

Factors Affecting Material Procurement, Supply and Management in Building Projects of Pakistan: A Contractor's Perspective

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Abstract: *Material management plays an inevitable role in any construction project. The current research identified and ranked the most significant factors related to material procurement, supply and management of building projects in Pakistan. Several factors from previous literature were identified and filtered through experience professionals having practical experience of more than 20 years. 28 factors were presented in the research questionnaire. Survey was limited to the building projects of Pakistan. Data was collected from contractors and sub-contractors working in various building projects. Top five most significant factors identified in the present research are difficulty in managing materials among sub-contractors due to the limited storage space on-site, difficult to store materials on-site due to insufficient space available, conflict among sub-contractors due to acute space available for material, hindrance to work progress due to improper stocking of material, difficulty in coordinating sub-contractor's material on-site. Least significant factor highlighted after descriptive analysis of the data is strike's impeding supply of material to the site. Finding of the research would help project professionals to streamline the project(s) and reduce hurdles during the execution of planned activities.*

Keywords: *Material Procurement, Supply, and Management, Building Projects of Pakistan*

1. Introduction

Material management is a scheduled procedure that contains the procuring, control, supply and waste minimization to ensure the requirements. It is a procedure for executing, planning, and controlling site activities in the construction project(s). Material constitutes substantial portion of the total project cost. Thus material related issues can escalate project(s) cost and may cause time overrun in the project. On the other hand, management of construction materials in building projects can raise the project profit dramatically and saves considerable times. Mostly, projects fails due to the unplanned material availability and mismanagement of material stocks provided to sites for the construction.

Shortage of materials and equipment for construction projects in developing countries are very common due to which construction projects are adversely affected [1] and Pakistan's building projects are no exception to this phenomenon. This research paper is envisaged to promote awareness in the construction industry of Pakistan regarding material procurement and management and factors are worked out to help the professionals in construction projects to avoid issues occurring due to ill planning of materials.

Materials if not properly managed at site can lead to termination or even suspension of a project that is why it is the most critical part of a project and needs serious attention. In order to store construction materials, sites should be divided into three different zones i.e. exterior, staging and interior [2]. Materials management covers an

integrated coordination of the materials related functions such as to takeoff, purchase, speed up, transport, receive, warehouse and distribute [3].

The first section of this paper gives literature review of the material management, procurement and supply. The second section defines the research methodology and the third section gives the results and analysis. In the fourth and final section, conclusion and recommendations are presented.

2. Literature Review

Material indicates prime expenses in a construction, so the overall cost can be reduced by controlling procurement cost. Too early procurement of materials may held up capital and interest charges sustained on the surplus inventory of materials and construction materials may be weakened during storage or get stolen. Construction material if required for particular activity is not purchased can delay the project.

Arrangement of larger quantities of material less rarely minimizes probability of the material unavailability and project interruptions. However, it increases the cost of locked-up capital [4].

There is an increase in the materials management in urban developments which results in additional supervision. In limited space, material management becomes difficult. Almost 50-60% of the total project cost is that of material and equipment required for the project, and unavailability of material and equipment delays the project [5].

Often, materials are not registered in the inventory register, thus for proper control visual availability is very essential [6]. Material management planning and controlling is to ensure the required quantity, quality of construction materials and installed equipment, planned in the schedule and are acquired at equitable cost when required [7].

2.1. Procurement:

Procurement covers a wide purchasing of materials, equipment, labor and services needed for execution of a project. Procurement is organizing the purchasing and scheduling delivery of materials to the suppliers. Over-ordering of materials can result wastage problems in the construction site.

Overall project cost can be reduced by lessening the procurement costs [8]. For improvement of labor productivity precise communications regarding material availability is needed [9]. Material procurement and limited site space can lead to serious problems including shortages of materials, improper storage, unsafe and poor marking, and productivity losses. Project(s) having improper material management system may spend additional time in finding materials and procurement orders, instead the time can be utilized in supervision of the construction activities [10].

Material delivered to the site need communication among the parties for timely implementation of activities. Non-conforming materials to be recorded and photographed for expected resolution of claims and conflict of interest issues. The purchasing function to be integrated and must be incurred into the overall management [11].

2.2. Supply:

Normally problems arise due to improper storage materials when supplied to the site. Survey shows that purchasing and supply management can evaluate firm's financial performance. Timely demand for the materials is critical for leveling the required supply [12].

The material needed for required activities to be properly scheduled in order to ensure supplier's demand. Space provided at a site for stocking of ample materials dramatically reduce procurement cost, wastes and other associated risks. Material management process establish framework for provision of scheduled materials required prior to commencement of the activity [13].

2.3. Material Management:

Material management is difficult in urban areas and at sites of restricted surroundings [14]. The overall performance of construction projects in terms triple constraints and productivity are affected by improper handling of construction materials [15].

Subcontractors may be entitled for claims for unavailability of materials required to perform a specific task by the crews. The benefits of successful materials management and control is production improvements and avoiding delay in the construction [10, 16]. Construction professionals have to proactively focus on the materials management process, identifiable reasons that have a significant impact on the project cost. Materials if provided to subcontractors can significantly increase productivity of the project.

The benefits of materials management systems are significant. With the takeoff of material, management process begins to produce materials cost. Material management functions are normally performed on a fragmented basis with proper communication. No clearly established responsibilities are assigned to the client, contractor and engineer [16].

3. Methodology

3.1. Measures:

Several factors having direct and indirect effect on the progress of construction projects from were identified literature research. Those factors were then filtered to 28 most relevant factors through interviews held with the experienced professionals having construction project management experience of over 20 years. The filtered factors highly influence the construction projects of contractor and sub-contractor. Survey was limited to the building projects of Pakistan.

3.2. Development of Questionnaire and Data Collection:

The identified factors were transformed into research questionnaire to gather the data from contractor and sub-contractor. Total seven construction projects consists of three commercial, two residential, and two public service buildings were visited for the purpose of onsite feed-back and to get the required data from the professional engineers working at different building projects.

Questionnaires were sent to different professional engineers working with construction firms by post, through email and through engineers working on site. Fifty six responses were collected from the professionals out of which six responses were discarded for not being valid responses.

The respondents were asked to encircle the appropriate item according to their projects. Quantitative data analysis of 47 responses of the professionals engaged in construction projects for 28 different factors were analyzed on likert's scale. "1" described as strongly disagrees, whereas "5" strongly agree.

3.3. Data Analysis Technique:

Following tests were carried out for data analysis:

- Cronbach's alpha
- Relative Importance Index

4. Results and Discussions

4.1. Cronbach's Alpha:

For internal reliability, Cronbach's alpha was calculated for each scale. Cronbach's alpha for 47 samples was collected as 0.734. Thus the results indicate internal construct consistency and reliability of the data. Cronbach's alpha value range from 0 to 1 with 0.75 being considered the most sensible value (Hinton et.al. 2004)

4.2. RII Ranking Results:

The data included 28 factors that were to be analyzed. Strength of index familiarity, frequencies and agreements were computed through the technique of Relative Importance index (RII). Ranking carried out through the Likert's Scale and top five factors were identified.

$$RII = \frac{\sum PiUi}{N(n)} \quad (1)$$

Where N is the total number of respondents for a particular factor. Pi is a constant showing the weight of the ith response, Ui is the frequency of ith response, i is response category index where n = highest score of material managing factors order. The importance of the indices and overall ranking the factors calculated are shown in table 1.

TABLE I: RII and ranking of factor affecting material management

Sr. No.	Factor	Code	RII	Rank
1	Difficulty in managing materials among sub-contractors due to the limited storage space on-site	f18	0.91	1
2	Difficult to store materials on-site due to insufficient space available	f11	0.89	2
3	Conflict among sub-contractors due to acute space available for material	f13	0.87	3
4	Hindrance to work progress due to improper stocking of material	f21	0.83	4
5	Difficult to coordinate sub-contractor's material on-site	f19	0.81	5
6	Difficulty in placement/fixing of material due to Manual handling on-site	f20	0.77	6
7	There are effective purchasing plans & procedures throughout the life of the project	f4	0.75	7
8	Proper receipt and inspection procedures for critical materials and equipment are implementing	f6	0.75	8
9	Lake of coordination between prime-contractor and supplier	f12	0.74	9
10	There are procedures to utilize QA/QC plans with the suppliers of major equipment and materials	f7	0.74	10
11	There was a transparent process for pre-qualification of securing the appropriate suppliers of prime equipment and materials	f5	0.73	11
12	Cash flow problems to Contractor due to delayed payments	f17	0.73	12
13	Enforcement of law & order situation in the locality	f28	0.71	13
14	Poor site management of materials during the execution phase	f23	0.70	14
15	Written materials management plans are utilizing throughout the life of the project	f2	0.69	15
16	Plans for addressing the effects of change orders on materials management are implementing	f3	0.67	16
17	Poor project planning observed during construction phase	f8	0.67	17
18	Difficulty of shifting material from main store/stocking place to site	f14	0.67	18
19	Accessibility of material to the site	f15	0.66	19
20	Rejection of material due to non-compliance to the specification	f25	0.65	20
21	Health and Safety procedures implementation on site	f26	0.63	21
22	Incompetent material suppliers are selected for the project	f9	0.63	22
23	Accidents/injury occurred at site	f27	0.62	23
24	Project have a designated materials management organization that was integrated and communicated across project teams	f1	0.62	24
25	Site entrance make delivery of materials difficult	f10	0.62	25
26	Damage to materials during transportation to the site	f22	0.61	26
27	Proper tracking and reporting system of construction materials is applying	f16	0.59	27
28	Strikes impeding supply of material to the site	f24	0.58	28

Five most important factors identified are discussed below:

- 1. Difficulty in managing materials among sub-contractors due to the limited storage space on-site.** Managing materials among sub-contractors is an issue almost on each construction site, 57% participants (27/47) strongly agreed on management of such materials. Materials are sometimes needed to be shifted from one place to another place on the site resulting additional cost of manpower and machinery. In building projects various sub-contractors perform their activities in parallel as per agreement with the prime contractor or owner. Practicing Just in time (JIT) approach can best address the issue.

2. **Difficult to store materials on-site due to insufficient space available.** Sometime machineries can't be adjusted on site due to acute space or mismanagement of site activities, 57% participants (27/47) agreed in highlighting the problem thus resulting in more manual work to be executed by the crew. In construction projects especially high rise buildings insufficient space for the required material is a very common problem. To overcome this problem contractor and subcontractor may arrange an additional warehouse nearby that can cater for the required material.
3. **Conflict among sub-contractors due to acute space available for material.** Conflict among subcontractor arises whenever there is limited space available on a site, therefore disputes and barriers to each other's needs are generated. 55% respondent (26/47) agreed on the conflict amongst sub-contractors due to limited space. Project coordinators are responsible to avoid conflict among subcontractors and can play a significant role in this regard.
4. **Hindrance to work progress due to improper stocking of material.** 66% Professionals (31/47) agreed that if construction material stacked is improperly at a site, there would be a hurdle in executing planned activities. Only the material required should be brought to site as per JIT.
5. **Difficult to coordinate sub-contractor's material on-site.** Subcontractors install or fix materials of the project with in accordance to the specifications as per agreement. 55% respondent (26/47) agreed upon the difficulty in coordinating to store material on site due to insufficient space. Various subcontractors' materials are difficult to be coordinated and managed if there are cash flow problems with the client and supplier. Often prime contractor may hire subcontractor on labor rate, so the materials are procured and supplied to the site by prime contractor.

5. Recommendations

Based on the findings, it is recommended that arrangement of additional space for construction materials is vital during planning phase prior to the execution; project(s) having limited space most commonly in the urban areas can be managed by supplying construction materials to the main store and then transfer to the site as per demand. Conflict among sub-contractors due to acute space for material to be handled by Quality Control supervisor(s) and issues/ problems to be timely communicated to the immediate supervisor through proper channel. Planned project(s) can be constructed in a sequential manner, and required materials to be procured and managed accordingly.

6. Conclusions

Material management is crucial for the timely completion of the project. Various researchers have addressed different issues and suggested possible solutions regarding material handling. In the present research, we identified factors affecting material management from the respondent's opinions of managing materials among contractor and sub-contractors in the context of a developing country. Construction project(s) passing through the various phases i.e. initiation, planning, implementation and closure may have the problems of material management. Managing materials among contractor and sub-contractors due to the inadequate storage space on-site is the utmost critical factor observed in the analysis. Storage of materials on-site due to insufficient space, conflict among sub-contractors, hindrance to work progress due to improper stocking of material, coordination of sub-contractor's material are also highlighted as critical factors which directly or indirectly unease the progress of ongoing construction project(s).

On the other hand strikes impeding supply of material to the site observed as the least important factor; moreover factors like tracking and reporting system of construction materials, damage to materials during transportation, project have a designated materials management organization that was integrated and communicated across project teams and site entrance make delivery of materials difficult are the factors of least importance.

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