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

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Abstract: *The time, quality, and cost are three important but contradictive objectives in a building construction project. It is a tough challenge for project managers to optimize them since they are different parameters. Tradeoffs between project duration, total cost, quality and risk are extensively discussed in the project scheduling. This paper tries to develop a Time, Cost and Quality optimization model that enables managers to optimize multi objectives. The model is from the project break down structure method where task resources in a construction project are divided in to series of activities and further in to construction labors, materials, equipment and administration. Quality is an important parameter correlating highly with time and cost parameters .But it is not a quantitative in nature , practical time cost , quality tradeoff models are seldom developed from previous research works of the literature. Although the objectives of cost and time must be mentioned frequently by natural numbers. This paper will present a new solution for solving time, cost, and quality tradeoff problem based on project break down structure method and task resource allocation. The resource utilized in a construction activity would eventually determine its construction time, cost, quality tradeoff model is finally generated based on correlations between construction activities.*

Keywords: Modeling of Building Construction

I. INTRODUCTION

The time, quality and cost are usually three contradictive objectives which are often trade off in project practices by managers randomly if they lack efficient tools. The time, Quality and cost are interdependent parameters in a building project. When the construction time is shortened, the project Cost should be added. It is a tough challenge to balance those objectives in a practice. The cost is usually the most important determinant of selecting a contractor in current construction industry. A contractor is undergoing fewer profit margins now than ever when current construction industry is more competitive. He might lose all profit or even if he fails to implement one or two more projects properly in right quality, time and cost. In order to reduce cost, some contractors risk using inferior construction materials and incapable labor which frequently results in poor quality and safety standards. A construction project contains many un certainties. It requires a number of resources and a large amount of investment. Time and cost are main management goals. Contractors want to get the highest profit so they must plan to complete the job in early time with a minimum cost.

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 , 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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The main focus of this research is targeted towards constructor of residential projects. It is observed that such projects are considered as small. It is often presumed that these projects don't need any type of scheduling. Tentative oral time limits for plinth completion, 1st floor completion, 2nd floor completion, finishing is kept in mind accordingly timeline is followed. (Source: Interview with Practicing Architect Ajinkya Khond). Every constructor's organization has different quantities of machineries, labors, materials. The capacity of machines, procurement strategies differ from firm to firm. The business model differs as per financial and other personal and leadership qualities of managers of firms as well as various location of the project.

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.

1.4 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] Rhuta Joshi and V.Z. Patil (2013) "Resource scheduling of construction project." International journal ofscience and research, Volume 4, Issue 5, PP.563-568.

Author analysed the project management technique by scheduling various construction activities, allocation of resources and resource leveling using Microsoft Project 2013 for residential building. The study was carried out in two phases. In first phase data was collected from site and quantities were calculated as per drawing and required manpower was calculated. In

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second phase of construction activities was defined in MSP 2013. The result was asresource decreases duration increased by 10.38% and cost by 0.94%.

[2] Wallace Agyei (2015) "Project Planning and Scheduling using PERT and CPM techniques with linear programming." International journal ofscientific and technology research, Volume 4, Issue 8, PP.222- 227

The methodology adapted by them was to compare Microsoft Project and Traditional Method. Schedule was prepared for both conventional and prefabrication method. A residential building was taken for comparison. The software used was MSP, the duration required for completion of project was collected from respective company. The comparison was made by comparing the total time required for completion by using critical path method with MSP project. The result shows that the total duration for both the conventional and prefabrication method and prefab construction for individual house and double story the required cost is 13% more than conventional but it reduces the project duration by 63 days.

[3] P. M. Wale and N. D. Jain (2015) "Planning and scheduling of Project using Microsoft Project." IOSR journal of mechanical and civil engineering (IOSRJMCE), Volume 12, Issue 3, PP. 57-63.

The study was aimed at finding the difference between the cost and minimum expected time that will be required to complete the project. Both CPM and PERT techniques were used for analysis and from the result it was concluded that schedule proposed by bus provides much shorter completion time as compared to the actual time taken by the process. Construction of building using Traditional way proves to be uneconomical and consumes more time with many complexibility and enormous error which actual execution of the Project. Traditional way of planning doesn't sub divide the main task which future gets the hurdle of over allocation of resources, improper judgment of resources for particular activities etc. Microsoft Project is the modern tool of Project Management that aid to overcome the obstacles faced owing to traditional way of Planning and Management. It helps for the optimum and effective organization of activities which helps to give the vision to complete the project in planned duration and within the Economy.

[4] Monish Kumar and Maheshwar S. Margoundra (2017) " Construction project scheduling of M. K. Apartments using MS Project 2013, International research journal of Engineering and Technology (IRJET), Volume 4, Issue 7.

They analysed the planning and scheduling of multi-storeyed building in two phase by conventional execution approach & again analysis of same building was carried out by applying MSP to compare the result for justification. For their study they considered G+3 with basement and the type of RCC frame structure, to estimate the overall cost and time required to execute a multistoreyed residential building. The result of their study showed that proper manage of project management skills and technique reduces the time by 23.2% and cost by 3.14%.

[5] Nikhil R. Mahajan, M. V. Bhogone (2017) "Resource scheduling in construction project using MSP". International journal of innovative research in science, Engineering and Technology volume 6, Issue 9

In their study they focused on the scheduling using MSP and earns value analysis for an apartment building. Thereby time required for the process of cost overrun is avoided. Project schedule is considered as core of the project plan, and the purpose of the project schedule is to show the organization how the work will be performed to uncover the mistakes. After completion of project it has been observed that there is more difference between budget cost and actual cost, cost increases as the material price increases. Earned value analysis is carried out in order to find the variance cost of the project.

[6] Prof. A. Ray Chaudhuri, B. Sivakonda Reddy, Prof. A. Ray Chaudhuri, "Resource Management in Construction Projects – a case study" Engineering Science and Technology: An International Journal (ESTIJ), ISSN: 2250-3498, Vol.2, No. 4, August 2012 PN (660 – 665)

In this technique, each activity was divided into separate time segments to accurately identify all critical path fluctuations, better allocation of limited resources, avoid multiple calendar problems and accurate analysis of project delays. CPS facilitates accurate schedule analysis by simplifying complex relationships and avoiding the use of leads and lags. CPS is expected to assist Project managers in preparing reliable schedules that reflect better reality and offer better support for planning, corrective action and schedule analysis decisions. Apart from CPM technique, project duration can be minimized by employing a variety of crew scheduling techniques. Standard crew schedule includes, 40-hr work per week, considering five 8-hr days, four 10-hr days or a second shift.

[7] Indrasen Singh, P. Venkateswaralu, "Planning and controlling of a National Highway Project- A case study", Journal of the Indian Road Congress Paper No.613, April – June 2014 PN (91 – 102)

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Various crew scheduling techniques were applied to provide a comprehensive comparison that outlines a variety of crew scheduling options, along with their impact on labor efficiency, project duration, worker safety and project cost. The tables provided by authors can be used as a tool by contractors who are interested in selecting a scheduling technique that will meet the specific requirements of a project. As the nature of construction industry is Resource driven and huge investment is involved in resources, resources are supposed to be properly utilized by different techniques.

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.

3.1 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.

3.2 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:

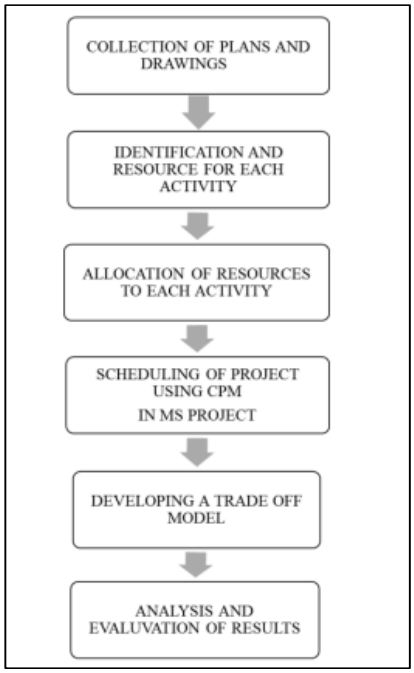

Figure 1: Methodology

3.3 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.

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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.

3.4 Work Breakdown 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 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.

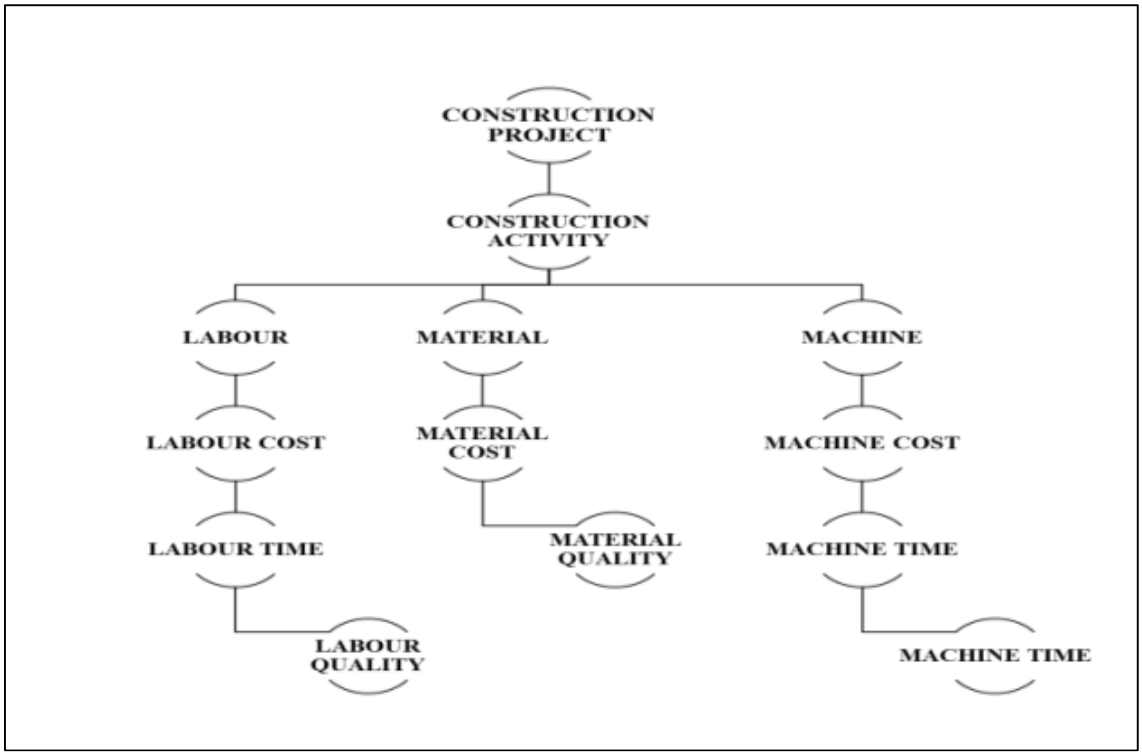

Figure 2: Activity breakdown structure

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