

Line of Balance

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Abstract: Now-a-days whole world facing competition in every fields, including construction industry. Large construction companies carry out big projects, according to the need of that project, they uses different methods of construction and management. Critical Path Method (CPM), Linear Scheduling Method (LSM), and Line Of Balance (LOB) are the different methods of construction project management. All the construction companies utilize these methods according their utilities and requirement of project. In this report, Line of balance method is explained with its different component on the basis of some related works discussed different alternatives and strategies to sequence activities in the long run. This report contains a study carried out in a construction company in which LOB concept is used in the initial planning phase of a high-rise residential project. Based on the information provided by different LOBs, representing different scenarios, It is further discussed with projects managers, superintendents, and crews the advantages and disadvantages of each scenario regarding the project's lead time, activities cycle time, gang sizes, batch sizes, buffers, sequencing and interferences between activities .

Keywords: 1 Line of Balance, Preplanning methods of LOB, Advantages, Disadvantages.

I. Introduction

In different types of construction companies different methods are used for different projects. As the requirement of a project the method like critical path method (CPM), linear scheduling method (LSM), and line of balance (LOB) are applied on it.

The construction industry currently utilizes the Critical Path Method scheduling technique (CPM) to plan and manage most construction projects. This phenomenon is depicted in a study conducted by Tavakoli and Riachi in 1990. In their study, they surveyed the use of CPM scheduling in the top ENR 400 contractors.

For the past three decades, numerous researchers have identified the various intrinsic advantages of the Line of Balance scheduling technique (LOB) in comparison to the CPM. The concept of finding a critical path is another major fundamental difference between LOB and CPM scheduling. Arditi, Tokdemir, and Suh (2001) explained how "In network analysis, at least one critical path exists. Activities which are on the critical path have to be started and completed by their assigned times if the total project duration is not to be extended." The LOB scheduling methods criticalness is based on time and resources, unlike network scheduling where it is only based on time.

The LOB method allows the team to deliver at its maximum speed, by helping balance the different activities in the production chain. In keeping with the idea of using the team's actual performance, we also propose to derive the lead-times for the so called "control points", not from an activity network as in the original LOB formulation, but from the team's "velocity". Line of Balance (LOB) is a method of showing the repetitive work that may exist in a project as a single line on a graph. Unlike a Bar Chart, which shows the duration of a particular activity, a LOB Chart shows the rate at which the work that makes up all of the activities has to be undertaken to stay on schedule, the relationship of one trade or process to the subsequent trade or process is defined by the space between the lines. If one group is running behind schedule, it will impact on the following group and this is shown by the lines intersecting.

The Line-of-Balance then would have a series of stair step offsets. Making those decisions is the job of the management team. Once the Bedding, Laying of Pipe, and Testing of the 1st segment to done, then the Backfill can begin and work continuously. However, the difficulties in using the LOB for scheduling projects have been stripped off from the method when authors have downplayed problems that surround the definition of task durations, the choice of the repetitive unit or batch size, cycle time, and the definition of buffers between tasks.

II. Line Of Balance

A simple diagram in which line shows location and time at which a certain crew will be working on a given operation is known as LOB. it is used on repetitive work such as constructing multiple dwelling units, when used on linear work such as roads and railways the technique is more accurately called Time/Location Charts or Chainage Charts which include 'blocks' to mark out chainages such as bridges and culverts that require substantial time to build and interrupt the general flow of work.

The purpose of the LOB method is to ensure that the many activities of a repetitive production process stay “in balance” that is, they are producing at a pace which allows an even flow of the items produced through a process and at a speed compatible with the goals set forth in a plan. The method does this by calculating how many items should have passed through a given operation or control point, and showing these figures alongside the number that actually did.

The LOB technique is very suitable for repetitive projects like residential buildings, however it may be adapted for non-repetitive projects as well. The main advantages of LOB schedule are its graphical presentation, easy understanding of the schedule and the goals of planning used in it. The research conducted by the authors aims to improve the LOB concepts on building construction and prove its usefulness.

The LOB method helps project managers take corrective actions such as allocating more resources or prioritizing the work when there is still time to do it. In terms of the data required to implement the LOB technique, most of it should be readily available from your defect tracking system or could be derived from it with a few calculations implemented in Excel or any other spreadsheet. Preplanning using the line of balance technique attempts to solve planning problems by making production process clearer and simpler. A preplanning method is presented which needs little detailed information about productivities and work volumes and may be rapidly produced. The plan brings an overall view of the project by grouping the main activities that are highly interdependent. The concept on the best rhythm for each group of activities focus on the sequence of work, continuity of labor team working and completeness rather than on pure schedule goals. Many characteristics of the method support lean construction concepts, such as waste elimination, variances minimization, flexible planning and scheduling sequencing. Using line of balance concepts also suggests some control tools which are being experimented on application cases and are briefly described.

LOB scheduling is superior to the CPM when scheduling projects of a repetitive nature; and these projects capitalize and make use of many of LOB scheduling benefits, and explained how in repetitive projects, LOB scheduling is more beneficial in areas like managing the project resources, visualization of the project schedule, creating schedules more efficiently, managing and updating the schedule, and decreasing the chance of scheduling errors.

The lessons learned from the first jobs helped the efficient use of the developed tools for the planning of new projects and the development of the second stage of the work, which is the LOB application on multi-story building sites as a medium term planning and control tool. The LOB application is imbedded into a new model of planning and control which attempts to solve planning problems by making production control process clearer and simpler. The main idea would be: “let everybody manage his own problems and do not create new problems by managing other people’s problems”. The line of balance technique has many concepts close to this new model and the research is investigating them on practical site applications.

III. Preplanning Method

Repetitive projects such as multi-story building allow working with rhythmic planning. In this case, in order to find the optimum use of resources, a different type of planning is typically used. Crews and equipment are designed to yield the same production rate, in terms of construction units (i.e., one floor/week, one apartment/week, etc.). If activities are planned to be built in this way, all activities could become critical. Nevertheless, most building projects (even simple building construction projects) are not repetitive ones in all their extent. Thus, an “all activities critical” planning might not be applicable for the whole project. When planning is based in construction units (floors or apartments) and production velocities, fairly repetitive construction subdivisions can be developed. In this case the schedule is developed based on the production velocity, in such a way to generate the same work rhythm for all the involved crews. The number of optimum crews is selected so that all crews will perform the same amount of construction units in the same period of time. This approach is essentially the line of balance concept and was proved successful in the applications described in this paper and by others.

Detailed construction procedures were developed for major construction activities. The fact of working with a repetitive apartment building project eased the work and allowed development of a significant level of detail for the majority of activities on site.

The construction procedures included:

- I) Crew composition
- II) Daily construction volume
- III) Crew sizes
- IV) Required tools and equipment

IV. Advantages

The Advantages of Line Of Balance is as :

- 1) Clearly shows the amount of work taking place in a certain area at a specific time of the project.
- 2) Has the ability to show and optimize the resources used for large number of repeated activities, executed in several zones or locations.
- 3) Easier cost and time optimization analysis because of all the information available for each activity in the project.
- 4) Ease of setup and its superior presentation and visualization.
- 5) Easier to modify, update and change the schedule.
- 6) Better managing of all the various sub-contractors in the project.
- 7) Allows for simpler and clearer resource management and resource optimization functions.
- 8) Visualization of productivity and location of crews.
- 9) It allows project managers to see, in the middle of a project, whether they can meet the schedule if they continue working as they have been.

V. DISADVANTAGES

- 1) Inability to generate a clear critical path of the project schedule, relative to the one provided by CPM schedules.
- 2) Could only be divided by location.
- 3) In CPM scheduling the user could divide project by location and other systems like trades, in LOB only location.
- 4) Productivity rates in LOB schedule do not include the effect of crews' learning curve, or if the individuals working in the crews changed.
- 5)

V. Conclusion

As the Line Of Balance is more suitable than other methods and the study shows the use of LOB as a means to simulate and discuss decisions related to the design of a production system for a multi-storey building and its impacts on daily operations. As the LOBs presented to the Company, project managers, different cultural aspects surfaced regarding the adoption of Lean Construction concepts and presentation of LOB for the purpose of easy understanding is convenient.

Therefore now a days Line Of Balance is more popular method in construction management and adopted by most companies.

References

- [1] Ballard, G. (1995). "Toward construction JIT." Proc. 3rd Workshop on Lean Construction, Albuquerque, ed. Luis Alárcon, Santiago, 1997, Chile: Catholic University of Chile, pp. 291-300.
- [2] Ballard, G. (1997). "Lookahead planning: the missing link in production control." Proc. 5th Conf. of Lean Construction, pp. 13-25, <http://www.vtt.fi/rte/lean/>
- [3] Lutz, J.D. and Hijazi, A. (1993). "Planning repetitive construction current practice." Construction Management and Economics, 11:99-110.
- [4] Melles, B. and Welling, D.T. (1996). "Towards a different view on production control in construction." Proc. 4th Conference on Lean Construction, <http://www.vtt.fi/rte/lean/>
- [5] Mendes Jr., R. (1998). "Modelo em planilha eletrônica para programação de edifícios— novos desenvolvimentos" (in Portuguese), Encontro Nacional de Tecnologia do Ambiente Construído—ENTAC 98, Proc., April, Florianópolis: UFSC, pp. 671-678.
- [6] Kemmer, S. L. (2006) "Análise de diferentes tempos de ciclo na formulação de planos de ataque de edifícios de múltiplos pavimentos." (in Portuguese) Master's thesis. Programa de Pós-Graduação em Engenharia Civil. Federal University of Santa Catarina, Florianópolis. 122pp.