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A Project Report on Planning, Scheduling, and Delay Analysis of a Construction Project during Covid-19 Pandemic: A Case Study

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Abstract: ***Time delay is one of the biggest problems faced by the construction industry in India. Completing projects on time isthe key factor of the project, but the construction process is subject to many variables and unpredictable factors, which result from many sources such as the availability of resources, external factors, the performance of parties, and the type the structure. Delay in the project, leads to loss of productivity,increased cost, contract termination, and disputes between contractor and owner. These types of unrealistic exceptions are usually avoided by using a clean and efficient planning mechanism, which specifies the work and timetable to be used.This project aims to examine the causes and effects of delay ona building construction project during the construction phase and to provide control measures for time overrun in the project. A study was carried out on construction schedule, delays an,d various delay analysis techniques and methods to evaluate the causes of delay and their impacts on the construction project. The current study is based on a residential building, "Savali Saffron" located at Mundhwa, Keshav Nagar, near the old Orbis School, Pune, developed by Sapthasiddhi Associates. Studyingthe A-Wing, during the COVID-19 Pandemic, a delay of 42 days has been observed, with a sum of RS 8,26,500/- added to the original budget of the construction project. The effect of the COVID-19 Pandemic on Constructiontion Project is studied.***

The major factors identified in this study are delays due to government restrictions such as weekend curfew, strict half-day lockdown, restrictions on travel & transport, and work approval problem from the government, due to the COVID- 19 Pandemic. Changes in the staff, lack of human resourcand delays in procuring materials, the untimely release of funds, and lems in RCC drawings and una,vailability of RCCan consultants are some other factors affecting the construction schedule. The major effects of delay are cost impact, postponement in work, change in labor allocation, etc.Not all delays can be rectified, but a few of them can be overcome by improving management responsibilities.

Keywords: Planning, Scheduling, Delay analysis, causes for delay, MS Project.

I. INTRODUCTION

The Construction industry has a major impact on the overall economic development of India. The construction industry is the second largest employer of labor in India. It is the second largest economic activity preceded by agriculture. Construction in India has accounted for more than 40% of investmein on development over the past 50 years. Nearly 16% of India's working population depends on constructionfor its livelihood (TIndo-Italianian chamber of commerce and industry, 2008). It contributes about 78% he gross capital formation (Iyer and Jha, 2006). The Indianconstruction industry's impact on employment, interconnection with other sectors, and major contributions to GDP highlight its importance and also stress that any further inefficiencies could contribute to the economy's eventual decline. India's rapid economic growth over the last decade has placed tremendous stress on its limited infrastructure and increasing demand. Investment in construction is on the rise, with more than US$ 500 billion worth of investment planned to flow into India's infrastructure. The planning commission of India has proposed an investment of around US$ 1 trillion, doubled since the last plan. This illustrates the demand and funds committed fortovethe lopment of the infrastructure in India and the future growth in construction projects.

From an economist's point of view, construction is a service, which has a demand to improve the economy. The construction industry has certain special economic characteristics that are given below:

1) Construction projects take a relatively long time tobe planned and considered.
2) The lifefe of construction projects is very long; some may take decades.
3) Constructions are always allotted to lands, thenormal economic laws, like import-export goods,do not apply to construction,
4) Public infrastructure, such as roads, brid,ges and dams, which in a major portion of a cotruction, cannot be studied with the usual concept of profit maximization. Special economictheories are essential to value these facilities.

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These characteristics have led to thegrowth of special problems and solutions in the construction economy.

The construction industry is generally much fragment several of features of the industry generallycreated favorable conditions for the establishment of new firms. These factors have made the construction industry very competitive. The profit margin is lower than, that of other industries. The average profit margin tends to be lowand is generally assumed as 10%. However, the actual gross book profit may be lower than 10%. In some cases, big firms have registered below-profit margins and were at loss.It is here where proper management comes into the picture. If proper management of work is done the company could be saved from making lossesss. Ithe n construction in,dustry there was a time when all the projects were labor intensive and management in those days meant proper utilization of labor to make optimum progress in construction in the most economical manner. But now-a-days technological advancement and new scientific inventions have added in new dimensions to the construction industry. A project is now considered as a group of activities, having inter- relations, which may include the role of specialists and specialized work using the latest knowledge and skill available, to be undertaken in most systematic manner, failing which the project may be stalled or progress may be hampered. The "most systematic manner" involves adoption of techniques commonly known as Critical Path Method "(CPM) or Program Evaluation and Review Technique (PERT) are being applied for the management of the project. The use of plant and machinery and expert workers has improved the quality of construction and reduces the time for construction. New techniques and methods are now adopted in construction with aid of these plants and machinery, the construction is easier, well withintime schedule, and of high quality.

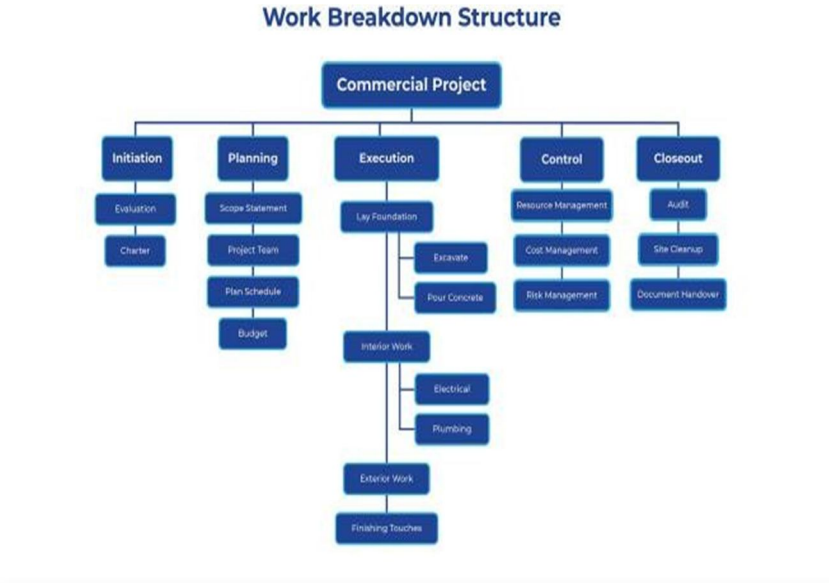

Fig. No. 1 Work Breakdown Structure

II. LITERATURE REVIEW

Many authors and researchers have conducted their own experiments on different ongoing projects using different techniques and methods to reduce the factors thathave major contribution towards causing delays in the project along with rise in the actual budget of the project which was fixed during the start of construction.

A splendid work by professor 'Rajshekhar GopalRathod (2016)', where he studied the planning, schedulingand delay analysis on the project named "SANGAM APARTMENTS" located in Whitefield Bangalore, using Microsoft project (MSP), with the primary goal ofcompleting the construction in given scheduled time of 743days as well as in amounted budget only which was Rs4,93,12,027/-.

This paper revolves around different factors that were heldresponsible for causing delays and escalating actual price, as according to him the heterogenous weather condition mainly because of rain accompanying with delay in GFC were the major reasons as these both factors alone caused a delay of 6 days each and also contributed towards adding a total sum of Rs 46,750 and Rs 39,000. respectively. Although the one which caused a surplus increase in budgetwas shortage of materials which alone added up the sum of Rs 1,68,600. though it only caused a delay of 2 days only. In company with three more reasons that led to delay of total 28 days as well as original price was jumped by moreRs3,71,000 approximately.

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In another work by prof. 'Rathod Rajshekhar Gopal (2016)' he conducted an on-situ performance improvementprogram which was a case study of three residential buildings (Block A, Block B, Block C) spread over area of 6.3 acre, having main objective of finding out whether the project is overrunning and also to discover which are the main disruptive sources why the construction was delayed. This paper actually revolves around the techniques of estimating the baseline productivity chart with the help of data collected through BOQ and drawings of the construction site. During the planning various assumptionswith respect to execution of construction activities, availability of resources, suitability of construction methods.

In which required source (MANPOWER) team was calculated with given formula. Required resource = total quantity / (productivity x duration)

Together with the productivity chart the baseline was also set up after the preparation of schedule model which was used as benchmark to compare the dates, resources and costto the current schedule

In his compendium he stated that: - The project was behind by 273 days.

Main disruptive parameters were material and manpower. Accompanying with the performance of the project withrespect to amount of work done wasn't also constant.

Therefore, actual productivity of labors was also below theexpected baseline productivity.

R Santosh Kumar (2018), used relative importance indexmethod to prioritize the factors which are critical delay andits significance level compared to other factors. Based on these risk factors allocate in the project schedule delay for the duration of whole project can save money and time. Because of difficulty and lengthy time of projects, Investment and risks are more in this industry. From the analysis results, major risks are identified based on relative importance index (RII), Critical risk is delays due to late delivery of material (0.71), Shortage of equipment in construction site (0.68), Poor quality of construction Material affect the productivity (0.66) these are primary risks for delay analysis. 62 days were delayed for the project and the cost due to delay was 7,23,200 (as estimated price was 5,92,750/- Rs.)

Thamer Alenezi in 2020 studied and figured-out Major causes of delays on construction project during covid-19 Pandemic in Kuwait. Where Relative Importance Index (RII) is used to evaluate the major causes of the delay. Thefollowing equation of Relative Importance Index (RII) waschosen to evaluate the major causes of delays obtained fromthe survey.

$RII = \sum W / A*N$

where, W = weight given to each factor (ranging from 1 to5) by the participants,

A = the highest weight (i.e., 5 in this research study), andN = the total number of participants.

The higher the RII value means that it is more importantthan the others.

The majority of the highly ranked causes for delay in thisstudy, such as delay in approval of completed work (ranked 3) and delay from consultants in providing instruction (ranked 2), can be resolved through proper planning. Others, such as low productivity of workers (ranked 3), might be a management or training issue.

Many delays in construction projects can be eliminated when their causes are clearly identified. Therefore, the aimof this paper was to identify the major causes of delays on construction projects in Kuwait during the covid-19 Pandemic. To do that, a questionnaire survey with 17 factors of delay was designed, based on a literature review. The questionnaire survey was sent to various construction professionals based in Kuwait. 35 respondents evaluated the delay factors and these factors were ranked according to their importance level for delays using a relative importance index. The importance factors were achieved through ranking results.

He suggested that the programs should be re-designed so that there is less labour on site and also follow the social distancing norms, to avoid crowd, while casting on site thepre cast materials should be used.

Ar. Meena V (2015), conducted a questionary survey to calculate the ranking and % of delay caused by various groups. The group which is more responsible for delay in the project is found. Delays were observed and Recommendations were suggested for major causes of delay. The major causes of delay which is found repeating in almost every project are external factors, financial difficulties, shortage of labour, insufficient labour productivity, owner interference and improper planning. After analysing the data, it is clear that the contribution of Contractor in delay of the construction project is high then followed by client then consultant side and others. Resourceallocation is the main criteria for doing schedule planning to allocate duration for each activity included in the projectso that delay in the construction project can be reduced.

Venu K.C., Mr. Rajeeva (2017), in her research paper, themain objective was for planning, scheduling and track the progress of various activities using BOQ and Productivity chart, and monitor the delay. BOQ & Labour productivity chart was designed. Cost incurred due to delay was calculated. Delay of 130 days was observed and the total Project duration was 652days. Major cause of the delay wasColumn shuttering, reinforcement and concrete work whichobserved 47 days of delay, and the total cost incurred due to this delay was Rs. 4748880/-. Cost incurred due to delay i.e. Total loss of Rs 8758259.

The study summarizes the reasons that cause the delay in the activities of the construction work. Possible reasons for the delay caused in the activities were tried to identify and the impact that occurred due to delay were analysed. The reasons that cause the delay were identified into: untimely release of funds from the office, approval problem from government more often changes in the staff, deficient management of engineers, lack of human resources and delay in procuring materials. These delays lead to the increased budgeted cost, consuming more time in the completion of the project, The analysis shows that overcome these delays by doing a proper planning, scheduling.

III. PROBLEM STATEMENT

Proper planning and scheduling of construction projects with proper technique is a must, because there have been incidents in the past where, due to lack of proper planning,projects have cost more than what they should have cost and also delayed to a great extent. The concept of scientific planning and scheduling was totally neglected in the construction industry until the late 50's when the concept ofCritical Path Method and Program Evaluation and Review Technique made an impact.

Most of the project that begins well gets stuck due to bad planning and scheduling. A good schedule helps the completion of the project within the expected time and with optimum resource and cost. Timely completion of the project is particularly important when the failure to complete the project within the time specified in the contract carries a financial penalty or liquidated damages. It is also seen that for a bigger project, planning and scheduling are done manually which is a laborious task. The unwillingness to use the available project management software, for planning and scheduling has resulted in the production of improper planning and scheduling. It is a sadfact that a though that have the latest tools and techniques for planning and scheduling it is not used to its full potential. In India almost all the construction programs arenot planned in a proper way, as a result they finish well afterthe scheduled time, resulting in wastage of valuable resources. So, it can be seen that for proper use of resourcesin a project, a proper planning and scheduling has to be done.

The different resources required in a construction project include labor, materials and equipment. Of all the resources that are used in a project the most important is manpower. It is the most valuable asset of an organization. Normally, barring a few large-scale projects, the aspect of manpower planning is usually neglected or not given due attention. Most of the labor work is given sub-contracts. However, the availability of skilled labor of proper quality and in quantity is not pre-judged, with the result at many construction sites costly equipment lies idle for want of supporting labor. This results in postponement of, or delay in executing new projects and expansion programs, which eventually leads to inefficiency and lower profitability. It is seen that; the manpower planning is not done timely or notplanned properly for timely deployment of just the requirednumber of workmen of right trade and skill. It can be seen that both over-manning and under-manning in our construction site and also sometimes sudden fluctuations inthe requirement of labor strength. In construction industry, operations may not be of repetitive nature hence the composition of work force may change on a given project depending upon the stages of construction.

Therefore, meticulous care has to be taken in manpower planning in order to identify areas of surplus manpower and areas where there is a shortage of manpower.If there is a surplus, it can be re-deployed, and if there is a shortage it may be made good. Our main concern, naturally,is to plan, schedule and allocate manpower in an optimum manner so as to complete the project in stipulated time.

IV. OBJECTIVE OF THE STUDY

The main objective of the project is to plan, schedule, monitor the progress and delay of various constructionactivities performed at site using Microsoft Project Software, calculating the Bill of Quantity (BOQ) and Productivity of workman along with various equipment's. Observing the delay reasons for each activity on site and analyzing the cost incurred due to it, also findingthe possible cost escalate due to delay. Minimizing the delay of the project by providing bestrational possible solution for each activity.

V. PLANNING

A. Introduction

Planning involves listing of all the work packages, activities, tasks that are involved in the construction. Requirement of materials, manpower, machineries and money are determined in this phase. Estimates of costs andduration for the various activities are made. The objective of construction planning is to operations require to be performed for the completion of the work and to produce a time table or proper sequential relationship between the activities, with each activity allocated a start date and finish date and with the assurance that the things necessary to do each activity will be available when required. The steps required to accomplish such a planning include logic (planning), timing, analysis and scheduling. Input for planning comes from the estimating departments, project managers, field engineers, foremen, contractors.

Planning is the base of the whole project and must be based on clearly defined objectives. With proper planning, adequate resources are available at the right moment and adequate time is allowed for each stage in the process and all the various component activities start at appropriate times. planning includes, Estimate, Budget, Time schedule, sequence for completion of each part of work, Cash flow budget, Manpower, Plant and equipment planning, Materialplanning.

B. Steps in Planning

The following are the step-by-step procedure for project planning. They are, make a detailed list of activities. prepare a network diagram, identify the critical path, allocate the resources or juggle the schedule, consider the tradeoff of time and money, organize the project information, record the status of every activity, compare reported original plan.

C. Planning Methods

Due to the need for planning many methods were developedin order to assist management in the construction field. Themost widely used techniques are Bar chart or Gantt chart Method, Critical Path Method (CPM), Program Evaluation and Review Technique (PERT).

VI. SCHEDULING

A. Introduction

A construction schedule may mean different things to the designers, contractors, sub-contractors, suppliers and the owners involved in the construction process. The schedule may mean the completion date required for phase of the work. The schedule may mean the schedule values the contractors submit against which monthly progress payments will be made. The schedule may also refer to the process of sequencing and phasing individual activities required to complete the project. In this report construction schedule means a graphical presentation, which shows the phasing rate of construction activities with the starting and completiondates are sequential relationship among the various activities in a project so that the work can be carried out in an orderly and effective manner.

B. Scheduling Steps

Construction schedule is a projected timetable/calendaringof construction operations. Steps are, estimation of time required to carry out each network activity. using these timeestimates, compute the time period required for overall project completion, estimate time intervals within which each activity must start and finish satisfying the completiondate requirement, estimation of quantities of work for each of the component activity involved, identify these activities whose expedient execution is crucial to timely project completion, if the project completion date is not constant with contract or other requirements, shorten the project duration at least possible cost. Utilizing the surplus of float times that most activities possess, adjust the start and finish times of selected activities to minimize resource conflicts and smooth out demands on manpower and equipment, makeupa working project schedule that shows anticipated calendardates for the start and finish of each activity.

C. Scheduling Method

Scheduling methods are Bar chat method and Ghant chart method generally used.

VII. DELAY ANALYSIS

Delay in construction can be defined as an event or acondition that results in finishing the project later than stipulated in the contract or delay in construction claims asthe time during which some part of the construction project has been extended or not executed owing to an unexpectedevent.

Types of Construction Delays

There are four main groups of construction delays:

1) Critical or noncritical.
2) Excusable or non-excusable.
3) Compensable or non-compensable.
4) Concurrent or non-concurrent.

Firstly, if the delay is critical or noncritical and concurrent or non-concurrent should be determined in the process of analyzing delay effects on the project. All construction delays are either excusable or non-excusable as shown in the figure. Then, excusable delays are classified into compensable or non-compensable delays. This figure presents only one interpretation, since executability and compensability of delays can change according to the contract.

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A. Critical and Non-critical Delays

Delays which result in extended project completion are considered critical delays, and delays that do not affect the project completion date are known as noncritical delays. All projects have a critical path and if these critical activities on the path are delayed than the completion date of the projectwill be extended. The criteria determining the project completion date are as follows

1) The project itself.
2) The contractor's plan and schedule (particularly the critical path).
3) The requirements of the contract for sequence andphasing.
4) The physical constraints of the project- how to build the job from a practical perspective.

B. Excusable and Non-excusable Delays

Excusable delay, in general, is owing to an unforeseeable event beyond the contractor's or the subcontractor's control. Following few excusable delay-

1) General labor strikes,
2) Fires,
3) Floods,
4) Acts of God,
5) Owner-directed changes,
6) Errors and omissions in the plans andspecifications
7) Differing site conditions or concealedconditions,
8) Unusually severe weather,
9) Intervention by outside agencies,
10) Lack of action by government bodies, such asbuilding inspection.

Non-excusable delays as "delays that are either caused by the contractor or not caused by the contractor but should have been foreseen by the contractor". Following few non-excusable delay,

a) Untimely performance by suppliers,
b) Faulty workmanship by the contractor or subcontractors,
c) A project-specific labor strike caused by the contractor's unwillingness to meet with labor representatives or by unfair labor practices.

C. Compensable and Non-compensable Delays

Compensable delays are caused by the owner or the designer (engineer or architect). The contractor is typically entitled to a time extension or recovery of the costs related with the delay, or both. Factors which are specified in the contract resulting in delays such as differing site conditions, changes in the work, access to the site are some examples of compensable delays, excusable delays may be compensable. Non-compensable delays as those which despites being excusable do not entitle the contractor or client to any compensation. Excusable non-compensable delays are normally beyond the control of either owner or contractor such as unusual weather conditions, natural disasters, wars, national crises, floods, fires or labor strikes. They add that usually the contractor is entitled to a time extension, but notadditional compensation.

D. Concurrent Delays

Concurrent delay includes a combination of two or more independent causes of delay occurring within the same time frame or a concurrent delay often includes an excusable delay and a non-excusable delay or "more than one delay contributed to the project delay, not that the delays necessarily occurred at the same time". Although this type of delays seems like a simple issue, still there is no clear definition of concurrent delay.

VIII. CASE STUDY

The proposed project for case study is a residential apartment named Savali Saffaon located at Mundhwa, Keshav Nagar, near old Orbis School, Pune. Savali Saffaonis a project developed by Sapthasiddhi Associates, Pune. The Savali Saffaon project consists of the construction of168 flats (G+13).

Type of the project: Residential apartment

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The construction of proposed structure is taking place under the supervision of Sapthasiddhi Associates, Pune.
The Savali Saffron is being constructed on an available land of 2.64-acre area at Mundhwa, Keshav Nagar, Pune.
The total time period given for completion of entire project is about 3 years (inclusive of rainy season).
There are three residential blocks A, B and C.
A and C block have same features and configuration.
The residential block with configuration of G+13, is having two staircases for entrance in the building and is also provided with two lifts.
The ground floor is designed as parking area.
Each floor of A and C block of building consists of 4- 2BHK and 1- 1BHK.
Counting both the blocks there are 24 flats of 1BHK and 96 flats of 2BHK.
In B block each floor has 4 flats of 2BHK. Total there are 48 flats in B block.
The salient features of residential block are each apartment with terrace or balcony, power backup for lift and common area, firefighting system and earthquake resistant structure. Each flat is configured with master bedroom, living room, balcony, kitchen and toilet.

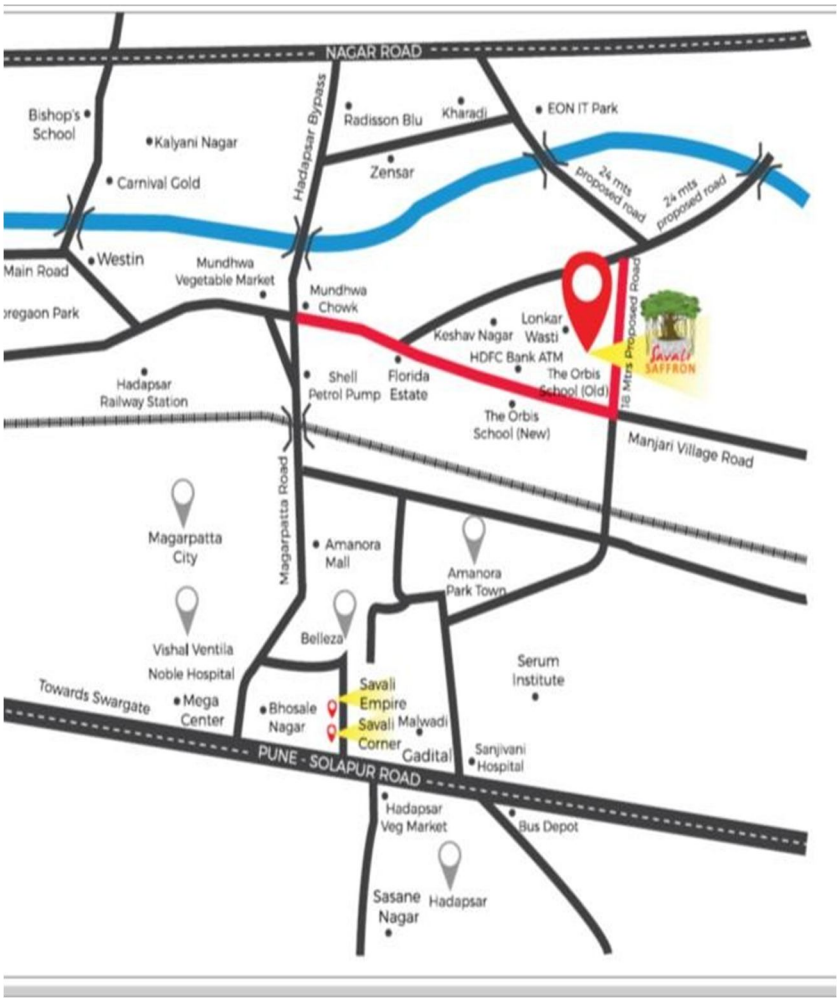

Fig. No-2 Satellite View of Project Site

IX. METHODOLOGY

The aim of the Study is to plan, schedule and track the progress and delay of various construction activities performed at site using Microsoft Project Software.

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A. Phase 1

For planning and scheduling: -

1) At first, calculate the Bill of Quantity (BOQ) usingavailable data from site for every slab level.
2) Gather information from the workers and analyzethe productivity of each worker per day.
3) Knowing the manpower available at site, determine the number of days required to executethe particular work.
4) Required Manpower = TotalQuantity/productivity x duration

B. Phase 2

1) Planning and scheduling of various construction activities performed at site is executed using Microsoft Project Software.
2) Considering the number of days required to complete a work, estimated time duration is calculated & hence planned start and planned finish is estimated.
3) Comparing the planned start / finish and the actual start / finish, the total number of delays is calculated.
4) Then analyze the main reasons because of which major delay in days were figured.
5) Aim to study the causes and the effects of the delay and identify the major causes of delay occurring at the given construction site.
6) Furthermore, also calculated the increase in budget of the construction for which bar graphs are to be prepared as it gave the estimate regarding the escalating in cost of construction.
7) Histogram is prepared representing the causes of the delay and the number of days lost due to the delay, along with the cost incurred due to the individual factor causing delay.
8) The cause which is more responsible for delay in the project is found along with the cost incurred due to it.
9) Recommendations to control delay during construction work are provided after studying the causes of the delay.

Hence from our study one came to know major causes thatwere taking major part in delaying the work on constructionsite for which, also gave the company possible solutions which could reduce the delay in their future projects.

X. PRODUCTIVITY

ACTIVITY	*QUANTITY REQUIRED (PER FLOOR)*	*PRODUCTIVITY (PER DAY)*	*DURATION (DAYS)*	*MANPOWER REQUIRED (PER DAY)*
Excavation	1536 CUM.	50 cum/day	31	
Back Filling	1350 CUM.	45 cum/day	15	
Concrete For Columns	35 CUM.	5 cum/day	7	12
Shuttering For Footing	500 SQM.	27 sqm/day	7	3
Steel For Footing	12MT.	266 kg/day	10	5

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ConcreteFor Footing	190 CUM.	27 cum/day	3	3
Concrete For Slab	100 CUM.	50 cum/day (By RMC)	2	20
Steel For Columns	6MT.	62 kg/day	8	12
Steel For Slab	9.4MT.	110 kg/day	7	13
Steel For Stirrups (Slab)	1.6MT.	350 kg/day	2	3
Slab Shuttering	465 SQM.	14 sqm/day	8	5
Column Shuttering	550 SQM.	12 sqm/day	8	6
Acc Concrete Block (Mason)	745 SQM.	12 sqm/day	11	6
Internal Plaster	920 SQM.	18 sqm/day	10	6
External Plaster	770 SQM.	18 sqm/day	11	4
Internal Paint	920 SQM.	18 sqm/day	10	6
External Paint	770 SQM.	18 sqm/day	11	4
Flooring Tiles	500 SQM.	10 sqm/day	7	4
Toilet Tiles & Dados; Kitchen Dados	95 SQM.	4.5 sqm/day	3	7

Table No. 1 Representation of Productivity Chart

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A. Explanation for Time Duration Taken To Complete 1 Floor

For Concrete in Columns 12 labors can execute a volume of 5 cum per day for columnconcreting, so by allotting 12 concreting labors per day willexecute 35 Cum within 7 days.

For Concrete in Slabs 20 labors can execute a volume of 50 cum per day for slab concreting, so by allotting 20 concrete labors per day will execute 100 Cum within 2 days.

REQUIRED RESOURCES

$$\text{(manpower)} = \frac{\textit{TOTAL QUANTITY}}{\textit{PRODUCTIVITY X DURATION}}$$

Shuttering for footing :-

Quantity:- 500 sqm; Productivity per day:- 27sqm/ day; Duration:- 7 days

REQUIRED RESOURCES (manpower)= $\frac{500\text{sqm}}{27\text{sqm/day} \times 7\text{days}}$

= 3 Nos.

3 carpenters should be allotted per day for column shuttering.

Steel for footing:-

Quantity: - 12 MT; Productivity per day:- 266 kg / day; Duration:- 10 days

REQUIRED RESOURCES (manpower)= $\frac{12000\text{kg}}{266\text{kg/day} \times 10\text{days}}$

= 5 Nos.

5 Nos. of men should be allotted per day for bar bending of steel used in slab.

Concrete for footing :-

Quantity:- 190 cum; Productivity per day:- 27 cum/ day; Duration:- 3 days

REQUIRED RESOURCES (manpower)= $\frac{190\text{cum}}{27\text{cum/day} \times 3\text{days}}$

= 3 Nos.

3Nos. of labors should be allotted per day for concreting of footing.

Steel for column :-

Quantity: - 6MT; Productivity per day:- 62 kg / day; Duration:- 8 days

REQUIRED RESOURCES (manpower)= $\frac{6000\text{kg}}{63\text{kg/day} \times 8\text{days}}$

= 12 Nos.

12 Nos. of men should be allotted per day for bar bending of steel used in column.

Steel for slab :-

Quantity: - 9.4 MT; Productivity per day:- 110 kg / day ; Duration:- 7 days

REQUIRED RESOURCES (manpower)= $\frac{9400\text{kg}}{110\text{kg/day} \times 7\text{days}}$

= 13 Nos.

13 Nos. of men should be allotted per day for bar bending of steel used in slab.

Steel for stirrups :-

Quantity: - 1.6 MT; Productivity per day:- 350 kg / day ; Duration:- 2 days

REQUIRED RESOURCES (manpower)= $\frac{1600\text{kg}}{350\text{kg/day} \times 2\text{days}}$

= 3 Nos.

3Nos. ofmen should beallottedper day for bindingstirrups used in slab.

Slab shuttering :-

Quantity:- 465 sqm ; Productivity per day:- 14 sqm/ day ; Duration:- 8 days

REQUIRED RESOURCES (manpower)= $\frac{76\text{sqm}}{14\text{sqm/day} \times 8\text{days}}$

= 5 Nos.

5 Nos. of carpenter should be allotted per day for slab shuttering.

Column shuttering :-

Quantity:- 550 sqm ; Productivity per day:- 12 sqm/ day ;
Duration:- 8 days
REQUIRED RESOURCES (manpower)= $\frac{550\text{sqm}}{12\text{sqm/day} \times 8\text{days}}$

= 6 Nos.

6 Nos. of carpenter should be allotted per day for column shuttering.

Brick masonry :-

Quantity:- 745 sqm ; Productivity per day:- 12 sqm/ day ;
Duration:- 11 days
REQUIRED RESOURCES (manpower)= $\frac{745\text{sqm}}{12\text{sqm/day} \times 11\text{days}}$

= 6 Nos.

6Nos. of masons should be allotted per day for brick masonry.

Internal plaster :-

Quantity: - 920 sqm ; Productivity per day:- 18sqm/ day ;
Duration:- 10 days
REQUIRED RESOURCES (manpower)= $\frac{920\text{sqm}}{18\text{sqm/day} \times 10\text{days}}$

= 6 Nos.

6 Nos. of men should be allotted per day for internal plaster.

External plaster:-

Quantity: - 770 sqm ; Productivity per day:- 18sqm/ day ;
Duration:- 11 days
REQUIRED RESOURCES (manpower)= $\frac{770\text{sqm}}{18\text{sqm/day} \times 11\text{days}}$

= 4 Nos.

4 Nos. of men should be allotted per day for external plaster.

Internal paint:-

Quantity: - 920 sqm ; Productivity per day:- 18sqm/ day ;
Duration:- 10 days
REQUIRED RESOURCES (manpower)= $\frac{920\text{sqm}}{18\text{sqm/day} \times 10\text{days}}$

= 6 Nos.

6 Nos. of men should be allotted per day for internal paint.

External paint :-

Quantity: - 770 sqm ; Productivity per day:- 18sqm/ day ;
Duration:- 11 days
REQUIRED RESOURCES (manpower)= $\frac{770\text{sqm}}{18\text{sqm/day} \times 11\text{days}}$

= 4 Nos.

4 Nos. of men should be allotted for a day for external paint.

Flooring tiles:-

Quantity:- 500 sqm ; Productivity per day:- 10 sqm/ day ;
Duration:- 7 days
REQUIRED RESOURCES (manpower)= $\frac{500\text{ sqm}}{10\text{sqm/day} \times 7\text{days}}$

= 8 Nos.

7 Nos. of workers should be allotted for a day to complete floor tiles.

5**Toilet tiles & dados ; kitchen dados :-4**

Quantity:- 95 sqm ; Productivity per day:- 4.5 sqm/ day ;
Duration:- 3 days
REQUIRED RESOURCES (manpower)= $\frac{95\text{ sqm}}{4.5\text{sqm/day} \times 3\text{days}}$

= 7 Nos.

7Nos. of workers should be allotted per day to complete toilet tile and daddo.

XI. QUANTITY AND RATE ANALYSIS

BILL OF QUANTITY (BOQ)					
S. No.	Description	Quantity	Unit	Rate	Amount
1	Excavation	1536	cum	600	9,21,600/-
2	Back filling	1350	cum	400	5,40,000/-
3	Concrete for columns	35	cum	500	17,500/-
4	Shuttering for footing	500	sqm	1345	6,72,500/-
5	Steel for footing	12	MT	50,000	6,00,000/-
6	Concrete for footing	190	cum	5,000	9,50,000/-
7	Concrete for slab	100	cum	5000	5,00,000/-
8	Steel for column	6	MT	50,000	3,00,00/-
9	Steel for slab	9.4	MT	50,000	4,70,000/-
10	Steel for stirrups (slab)	1.6	MT	48,000	76,800/-
11	Slab shuttering-	465	sqm	1507	7,00,755/-
12	Column shuttering	550	sqm	860	4,73,000/-
13	ACC concrete block (mason)	6000	No.	75	4,50,000/-
14	Internal plaster	920	sqm	236	2,17,120/-
15	External plaster	770	sqm	269	2,07,130/-
16	Internal paint	920	sqm	64	58,880/-
17	External Paint	770	sqm	86	66,220/-
18	Flooring tiles	500	sqm	247	1,23,500/-
19	Toilet tiles &dados; kitchen dados	95	sqm	215	20,425/-

Table No. 2 Bill of Quantity

XII. RESULT

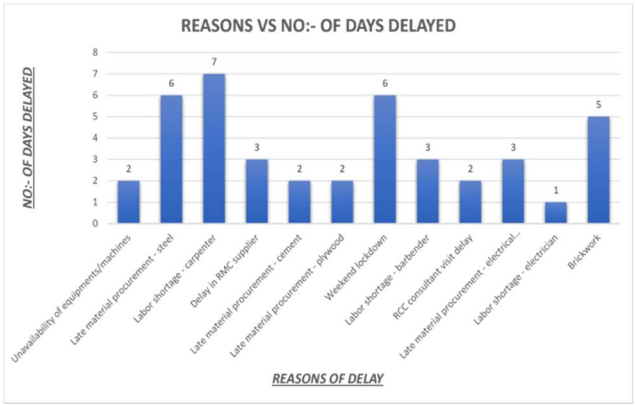

FIG. NO. 3 Representation Of Reasons Vs No Of Days Delayed.

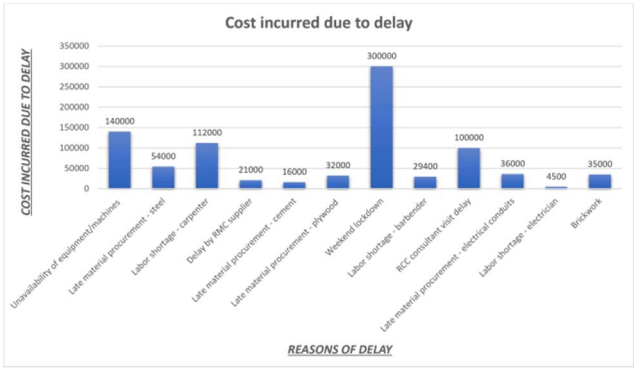

Fig. No.4 Representation of cost incurred vs reasons of delay

The work breakdown structure of Savali Saffron is mainly divided into 3 parts. This is a residential building and has repetitive schedule followed. It has three blocks and consists of silt floor, ground floor, and 13 floors accommodating 182 flats in total. A & C block in each floorhas 5 flats, B block in each floor has 4 flats. The flats here are 2BHK four in number and 1BHK- 1 in number, other amenities provided within the building area. Site clearance and mobilization had taken place on 1st sept 2020 and excavation with anti-termite treatment is carried out. Next part is the major activity i.e., structural work which incorporates tasks like raft foundation, basement columns and shear wall, first floor slab and columns and continues till the 13th floor. The third activity is named as finishes as it includes the left-over work like masonryworks, electrical conduiting, internal plastering, and water proofing works, painting works, floor finishes, landscapingworks, elevators, firefighting. The main critical activities instructural work are raft foundation, construction, columns and shear walls of basement and the slabs of each floor. The critical activities for finishes are masonry works, electrical conduiting and internal plastering. In addition to the critical activities which cannot be delayed at any cause, there are some other additional activities where the project really experienced difficulties inexecution and delay in completion. It has been observed that 42 days delay due to which, extra cost of Rs. 8,26,500/- tookplace.

XIII. CONCLUSION

1) While planning and scheduling the activity, due consideration has been given to complete the work within the stipulated 18 months for Savali Saffron. Schedule was prepared to finish the work by 18 months excluding grace period of 2 months and with 21-22 days slab cycle, which is commonly implemented in all construction companies.
2) Reason responsible for maximum no. of delay(i.e.,7days) –Labor Shortage (Carpenter)
3) Max Cost incurred due to a delay (weekendlockdown-6 days) – Rs 3,00,000/-
4) The initial estimated cost of the project - Rs.10,41,31,000-
5) An extra cost incurred due to delay - Rs.8,26,500/-
6) The schedule was lacking along with the delay in process due to problems in excavation, lack of manpower and materials, shortage of labor and themain reason for the delay observed was the weekend lockdown due to covid-19 pandemic etc.

7) Scheduling using computer as a tool was found to be easy and accurate. Software used here i.e., MS project. The project schedule and project track generation were its main highlight. The schedule report helps in identifying start date, finish date, total float, also the duration of the project as a whole. The schedule tracking report helps in delaycalculation.

XIV. POSSIBLE SOLUTIONS TO OVERCOMEDELAY

CAUSES OFDEL AY	RECOMMENDATIONS
Weather condition	Conducting detailed and perfect surveys towards the field condition and previous weather data
External factors	Monitor the work done by the earliercontractors to make sure that delays
	outside your control are recognizedand documented.
Lack of funds	Optimize cash flow in accordance with the requirements and make surefund needed for project is available to execute the project
Deviation of scheduling	Develop detailed and accurate schedule to facilitate easy andcontrolled scheduled execution
Lack of communication	Planning and applying Management Information System (MIS)
Poor decision making process	Conduct routine/regular coordination meeting and develop a procedure regarding decision making.
Lack of coordination / Wrong delegation of authority	Develop a good, simple and easy to understand system to regulate coordination procedures and responsibility of units. Make organization chart with detail job description which includes responsibilities and roles of each function
Lack of inspection	Provide separate technical staff or site manager for periodic inspection and monitoring work process which includes starting late, late submission of drawings, mistakes or errors, resource availability, etc. then proper record has to be maintained to detectrisk and mitigate.
Improper planning	Understand the level of supply and demand to produce detail planning and schedule. Implement automatic machine work to avoid shortage of labor such asautomatic plastering machine, wall painting, precast concrete wall, etc.
Lack of knowledge	Contractor needs to aware of new technology and techniques to reducetime duration for activity or labor force
Lack of facilitiesat site	Site management should be properlydone to ensure proper resource; basic facilities for worker are available to increase productivity by doing detail study in site condition.
Poor selection of vendors	Consider supplier daily capacity and material quality for selecting vendorsto avoid delay and conflicts.

Labor shortage	Early workforce planning is essential for owners and contractors to effectively manage project labor risks.Then providingincentives/awards for workers like best employer of the year/ month sothat productivity and quality of work will be increased.
Skilled labor shortage	Providing training and upgrade skills to use new technology and techniques for unskilled labors to increase productivity and efficiency of the worker.

Table No. 3 Possible Solutions to overcome Delay

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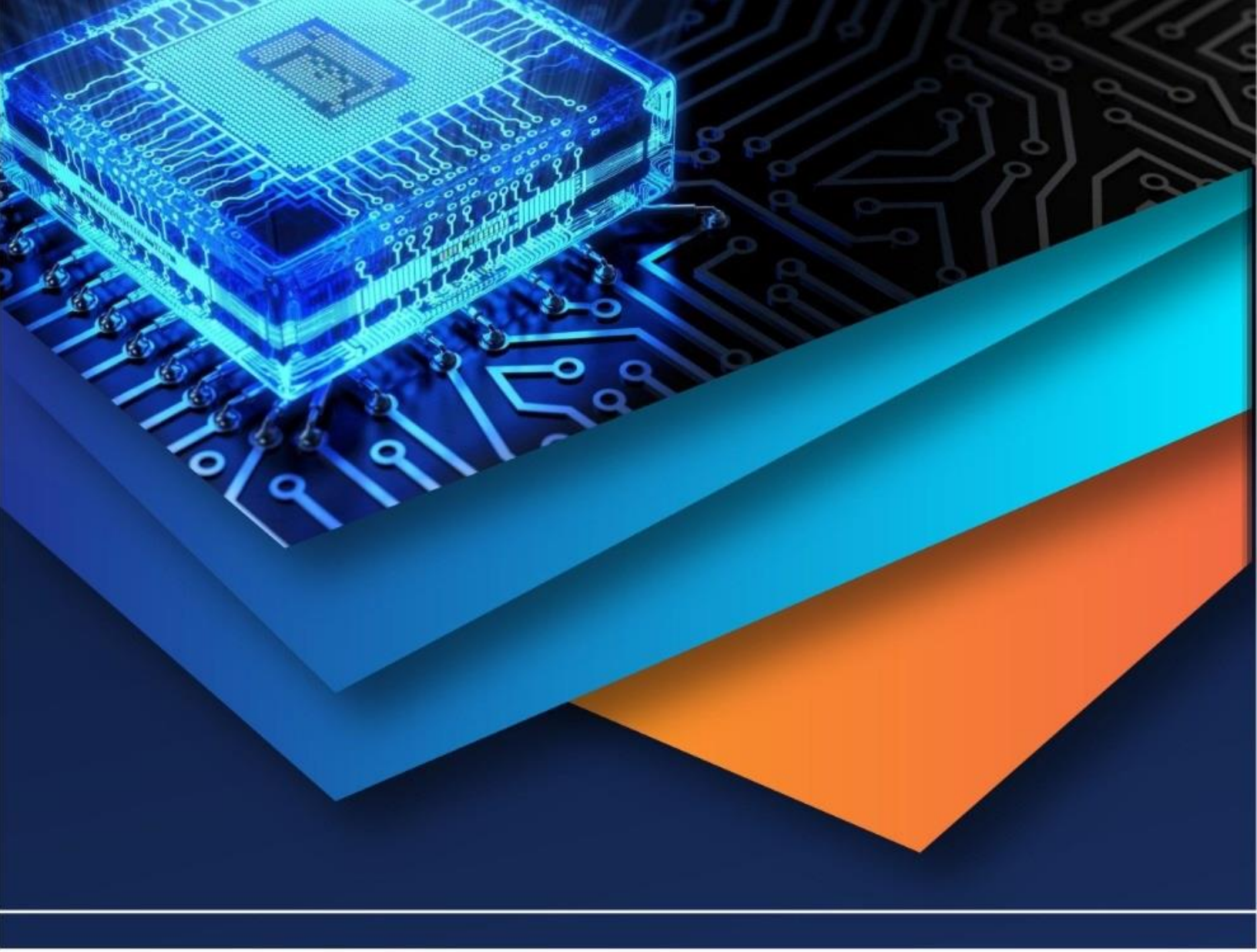

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