CONTRIVANCING 4D-BIM IN METRO RAIL PROJECT USING POWER PROJECT SOFTWARE

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Abstract : Construction Industry faces lot of problems in managing huge projects like Infrastructure, especially the construction and management of Metro Rail project within the assigned duration is a nightmare. There are so many risks and delays associated with the metro projects, as the project takes over 5 years of duration. The metro project causes many types of risks and delays such as excusable, non-excusable, and concurrent delays. As the project involves usage of heavy equipments, over and underground construction of the rail routes, sudden withdrawal of the third parties and other such risks causes commotion and lot of problems, confusion in completion of the work. To avoid such issues, the management should use the proper tool and the apt method in managing and completion of the project. In India, the metro rail has adopted the 4D-BIM tool and has implemented in some of the stations and is in process of doing 5D, though it has the start-ups of the 4D, the scheduling of the projects still lacks proper method. The traditional techniques and tools like CPM, PERT, Primavera, BIM360 and others which are been practiced still lacks and has limitations in the scheduling of the projects. So to avoid all these limited traditional version, this project focuses mainly of using the ELECOSOFT Power Project Software which has more of advantages compared to other traditional tools in implementing the Critical Chain Path Method which allocates resource tasks and buffers to the project's activities. This CCPM method has proven the early completion of the project with estimated time and cost. So this project is the implementing of the new idea in a new BIM tool with two cases which gives practical solutions to the trending problems in the Metro Rail projects.

IndexTerms - **Metro Rail, 4D-BIM, ELECOSOFT Power Project Software, Critical Chain Path Method(CCPM), Risk and Delay Management.**

I. INTRODUCTION

The construction sector in India is a major contributor to the Indian GDP. But delay in construction projects especially infrastructure projects causes both cost and time overrun and resulted in loss to stakeholders. Indian construction industry presently used many scheduling techniques but they're mostly task based there's less use of resource based scheduling techniques. albeit construction sector using scheduling techniques all the project won't be completed on time because of various uncertainty that are not concerned while scheduling.

The traditional approach followed in Metro projects often struggles to deliver the project on time and within the estimated budget. Lack of precision and exactness within the method of knowledge flow leads to conflict between stakeholders. Inability to know and interpret 2D drawings often results in reductions in productivity, more chances of defects leading to rework, wastage of resources, extra cost and time. Design management, document control, quality assurance, timely completion, cost control, risk mitigation, maintaining safe construction environment, and effective operation & maintenance of services are among the foremost common challenges faced by the development industry.

To overcome these issues, the effect of CCPM is one among the simplest tool to finish the project in frame of your time . It also facilitate in reducing extra safety time that added into each and each activity and rather than that it'll use buffers for maintaining project consistent with time. The implementation of this unique method during a new BIM tool like Power Project Software will give a perfect and more practical solutions in submitting the Metro rail projects within the assigned time.

1.1 METRO RAIL

There are currently 13 operational Metro transit systems in 21 cities in India. as an example , the Delhi Metro itself is connected to few other nearby cities within the capital Region. As of August 2019, India has 678.52 kilometres of operational metro lines and a total of 540 stations. An extra 578.34 km of lines are under construction. Metro rail lines in India are composed of mainly railroad . Projects a bit like the Kolkata Metro and Delhi Metro used railroad for his or her earliest lines but all new projects in India are on railroad as vehicle is of ordinary gauge.

In May 2015, the Union Government approved the Union Urban Development Ministry's proposal to implement metro rail systems in 50 cities. the bulk of the planned projects are getting to be implemented through special purpose vehicles, which may be established as 50:50 joint ventures between the Union and respective government . The Union Government will invest an estimated budget of about ₹5 lakh crore. during a new draft policy unveiled in March 2017, the Central Government stated that it wanted state governments to believe metro rail because the "last option" and implement it only after considering all other possible mass rapid

transit systems. The choice was taken because of the high cost of constructing metro rail systems. In August 2017, the Union Government announced that it'd not provide financial assistance to new metro rail project, unless some quite private partnership is involved. During the 2020 pandemic, metros across the country were close up from 22 March 2020 and resumed operations on 7 September 2020.

1.2 4D-BIM IN INDIA

In India BIM is additionally referred to as VDC-Virtual Design and Construction. Due to its population and economic process , India has an expanding construction market. BIM usage was reported by only 22% of respondents to a 2014 survey. In 2019, officialdom said BIM could help save to twenty by shortening construction time, and urged wider adoption by infrastructure ministries. 4D BIM refers to the intelligent linking of individual 3D CAD components or assemblies with time- or scheduling-related information. The term 4D refers to the fourth dimension: time, i.e. 3D plus time.

4D modelling enables project participants such as architects, designers, contractors, clients to plan, sequence the physical activities, visualise the critical path of a series of events, mitigate the risks, reports and monitors the progress of activities throughout the lifetime of the project. 4D BIM enables a sequence of events to be depicted visually on a time line that has been populated by a 3D model, augmenting traditional Gantt charts and important path (CPM) schedules often used in project management. Construction sequences are often reviewed as a series of problems using 4D BIM, enabling users to explore options, manage solutions and optimize results.

As a complicated construction management technique, it's been employed by project delivery teams performing on larger projects. 4D BIM has traditionally been used for higher end projects thanks to the associated costs, but technologies are now emerging that allow the method to be employed by laymen or to drive processes such as manufacture.

1.3   ELECOSOFT POWER PROJECT

Power project BIM is an integrated module for Power project which enables you to easily link the tasks in your project plan with 3D model components for 4D planning in one application. This makes it supreme for tendering and progress monitoring. Power project's easy-to-use graphical layout helps you plan your projects and access the information you need with ease. Its rigid integration with Microsoft Office products, with standard menus and toolbars, makes it easy to learn. Power project simplifies resource and cost management, both within individual projects and across large programmes. Power project's extensive reporting facilities enable you to extract the information you need from a project and direct it to the right people. Despite its ease of use, Power project is a very powerful tool. You can configure Power project to work in a way that suits you, with customisable fields and industry standard OLE automation. You can interface Power project with external applications, manipulate your data, create reports and automate standard procedures to speed up processes.

1.4 CRITICAL CHAIN PROJECT MANAGEMENT

Completion of a project, with the initial specified constraints of time, cost, and quality is a rare occurrence which can be due to many reasons. A number of studies conducted on the project success factor have suggested various verifying solutions since no two projects are alike. In 1997, E.M. Goldratt postulated a new approach to minimise time and cost overruns that addresses both, the human aspect and the technical approach in project management. This approach is called Critical Chain Project Management(CCPM).

According to the Theory of Constraints (TOC), any system must have constraints; otherwise, its output would either increase without bounds or go to zero. To optimise this operation, Goldratt laid stress on identifying and managing the constraints optimally.

In Project Management, the core constraints are time, resources, and cost. The focus of Critical Chain Project Management is to identify the core problems that causes project failures and on how the project schedules can be managed.

Some of the undesirable causes identifies in CCPM are:

- ➢ Excessive activity duration estimates
- ➢ Lack of activity positive variations
- ➢ Failure to make use of positive variations
- ➢ Failure to avoid delays caused by merging activity paths.
- ➢ Low efficiency and loss of focus on project constraint caused by multi-tasking.

II. SCOPE OF THE PROJECT

The main scope of the project is to overcome all types of delays and risks in Metro Projects using the new 4D-BIM tool Power Project with the Critical Chain Project Management concept over the other traditional methods and tools.

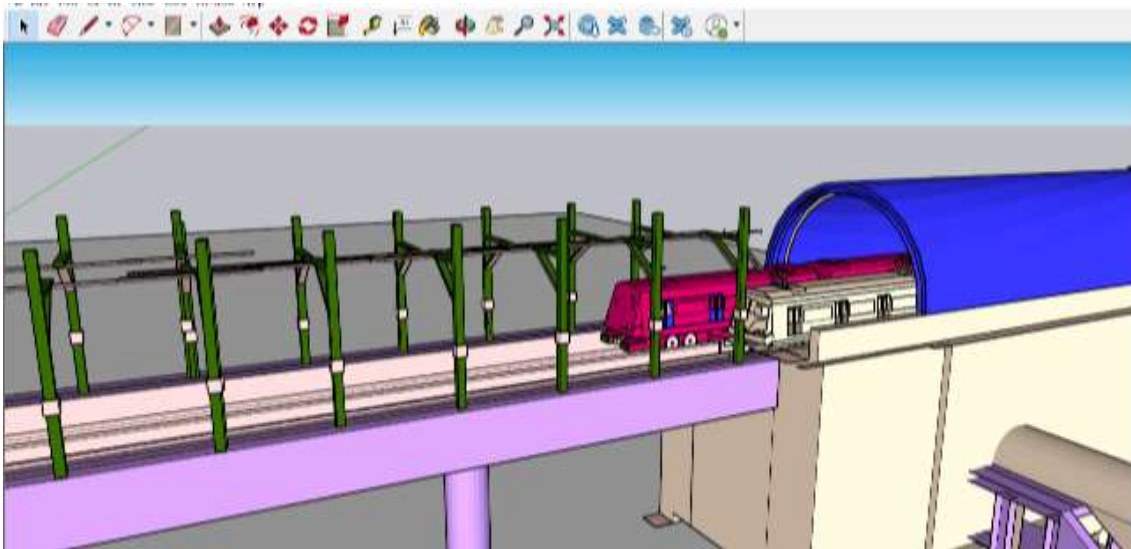## III. METHODOLOGY
3.1 3D Modelling

Fig3.1 M Metro station

The 3D model of 2 Metro stations connecting with viaducts and spans with real time components was created using Sketchup software. Initially the two stations of two different stages were selected and the basic model was created with respect to the real time models with all considerations. Then for each and every component materials were assigned with respect to their nature and need and finally colours were applied using the colour bucket option in sketchup. After the creation of the model with all detailings and specifications the whole project was exploded into separate components and 9 components were categorized to make it easy for linking the model to the BIM software. To make it more interesting, the trending Google map incorporation was used. The areas with respect to the stations and its surrounding areas were imported into the model and finally this gave a very realistic look which makes the work more easier for the planners and engineers in identifying the risks accompanied.

3.2 Scheduling

Coming to the scheduling of the project, the new project was created with all basic details are given as MMETRO. Then the starting date of the project was assigned as 01-03-2021 and each and every activity was assigned as same the real time actuals. At the end of the scheduling the project end was seen as 27-09-2024. So this the original schedule of the project.

3.3 Linking 3d Model With The Schedule

As we already exploded the model into 9 categories, this makes it easy for us to link the model to the BIM tool. The model sketchup file is converted into IFC File format. Then the BIM option is opened in the power project and this IFC file is opened. Now using the selection mode, each and every component of the model is assigned to its respective activities. Then to check whether the schedule is in correct progress, the Simulation Tracking can be runned. By running the schedule with the model it gives accuracy in scheduling and we can spot the problem associated while the actuals are in progress. And more importantly this linking of 3D model with the schedule within the software can never been seen in any other softwares expect Power Project. And the end an video of the project's progression is also done.
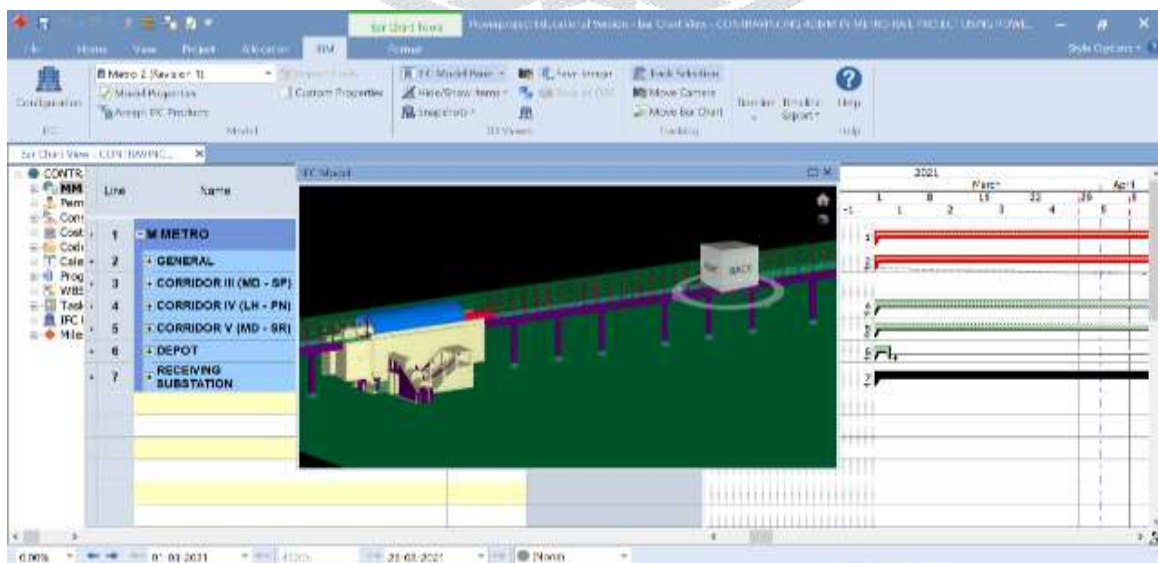

Fig3.2 Linked 3D model with schedule

3.4 Case 1: Addition Of Buffer   Before Actuals

The concept of this case is identifying risks associated with each activities and giving buffer to the whole project instead of providing buffer to each activity. This makes no change or delay in project for the clients and public as the risks and delays are

been consumed in the buffer itself. This case is about the CCPM concept were the Buffers are provided to the whole project. Even though this concept seems to be difficult but with accurate scheduling and management the result would be a hit.

An baseline S1 was created to the schedule and the risk was runned, providing 15 iterations with the inbuilt Monte Carlo Simulation technique with Uniform distribution. After generation of the results, a probability within the 15 iteration was selected and the risks are analysed with sensitivity and likelihood charts and the risks associated activities are highlighted and finally the Buffers are added accordingly by the software. In our case, the deadline was 26-05-2023, with all buffers added the rescheduled result gives us the deadline of 27-09-2024 . So this gives us a real time solutions to the unidentified risks and delays which was associated with project. With this we can give the clients deadline with the buffered dates so there will be no delays of the project in future and most importantly the cost overrun is avoided.
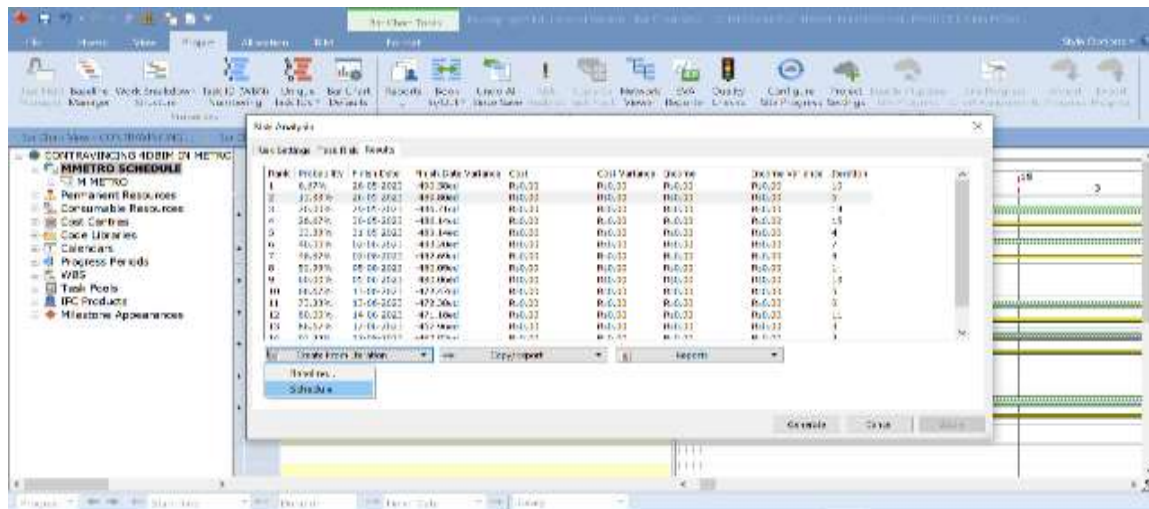

Fig3.3 Case 1 result

3.5 Case 2: Addition Of Delay Fragnets After Actuals

In his case, when the delays occurs after the application of the actuals over the actual deadline and we give solutions using the Time Impact Analysis.

- Time during which some part of the construction project has remained incomplete or not performed as per contractual sections/ Key dates or completion date due to an unanticipated circumstance.

- Delays of activities which are on critical path.

- A time impact analysis is a method used to determine extent of impact from potential delay in construction process. This schedule analysis method involves the insertion or addition of activities indicating delays or changes into an updated schedule representing progress up to the point when a delay event occurred to determine the impact of those delay activities.

An activity is assumed as Pandemic Period and assigned with a duration of 30 days. After rescheduling the actual deadline is delayed accordingly. On the progression of the actuals these unexpected delays causes loss of time, money, and resources. This can be solved by changing the order of activities by analysing its duration. After setting the baseline S1, an progress period is added after the pandemic and it is applied to the schedule with the percentage of completion. Then the activities which have been selected are selected and rolled up according to the duration and by adjusting the resources. Then this setup is rescheduled. The date of the delayed schedule which went over the deadline for about 6 months is minimised to about 2months by making the activities parallel and adjusting the resources. This method is effective as all the results are applied automatically and the results are accurate.
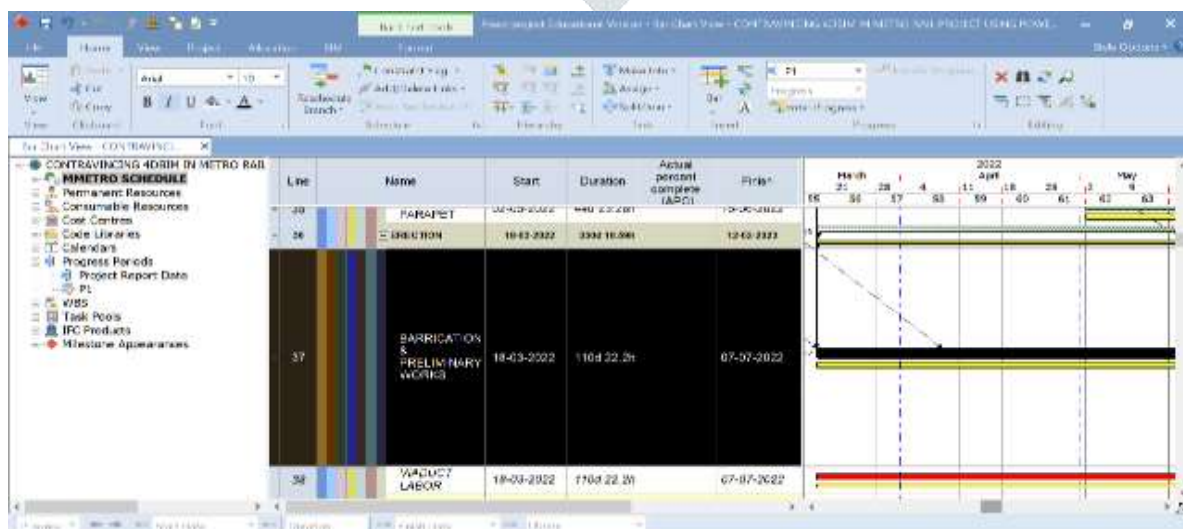

Fig3.4 Rolling up of activities

IV. CONCLUSION

The aim of this project is to overcome all types of delays and risks in Metro Projects using the new 4D-BIM tool Power Project with the Critical Chain Project Management concept over the other traditional methods and tools. And the aim was satisfised by the application and analysis of the real time problems associated in construction and management of Metro Rail Projects with 2 cases that is addition of buffer before actuals and addition of delays fragnets after actuals. These two cases has given real time solutions and it is proven automatically by the software were no human errors can be done. The 3D model, BIM, Scheduling, and the application of two cases has proven by giving new and real solutions to all the new risks and delays occurring. Thus, by contrivancing 4D-BIM in Metro Rail project using power project software can knock out real time problems and more importantly the traditional techniques and tools, by upgrading our field to the next level.

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