration	Usage of materials without systematic control	0.8467	4
Procurement	Ineffective control of storage	0.7567	5
Time	Too early receiving of materials	0.6267	6
Communication	Communication to previous stages	0.5767	7

**Table- X: Storage and Inventory**

Major factor	Sub factors	RII	RANK
Scope	Availability of modern equipment & methods for handling	0.8	1
Quality	Poor storage of materials	0.7167	2
HR	Shortage of skilled labour for handling	0.5767	3
Risk	Burglary, theft and vandalism	0.49	4

Table X shows the various factors considered in the storage and inventory phase and their RII value along with their ranking.

Table XI shows the various factors considered in the supply and distribution phase and their RII value along with their ranking

**Table- XI: Supply, Distribution and Onsite**

Major factor	Sub factors	RII	RANK
Risk	Damage of material on site	0.7767	1
Integration	Lack of onsite materials control	0.75	2
Integration	Existence of unnecessary materials on site	0.5733	3
Integration	Using excessive quantities of materials	0.51	4
Quality	Use of incorrect material	0.4967	5

## VII. CONCLUSIONS

In this paper, the factors affecting material management in construction industry were identified. The factors were put in a form of questionnaire and response was elicited from stakeholders at small and medium scaled residential projects in urban area. Based on the response from the stakeholders, the following conclusions are made.

- 1) In material planning stage of material management, poorly defined roles and responsibilities was considered to be the major problem followed by storage of materials in faraway stores and poor store layout.
- 2) In vendor analysis stage of material management, poor coordination and communication among contractor and material supplier was considered to be the major problem.
- 3) In material purchasing stage of material management, local issues causing material delays and unavailability is considered to be the major problem.
- 4) In storage and inventory stage of material management, lack of availability of modern equipment and methods for handling is considered to be the major problem.
- 5) In supply and distribution stage of material management, damage of material on site and lack of onsite material control were considered to be the major problem.
- 6) The important factors for delay in each stage of material management were identified within the limited scope of work and a focus of these factors would improve material management in construction.

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