International Journal of Applied Engineering Research ISSN 0973-4562 Volume 10, Number 17 (2015) pp 38205-38213

Development of Design to Schedule the Project using CPM and its Impact on the Project Management.

K.Kavitha,

Assistant Professor, SRM Faculty of Management, SRM University
kavithakumaradhas@gmail.com

Dr. S. Jacob Pratabaraj,

Assistant Professor, Head – IS&OM, SRM Faculty of Management, SRM University
jacobjabs@gmail.com

Abstract
Project scheduling is one of the important goals of any construction firms, but it is difficult to measure the effectiveness in the project management. Time management in each projects seem to have been largely ignored by project managers in all firms. Time management depends up on many factors this study facilitates to understand the impact Critical path method in the project scheduling and to measure its impact on duration of projects in Eco homes, Kochi. The research is designed to schedule the project using critical path method and its impact in the project management of Eco home builders, Kochi. This study identifies the straight-way method used for scheduling the project. And develop a schedule for the project using critical path method. Further this study analyse the factors in straight-way method this causes delay in project. This research study helps in assessing the project efficiently with in the time constrains, combining and compiling the activities which will add a great advantage for project managers.

Keywords: Project Management, Critical Path Method, Scheduling, Project efficient, time constrains.

Introduction

Indian Construction has accounted for around 40% of the development investment during the past 50 years. Around 16 per cent of the nation's working population depends on construction for its livelihood. The Indian construction industry employs over 30 million people and creates assets worth over ₹ 200 billion.It contributes more than 5 per cent to the nation's GDP and 78 per cent to the gross capital formation.This sector is labour-intensive including indirect jobs, provides employment to more than 35 million people(Kakkar, 2014).The Indian construction industry comprises 200 firms in the corporate sector. In addition to these firms, there are about 120, 000 classes.A contractor registered with various government construction bodies. There are thousands of small contractors, which compete for small jobs or work as sub-contractors of prime or other contractors.

Construction management or construction project management (CPM) is the overall planning, coordination, and control of a project from beginning to completion. CPM is aimed at meeting a client's requirement in order to produce a functionally and financially viable project.The construction industry is composed of five sectors: residential, commercial, and heavy civil, industrial, and environmental. A construction manager holds the same responsibilities and completes the same processes in each sector. All that separates a construction manager in one sector from one in another is the knowledge of the construction site. This may include different types of equipment, materials, subcontractors, and possibly locations.

The functions of Construction management typically include the following:Specifying project objectives and plans including delineation of scope, budgeting, scheduling, setting performance requirements, and selecting project participants.Maximize the resource efficiency via procurement of labour, materials and equipment. Implement various operations through proper coordination and control of planning, design, estimating, contracting and construction in the entire process.Develop effective communications and mechanisms for resolving conflicts.

The customer satisfaction within the constraints of quality of the product with minimum cost and minimum lead time is the essential process for the sustainment of the construction industry (Garcia, 2006). The application of critical path method in project management practices to this industry has got significant role. The construction is open seven days per week, all time. The research deals with specific elements of CPM, including project networks, slack, uncertainties, cost trade off, in order to determine how well the CPM will work in this environment. The research relies on existing empirical evidence of the use of CPM in the construction industries as well as studies examining the issues faced within the scheduling of the projects. In the short-term, the CPM implementation may be more difficult for the organization due to the time consumption and lack of experts in the area. However, in the long term it is likely to save money and time. With the increasing number of businesses and growing competitions today, each company wants to be the customers' first choice. To achieve this, organizations need to meet objective of satisfying their customers and making profits. Because customer satisfaction is the main concern of business sectors of today, their researchers are always conducting research about the customers especially on what relates to their satisfaction. Moreover, because this problem of satisfaction concerns themost unpredictable stakeholder in the

business environment (the customers), who remains the main character that keeps the business in operation; and because satisfaction varies and changes among individuals, there is a need for continuous research in this area.

This research provides a comprehensive analysis of the construction industry in India. Historical (2008-2012) and forecast (2013-2017) valuations of the construction market in India using the construction output and value-add methods. Segmentation by sector (commercial, industrial, infrastructure, institutional and residential) and by project type.Breakdown of values within each project type, by type of activity (new construction, repair and maintenance, refurbishment and demolition) and by type of cost (materials, equipment and services).Analysis of key construction industry issues, including regulation, cost management, funding and pricing. Assessment of the competitive environment using Porter's Five Forces.Detailed profiles of the leading construction companies in India

The overall industry attractiveness is very low. The collective impacts of the five competitive forces will result in lower profitability of the industry participants. The rivalry amongst competitors is very vigorous. The entry barriers are low and allow new rivals to gain a market foothold. There is intense competition from substitutes. Buyers are able to exercise considerable bargaining leverage.

Table No:1 Showing Porters 5 Forces Applied to The Construction Industry

Conclusion	
Threat of New Entrants	Weak
Bargaining Power of Customers	Strong
Bargaining Power of Suppliers	Weak
Threat of Substitutes	Strong
Rivalry Among Firms	Strong

Literature Review

Projects without any end ownership are not sensible. (Martin, 1976, Pruitt, 1999) At the same time however, projects are becoming more complex. The risks involved in project planningand design are also higher. Organizations can save money and resources by utilizing various simulation models to determine the effectiveness of the project. (Doloi and Jaafari, 2002) Planning is necessary for all projects. Simulating project needs at every stage of the project life cycle can help decision makers view the changes or modifications that might be needed in a plans. Research indicates that many of the problems experienced in projects are of a "management, organizational or behavioural nature" and rarely due to inadequacies in technique or skill. This is especially true of software related projects. (Hartman and Ashrafi, 2002)

The Resource based theoryfor managing projects is now becoming more acceptable. This theory postulates that the physical capital, human capital and organizational capital are all important variables in strategy planning. (Kotelnikov, 2004) Resources possessed by companies can be tangible (facility, equipment) or non-tangible (knowledge base, patents). A project feasibility analysis should be conducted at the initial stages and at periodic intervals during the project life. (Clifton and Fyffe, 1977) Projects should also have the internal financial flexibility to adjust to changes and modification in the plan and design during the duration of the project.

It is important that management and decision maker in organizations using the project based model to realize that "projects are a highly distinctive form of work organization." (Sauer et al., 2001) .The ability of an organization to effectively document, archive and retire information in a timely manner determines its competitive edge. (Back and Moreau, 2001). The success of a project depends on "its efficiency, effectiveness, and timeliness." (Jiang et al., 2002) Self-evaluation in any project is most likely the best method for evaluating the performance of the individual members of the project team and might help the members develop better skills and capabilities.

CPM as a management methodology has been used from the mid50s. The main objective of the CPM implementation was to determine how best to reduce the time required to perform routine and repetitive tasks that are needed to support an organization. Initially this methodology was identified to conduct routine tasks such as plant overhaul, maintenance and construction. (Moder and Phillips, 1964) Critical path analysis is an extension of the bar chart. The CPM uses a work breakdown structure where all projects are divided into individual tasks or activities. For any project there is a sequence of events that have to be undertaken. Some tasks might be dependent on the completion of the previous tasks while other might be independent of the tasks ahead and can be undertaken at any given time.

As the person at the helm of a project, the project manager is responsible for the success or failure of the project as a whole. (Globerson and Zwikael, 2002) It is the responsibility of the project manager to look into the root cause of a problem if one exists and to identify the potential solutions that can be implemented. If the project manager himself or herself is the cause of the problem however, then arriving at an honest and appropriate solution might be impossible.

Realistically determining the sequence of events needed in the critical path is important. Nabors in the article '*Considerations in planning and scheduling,* 'identified that often in construction jobs the sequence of events are not always dependent. For example, the **"**electrical drawings did not have to be complete before foundations could be constructed, that all engineering did not have to be complete before construction could start." (Nabors, 1994)

There are two methods by which the Critical Path can be identified. They are CPM calculates 1. the earliest time within which a project can be completed. "The date each activity is scheduled to begin is known as the "early start, " and the date that each activity is scheduled to end is called "early finish." (Winter, 2003) In this method of critical path determination, the earliest possible date for starting of the project is identified and then the activities are lined up to identify the completion date.When an organisation decides to start a project it will first collect the Request For Proposal(RFP). Based on the RFP the company will proceed the project, to calculate the duration in the project the company choose one of the networking method CPM

The selection of either the forward or the backward pass depends on the final desired results and the available documents and accurate data needed to determine the time for every activity on the network diagram. (Baram, 1994) Slack or float is defined as the time between the earliest starting time (using the forward pass method) and the latest starting time (using the backward pass method) used for identifying the critical path. "Total float (float) is the amount of time an activity can be delayed without delaying the overall project completion time." (Winter, 2003).CPM also connects the different functional factors of planning and scheduling with that of cost accounting and finance. In many situations, schedules are often created without considering the resource needed (the availability of the resources at the time it is required) and cost that is incurred in case these resources are not available. (Just and Murphy, 1994)

Organizational culture also impacts the CP analysis. It is normally observed that the work process "tends to accelerate as a deadline approaches." (Cammarano, 1997) Most CPM account for buffer times in the activity duration. All the personnel involved in the project generally know this fact. Consequently work is often not always started when stated and any uncertainties in the activity process can seriously impact the completion date. Slippage on any one of the activities can result in the delay of the completion of the entire project. Corporate culture and values also have the ability to impact the CP analysis and management.

Identifying the needs for each project and developing an appropriate request for proposal is very critical. (Gido and Clements, 2003) The WBS for any project identifies the major steps needed to undertake this project. "A good WBS simplifies the project by dividing the effort into manageable pieces." (Rad and Cioffi, 2004) In addition, often, WBS offers members in the project an opportunity to define the standard operating procedure to handle issues such as estimating and costing, change management and work completion review. (Baar and Jacobson, 2004, Lamers, 2002) "It is vital to the success of any project that one unifying foundation be established for the project controls system." (Hobb and Sheafer, 2003)

Resource planning and tracking project schedules is very important for any project to be successful. Resource levelling is concept in project management that takes into account that the project might have many tasks that have to be completed concurrently for different projects at the same time.. If there is no levelling and no constraints of resources for the project then the manpower peaks early in the project. (Just and Murphy, 1994) Floats and critical paths breakdowns are generally as a result of the resource constraints and different methods of crashing the project can yield different results for the project.

Goldratt stated *that a production facility is only as fast as the slowest process in the critical chain of the manufacturing*. Detailed understanding of the logistics involved in getting the product from suppliers to the customers, both internal and external is important. (Ayers, 2001) TOC postulates that a seamless, flawless and well-connected supply chain can help keep manufacturing-costs down. TOC looks at the cost effectiveness of running an operation and proposes that manufacturing should not create waste on the sole basis that waste is useless and therefore cost the company money. TOC postulates that many constraints could be eliminated or reduced by proper design and scheduling. There will however, always be an operation on the critical path, which will determine the rate of manufacture of a production plant. For this process to be successful, upper level managers have to be actively involved with the shop floor workers in determining the critical path. Critical paths will change and evolve with every change that is made to the flow of material in the plant.

The goal for any organization therefore, is to increase profits by simultaneously increasing the Net profit, Return on Investment and the Cash Flow. A connection between these three measures has to be established for an organization. An important relevance of the TOC for projects is the "Critical Chain Scheduling." In this, the focus is shifted from "assuring the achievement of task estimates and intermediate milestones to assuring the only date that matters--the final promised due date of a project. As a matter of fact, the scheduling mechanisms provided by Critical Chain Scheduling require the elimination of task due dates from project plans." (Patrick, 1999)

By removing the dates from the activities in the critical path, Parkinson's effects in the working of project planning is eliminated. Here, workers are not restricted by the start time. This is especially important in projects with a large number of activities. When allocating time for each activity project managers and planners often introduce buffer times. These buffer times might be small numbers for each activity that might be added to guard against statistical fluctuations that normally occur in each activity. While these numbers are small they add up over the entire project activities to a significant time frame. In addition, as the workers realize that they have the necessary time built in as buffers they are more likely to push out the start of the job and concentrate their efforts on other task at hand.

Leadership role in any project management and scheduling activity

Projects generally require a project manager and a functional manager. The role of these individuals and their interactions or disputes can signal the success or failure of the workers empowerment in the entire project. Most projects have a project manager. And successful project managers "are those who can plan for the unexpected and are flexible enough to accommodate the unforeseen." (Needleman, 1993) Organizations are also increasingly using teams from various functional departments for planning and execution of the activities. Project teams are often not limited to just the organization but there might also be members from supplier and contractors who play a vital role in ensuring that the project is on time and within budget. The concept that the project leader or manager will be measured on how the team manages itself, rather than how well the leader manages the team will be important. (McKinlay and Taylor, 1996) No matter what the method of planning and scheduling used by the project team, guidance and motivation by the project manager is very important.

Project leaders typically display two types of leadership styles in their dealing with others. Leadership performances are either "transactional" or "transformational." *Transactional*

leadership seeks to motivate followers by appealing to their own self-interest. Its principles are to motivate by the *exchange* process. Any commodity and product can be used in the exchange system; in many cases it can be higher monetary compensation, more prestige and power or more authority. Transformational leadership is intended to join leaders and followers in a mutual pursuit for higher purposes. Individuals who lead by encouraging participation and interest among their subordinates lead using the transformational style of leadership. Leaders using this style will try and convince their followers that they need to work together to obtain their final goals.

Design of the Study

Critical path method is one of the frequently used techniques in project planning. A typical project has many tasks involving lots of different people so project managers have a hard time keeping track of things. It is far too easy for certain activities to fall behind and get lost in the sea of endless jobs. These forgotten tasks and errors in planning can severely affect the time scale of the whole project. A late project will cost money and lead to unhappy customers and bosses. Critical path method helps managers figure out two very important things. How long it will take to complete the project and what are the critical tasks that must be completed before starting other dependent tasks.

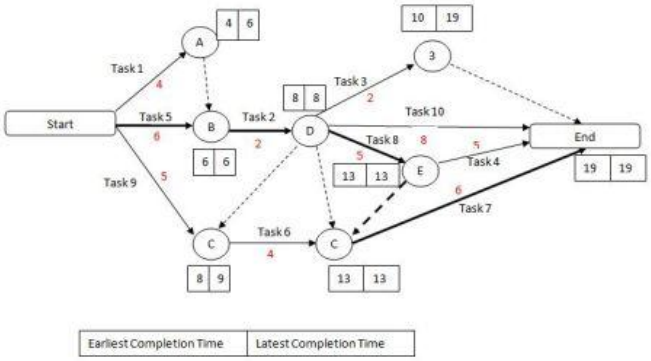
The best way for project managers to avoid poor planning is to incorporate the critical path method in their diagrams. Having this as a diagram makes it easy to visualize theimportant tasks of a project. This is really helpful for managers and makes it easier for the project team to visualize and plan their work accordingly. The main aim is to produce a visual of the entire project broken down into smaller activities which are vital to the completion of the entire project.

All of the activities which are added onto the network diagram are ones which have to be completed on time. By adding them on to a diagram it is possible to see how long each section will take. This is essential when it comes to predicting the timescale of the project. The benefits of applying each of the set time critical and essential activities to a diagram include:

- Predicating the time each activity will take and offering a timescale to the client
- Seeing how each section is important to the progress of the rest of the plan
- Assigning the right team and department to their corresponding task

Critical path is the sequential activities from start to the end of a project. Although many projects have only one critical path, some projects may have more than one critical paths depending on the flow logic used in the project.If there is a delay in any of the activities under the critical path, there will be a delay of the project deliverables.Most of the times, if such delay is occurred, project acceleration or re-sequencing is done in order to achieve the deadlines.

Critical path method is based on mathematical calculations and it is used for scheduling project activities. This method was first introduced in 1950s as a joint venture between Remington Rand Corporation and DuPont Corporation.The initial critical path method was used for managing plant maintenance projects. Although the original method was developed for construction work, this method can be used for any project where there are interdependent activities.In the critical path method, the critical activities of a program or a project are identified. These are the activities that have a direct impact on the completion date of the project.



FigureNo: 1

Research Design

This study facilitates to understand the impact Critical path method in the project scheduling and to measure its impact on duration of projects in Eco homes, Kochi.

Statement of Problem: A study on designing the project schedule using critical path method and its impact in the project management of Eco home builders, Kochi

Objectives of the Study

- To identify the straight-way method used for scheduling the project.
- To develop a schedule for the project using critical path method.
- To analyze the factors in straight-way method this causes delay in project.
- To identify the advantages of critical path method over straight-way method of scheduling the project.

Scope of Study: Project scheduling is one of the important goals of any construction firms, but it is difficult to measure the effectiveness in the project management. Time management in each projects seem to have been largely ignored by project managers in all firms. Time management depends up on many factors such as duration of activities, availability of resources, undertaking different projects simultaneously, project management and efficiency of staff. Therefore assessing the project efficiently with in the time constrains, combining and compiling the activities which will add a great advantage for project managers.

Methodology: Research methodology incorporates the purpose of research study, the way research problem is defined, the way hypothesis formulated, method of collection of data, nature of data gathered, justification of techniques adopted for analysis of data. Research approach is blue print

that he investigator adopts to carry out for the study. Basic approach used is quantitative approach.

A research design is a blue print for conducting a study that maximizes control over factors that could interfere with the validity of the findings.

The research design used in this study is descriptive-cross sectional design.Setting of the study: Setting is the natural, partially controlled and highly controlled physical location and condition in which data collection take place in study.Setting selected for the study was Eco homes builders and developers at kochi. The various working sites of Eco homes are at kochi, thrissur and nagercoil.in this study the setting is out site engineers, supervisors and project managers of the organisation.

Sample and sample technique: The study sample comprised of site engineers, supervisors and project managers in the organization. The sample consists of 10 people. The sample was selected using purposive sampling method.

Development/ selection of tools

After an extensive literature review, the investigator selected the demographic variables of study the investigator send the tools to content validity expert's suggestions of the experts were incorporated in the tool. The tool was send again to the experts, their concurrence was obtained and the tools were finalized. Setting selected for the study was Eco homes builders and developers at kochi. The various working sites of Eco homes are at kochi, thrissur and nagercoil.in this study the setting is out site engineers, supervisors and project managers of the organisation.The study sample comprised of site engineers, supervisors and project managers in the organisation. The sample consists of 10 people. The sample was selected using purposive sampling method.

Tool 1: Tool 1 consists of a questionnaire to collect information regarding the respondents profile and timing of various activities involved in their projects. Three options were given for each activity and the subject is instructed to read each questions carefully and put a tick mark in the appropriate column.

Data collection process: After the approval of the company CEO and the organisational head the data was collected. 10 site engineers from different localities were met and data were collected. Time schedule for the study was programmed. The respondents were made comfortable and respondents profile was collected using the structured questionnaire which was followed by questions for assessing timing of each project activities.

Data Analysis

Table No: 2 Showing Activity List for the Eco Homes Project(1000 Sqft Project)

Activity	Activity Description	Immediate Predecessors	Duration (weeks)
A	Excavation	-	1.5
B	Foundation laying	A	1.5
C	Rough wall	B	3
D	Plumbing	B	1
E	Electrical works	C	1
F	Cement application	D	2
G	Curing	C	2
H	Coating on walls	E	2
I	Fittings	G, F	2
J	Roof	G, F	2
K	Finishing	H, I	2

For any given activity, its immediate predecessors as given in the third column of table are those activities that must be completed by no later than the starting time of the given activity.(similarly the given activity is called an immediate successor of each of its immediate predecessors .

Eg: excavation does not need to wait for any activities. Excavation must be completed before starting to lay the foundation. The foundation must be completely laid before starting to put up the rough wall etc/ When the activity has more than one immediate predecessor, all must be finished before the activity can begin.In order to schedule these activities, first consulted with each of the crew supervisors to develop an estimate of how long each activity should take when it is done in the normal way. These estimates are given in the rightmost column of the table.Adding up these times gives a grand total of 20 weeks, which is far beyond the deadline of the project. Fortunately, some of these activities can be done in parallel, which substantially reduces the project completion time.

A network diagram will help to analyse many kind of problem. In much the same way, networks play a key role in dealing with projects. They enable showing the relationships between the activities and succinctly displaying the overall plan of the project. They then are used to help analyse the project and answer the kind of questions raised at the end of preceding section.

Project Networks: A project network consists of a number of nodes and number of arrows that connect two different nodes. The above table indicates, the types of information are needed to describe the project.

I. Activity information: break down the project into its individual activities
II. Precedence relationships: identify the immediate predecessors for each activities
III. Time information: estimate the duration of each activities

The project network should convey all this information. Two alternative types of project networks are available for doing this: Activity-on-arc(AOA) and Activity-on-node (AON). The original versions of PERT and CPM used AOA project networks, so this was the conventional type for some years. However, AOA project networks have some important advantages over AOA network for conveying the same information.

Table No:3 Showing The Activity Codes And Respective Activities

Activity Code	Activity
A	Excavation
B	Foundation laying
C	Rough wall
D	Plumping
E	Electrical works
F	Cement application
G	Curing
H	Coating on walls
I	Fittings
J	Roof work
K	Finishing

Table No: 4 Showing the Path and Durations

PATH	LENGTH	DURATION (Weeks)
START→A→B→C→E→H→K→FINISH	1.5+1.5+3+1+2+2	11
START→A→B→C→G→I→K→FINISH	1.5+1.5+3+2+2+2	12
START→A→B→C→G→J→K→FINISH	1.5+1.5+3+2+2	10
START→A→B→D→F→I→K→FINISH	1.5+1.5+1+2+2+2	10
START→A→B→D→F→J→K→FINISH	1.5+1.5+1+2+2	8

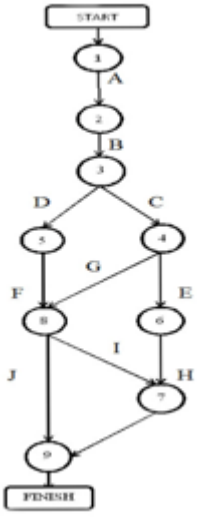


Fig:2 Figure Showing The Network Diagram Of The Projects

From the study the duration of all the activities gives a grand total of 20 weeks. A path through a project network is one of the routes following the arrows from the 'START' node to 'FINISH' node. The length of the path is the sum of the estimated durations of the activities on the path.

The fivepaths through the project network is given in the table along with the calculations of the length of theses paths. The paths range from 8 weeks to 12 weeks for the longest path.Since the activities on any given path must be done in sequence with no overlap, the project duration cannot be shorter than the path length. However the project duration can be longer because some activities on the path with multiple immediate predecessors might have to wait longer for immediate predecessors, not on the path to finish than for the one on the path. However the project duration will not be longer than one particular path. This is the longest path through the project network. Therefore the time required to reach the FINISH node equals to the length of this path. Furthermore, all the shorter path will reach the FINISH node no later than this.

Key conclusion: the project duration equals the length of the largest path through the project network. This longest path is called the critical path.Thus for the Eco homes project, we have

Critical path: START→ A→ B→ C→ G→ I→ K→ FINISH
(Estimated) project duration= 12 weeks

Scheduling Individual Activities

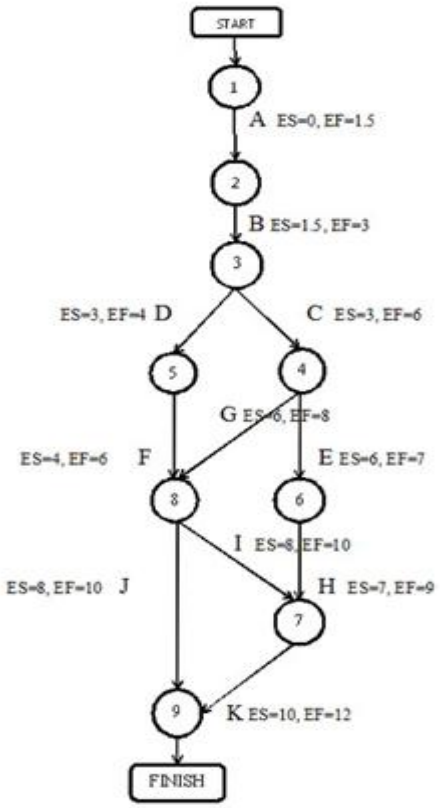


Fig 3 Figure Showing Earliest Time Durations

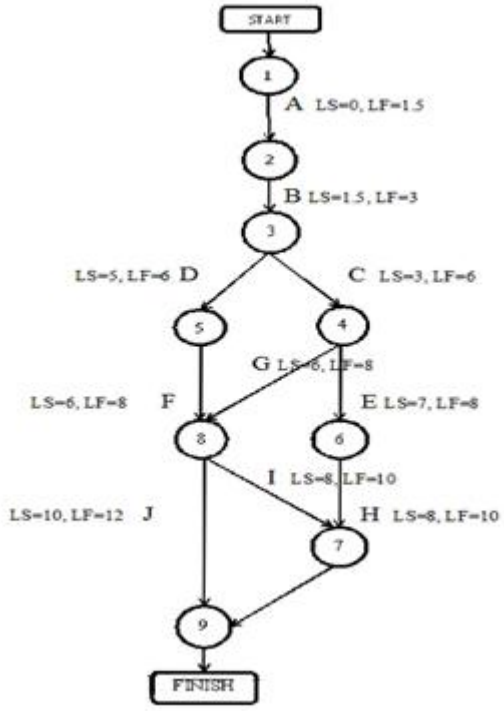


Figure 4.showing latest start and finish

Table No. 5 table displaying the float (slack of each activity)

Activity	Duration	Earliest time		latest time		Float(slack)			On critical path
		START(E_i)	FINISH(E_i+t_{ij})	START(L_j-t_{ij})	FINISH(L_j)	TOTAL	FREE	INDEPENDENT	
A	1.5	0	1.5	0	1.5	0	0	0	yes
B	1.5	1.5	3	1.5	3	0	0	0	yes
C	3	3	6	3	6	0	0	0	yes
D	1	3	4	5	6	2	1.5	0	no
E	1	6	7	7	8	1	0	0	no
F	2	4	6	6	8	2	2	0	no
G	2	6	8	6	8	0	0	0	yes
H	2	7	9	8	10	1	1	0	no
I	2	8	10	8	10	0	0	0	yes
J	2	8	10	10	12	2	2	2	no
K	2	10	12	10	12	0	0	0	yes

Gantt chart (Fig no: 5) was used to show the progress of a project graphically, this helps the organization to identify the parallel process, tracking and overall processing time of the project

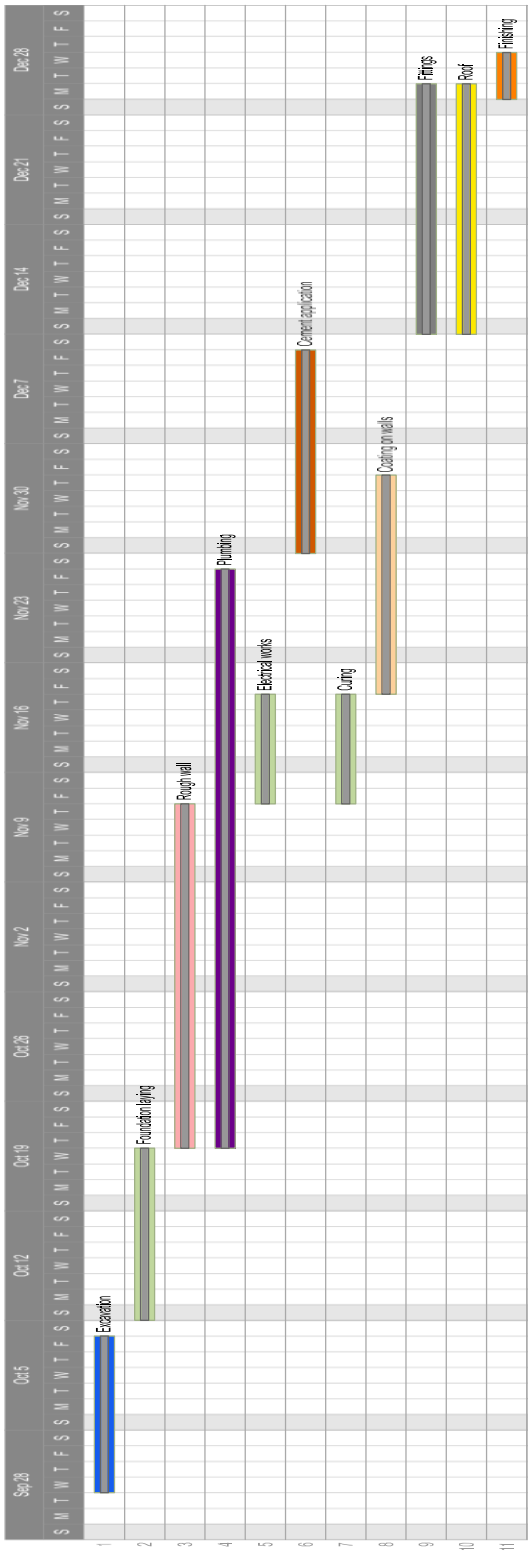


Fig: 5. GANTT CHART DISPLAYING ACTIVITIES AND DURATION.

Summary of Findings

Few respondents responded as the duration of the excavation as 2 weeks and the remaining responded it as 1 week. From the respondents it was found that the duration of the

foundation as 2 weeks and the rest of the respondents responded it as 1 week. 60% of the respondents responded as the duration for rough wall construction is 3 weeks. 100% of the respondents responded as the plumbing and electrical work takes 1 week each.80% responded as cement application takes 2 weeks. 50% responds as the duration of the curing and coating on walls as 3 weeks and the rest half (50%) responded it as 1 week. 80% responds as fittings and roof takes 2 weeks. The duration of the finishing works was 3 weeks and 1 week. Critical path of the project was found as START→ A→ B→ C→ G→ I→ K→ FINISH with estimated project duration of 12 weeks. Found the earliest starting time, earliest finishing time, latest starting time, latest finishing time of the project.

Suggestions and Conclusion

Regular monitoring of finished works has to be introduced.Projects should strictly follow the time schedule.Experienced workers has to be introduced which will in turn help the project completion within the time period.The company has to introduce new marketing techniquesAs the construction technique is new they should give awareness about the technique to the clients. Material management of the company is efficient but they are not keeping enough records for that.

A typical project has many tasks involving lots of different people so project managers have a hard time keeping track of things. It is far too easy for certain activities to fall behind and get lost in the sea of endless jobs. These forgotten tasks and errors in planning can severely affect the time scale of the whole project. A late project will cost money and lead to unhappy customers and bosses. The best way for project managers to avoid poor planning is to incorporate the critical path method in their diagrams. Having this as a diagram makes it easy to visualize the important tasks of a project. This is really helpful for managers and makes it easier for the project team to visualize and plan their work accordingly.

The present study entitled "Development of design to schedule the project using Critical path method and its impact on the project management." of Eco homes builders and developers has thrown light on the various aspects of the company. There have been certain drawbacks which have been studied at appropriate places and suggestions have also been made. It can be said that the present study may serve the purpose to some extend but not to a great extent.

References

1. American National Standards Institute https://www.ansica.org/wwwversion2/outside
2. For Construction Pros.com *Responding to Changing Economic Conditions-10th Annual Survey of Owners Now*
   Available http://www.forconstructionpros.com/online/Construction-Equipment-Rental-News/Responding-to-Changing-Economic-Conditions---10th-Annual-Survey-of-Owners-Now-Available/40FCP14571.
3. Ayers, J. B. (2001) Handbook of supply chain management, St. LuciePress .
4. Baar, J. E. and Jacobson, S. M. (2004) ForecastingWhat a Responsibility. Cost Engineering., 46, 19,
5. Back, W. E. and Moreau, K. A. (2001) Information management strategies for project management. Project Management Journal., 32, 10-20,
6. Baram, G. E. (1994) Delay analysis-Issues not for granted Transactions of AACE International, 1994, DCL5.1-9,
7. Cammarano, J. (1997) Project management: How to make it happen IIE Solutions, 29, 30-34,
8. Clifton, D. S. and Fyffe, D. E. (1977) Project feasibility analysis: a guide to profitable new ventures, Wiley, New York.
9. Collinson, D., &Collinson, M. (2004). The power of time: Leadership, management and gender. In C. F. Epstein & A. L. Kalleberg (Eds.), Fighting for Time: Shifting Boundaries of Work and Social Life (pp. 219-246). New York: Russell Sage Foundation.
10. Doloi, H. K. and Jaafari, A. (2002) Toward a dynamic simulation model for strategic decision-making in life-cycle project management Project Management Journal., 33, 23-39,
11. Gido, J. and Clements, J. P. (2003) Successful project management, Thomson/South-Western, Mason, Ohio
12. Globerson, S. and Zwikael, O. (2002) The impact of the project manager on project management planning processes. Project Management Journal., 33, 58-65,
13. Hartman, F. and Ashrafi, R. A. (2002) Project management in the information systems and information technologies industries Project Management Journal., 33, 5-16,
14. Hobb, L. J. and Sheafer, B. M. (2003) Developing a work breakdown structure as the unifying foundation for project controls system development. Cost Engineering., 45, pg. 17,
15. Jiang, J. J., Klein, G. and Ellis, T. S. (2002) A measure of software development risk. Project Management Journal., 33, 30-42.
16. Kakka.A, Training Construction Workers for Sustainable Environment, International Journal of Environmental Research and Development. ISSN 2249-3131 Volume 4, Number 1 (2014), pp. 21-26
17. Kotelnikov, V. (2004) Resource Based Model, from:http://www.1000ventures.com/business_guide/mgmt_stategic_resource-based.html
18. Lamers, M. (2002) Do you manage a project, or what? A reply to "Do you manage work, devliverables, or resources" International Journal of Project Management., 20, 325,
19. Martin, C. C. (1976) Project management: how to make it work, Amacom, New York.
20. McKinlay, A. and Taylor, P. (1996) In The New Workplace and Trade Unionism(Ed, Smith, P.) Routledge, London

21. Moder, J. J. and Phillips, C. R. (1964) Project management with CPM and PERT, Reinhold Pub. Corp., New York,
22. Needleman, T. (1993) It's not just for big firms Accounting Technology, 9, 59-64,
23. Patrick, F.S. (1999). Critical chain scheduling and buffer management – Getting out from between Parkinson's rock and Murphy's hard place. PM Network, 13 (April), 57-62.
24. Pruitt, W. B. (1999) The value of the system engineering function in configuration control of a major technology project Project Management Journal., 30, 30-37,
25. Rad, P. F. and Cioffi, D. F. (2004) Work and Resource Breakdown Structures for Formalized Bottom-Up Estimating. Cost Engineering., 46, pg. 31, 7 .
26. Rivera, F. A. and Duran, A. (2004) Critical clouds and critical sets in resource-constrained projects International Journal of Project Management, 22, 489,
27. Sauer, C., Liu, L. and Johnston, K. (2001) Where project managers are kings. Project Management Journal., 32, 39-50,
28. Tompkins, P. K. (1993). Organizational Communication Imperatives: Lessons of the Space Program. Los Angeles: Roxbury.
29. Weglarz, j. (ed.): Project Scheduling: Advances in modeling, algorithms and applications, Kluwer academic publications.
30. Winter, R. M. (2003) Computing the near-longest path AACE International Transactions, PS111,
31. http://www.iiuedu.eu/press/journals/sds/sds1_july_2008/05_SECC_01.pdf
32. http://pmbook.ce.cmu.edu/13_Quality_Control_and_Safety_During_Construction.html
33. https://www.business-case-analysis.com/return-on-investment.html
34. http://www.academia.edu/8813440/Corporate_Finance_Solutions-Manual

ANNEXURE

Questionnaire for assessing activity timings of project

Project no:
Place:
Name:
Designation:
Instructions:

- This questionnaire contains information related to duration of the activities residential construction project.
- Read all the questions carefully and put a tick mark in the appropriate column.
- Information collected from you will be utilized only for this study purpose and strictly maintained confidentiality.

Activity	1week	2week	3week
Excavation			
Foundation laying			
Rough wall			
Plumbing			
Electrical work			
Cement application			
Curing			
Coating on walls			
Fittings			
Roof			
Finishing			

Thank you…