

Computer Aided Construction Management

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Abstract-The construction management is an important part of the any construction activity. The construction industry has undergone large scale mechanization with rapid changes and advancement in construction practices as well as in the management of construction work. The term construction is no longer limited only to the physical activity involving men, material and machinery but covers entire gamut of activities from conception to realisation of a construction projects. All over the globe, the construction activity is getting increasingly complex day to day. Rapid improvement in design and technology has added new dimensions to the industry. Skilled and economic use of materials has become imperative because of unexpectedly high escalation in prices and scarcity of the essential material of construction. The need for better construction practices, systematized planning and programming of work and effective management in the industry is, therefore the demand of the day. The construction planning of a civil engineering project must consider the wide range of aspect involved, such as site investigation, market survey, bidding the works, post tender negotiations and agreement, planning for the works (including the mode of construction and supervision, and the requirements of men, materials, machines, and money) monitoring and controlling the progress of work during the execution up to the completion of work, even its maintenance during the stipulated period, the important aspects of settlement of contractual disputes etc. the entire process is very complex and requires deep knowledge and skill of construction management. Today, construction is a highly competitive field. So main aim to present this paper is, to review the brief of history of construction management, various constrains, activities, its objectives, artefacts, approaches & systems in construction management with the introduction of a software package Microsoft project.

Keywords: Computer Aided, Construction Management, Planning and Scheduling, Software packages, Web based.

I. INTRODUCTION

Construction Management is the discipline of organizing and managing resources (e.g. people) in such a way that the project is completed within defined scope, quality, time and cost constraints. A project is a temporary and one-time endeavor undertaken to create a unique product or service, which brings about beneficial change or added value. This property of being a temporary and one-time undertaking contrasts with processes, or operations, which are permanent or semi-permanent on going functional work to create the same product or service over and over again. The management of these two systems is often very different and requires varying technical skills and philosophy, hence requiring the development of construction management.

The first challenge of construction management is to ensure that a project is delivered within defined constraints. The second, more ambitious challenge is the optimized allocation and integration of inputs needed to meet pre-defined objectives. A project is a carefully defined set of activities that use resources (money, people, materials, energy, space, provisions, communication, quality, risk, etc.) to meet the pre-defined objectives.

Most projects share common activities, including breaking the project into easily manageable tasks, scheduling the tasks, communicating with the team, and tracking the tasks as work progresses. And all projects consist of three major phases:

Build the plan

Track and manage the project

Close the project

The more successful these phases are, the greater is chance of a successful project.

1.2 History of Construction Management [1, 8, 9]

As a discipline, Construction Management developed from different fields of application including construction, engineering, and defence. In the United States, the forefather of Construction management is Henry Gantt, called the father of planning and control techniques, who is famously known for his use of the "bar" chart as a Construction management tool, for being an associate of Frederick Winslow Taylor's theories of scientific management, and for his study of the work and management of Navy ship building. His work is the forerunner to many modern Construction management tools including the work breakdown structure (WBS) and resource allocation.

These were refined to milestone method. In order to obtain a better idea of programme status, milestones are called within the individual bars on the charts. These led to "line of balance" technique, which was developed to handle serial method of production i.e. in a production line, where repetitive methods are used.

However, with increase in the size of the projects and increasing demand in construction necessitated more sophisticated techniques. In 1957, the integrated engineering

control group developed a technique, which could be handled on computers and evolved a new technique called, critical path scheduling (CPS), later to be developed into critical path methods (CPM). On the other side, at same time, two mathematical project scheduling models were developed:

1. The "Program Evaluation and Review Technique" or PERT, developed by Booz-Allen & Hamilton as part of the United States Navy's (in conjunction with the Lockheed Corporation) Polaris missile submarine program; and
2. The "Critical Path Method" (CPM) developed in a joint venture by both DuPont Corporation and Remington Rand Corporation for managing plant maintenance projects. These mathematical techniques quickly spread into many private enterprises.

These two methods resulted in further specialized techniques as, precedence networks, for repetitive or serial production and Graphical Evaluation Review Techniques (GERT) involving more than one uncertainty in the total system.

With the introduction of computers, bigger projects with greater efficiency could be handled. It led to further modification of these techniques. A lot of progress has been made to handle various aspects of a project with computers. With these computer soft wares, right from time scheduling, calendar dating, resource levelling, ascertaining cost status, status of resources etc. can be done very easily and efficiently.

In 1969, the Project Management Institute (PMI) was formed to serve the interest of the Construction management industry. The premise of PMI is that the tools and techniques of Construction management are common even among the widespread application of projects from the software industry to the construction industry. In 1981, the PMI Board of Directors authorized the development of what has become the A Guide to the Project Management Body of Knowledge (PMBOK), containing the standards and guidelines of practice that are widely used throughout the profession. The International Project Management Association (IPMA), founded in Europe in 1967, has undergone a similar development and instituted the IPMA Project Baseline. Both organizations are now participating in the development of a global project management standard.

1.2 The Traditional Triple Constraints [17]

Like any human undertaking, projects need to be performed and delivered under certain constraints. Traditionally, these constraints have been listed as scope, time, and cost. These are also referred to as the Construction Management Triangle, where each side represents a constraint. One side of the triangle cannot be changed without impacting the others. A further refinement of the constraints separates product 'quality' or 'performance' from scope, and turns quality into a fourth constraint.

Another approach to Construction management is to consider the three constraints as finance, time and human

resources. If you need to finish a job in a shorter time, you can throw more people at the problem, which in turn will raise the cost of the project, unless by doing this task quicker we will reduce costs elsewhere in the project by an equal amount.

1.3 Objective of present study

The success of a project is greatly determined by the maximization of efficient resource utilization through procurement of labour, materials, and equipment according to described schedule and plan. It is the aim of the present study to briefly review the field of construction management in software development and introducing new software "Microsoft Project", which is user friendly tool nowadays in construction management and used by the construction managers to work for the many complex construction projects, and in this way this results in the both time & cost saving to the construction firm.

2.1 Construction Project Objectives

Construction Project objectives define target status at the end of the project, reaching of which is considered necessary for the achievement of planned benefits. They have to be formulated as S.M.A.R.T. Specific, with Measurable (or at least evaluable) achievement, Achievable (recently Acceptable is used regularly as well), Realistic and Time terminated (bounded).

The evaluation (measurement) occurs at the project closure. However a continuous guidance on the project progress should be kept by monitoring and evaluating.

2.2 Approaches

There are several approaches that can be taken to managing project activities including agile, interactive, incremental, and phased approaches. Regardless of the approach employed, careful consideration needs to be given to clarify surrounding project objectives, goals, and importantly, the roles and responsibilities of all participants and stakeholders.

2.3 Computerized Construction Management [11, 21]

Real projects are often extremely large, with many hundreds or thousands of tasks. Diagramming, Scheduling and tracking all these tasks are clearly a job for computer. In general there are five areas of computerized construction management.

2.3.1 Project Planning

In the initial area, consideration should be given to the number of activities per project, the use of various calendars and time units, data recording and organization, time estimation graphic generations, Gantt chart and PERT chart capabilities, early and late starts, and the ability to handle sub networks (in nested networks). Of particular interest in this category is the ability to reschedule / updated automatically.

2.3.2 Resources Management

The issues here are similar and include the number of resources types, the number of resources per project, sharing of resources, resource leveling, scheduling by resources load resource updating, resource usage conflicts, multi project

resource analysis, resource planning and analysis, cost estimating and financial modeling analysis.

2.3.3 Tracking / Monitoring

The area includes critical path analysis, sub network analysis, early warning system, baseline and actual schedule updating and display, and similar items.

2.3.4 Report Generation

This topic includes project status summaries, computer assisted report generation, sophisticated data evaluation, resource lists and histograms, schedule lists, task details, updating of reports, resource detail, resource assignment, and current Gantt and PERT diagrams.

2.3.5 Decision Making

This area includes a number of capabilities, some involving external- software packages, generally, what- if analysis, expert system capability, multi project tracking with cross analysis and other such types of capabilities are useful.

3.1 Need for Computer Software [21]

As technology progress, construction projects are becoming increasingly complex. Construction engineers and managers are being bombarded by information at the site from all the directions; unfortunately, the job site office environment often does not lend itself to proper handling of all the day-to-day paperwork generated on most construction jobs. Proper maintenance of daily project information is crucial successful project management. The more complete and effective the records, the more effective they will be in resolving any problems that may arise. To ensure safe and efficient operations at the project site, it will be necessary to use computer software.

3.2 Review of Previous Work

First dissertation on networks in the civil engineering department, IIT Roorkee was done in 1975 by Viswanath G. In that dissertation attention has been focused principally on the scheduling phase of CPM. Programmes for scheduling computation (including resource levelling) for non-stochastic acyclic directed networks were developed.

The work of Viswanath G. was further extended by Mehra Sania (1975) & it has been done in the field of cost control. The main aim was to cover the basic requirements of project cost control. The programme for the cost requirement was written in FORTRAN II for PERT networks.

Mrs. Das K. (1976) has done her dissertation work on application of serial production technique in mass housing construction. She had given a computer programme using precedence network diagram.

Mujibuddin (1977) extended the work of Mehra Sania in the field of project control. A computer programme was developed for project control of CPM networks. The material requirement predictions were included in the programme.

Capt. Singh Hari (1986) did his dissertation work on "precedence network for planning and management of civil

engineering projects" he has prepared comprehensive software on scheduling and cost control aspect.

Kumar Sarvendra (1990) linked the computer programs, developed by Viswanath, for project scheduling and for resource leveling in their modified form. Also, calendar dated scheduling and interactive input modes are adopted.

Laxmi Kant Joshi (1993) had done his dissertation work on computer aided project management using precedence network. He had prepared software for scheduling resource leveling of projects.

Kumar Shailesh (1998), in this dissertation an interactive computer software has been developed on "Cost Control of Projects" that can perform scheduling, budgeting, cash flow forecasting at start of the project, revised cash flow forecasting, performance monitoring, and final budget forecasting.

Sharma K.K. (1999), in this dissertation software has been developed in C++ using object oriented approach on "Project, Cost Management"; the software is applicable to only CPM networks.

3.3 Microsoft Project

Microsoft Project (or MSP) is a project management software program developed and sold by Microsoft which is designed to assist project managers in developing plans, assigning resources to tasks, tracking progress, managing budgets and analyzing workloads. The first version, Microsoft Project for Windows v1.0, was started in 1987 on contract to a small external company. In 1988 the company was acquired by Microsoft, bringing the development project in-house where it was finished and released in 1990 as part of the company's applications offerings for Microsoft Windows 3.0. Microsoft Project was the company's third Windows-based application, and within a couple of years of its introduction, WinProj was the dominant PC-based project management software. A Macintosh version was released in July 1991.

The application creates critical path schedules, although critical chain and event chain methodology third-party add-ons are available. Schedules can be resource levelled, and chains are visualized in a Gantt chart. Additionally, Project can recognize different classes of users. These different classes of users can have differing access levels to projects, views, and other data. Custom objects such as calendars, views, tables, filters and fields are stored in an enterprise global which is shared by all users.

3.4 The Microsoft Project database

As project manager, one has a lot to do. How does Microsoft Project work? First, it stores the details about the project in its database. And it uses that information to calculate and maintain the project's schedule, costs, and other elements, creating a project plan. The more information we provide, the more accurate the plan.

Like a spread sheet, Microsoft Project displays results of its calculations immediately. But the project plan isn't done until we enter critical information about all tasks. Only then do we see when our project will end or the dates when tasks are scheduled.

Microsoft Project keeps the information we enter and the information it calculates in fields, which contain specific types of information, such as task names or durations. In Microsoft Project, each field usually appears in a column.

3.5 Approaches to Microsoft Project software

3.5.1 Desktop

Project management software can be implemented as a program that runs on the desktop of each user. This typically gives the most responsive and graphically-intense style of interface.

Desktop applications typically store their data in a file, or to store their data in a central database. Even a file-based project plan can be shared between users if it's on a networked drive, and no two people want to access it at once.

3.5.2 Web-based

Microsoft Project software can be implemented as a Web application, accessed through an intranet or extranet using a web browser.

This has all the usual advantages and disadvantages of web applications:

- Can be accessed from any type of computer without installing software
- Ease of access-control
- Naturally multi-user
- Only one software version and installation to maintain
- Typically slower to respond than desktop applications
- More limited graphical capability than desktop applications
- Project information not available when the user (or server) is offline.
- Some packages do allow the user to "go-offline"

3.5.3 Single user

A single-user system is programmed with the assumption that only one person will ever need to edit the project plan at once. This may be used in small companies or ones where only a few people are involved in top-down project planning.

3.5.4 Collaborative

A collaborative system is designed to support multiple users modifying different sections of the plan at once, for example, updating the areas they personally are responsible for such that those estimates get integrated into the overall plan. Web-based tools, including extranets, generally fall into this category, but have the limitation that they can only be used when the user has live Internet access. To address this limitation, client-server-based software tools exist that provide a Rich Client that runs on users' desktop computer and replicate project and task information to other project team members through a central server when users connect periodically to the network and other tasks.

3.5.5 Integrated

An integrated system combines project management or project planning, with many other aspects of company life. For example, projects can have bug tracking issues assigned to each project, the list of project customers becomes a customer relationship management module, and each person on the project plan has their own task lists,

calendars, and messaging functionality associated with their projects.

3.5.6 Non-specialised tools

While specialised software may be common, and heavily promoted by each user, there are a vast range of other software (and non-software) tools used to plan and schedule projects.

- Calendaring software can often handle scheduling as easily as dedicated software
- Spread sheets are very versatile, and can be used to calculate things not anticipated by the designers.

II. CONCLUSIONS

On the basis of the study it can be concluded that:-

- i. Previously, the trend was to develop software using programming languages. All softwares which were developed earlier have certain limitations as discussed. It needs to regularly revise and modify the features with programming languages. Now-a-days ready-made web-based softwares packages are available with distinct features; one of them is "Microsoft Project". With heavy work load, complexity in construction and multi-spatiality in most of construction activities, this software is very useful in construction management.
- ii. It allows many different ways of entering and observing information: - "Microsoft Project" is a user friendly tool. It guides the whole project together i.e. if some activity data changes in any of the activities accordingly, it modifies the whole project. It gives the option for data change at any instant without referring to some specific window.
- iii. "Microsoft Project" works on Gantt Chart concept. This gives the easy understanding of the progress of work with scheduled time. It doesn't shows EST (earliest start time), EFT (earliest finish time), LST (latest start time), LFT (latest finish time) etc. It shows the float, which is useful in the resource leveling. By using floats we can level the peak resource requirement on a particular day.
- iv. It overcame the shortcomings in the basic Gantt chart as the interdependency of activities, critical path and critical activities are established first. Due to known critical & non critical activities, we can optimize the project cost. It makes ready network diagram on other window. We can show the milestone by writing the task name and assigning zero time on Gantt Chart and thus control, completion of various activities / task within stipulated time.
- v. Due to the web- based features communication gap between the various authorities/ managers/ contractor etc is practically reduced to zero. The time lag during various processes is minimized, which results in meeting the targets more convenient.
- vi. Microsoft Project Limitations: -
 - It accounts unlimited recourses.
 - Its default estimating unit is in dollar (\$). So, project manager has to analyze carefully the project cost and all expenditure involved in the project as per Indian environment by taking prevailing conversion factor from dollar to rupees

It clearly demonstrates that, with the help of “Microsoft Project” the current construction environment of any project can be handled effectively & efficiently.

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