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Study on an Innovative Time-Cost-Quality Tradeoff Modeling of Building Construction Project Based on Resource Allocation

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Abstract: *The construction industry which provides large-scale employment is the foundation of development for emerging countries like India. The productivity of the construction industry depends largely on resource management methods. Also, it is very difficult to prepare accurate and achievable plans in large construction projects. As the complexity of the project increases and the cost of the project surges, companies must effectively manage their budgets and schedules. Using automated software tools is essential for successful planning and managing of projects. Many automated software tools have been developed in the industry. The literature on how to select the appropriate project management software tools is quite limited. This study provides a comparison of a set of project management software tools (PMST). In this study, first, we developed criteria to determine which PMSTs would be subject to our analysis. Then, we developed criteria to compare and evaluate these PMSTs. Finally, we present our findings in a tabular format. Our findings will help project managers to assess the strengths and weaknesses of these tools. Using automated software tools is essential for successful planning and managing of projects. Many automated software tools have been developed in the industry. The literature on how to select the appropriate project management software tools is quite limited.*

Keywords: Resource allocation.

I. INTRODUCTION

Project management is the planning, monitoring and scheduling of all aspects of a project and the motivation of all those involved in it to achieve the project objectives on time and to the specified cost, quality and performance. Construction project management is the art and science of managing all aspects of the project to achieve the project mission objectives, the specific time, budget cost and predefined quality specifications; working efficiently and effectively in the changing project environment with due regards to construction worker's safety and health. Project management is essentially aimed at producing an end product that will effect some change for the benefit of the organisation that instigated the project. It is the initiation, planning and control of a range of tasks required to deliver this end product.

The number of automated project management tools available in the market is increasing rapidly. With significant evolution of these tools, many project managers have started using various software project management tools to manage and support their project activities. These tools are mainly used in planning, monitoring and controlling projects. The features provided with these tools vary. The project managers must choose an appropriate set of tools with necessary features among many tools found in the market. According to Capers Jones [18], in complex construction projects, successful project planning highly utilizes automated project planning tools. Hence, it becomes important for project owners or managers to choose the most appropriate tool or set of tools for their project management needs

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1.1 Need and Relevance

Scheduling ensures that project will run in systematic manner. Scheduling and planning of project will eventually benefit the constructor executing construction projects. Scheduling provides info about which activities need maximum attention. It acts as road map for site engineers. It provides documentation for tracking of the project. It provides info to managers about the persons responsible for said task/s. It provides info about on each date what estimated quantities of labor, material and machineries resources will be required. It can give breakdown of estimated funds required for each step of construction.

1.2 Problem Statement

Many of the construction industries, nowadays, are facing problems with respect to the time consumed, cost incurred and delays occurring in completing a construction project. Usually these problems occur when a project has not been planned properly. Project planning involves and explains the customers about the detailing strategy that should be followed for the project completion. The primary and important uses of planning the project are to facilitate communication among stakeholders, to plan the documents related to planning assumptions and decisions, and also to develop document approved scope, cost and schedule baselines. Construction project scheduling is the art and science of managing all aspects of the project to achieve the project mission objectives, the specific time, budget cost and predefined quality specifications; working efficiently and effectively in the changing project environment with due regards to construction worker's safety and health.

1.3 Objective

Time Cost Trade off techniques are developed to achieve the delivery of the project at the required completion date & the least cost associated with the project. In general Time-cost optimization may be defined as a process to identify suitable construction activities for speeding up and for deciding by how much so as to attain the best possible savings in both time and cost. Resource leveling is a technique in project management that overlooks resource allocation and resolves possible conflict arising from over-allocation. When project managers undertake a project, they need to plan their resources accordingly. This will benefit the organization without having to face conflicts and not being able to deliver on time. Resource leveling is considered one of the key elements to resource management in the organization. An organization starts to face problems if resources are not allocated properly i.e., some resource may be over-allocated whilst others will be under-allocated. Both will bring about a financial risk to the organization.

Scope

- It is targeted towards residential construction projects ranging from 250 to 750 Sq. m
- The study is limited to Bungalow and flat schemes types of residential projects only.
- To understand merits and demerits of manual and computer assisted scheduling tools used in above said projects
- The enquiry is limited to understand degree of benefits of scheduling tools to residential construction project executors over residential project executors whom are not using any scheduling tools.

II. LITERATURE REVIEW

[1] Antony Prasanath MA, Thirumalai Raja K, "Analysis of cost & schedule Performance of Residential Building Projects by EVM technique", Journal of Construction Engineering, Technology and Management ISSN: 2347-7253, Vol. 4, (2014) PN (1-7)

For proper scheduling of resources author had developed a Packing method which is based on Critical Path Method (CPM). In this method, to measure the level of resources, the minimum moment of resource histogram was used. The heuristic program assigns project activities to specific days so that the final resource histogram approaches a rectangle and its moment approaches a minimum value.

[2] Tarek Hegazy, Wail Menesi, "Critical Path Segments Scheduling Technique" Journal of Construction Engineering and Management ASCE/ (Oct 2010) PN (1078-1085)

Serial methods for resource levelling and a measure for judging the effectiveness of resource levelling techniques was presented by author. This paper deals with establishment of initial resource profiles for construction projects, resource

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levelling of the schedule, analysis of resource usage verses assumed levels and the adjustment of resource profiles based upon this analysis.

[3] Awad Hanna, Aviad Shapira, Mounir Asmar and Craig Taylor, "Impact of crew scheduling on project performance", Practice Periodical on Structural Design and Construction ASCE (2013) PN (35 – 44)

To minimize undesirable resource fluctuations and to maximize efficiency of resource utilization on construction site author developed two innovative resource levelling matrices. The first metric considers the total amount of resources that need to be temporarily released during low demand periods and rehired at a later stage during high demand periods. The second metric measures the total number of idle and non productive resource days because of undesirable resource fluctuations. Application examples of these two matrices highlights that these two matrices are useful to construction planners and schedulers to enhance the efficiency of resource utilization and improvement in construction productivity.

[4] Daniel Castro-Lacouture, Gürsel A. Süer Julian Gonzalez-Joaqui; and J. K. Yates, " Construction Project Scheduling with Time, Cost, and Material Restrictions Using Fuzzy Mathematical Models and Critical Path Method" ASCE , ISSN 0733-9364/2009/10-PN (1096– 1104)

Artificial intelligent methods are exploited in the form of expert system, artificial neural networks for scheduling of construction project. An expert system is a computer system that emulates the decision-making ability of a human expert. Expert systems are designed to solve complex problems by reasoning about knowledge, represented primarily as if–then rules rather than through conventional procedural code. An expert system for the progress scheduling in the construction of modular multi-storeyed building was developed by auther. Practical limitations of heuristic methods cause the writers search for optimal & suboptimal schedules for construction projects using evolutionary algorithms. An evolutionary algorithm was developed by author to solve the problem of minimizing construction project duration in deterministic conditions, with – in time changeable parameter and limited accessibility of renewable resources.

[5] Awad Hanna, Aviad Shapira, Mounir Asmar and Craig Taylor, "Impact of crew scheduling on project performance", Practice Periodical on Structural Design and Construction ASCE (2013) PN (35 – 44)

To achieve the project objectives that are minimizing cost and time under resource restrictions fuzzy logic have been used. Author evaluated the viability of using fuzzy mathematical models for determining construction schedules and for evaluating the contingencies created by schedule compression and delays due to unforeseen material shortage. Resource scheduling is normally used to minimize the duration & cost of project, by proper allocation and leveling of resources. For schedule monitoring Earned Value Management (EVM) technique is used.

[6] Khaled El-Rayes and Dho Heon – "Optimizing Resource Leveling in Construction Projects", Journal of Construction Engineering and Management © ASCE, Vol. 135, No. 11, November 1, 2009. PN (1172 - 1180)

Author have compared the budgeted cost of work performed against actual cost of work performed and budgeted cost of work scheduled to access cost and schedule variance respectively. For project scheduling CPM/PERT, different softwares like MSP, Primavera and optimization techniques, fuzzy logic is used. Researcher had successfully applied Primavera software to National Highway project for planning & controlling cost and resources and help to achieve timely completion of project.

III. METHODOLOGY

Literature review is carried out in first step search regarding problem area i.e. scheduling tools. After carrying out literature review it is understood scheduling tools help in planning, documenting, monitoring, and communicating the project with stakeholders. Hands on exercises solved on computer assisted scheduling tools had provided insight on their user interfaces, calendars, network diagrams, hierarchical orderings of projects, work break down structures, activities, sub-activities. Extensive literature survey and communication with supervisors lead to refining research problem with its definite scope. Investigation of relevant research methods for the purpose of analysis of the data collected. Detailed exploration of research methods investigated. Detailed explanation of research method used in the report. To carry out research with respect to data collected. To interpret the results, draw conclusions and suggest brief note residential building executors.

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Literature Review and Data Collection Sources –

Meta search engine Google, Google Scholar is used for finding out scholarly articles on related topics. Then these articles are studied to extract needed information. Website Review is done with help of internet. National digital Library and NPTEL courses are also referred on some occasions.

Case Study Selection Criteria and Details –

Case studies were selected based on the scope of the research. At least one case study per scheduling tool is studied to understand merits and demerits of scheduling tools.

Methodology of project is divided into some parts they are explained as below:

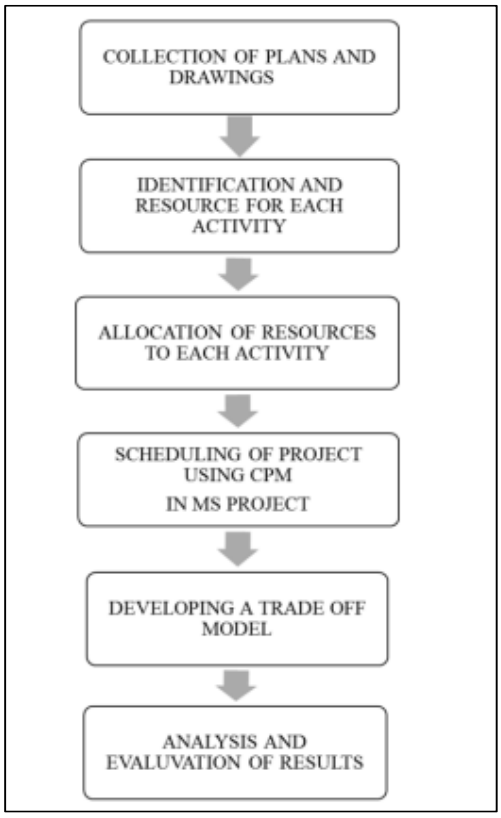

Fig.1.Methodology

Identification and Estimation of Resources for Each Activity

Each task involves different types of materials for construction. The type of materials required for each and every activity has to be determined. Quantity of materials required can be estimated from quantity of each work necessary for completion. Cement , sand ,coarse aggregate and fine aggregate should be identified in appropriate units Duration of each activity for completion should be estimated based on availability of materials and labors in site .Number of labors required will estimated on the basis of work quantity involved in construction process and productivity of each worker and nature of work include local preferences and culture, population density, distribution of trips, climate, geography, topography, available financial resources, local technical capacity.

Work Break Down Structure

A work breakdown structure (WBS), in project management and systems engineering, is a deliverable-oriented breakdown of a project into smaller components. A work breakdown structure is a key project deliverable that organizes the team's work into manageable sections. When an activity is too large or complex for a reliable duration estimate project guide lines state than an individual activity that takes up more than 10 percent of the project schedule has to be broken

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down. A project manager uses a break down technique to reduce the activity to smaller tasks. Ideally the project manager can estimate the duration of tasks that individual workers perform more accurately than the whole activity.

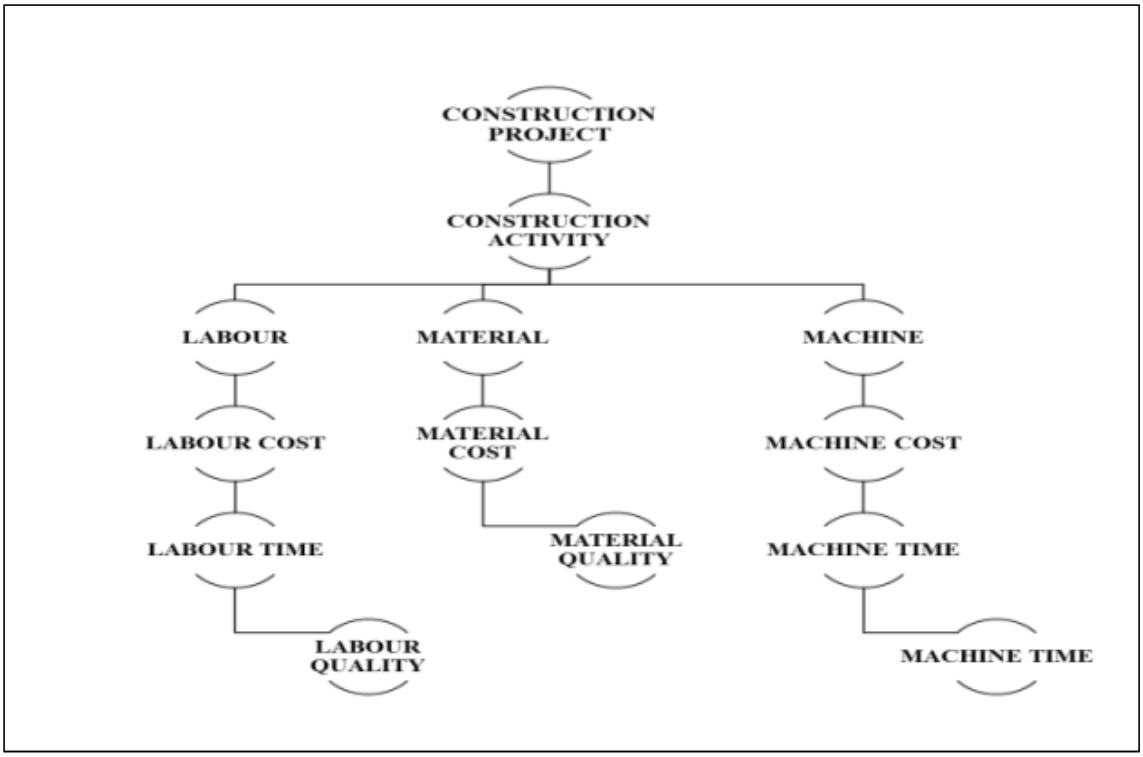

Fig 2. Activity breakdown structure

IV. CONCLUSIONS AND FUTURE SCOPE

Experience is very important in project management, but it is only part of the resource requirements. Large-scale scientific research projects often have lots of senate grinds unit, time is special tight. To work out the plan and repeated calculation only by personal experience will often spend a lot of time and usually easy to achieve objectives. Use the project management technology can do comprehensive management when managing a project. And it has characteristics of timely, rapid, accurate and convenient etc. Whatever, manual work only can't match it at all. For this reason, Depending on its significant role in project management, and its characteristics of simple operation, easy to tracking and adjust, Project must will be widely used**.**

While the number of Project Management and scheduling Software Tools is increasing, managers must choose a suitable tool for their projects. In this study, we chose a set of tools and investigated them. We further identified criteria that can be used to compare these and other tools in the market. Finally, we present our findings in Figure 5.2. This study enables project managers and team members to get a quick understanding of the tools subject to our study and to assess the strengths and weaknesses of them. Furthermore, we aim to help project managers in choosing appropriate tools by providing a set of criteria. This study is the first step in our forthcoming series of studies. As the next step, we would like conduct survey studies among project managers and project team members on how they choose scheduling tools. In addition, we would like to identify their needs in a project management software tool. The identification of these needs will help tool developers. Another line of study may be development of a framework for scheduling tools. With this framework, we will able to categorize the tools and further enhance our understanding of how these tools are actually used. Another study would be the identification and development of metrics for scheduling tools.

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