

DESIGN OF MATERIAL MANAGEMENT MODULE FOR CONSTRUCTION INDUSTRY

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Abstract - Construction material management is generally recognized to be the integrated coordination of material take off, purchasing, receiving, warehousing and distribution. When these functions are not properly managed, material shortage, surplus, and cash flow problems may likely to occur. The non-availability of materials of required quantity and quality may result in labour delays, thereby affects the total project duration, cost and productivity adversely. The construction materials and equipment may constitute more than 60% of the total cost of a typical construction project. Therefore the proper management of single largest component can improve the productivity and cost efficiency of a project. For a productive and cost effective site, efficient material management is very essential. So the aim of study is to determine the most influencing factors in management of materials and constraints regarding the usage of material managing software in construction sites. A total of 25 construction companies were selected for the study. An open ended questionnaire was prepared by incorporating most important factors and constraints identified through detailed literature reviews and site visits. Based on the results obtained a computational system was developed for material management.

Key Words: Construction materials, key factors, constraints, MMS, MS Excel, Web application, Python language.

1. INTRODUCTION

We are in the world of advancing technology. Each and every activities were getting simplified day by day. In the field of construction industries, the implementation of advance technology is dragging slowly. Construction industry is the second largest industrial sector in which a large number of people are working and it is also the main factor contributing to economic stability. The primary goal of any construction project is the transformation of the expressed desire of owner into tangible artefacts that satisfies his/her desire. For such transformations to be cost-effective, human and material resources have to be gathered and managed with the high degree efficiency. Thousands of tasks must be precisely controlled if a project is to run smoothly, on time, and in budget [4]. The completion of a construction project requires the judicious scheduling and allocation of available resources [5]. The supply and availability of resources can seldom be taken or granted because of seasonal storage, labour disputes,

equipment breakdowns, competing demands, delayed deliveries and a host of associated uncertainties. Nevertheless, if time schedules and cost budgets are to be met, the work must be supplied with the necessary workers, equipment, and materials then and as they are needed on the job site [2]. In this study the main concern was given to the influence of material management in the construction industry.

Effective material management is a key factor required for construction project to be successful. It has evolved and changed through years with respect to the ever-growing complexities in projects [1]. The application of computerized technology in construction industry can improve the performance of construction activities and make the information flow much easier [10]. The use of web application can minimize the complexities in planning and controlling of material in a construction site and reduce the human efforts and increase the efficiency. Conventional site management systems utilize few computer application programs like, Microsoft Project, Microsoft Excel, and Microsoft Word etc. This type of software applications requires computer professionals or experienced engineers in that field. In addition, it takes more time to manage all the resources in a construction industry. So, there is a need for a user-friendly computer software system to handle all the management functions effectively. This can be operated by supervisors or by common people without undergoing much difficulty.

2. METHODOLOGY

In this research, few data collection methods were used, including observation, documentation, interviews, questionnaires and documentation analysis. The good design of the questionnaire was to obtain good results. The methodology for the research includes [14]:

- Literature review
- Preliminary data collection
- Identify material management process and root causes in ineffective management.
- Preparation of the questionnaire.
- Distribution of questionnaire to the targeted response group.

- Interviewing a person in charge of managing construction materials.
- Data collection and analysis.
- Development of computational system.

The study is only limited to some Construction companies in Ernakulam India, and consider only first class and second class contracting companies.

2.1 Design of Questionnaire

The questionnaire was built mainly using closed questions, and it was divided into different sections as follows:

Section 1: company profile, which includes 5 items.

Section 2: Factors influencing material procurement which include 10 items.

Section 3: Factors influencing material storage & transportation, which include 9 items.

Section 4: Factors influencing material management on sites which include 12 items.

Section 5: Constraints in the implementation of MM softwares, which includes 8 items.

After the preparation of the questionnaire, it was presented to three experts to examine its validity. The experts generally manifest comforting complacency toward the questionnaire. However, they provide some comments and suggestions which were taken into consideration while modifying the questionnaire structure.

3. DATA ANALYSIS AND RESULTS

As many as 25 respondents' views were collected regarding the material management criteria preferences, who having enough experience in the construction industries. The data were analysed on the basis of Mean score and frequency analysis in SPSS.

3.1 General Information

Respondents for the survey includes 36 % of site engineers and project managers, 8 % of owners (organisation) , 16% were office engineers and 4% were the supervisors of the construction site. On considering the work experience of respondents, 20 % respondents having work experience of 1-3years, 20% of respondents having 3-5 years,28% respondents having 5-10 years and 32% respondents having an experience more than 10 years. In which 64% of the contracting companies were executing construction projects cost more than 10 crores, 20% having project turnover in range of 5-10 crores and 16% having a project turnover in range of 1-5 crore

3.2 Material Management in Construction Projects

1. Factors influencing material procurement in construction project

From the questionnaire survey, it was identified that the contractors gave more weightage to factors such as “requirement of proper schedule for procurement”, “higher rate purchase due to non-availability” and “not determining what and when the materials required”. The factors identified with less importance were “cash flow factors” and “duplication of orders” illustrated in table-1.

Table -1: Factors Influencing Material Procurement

Sl.No	Factors Influencing Material Procurement	N	Mean	Rank
1	Proper schedule requirement for material procurement	25	3.84	1
2	Higher rate incurred on purchase, due to non-availability	25	3.36	2
3	Not determining what and when materials required	25	3.04	3
4	Late or incorrect submittals	25	3	4
5	Ordering varied from initial budget	25	2.96	5
6	No good definition of the requirements	25	2.96	6
7	Purchase of material contrary to specification	25	2.68	7
8	Incompetent material supplier	25	2.6	8
9	Cash flow factors	25	2.44	9
10	Duplication of orders	25	2.36	10

2. Factors influencing material transportation and storage in construction project

It was found that the factors such as “unrealistic delivery dates”, “delay or late supply” and “hindrance to work in progress due to improper stocking of material” got more weightage from the respondents during the survey. The factors identified with less importance were “re-handling of material” and “unnecessary inventories on sites”

3. Factors influencing overall management on site

In this section, it was found that the factors such as “ exact data of material consumption and stocked”, “poor internal communication” and “wastage of material” which was helpful in improving the work productivity. Whereas the factors such as “poor site layout” and “theft and burglary” factors got low weightages during the survey.

4. Constraints regarding the usage of material management software on site

The table 2 illustrates the constraints faced in implementing the software packages in the construction industries with sample population of 25. From the survey, the factors such as "Lack of proper tracking and reporting system", "Lack of training and support" and "Shortage of user friendly software" got more weightage whereas the factors such as "Non availability of software" and "Lack of qualified personals on site" got less weightage or importance.

Table 2: Constraints Regarding Implementation of MM software

Sl.NO	Constraints Regarding Implementation of MM software	N	Mean	Rank
1	Lack of proper tracking and reporting system	25	3.32	1
2	Lack of training and support	25	3.25	2
3	Shortage of user friendly software	25	3.2	3
4	Cost of software	25	3.12	4
5	The functions of the software used for MM is not up to expectation	25	3.08	5
6	Occurrence of manual error	25	2.84	6
7	Non availability of software	25	2.72	7
8	Lack of qualified personals on site	25	2.72	8

From the questionnaire survey results, the influencing key factors of the material management system and constraints in implementing computerised applications in material management were analysed. It was found that most of the companies are using few conventional methods for the management of materials but still it needs some advancement to minimize the efforts. The survey also identifies that the implementation customized material management software packages were at initial stages. This leads a possibility in development of computational system by incorporating the positive influence of key factors and constraints identified from the survey.

4. DESIGN OF MATERIAL MANAGEMENT SYSTEM

An online web application is developed for the construction material management. The website is designed using Python programming language. This software can be implemented for construction

organisation and to their respective construction sites. This application is provided with unlimited storage space that helps in storing and managing project documents securely at online. The website can be accessed through the computers and mobile devices. So that users can access the system from anywhere at any time. Thereby the material flow of organisation can be properly tracked and verified. The website can be accessed by providing the web address (mt.xeoscript.com) at the search bar in any internet browser. The web address directs to the website's login page. The registered users can login into the website by providing the user id and password. This must be made to establish in advance to ensure the privacy of the company and keep it from information stealing.

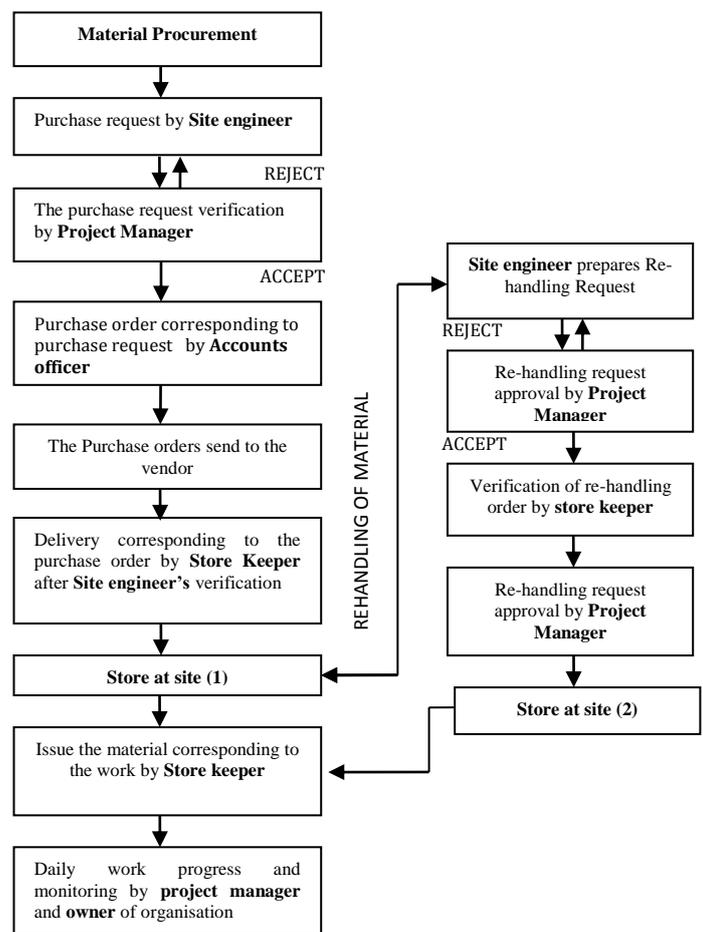


Fig-1: Work Flow diagram

Following are the main users for the software:

1. Site Owner: accessibility to all construction sites for monitoring purpose
2. Project Manager: accessibility limited to sites under control for monitoring and for approving the request.
3. Site Engineer: accessibility limited to the respective construction site

4. Store Keeper: accessibility limited to the respective store facilities of the site
5. Accounts Officer: accessibility limited to material purchase section
6. System Administrator: web site maintenance

4.1 Functions of Material Management System

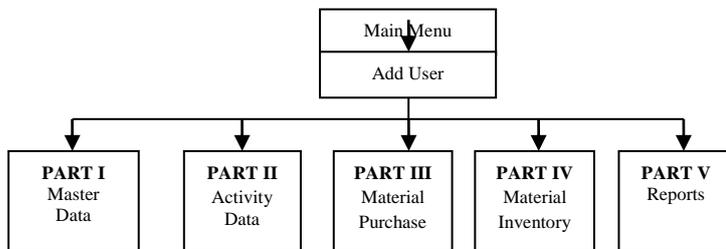


Fig -2: Functions of Material Management System

Part 1(Master data): The data should be added in the software which can be accessed as global objects, once it is added it can be saved universally and can be accessed in any sections of the software. In which the materials details, work unit quantities and vendor details can be set as master data

Part 2 (Activity data): In this section the main data such as the bill of quantity of work can be added along with the duration such as start and finish time ,work quantity ,work unit rate, material quantity etc. The application also gives a facility to input both estimated and actual data of the work.

Part 3(Material Purchase): This section of the application provides a facility for preparing purchase request and corresponding purchase order for each sites associated to the organisation. The site engineer is responsible in preparing the purchase request.

Part 4(Material Inventory): The web application is designed to provide an individual store facility for the respective sites of the organisation. The delivery can be taken corresponding to the purchase order and issue of material can be done according to the work. The re-order point facility is provided to notify the time of procurement. A rental stock facility was provided to add rental materials for accounting the total rental amount and durations. Re-handling facility was provided for site to site material transfer.

Part 5(Reports):This section of application gives the detailed reports regarding bill of quantity, schedules of activity, stock status, issues and delivery reports, cumulative quantity of materials , cumulative rates of materials used , rental materials, re-handled materials and, wastage analysis reports.

5. CONCLUSIONS

From the study it was clearly understood that efficient management of materials plays an important key role in successful completion of a construction project.

- From the questionnaire survey conducted, the most influencing factors of material management and also the constraints in implementation of management softwares in construction site were identified.
- On incorporating the positive influence of key factors and constraints identified a computational system was developed under Python program.
- For the system, users were provided with a username and password to access the prioritised area of the web application. This application has unlimited storage space that helps, store and manage project documents of all types securely at online.

On implementations of the system, following are benefits:

- The MMS act as centralised system that can maintain proper coordination and communication between the site and the organisation.
- The proper implementation of the MMS in construction projects helps to improve decision-making capabilities, maintain workflow and strengthen the material supply chain.
- Site engineer can add the work details along with estimated schedules, gives better idea regarding requirement of different materials, so that timely purchase of right quality material can be done. Thereby reduce the chance of deviation of estimated budgets.
- The owner of organisation and project manager can monitor the occurrence of delay, incorrect submittals , daily usage and progress of the work
- The application provides individual estimated quantities of each material required for the work. Thus wastage analysis can be effectively done.
- The employment of computer application in material management helps to get an outline and complete details of previous and on-going works including the cost, material supplied and issued for various works, transferred materials, rental materials, wastage of materials etc.
- The information on the application might be unreliable if not updated on a regular basis.
- At most probable conditions it was identified from the studies that the worker requires more time to adapt a new system.

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