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Planning and Scheduling of High Rise Building Using Primavera

T. Subramani[1], A. Sarkunam[2], J. Jayalakshmi[3]
[1]Professor & Dean, Department of Civil Engineering, VMKV Engg. College, Vinayaka Missions University Salem, India.
[2]PG Student of Construction Engineering and Management, Department of Civil Engineering, VMKV Engg.College,Vinayaka Missions University, Salem, India.
[3]PG Student of Structural Engineering, Department of Civil Engineering, VMKV Engg. College, Vinayaka Missions University, Salem, India.

ABSTRACT
Although the long-introduced Industrialized Building System (IBS) has promised to solve and improve the current construction method and scenario in our country, but the IBS method has not gained enough popularity. One of the reasons is due to lack of research works done to quantifying the benefit of IBS especially in construction time saving. In lieu with such scenario, this study conducted to quantify evidence of time saving in IBS application. The methodology adopted for this study is by modelling the construction process for high-rise residential building for both conventional and IBS with shared more a less the same nature and size of the structure. The model was developed using Primavera (P3) project planning software. The comparison was made by comparing selective building components for both method of construction. Different high-rise residential projects have been selected for this study. The result of the study clearly indicated that sufficient time saving can be archived. Also from this study shown not all IBS components can improved to the overall construction duration, however by adopting IBS components can improve and expedite the construction of 18 stories residential building from the point of departure of the project throughout of the whole of project's with a total 405 days or 42% the time saving.
KEYWORDS: Planning, Scheduling, High Rise Building, Primavera

I. INTRODUCTION

Due to an increasingly competitive environment, construction companies are forced to be more efficient and achieve competitive operational advantage. Companies are always looking for improvements in equipment features, communication tools, efficient management techniques, and training human resources. Construction companies are also narrowing their focus, becoming specialists in certain types of construction projects. This specialization requires more focused project planning and controlling techniques that prove to be better for certain type of projects while providing specialized construction services. The benefits of effective planning, scheduling and control of construction projects are: reduced construction time, reduced cost overruns and the minimization of disputes.

These benefits accrue to the contractors, owners, suppliers and workers in the form of improvements in productivity, quality and resource utilization. (Mattila and Abraham, 1998) been applied to highway type construction projects by the transportation departments in most states. The ability of CPM to these kinds of projects raises questions (Selinger, 1980; Reda, 1990; and Russell and Wong, 1993). Line of Balance (LOB) and its variations are developed to search for a better solution for highway type projects, such as tunnel construction, high rise building, pipe line projects, and even utility projects. Some researchers declare that LOB software is ready for commercial usage (Arditi, Sikangwan, and Tokdemir, 2002).

However utility projects have their own features. The application of LOB and Linear scheduling techniques in utility projects are questioned by industrial professionals. For the underground utility project, the layouts of several utility lines are diverged. But on some locations, these utility lines intersect with each other, one over another. The construction of each utility line must be sequenced in this situation to avoid workspace conflicts, or lines with higher elevation are constructed ahead of the ones with lower elevation, and to provide work continuity for crews or resources.

This study will focus on the comparison of construction scheduling technique application in utility projects, such as Gantt chart, CPM, and LOB, and indicate advantages and disadvantages of each technique. It develops the modified LOB method which uses a group of linear equations to identify the construction interference locations of utility lines, estimate the interference time based on the historical production rate, and adjust the construction schedule to satisfy the construction constraints. It helps to avoid the construction interruption, keep the continuity of crew work, and avoid the delay of construction and cost overruns.

1.1 CURRENT SCHEDULING METHODS IN CONSTRUCTION INDUSTRY

The most common scheduling method used in the construction industry is the Gantt chart (Bar Chart) and Critical Path Method (CPM). Gantt chart (Bar chart) has gained wide acceptance and popularity because of its simplicity and ease of preparation and understanding. No "theory" or complicated calculations are involved. CPM network can show logic dependencies of activities, and estimate and predict the completion date of the project based on mathematical calculations. But both Gantt chart and CPM are unable to accurately model the repetitive nature of linear construction. This includes the inability of CPM to provide work continuity for crews or resources, to plan the large number of activities necessary to represent a repetitive or linear project (Harris, 1996), and the inability of Gantt chart (Bar chart) and CPM to indicate rates of progress, and to accurately reflect actual conditions. (Mattila and Abraham,1998). The consequence of this is that there have been many attempts to find an effective scheduling technique for linear construction. These include, but not limited to, the Line of Balance (LOB), the vertical production method (VPM), the linear scheduling method, the repetitive project modeling (RPM), the linear scheduling model (LSM), and the repetitive scheduling method (RSM). (Mattila and Abraham,1998). All of these concepts and methods are the variations of LOB, which is originally developed in the manufacturing industry. This section discusses the popular scheduling methods in construction industry, such as Gantt chart and CPM, review current application of LOB and its variations, and indicates the inability of LOB in solving the construction interferences of two or more utility lines.

1.2 GANTT CHART SCHEDULING METHOD

The bar chart was originally developed by Henry L. Gantt in 1917 and is called a Gantt chart. A bar chart is "a graphic representation of project activities which are shown in a time-scaled bar line with no links shown between activities" (Popescu and Charoenngam, 1995). It quickly became popular in construction industry because of its ability to graphically represent a project's activities on a time scale. A bar chart has become a vehicle for representing many pieces of a project's information. A project must be broken into smaller, usually homogeneous components, each of which is called an activity or task. Bar charts basically use the x-axis to depict time, and the y-axis is used to represent individual activities. (Fig.1.1& Fig.1.2)

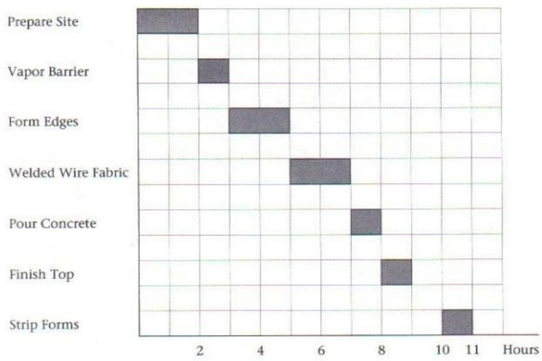


Figure1.1Bar Chart for Placing a Slab on a Grade (Mubarak, 2003)

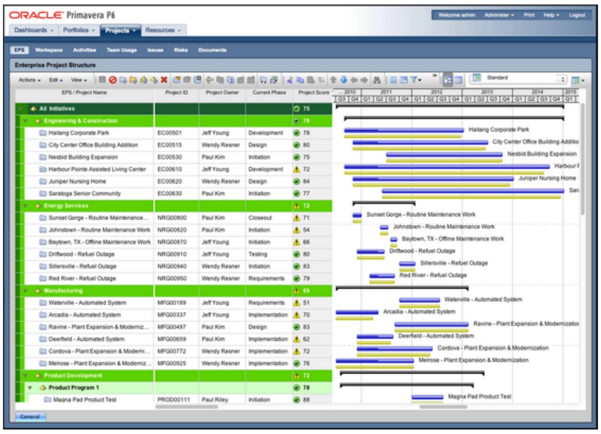


Figure1.2Bar Chart

1.3 Advantage of Bar Chart

Bar charts have gained wide acceptance and popularity mainly because of their simplicity of and ease of preparation and understanding. No "theory" or complicated calculations are involved. Anyone can understand them. Bar charts particularly appeal to persons who do not have a technical background. For example, some clients and upper-level managers may better understand the plan for carrying out a construction project by looking at a bar chart than by looking at a schematic of logic network. The advent of the critical path method (CPM) and the evolution of powerful computers, bar chart did not perish or lose importance. Instead, they evolved to a different supporting role that made them more valuable and popular. (Mubarak, 2003). The advantage of bar chart can be concluded as:

- Bar charts are time scaled, the length of the activity bar represents the time duration of the activity). Both the node, in the node networks, and the arrow, in the arrow networks, are not time-scaled.
- Bar chart are simple to prepare
- Bar chart are easy to understand

- Bar chart are acceptable for presentation, especially for field people and people who are unfamiliar with the CPM
- Bar charts can be loaded with more information, such as cash-flow diagrams and man-hours.

Limitation

The main limitation of bar chart is lack of logical representation. Bar charts do not reveal the answers of relationship. Although some software programmers tried to depict logical relationships on bar charts, the result was not always clear. The logic lines would get tangled, and unlike networks, bar charts do not allow the length of the bars to be changed or moved around to make items clearer or look better. (Mubarak, 2003). While applying the bar chart to linear construction project, a huge diagram would repeat *n* times in scheduling linear and repetitive project. And the bar chart is unable to indicate progress rate and actual location.

1.4 NETWORK SCHEDULING METHOD

One of the major network scheduling methods which have been used in the construction industry is CPM (critical path method). This method involves the use of a geometric representation of flow chart which depicts the precedence between activities. The critical path method (CPM) is a duration-driven technique in which the basic inputs are project activities, their durations, and dependence relationships. Activity durations are functions of the resources required (rather than available) to complete each activity. The CPM formulation assumes that resources are not restricted in any sense (Ammar and Mohieldin, 2002). The use of network techniques and CPM by construction companies has reached a steady level after the enthusiastic boom of the early 1960's. Computer programmes eliminate the need to prepare a network, but the network notation provides an easily understood output format for management personnel. (Lutz and Hijazi,1993)

1.5 Advantages of Network Scheduling Method

When comparing bar charts with networks, three advantages over bar charts(Mubarak, 2003):

- Network show logic, the relationships among the activities. Bar charts do not
- Networks can better represent large and complicated projects.
- Networks can estimate, or predict, the completion date of the project, or other dates, on the basis of mathematical calculations of the CPM

Limitation of Network Scheduling Method

Comparing to bar charts, network scheduling is not time scaled. It requires practitioners to be trained to understand the CPM. From the authors' experiences, the presentation of CPM is not as acceptable for field people as bar chart. And resource information can not be loaded in CPM. Some scheduling software vendors tried to take the advantage of time-scaled feature of bar chart and impose it on network which some persons called time-scaled logic diagrams. On the other hand, there is evidence that contractors do not use networks in highly repetitive jobs because of their belief that high repletion would reduce the chances of successful scheduling and control by networks (Arditi and Albulak, 1986).

For example, network method presents complications in projects of repetitive nature such as high rise building construction. CPM-based techniques have been criticized widely in the literature for their inability to model repetitive projects (Russell and Wong, 1993). The first problem is the sheer size of the network. In a repetitive project of n units, the network prepared for one unit has to be repeated *n* times and linked to the others; this results in a huge network that is difficult to manage.

This may cause difficulties in communication among the members of the construction management team. The second problem is that the CPM algorithm is designed primarily for optimizing project duration rather than dealing adequately with the special resource constraints of repetitive projects. The CPM algorithm has no capability that would ensure a smooth procession of crews from unit to unit with no conflict and no idle time for workers and equipment. This leads to hiring and procurement problems in the flow of labor and material during construction (Arditi, Sikangwan, and Tokdemir, 2002).

A new format was developed for work of a repetitive nature, such as work on floors in a high-rise project, or work on sections in underground pipe line or utility line project. In the pipe line or utility line instance, the use of basic CPM was laborious; the input for work on a typical section was duplicative and tedious. Further, once the schedule had reached the typical section, it was possible to predict a result through basic arithmetic without the use of a computer. This suggested that there were ways of graphing the result other than network presentation; this realization resulted in the development of some methods for use in linear and repetitive projects. Line of balance (LOB) method is one of them using a unit network to portray repetitive activities.(Fig.1.3)

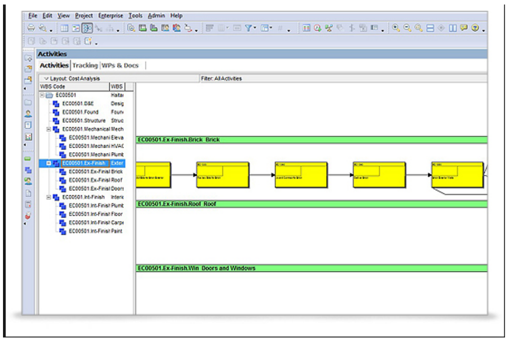


FIG.1.3 LIINE OF BALANCE (LOB)

1.6 LINE OF BALANCE (LOB)

The line of balance (LOB) method was originated by the Goodyear Company in the early 1940s and was developed by the US Navy during the Second World War for the programming and control of both repetitive and non-repetitive projects (Turban, 1968). A common characteristic of LOB techniques is the typical unit network. Representative construction projects that fit into this category are a repetitive housing project or a high-rise building. (Lutz and Hijazi, 1993) Typical process production or flow line curves are depicted in Figure1.4.

The Figures 1.4 depicts the balanced production flow line of high rise building and unbalanced production flow lines. For example, the sequence of processes for a high rise building construction project may include form erection, steel installation, concrete placement, form removal, curtain wall installation, and glazing. The production curves for activities are plotted as a function of time. The production rate for a process can be determined from its slope. The horizontal distance between the production curves for two consecutive activities at given location indicates the time buffer. The difference between the cumulative number of production quantities delivered and the LOB quantity at any given time is termed the “criticality”. The negative criticality indicates the actual progress is less than the production forecast. The LOB is a quantity-time diagram. It focuses on the required delivery of completed quantities.

Linear construction projects often consist of repetitive processes which have different production rates. This phenomenon of production rate imbalance has the potential for negatively impacting project performance by causing work stoppages, inefficient utilization of allocated resources, and excessive costs. Production rate imbalance occurs when the production curves of leading processes intersect the curves of following process because of different production rates and insufficient lag between start times of processes. (Fig.1.5)

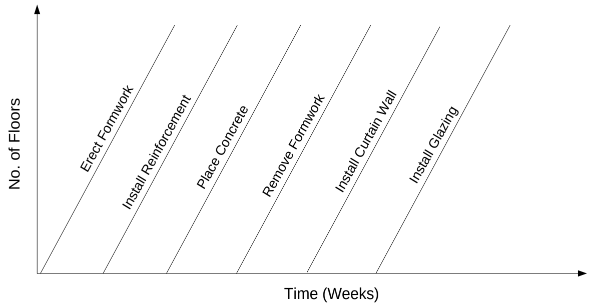


Figure1.4. Balanced Production Curves for Repetitive Processes (Source: Lutz and Hijazi,1993)

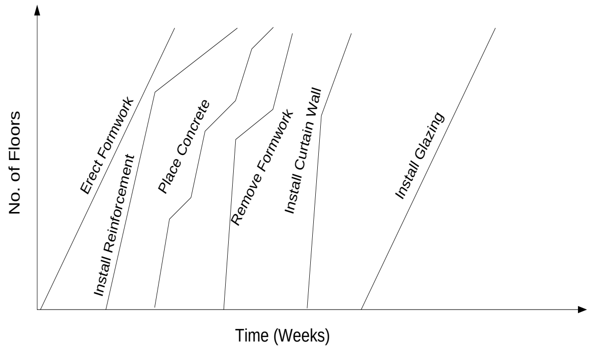


Figure1.5. Non-balanced Production Curves for Repetitive Processes (Source: Lutz and Hijazi,1993)

The LOB can determine at any time (Lumsden, 1968):

- Shortage of delivered materials which may impact production;
- Materials which are being delivered in excess which may cause additional material handling or require additional storage space;
- The jobs or processes which are falling behind and the required rate of acceleration to satisfy the required LOB quantities;
- The jobs or processes which are ahead of schedule which may b e placing heavier demands on operating capital than necessary, and
- A forecast of partially completed production units by job, work station, or process to support the delivery schedule of finished units.

Benefits and limitations

The major benefit of the LOB methodology is that it provides production rate and duration information in the form of an easily interpreted graphics format. The LOB plot for a linear construction project can be easily constructed, can show at a glance what is wrong with the progress of project, and can detect potential future bottlenecks.

Although LOB methodology can be used to aid in the planning and control of any type of project it is better suited for application to repetitive projects as opposed to non-repetitive projects. A limitation of the LOB methodology is that it assumes that production rates are linear. Due to the stochastic nature of construction processes, the assumption that production rates of construction projects and processes are linear may be erroneous. Additionally, the objective of many planning techniques based on the LOB concept is to reduce project duration with little regard for project cost (Reda, 1990)

Barriers to Implementing LOB

The application of the LOB methodology by the US construction industry had been very limited. Some barriers to implementation of the LOB methodology include the following:

- There is a lack of awareness among practitioners in the US construction industry that the LOB methodology exists.
- Owners and contractors began adopting network techniques as planning tools at about the same time that the LOB methodology was originated and developed. These entities are reluctant to adopt new planning tools which are not being used by their counterparts or competitors.
- Computerized tools employing network techniques are widely available whereas computerized tools employing the LOB methodology are not currently commercially available.

Due to the popularity of the relatively inexpensive computer in the US construction industry, there is a resistance to change to a planning method which is currently not supported by computer. However, researchers at several universities have attempted to computerize the LOB methodology and have working prototypes.

1.7 Comparison of current scheduling methods

Although scheduling methods, such as Gantt chart and CPM are popular in the construction industry. The applications of these popular methods do have problems in scheduling linear construction projects. The LOB and its variations are beneficial to linear construction. The researchers apply them to the activity level of linear project. It application in construction industry is limited (Table gives the comparison of Gantt chart, CPM, and LOB on their advantages, limitations, relationships, and application in linear construction project).

In addition, the current LOB and its variations have not solved the location interference problems in the underground utility project. For the underground utility project, the layouts of several utility lines are diverged. But on some locations, these utility lines intersect with each other, one over another. The construction of each utility line must be sequenced in this situation to avoid workspace conflicts, and to provide work continuity for crews or resources.

The Gantt chart and critical path method (CPM) scheduling technique are populous in construction projects for the easy-to-use softwares, such as Primavera Project Planning. Traditionally CPM scheduling has originally been applied to industrial process and later been introduced to the building construction projects. The technique has also Time, cost, quality target and participation satisfaction have been identified as the main criteria for measuring the overall success of construction projects (Dissanayaka and Kumaraswamy, 1999). Of these, cost and time tend to be the most important and visible, always considered as very critical because of their direct economic implications if they are unnecessarily exceeded. This study to compare time performance of the conventional method of construction for high- rise residential and Industrial Building System (IBS) method by formulate benchmark measures of industry norms for overall construction period using ‘scheduling simulation modeling. Such model development necessitated the enumeration of a group of significant variables affecting construction times by adopting IBS of public housing projects. Actual project schedule and project information from 15 case studies of conventional and IBS method of construction were collected from the client organization and their registered building contractors to develop the prediction model by using mean analysis. The derived model was verified and confirmed significant statistically. Both the client organization and the contracting firms could obtain many benefits from such improvements in their own in-house construction time planning and control systems.

II. 2 OBJECTIVES

The aim of this study is to develop Scheduling Modelling that can be used to analyse time optimization using Industrialised Building System (IBS) components or products (off-site) compared with the conventional method usually adapted in-situ method. The study basically to analyse of improvement involves reducing the production time, identifying and eliminating unnecessary wet works, which is can optimize production line according to a specific layout. To achieve the above aim, the following objectives have been identified:

- Develop scheduling modelling base on conventional and IBS practices for High-rise building;
- Identifying IBS products/components that can optimize construction time;
- Simulate scheduling modelling to proof time saving using IBS products for High-rise building; and

- Propose planning & scheduling strategy from above scheduling simulation for High-rise building.

III. ABOUT THE SOFTWARE

Primavera Systems, Inc was a private company providing Project Portfolio Management (PPM) software to help project-intensive organizations identify, prioritize, and select project investments and plan, manage, and control projects and project portfolios of all sizes. On January 1, 2009 Oracle Corporation took legal ownership of Primavera. Primavera Systems, Inc. was founded on May 1, 1983 by Joel Koppelman and Dick Faris. It traded as a private company based in Pennsylvania (USA), developing software for the Project Portfolio Management market. To help expand its product capabilities, Primavera acquired Eagle Ray Software Systems in 1999, Evolve Technologies (a professional services automation vendor) in 2003, ProSight [2][3] (an IT portfolio management software vendor) in 2006, and, in the same year, Pertmaster (a project risk managementsoftware vendor).

In 2008, Oracle announced it was acquiring Primavera, turning it into the Primavera Global Business Unit (PGBU).In 2011, Joel Koppelman announced his retirement and was succeeded by Mike Sicilia, SVP and General Manager. The co- founder, Dick Faris, remains in the PGBU as Sr Vice President, Customers. On 8 April 2013[1] Oracle Corporation announced the release of version 8.3 of Primavera P6 Enterprise Project Portfolio Management. This version was stated to enhance and extend previous work, improved reporting, user experience and application integrations. This version incorporated material from Oracle acquisitions of Skire and Instantis in 2012.

In 2012 Primavera P6 EPPM, upgrade Release 8.2, added capabilities for governance, project-team participation, and project visibility. Mobile PPM was introduced through Primavera's P6 Team Member for iPhone and Team Member Web Interface, to streamline communications between project team members in the field and in the office. In addition, Primavera P6 Analytics Release 2.0 gained new enterprise-reporting tools and dashboards for monitoring and analyzing performance data, including geospatial analysis. Organizations could also investigate comparative trends and cause-and-effect in multiple projects with Primavera Contract Management Release 14 as it now includes the report-writing capabilities of Oracle Business Intelligence Publisher.

3.1 Planning, Controlling, and Managing Projects

Before implementing Primavera to schedule projects, team members and other project participants should understand the processes involved in project management and the associated recommendations that help smooth the Primavera implementation that supports your corporate mission.If you were driving to a place you had never seen, would you get in the car without directions or a map? Probably not. More than likely you'd take the time to plan your trip, consider alternate routes, and estimate your time of arrival. Planning the drive before you even left would help your trip be more successful. And, along the way, should you encounter road blocks or traffic delays, you would have already identified alternate ways to reach your destination.

Project management follows the same methodology and purpose—to achieve each project's goals, you need to plan them in advance. Good project management is no longer an option in today's corporate world. It is a critical tool to help your company stay on target and accomplish its goals. Simply stated, project management is the process of achieving set goals within the constraints of time, budget, and staffing restrictions. It allows you to get the most out of your available resources. Resources include

- People
- Materials
- Money
- Equipment
- Information
- Facilities
- Roles

Project portfolio management factors in all of these variables across multiple projects, enabling project managers and company executives to see an accurate picture of how each project's resource use affects other projects.

The process of project management is guided by three key principles:

- Planning
- Controlling
- Managing

Planning a project The first step in project management is to define your project.

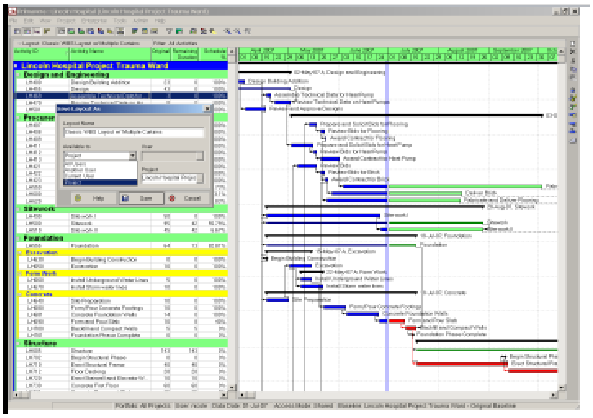
- What is the scope of the work? What activities will make up the project and what is their relationship to each other? You'll also want to identify the major milestones that will help you monitor the project's progress.
- What is the project duration? What are the dates when the project will begin and end?
- What resources are available to the project? Beyond labor, think about all the types of resources you will require.
- Who will perform what tasks? Determining your labor resources and their available workhours is a key part of building a successful project. You'll need to plan for downtime and holidays and

determine the regular workweek for various staffing types.

- How much will the project cost? What are the costs per resource? Are there any hidden project costs?
- What is the estimated budget? Establishing a project budget estimate in advance helps you monitor possible cost overruns.

The answers to these questions form the framework of your project.

Controlling a project Once you have built your project and estimated your budgeting needs, you save this original plan as a baseline, or target schedule, to help you control the project. A baseline provides a solid point of reference as your schedule changes over time. It allows you to compare the original schedule to the current one and identify significant changes and develop contingency plans. You control a project to keep it heading in the right direction. You'll want to track work progress and costs, compare them to your baseline, and then recommend what actions should be taken.



3.2 Overview and Configuration

Primavera - Project Management Effective project control reaps many benefits. It allows you to keep a close eye on possible problems before they become critical. It lets the project team and senior management view cost and scheduling timeframes based on the reality of the schedule.

3.3 Managing a project:

The process of guiding a project from start to finish is the responsibility of a project manager. A good project manager wears many hats, acting at various times as a motivator, communicator, coordinator, and advisor. As you control the project's progress, it is your job to keep your team aware of changes to the schedule and possible consequences. In many ways, you are the project's ambassador, ensuring that your project organization is carrying out its responsibilities for the best possible outcome.To be an effective project manager also requires consistency when you update your projects. Select a day each week, or biweekly, when you will regularly update projects. This regular update will include progress on values such as

- Dates on which activities started or finished
- Dates when resources are consumed
- Changes to resource rates

Determine a standard policy for the update and scheduling procedure, and for reporting progress.The Project Management module provides many tools to assist you in reporting progress to both team members and senior management. Use the Project Web Site option to create a central location where team members can view project progress.

Consider the many system reports as a means for communicating change. In addition, senior management can use Primavera's Web Portfolio Management module to summarize project data and easily capture a snapshot of how a project or group of projects is progressing.

IV. M ETHODOLOGY

The research methodology in this paper serves as a guide in achieving the objectives of the study and discusses in details the research procedures, from how the data is collected till how it is processed and analyzed to achieve the objectives and scopes of the study. It involves the identification and further understanding of the research topic, which consists of problem statement, research objectives and scope of studies. Literature review has been done on several references, either from electronic journals, books, magazines, articles and so on to further enhance the understanding on the research topic.

The assembly and erection of the conceptual high rise residential building has been modelled using computer software and analysed. More emphasize is on how the scheduling on assembly time is carried out efficiently at a site using IBS components for the proposed conceptual high rise residential building.

Therefore, a comparison between the work breakdown structure (WBS) between a typical high rise residential building construction using conventional construction method and the other using Industrialised Building System (IBS) components for the high-rise residential building been further analysed using Primavera (P3). Finally, a conclusion will be drawn out based on the results the analysis obtained. Figure4.1 show the flowchart of research methodology.

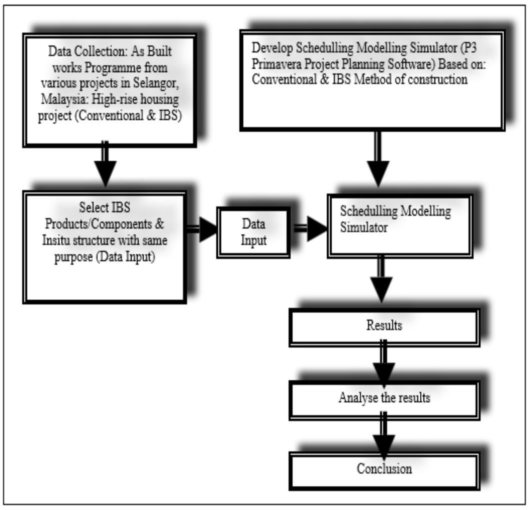


Figure 1: Research methodology flow chart

Fig4.1 Research methodology flow chart

V. ANALYSIS

Study conducted to analyze how long does it takes to assemble the components at the site to produce the entire conceptual building of the high rise residential building. It is important also to determine whether it takes the same speed and time to install the Industrialized Building System (IBS) components compared to conventional cast-in-situ method. Scheduling of IBS components at site can also help to further determine the work duration of the entire project implementing IBS components, as compared to conventional methods. The assembly and erection of the conceptual high rise residential building have been modeled and analyzed using computer software. More emphasize given on how the scheduling on assembly time is carried out efficiently at a site using IBS components for the high rise residential building.

Therefore, a comparison between the work breakdown structure (WBS) between a typical high rise residential building construction using conventional construction method and the other using IBS components been further analyzed. Primavera (P3) will be the scheduling software to be used for scheduling purposes, and the results generated by the software been carefully analysed at this stage. For the better result, scheduling simulation was done into 10 scenarios. In scenario one, an analysis was carried-out to determine the actual time required for both method of construction by incorporated all the data's collected. As result, conventional method of construction required a total 912 days to construct 18 stories high-rise residential building, described in figure 5.1.

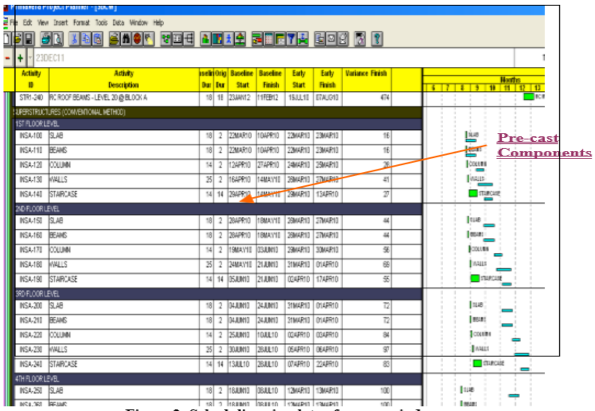
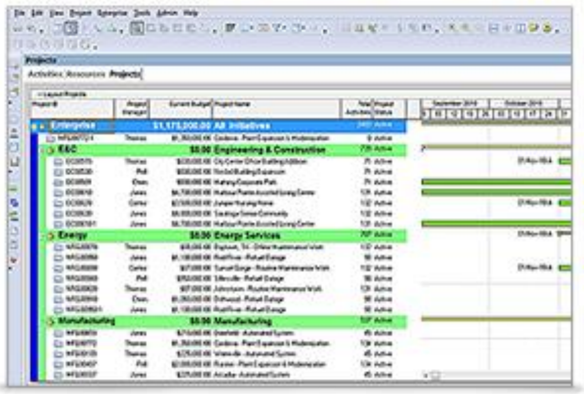
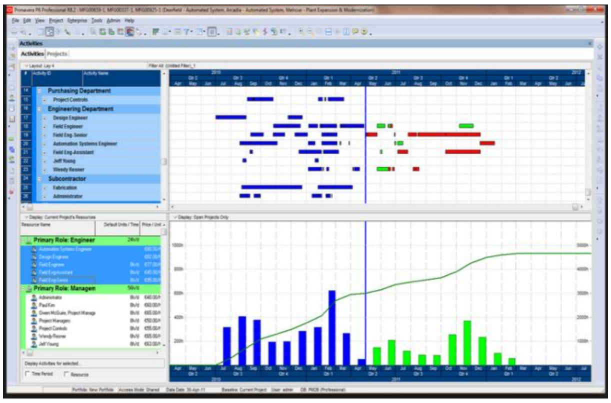
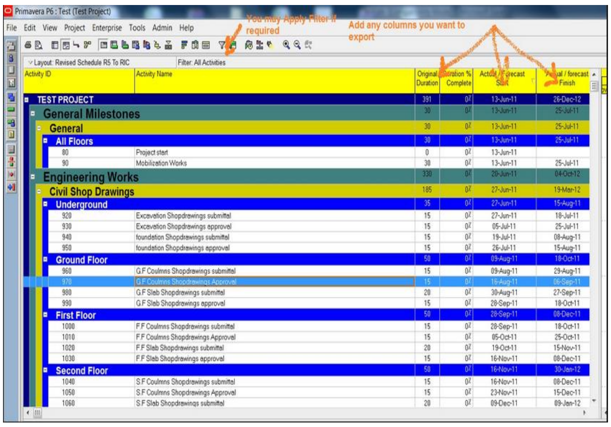


Figure 2: Scheduling simulator for scenario 1

Fig 5.1 Scheduling simulator for scenario







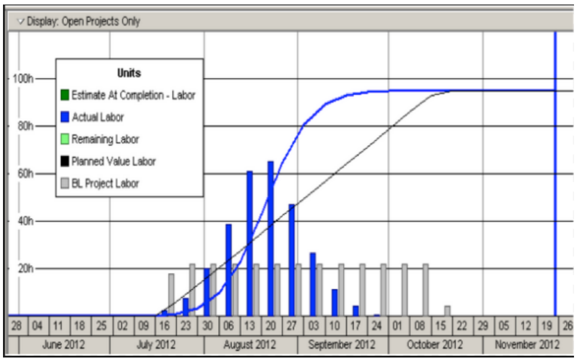
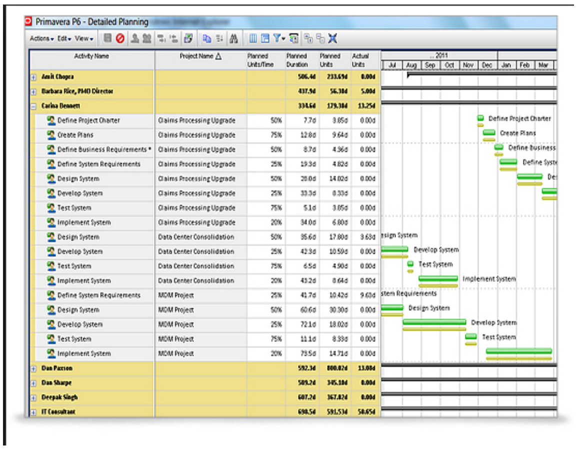
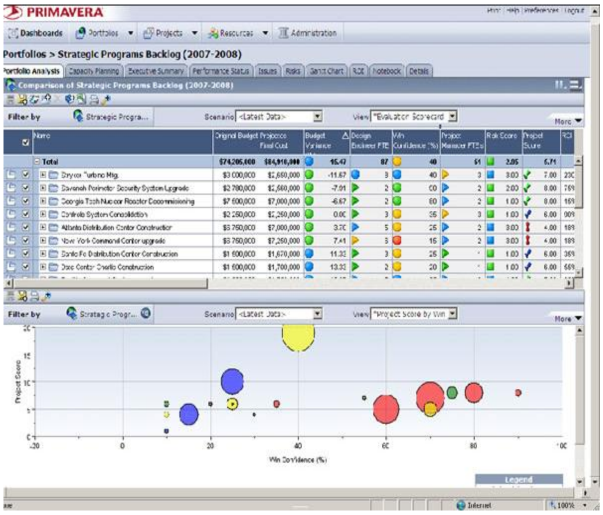


Fig 5.2 ASSIGNING OF LABOR

Figure 2. Earned value reports are automatically generated based on your dashboard filters.

Fig 5.3 Earned value reports are automatically generated based on your dashboard filters





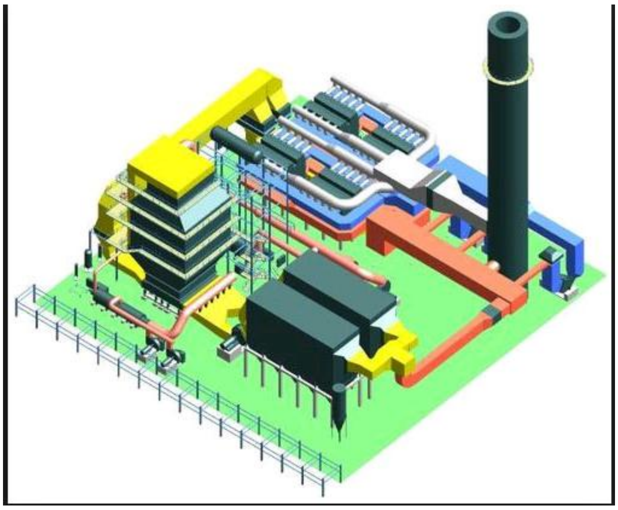


Fig 5.4 Industrial Building System

While a total 529 days required for IBS method by adopted all the selected IBS components to develop the IBS scheduling simulator to complete the construction of the high-rise residential building. Based on this exercise, it proved to the industries, by adopting IBS components shall improved the construction time. As result from this exercise, a total of 383 days or 42% of saving to the construction industry if the construction players considered to adopted IBS component in the project. The same method was used to analyse for another 9 scenarios and the result shown in table 1. Conclusions from the above table it shown that not all IBS components/ products can improve to the overall construction duration. However, by adopting IBS components can improved/ expedite the following activities:

- Quality of the construction products, which used IBS components.
- Minimized or eliminate mistake on height of each floor by standardized height of each components. iii. Expedite the construction

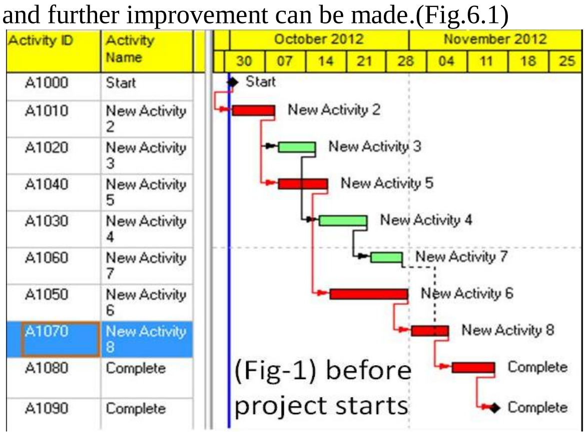
duration on each floor and overall construction duration. iv. The major components that will improve the overall construction duration are slab, beam, and column.

- This finding of the study gives an effective strategy to implement IBS in the current state of the construction industry.

VI. CONCLUSION

This study compared time performance of the conventional method of construction for high- rise residential and Industrial Building System (IBS) method by formulate benchmark measures of industry norms for overall construction period using scheduling simulation modeling. The positive changes include creating a healthy working environment among those involved directly in the construction industry. The major players in the are architects, engineers, town planner, developer, contractor and the supplier or manufacturer have to play their roles in enhancing their working system, management and administration to enable the modernization in the industry.

Although the long-introduced IBS has promised to solve and improved the current construction method and scenario, but the IBS method has been low in gaining popularity, partly due to lack of awareness and coordination among the relevant parties. Currently, the level of IBS usage method is very low as compared to the conventional methods in building construction. In spite of its many benefits, the different perceptions among the construction players and practitioners towards its application in construction industry has led to the low usage of IBS components in the construction industry. Nonetheless, there are still some areas in the IBS management that can be look into to conduct a research which can be look into for further studies and further improvement can be made.(Fig.6.1)



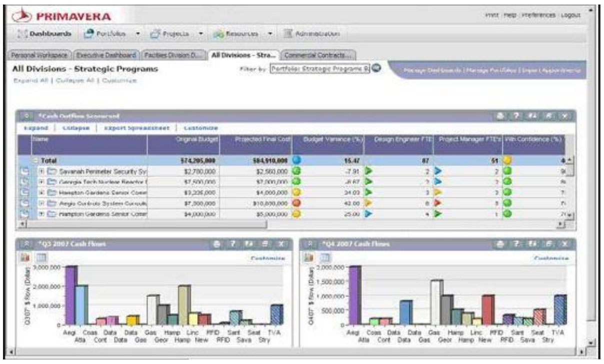


Fig 6.1 Activity With Concluded Output

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