

# PLANNING FOR (G+4) BUILDING CONSTRUCTION BY USING LINE OF BALANCE TECHNIQUE: A REVIEW

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**Abstract:** Line of balance itself a graphic device that enable a manager to see at a single glance which of many activities comprising a complex operation is in balance. Line of balance application has been further expanded, making it suitable now across the whole spectrum of activities ranging from Research and Development through job shop and process flow operations. Specific forms and report should be found to different in detail, but his basic pattern is quite uniform through industry. Line of Balance is a management control process for collecting, measuring and presenting facts relating to time, cost for all measured against a specific plan. The delivery actually made by the producer to the time of the analysis. Planned delivery and actual delivery are always collected and plotted in cumulative terms of end item sets. To monitor the project LOB method become easier to visualize and operate using set of flow line graphs

**Keywords:** *LOB application, Control process, Graphic device, Contractual delivery, Forecasting future performance*

## I. INTRODUCTION

The main concept on the line of balance is the uninterrupted flow of the crews over the construction units in a determined time unit. The major benefit of the LOB technique is to provide production rate, duration of activities, crew's flow, location, and date rhythm information in the form of an easily interpreted graphics format. Kenley and Saponin (2009) this technique is very suitable for repetitive projects, however it may be adapted for non-repetitive projects as well due to emphasis on the location based approach.

## II. LITERATURE REVIEW

- Karim Zahran<sup>[2]</sup>:** Although learning curves for repetitive work have been introduced since the 1930th of the last century and despite the fact that their effect on Line of Balance (LOB) project scheduling has been under research for a long time, they have reached a plateau, where no further development of their applications have been made. This paper addresses the problem of applying cost optimization on LOB scheduling while taking into consideration the effect of learning. The paper introduces a novel approach that depends on Genetic Algorithms (GA) for optimization. Furthermore, the paper presents an application prototype that is based on a "Microsoft Excel" spreadsheet. This prototype is validated against a hypothetical case study to confirm the cost and time optimization results.
- Ms. Harsha Talodhikar<sup>[3]</sup>:** In linear construction projects like high rise buildings, roadways, pipelines where activities are repeated after a specific interval, it is very much important for project manager to monitor the project at each stage. Line of Balance method is therefore useful for the project like high rise building to monitor the progress of the work. This method is useful for calculating the total duration of the project, crew synchronization and also shows the process, status, timing and phasing of the project activities. The overall objective of this study is to identify the total duration required by the project for its completion and its comparison with the actual plan by using Line of Balance method, to crash some of the activities and find out the total duration of crashed activities and to calculate labours required for the crashed activities by drawing the graph of Histogram.
- Mika Soini Ilkka Leske<sup>[4]</sup>:** Line-of-Balance has been successfully used as the principal scheduling tool in large construction companies in Finland. It has been utilized to improve the production flow in the projects. The problem in full-scale utilization was that there hasn't been a comprehensive Line-of-Balance software tool in the market. In international literature the usual view has been that the Line-of-Balance is only suited for highly repetitive routine construction. However, regardless of the difficulty of project, the main activities are the same in every project. In this paper it will be shown that resource-based Line-of-Balance can be successfully implemented as the main scheduling tool of a large company if there is an easy to-use software tool to support the implementation. The benefits need to be quantified after the use has been established. However, the biggest benefits and biggest challenges are still ahead. To achieve the full potential of the system, all projects should use

it. Some of the project teams are reluctant to accept new ideas. The focus on controlling the project is new thinking for many project managers and the greater transparency towards management and the client is scary to some.

4. **Prof: Siddesh K Pai<sup>[5]</sup>** : This paper reports one aspect of a Repetitive Scheduling Method (RSM) or Line Of Balance Scheduling Technique(LOBST) applied for a housing project having project activities repetitive in nature. Linear scheduling methods are planning and scheduling techniques mostly used in construction and manufacturing industries where repetitive operations are abundant. The Line-Of- Balance Scheduling Technique (LOBST) is a linear scheduling method that allows the balancing of the operations such that each activity is continuously and efficiently performed in each consecutive unit. Some construction projects that involve sets of tasks organized in repeating sequences are similar to continuous manufacturing processes in their structure. The basic concepts of LOBST have been applied in the construction industry as a planning and scheduling method Examples of such projects include pavement construction, multi housing projects, and high-rise building construction.
5. **Karim Zahran<sup>[8]</sup>**: The increase of populations and industrialization all over the world has always been accompanied by an increasing demand to extend countries' urban fabrics, infrastructure and dwelling units ranging from small economic housing blocks to high rise buildings and residential villas' compounds. These projects are well known for their repetitive nature; where a typical unit is repeated several times. It is envisaged that planning and scheduling techniques that take the learning effect into account as an influencing parameter in calculating productivity rates can improve the effectiveness of the scheduling process. This paper reports on on-going research work, where it investigates the role of learning and its effect on linear scheduling techniques. Furthermore, it investigates factors related to improving construction productivity rates in general and the learning process in particular.
6. **Muhammad Ahmad<sup>[6]</sup>**: Line of Balance (LOB) scheduling technique is a significant technique that plays a vital role in repetitive construction projects. It became more demanding in the construction industry due to the construction of mega repetitive projects e.g. housing schemes, high rise buildings, railways and highways, etc. This paper aims to evaluate the real application of LOB in repetitive housing projects in the UAE which could fill the gap as there is lack of similar empirical studies in the Middle East. The paper firstly presents a concise literature review on the application and limitation of LOB comparing to CPM in repetitive projects. Then, a case study of 275 villas housing project in the UAE is demonstrated and analyzed, where LOB technique was used and monitored throughout the lifecycle of the project. The findings point out significant controlling benefits of using LOB comparing with CPM in the project and address some limitations hindering the efficient use of LOB in the UAE.
7. **Caroline P. Valente<sup>[7]</sup>**: The line of balance (LOB) is widely used for projects with repetitive batches. Nevertheless, some authors in academic literature recommend the LOB for no repetitive areas. In the case of residential projects which have a high repetition of the same batch the LOB is a very useful tool to plan the construction. In the other hand, developing a LOB for common areas (pavements without repetitive areas and services, e.g. underground floors, leisure areas, guardhouse and mezzanine) where there are not repetitive batches is more difficulty, and this is the reason for its scarce use for common areas. Thus, major problems in the project are verified by the lack of planning and production control in common areas. The results of this study indicated that the LOB in common areas provided plan transparency to employees and engineers, improved the control of project's total term and decreased the allocation of workers teams.
8. **Ricardo Mendes<sup>[9]</sup>**: 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 labour 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.
9. **Tarek Salama<sup>[10]</sup>**: Integration of repetitive and non-repetitive scheduling methods utilizes the merits and unique features of those methods. This paper presents a new scheduling method for repetitive projects that integrates linear scheduling (LSM) and critical chain project management (CCPM) methods. The proposed method introduces a framework for scheduling of repetitive projects; accounting for constraints of resources continuity and uncertainties associated with activity durations. It introduces a new buffer, named resource conflict buffer (RCB) to account for delays that may occur due to conflict in controlling resources among successor and predecessor activities. The developed method provides a systematic procedure for identifying several critical chains to replace the visual identification method that is currently used in linear scheduling. The features of the proposed method are illustrated in a case example for scheduling of repetitive projects using an integration of

LSM and CCPM scheduling techniques. A discussion of results is performed and conclusions are drawn to highlight the features and capabilities of the proposed method.

10. **Sh uh Jung**<sup>[11]</sup>: The CPM (Critical Path Method)/LOB (Line of Balance) technique for planning and scheduling repetitive projects has been used since the 1994. The objective of this study is to propose faster and simple approach that can be used in the development of a computerized CPM/LOB scheduling system that overcomes the problems associated with existing systems. This study mainly examines the simplified CPM/LOB methodology, especially in construction scheduling planning and control, so as to achieve effective project schedule analysis without the complex procedure. The effectiveness of the proposed simplified CPM/LOB methodology will be investigated and validated by a case study. Finally, the suggestion and limitation are proposed and discussed for further related applications.
11. **P.R Sreemahadevan Pillai**<sup>[12]</sup>: Methods for planning and controlling highly repetitive projects have been investigated in the last two decades. The techniques that were developed are grouped under the generic term of "Linear Scheduling Methods". Their origins are not clear; there may actually have been multiple origins, possible in different countries. They have been originally devised to solve industrial production problems and their considerations for use in the construction industries are rather a recent event. They include a multitude of variations that are based on the same resource-oriented principles. They are named differently: Line of Balance Schedules, Vertical Production Method (VPM), Time-Space Scheduling, Cascade Networks, Velocity Diagrams, Fenced Bar-Charts, chain Bar-Charts, Construction Management Systems, and combined PERT1 LOB; but they have common features. Some others make use of process interaction simulation techniques, stochastic approaches, and dynamic or linear programming.
12. **David John Harmelink**<sup>[13]</sup>: This manuscript has been reproduced from the micro fine master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer. The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, collared or poor quality illustrations and photographs, print bleed through, substandard margins, and improper alignment can adversely affect reproduction. In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.
13. **Rafael de Sousa Leal Martins Moura**<sup>[14]</sup>: Evidence on the use of Line of Balance as a scheduling technique already exists in the Brazilian construction industry since the 80<sup>s</sup>. More recently it has been associated with Lean Construction applications, especially as tool for tactical planning of works. This conceptual paper discusses how line of balance can be taken not just as a straightforward graphical device to depict site programming in long, medium and short terms but also as an appropriate graphical tool to represent, induce and make self-evident the application of several Lean Production ideas like takt time, buffers transparency, integrated planning of long, medium and short term, minimization of production and transfer batches, PDCA, production levelling, inventory minimizing, pull production and parallel operations, among others. Each of these concepts is illustrated using line of balance displays. The work concludes that Line of Balance is akin to Lean Production and Lean Production is very well represented by Line of Balance diagrams, aiming at further discussions on this conceptual synthesis (lean is line and line is lean).
14. **M. C. Vorster**<sup>[15]</sup>: A bar chart or CPM schedule cannot provide the same level of understanding as a visual schedule. What-if scenarios can be played out to determine options and reduce overall project time. Only when these visual tools are used will linear transportation projects take on a meaning that is readily transferable among all members of the site and office. Success in the execution of transportation construction projects demands that work be done in an ordered sequence, that production crews be given the time and space needed to perform, and that delays and changes be minimized. The foundation for success in these areas is laid in the planning process, and the planner must visualize how the space provided by the physical dimensions of the project can be used to achieve a desirable construction sequence. Neither networks nor bar charts are of much value in this regard as they cannot represent space and time in a visual and easily understood format.
15. **E. Radziszewska Zielina**<sup>[16]</sup>: The paper presents a method of priority scheduling that is useful during the planning of multiple-structure construction projects. This approach is an extension of the concept of interactive scheduling. In priority scheduling, it is the planner that can determine how important each of the technological and Organisational constraints are to them. The article presents a general linear programming model of the planning of multiple-structure construction projects, as well as various values of each of the parameters that allow us to obtain different planning effects. The proposed model has been implemented in a computer program and its effectiveness has been presented on a calculation example.
16. **Zsolt T. KOSZTYÁN**<sup>[17]</sup>: In former research works matrix-based methods were developed for supporting multilevel project-planning problems. By using the introduced method traditional agile and extreme project management approaches can also be supported. Best project scenarios can be selected by genetic algorithms, and also by exact algorithms. However these

methods are used for project planning, they can also be used for simulations, and can be applied for risk management purposes.

17. **Mr. Thrash K. Matey<sup>[1]</sup>**: India is the second largest in construction industry. For growing need for shelter it is important that requirement of resources should be delivered on time. Linear scheduling methods is best suited to projects that display repetitive characters but their use in the construction industry is limited. It is important for project manager to handle the project within specific set of limitation where resources are available and optimum use. The overall objective of this study is to identify the total duration required by project for its completion and comparison with actual plan by using line of balance method and find out the float the project and representing the project with the use of flow line chart for repetitive nature of activities.

### III. CONCLUSION-

The overall objective of this paper is to identify the total duration required by project for its completion and comparison with actual plan by using line of balance method and also examining the extent of any deviations from specific plans in the form of knock-on effects. To identify in the advance problematic areas where corrective action may be required and to represent the project with the use of the flow line chart for repetitive nature of activity. Line of balance is linear scheduling method which uses of network technology. The Line of balance method is well suited to projects that are composed of activities of a linear and repetitive nature. Line of balance method of scheduling for project comprised of work of repetitive natures which involved in housing project, urban residential development, roads construction, high-rise construction buildings, pipelines, precast concrete production etc. To monitor the project LOB method become easier to visualize and operate using set of flow line graph. Line of balance method is used for analysis of project work and if the project is lagging behind the planned schedule the project manager can take suitable actions for completion of work progress. Forecasting of future performances is done by using line of balance method.

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