CPM Approach in Agile vs CPM Approach in Waterfall Projects

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Abstract

There have been advancements in project management methodologies because of dynamic business environments and technologies. These two project management frameworks have been developed to implement the Critical Path Method (CPM) of project scheduling, but they do it differently. This paper discusses how CPM principles are incorporated and applied in these two approaches. In this regard, it compares and contrasts the two most basic aspects of scheduling, resources, and timelines. Finally, it aims to analyze how CPM's approach can be integrated with the Agile method and determine where CPM outperforms in Waterfall projects.

Keywords: Critical Path Method, Agile, Waterfall, Project Scheduling, Comparative Analysis, Hybrid Methodologies, Sprint Planning, Project Management

Introduction

Several emerging issues affect the delivery of projects currently being managed traditionally in society. The Critical Path Method (CPM) was created in the late 1950s and has been used as a scheduling tool that helps to identify the longest chain of dependent activities that defines the minimum project duration. As much as CPM was developed for traditional planning models, different project management methodologies have evolved with Agile and Waterfall management styles[1]. Waterfall is a linear and systematic development that follows phase-by-phase development and composition, while Agile incorporates looping with analysis of frequent changes. This paper discusses how CPM is applied and customized in both methodologies, specifically regarding software development and IT projects, in which both are frequently used. Analyzing the peculiarities of CPM application in each of these contexts will help the project managers make the right decision regarding the scheduling techniques applicable to their project contexts.

Literature Review

CPM was originally designed for the construction industry, especially for engineering projects involving many dependent activities that must be sequenced accurately. It has been implemented in traditional project management practices as various studies show that it is useful in industries with sequential activities [4]. In the traditional approach, CPM entails defining all the activities within the project, defining the dependencies, estimating the duration, and defining the critical activities that directly influence the project end date. This approach fits well with the Waterfall methodology's phase-gate approach to approvals [9]. The studies also indicate that CPM in waterfall environments gives a good view of schedule risks and allows for proper resource management of risky tasks.

On the other hand, Agile methodologies were developed due to the conditions characterized by the frequent changes in the requirements, and it is possible to have development cycles that include feedback. Some difficulties arise when applying CPM concepts in Agile frameworks because the assumption of fixed scope in CPM is contrary to the nature of Agile frameworks that allow change to requirements. Some recent works have discussed the use of CPM in an Agile environment where critical path analysis is done based on

features within and across sprints instead of the strict sequence of activities [5]. This modified approach recognizes that Agile projects are flexible and unique while simultaneously offering visibility of the important dependencies.

Comprehensive Project Management, in conjunction with other approaches to Project management, has been seen as timely since organizations are trying to adopt more.However, this is where the adoption of CPM in conjunction with other approaches has been seen as timely, considering that organizations are looking for a between-form model. The research also shows that CPM is integrated into the strategic planning of the project's milestones, and Agile is integrated into the detailed planning [2]. This is a perfect strategy since it enables the project managers to have overall schedule visibility while at the same time working with the iterative nature of development.

Scope

This comparison is based mainly on the time planning and schedulingcomponents of the operation of CPM in Agile and Waterfall paradigms. It applies to mid to big software development, and IT projects with relatively high scheduling risks. The paper focuses on the practical implementation of CPM principles such as sequencing of activities, management of dependencies, allocation of resources, and critical path determination in both methodologies. Although recognizing the presence of other factors in project management, the focus of the analysis is more limited and is aimed at the time management and scheduling approaches rather than project management and organizational factors. The paper seeks to offer findings useful to project managers who practice in different settings and will be required to decideon scheduling strategies [3].

Problem Statement

Scheduling is one of the key activities in project management and it is quite challenging for the project managers to apply the right techniques in the different methodological frameworks. However, as much as Agile methods are flexible, they do not give clear information about the dependencies that are likely to impact on the time needed for the project. It makes it challenging to estimate when a task will be done and to determine schedule risks in successive cycles. The problem withorganizations using both CPM and Agile is that CPM has a more formal planning process, and Agile is more flexible. This is because the critical path is not visible in project teams due to the constant reprioritization characteristic of Agile environments [6]. These challenges mean a need to understand better how the CPM principles can be implemented across different methodologies.

Solution

Solving these issues means that the CPM concepts must be applied selectively and not entirely adopted or dismissed. In Waterfall projects, it is still useful to use CPM in the conventional manner, which includes the creation of comprehensive activity networks, defining the dependencies, and calculating float times. This approach is advantageous in that WBSs are developed in detail when the activities and their interdependencies are most apparent in the early phase of a project. The tools used in CPM help the user visualize the critical path and simulate the project to identify risks. This is made possible since CPM in Waterfall environments is deterministic, enabling accurate resource estimation to reduce project time [7].

In the Agile environments, different CPM methods are used based on the feature dependencies, not the activity level. When there are dependent user stories in different sprints, defining a "feature critical path" to help plan the sprints and prioritize the backlog is possible. This adapted approach recognizes that the product is still in the process of development and yet addresses potential dependencies that may slow the

delivery of the project. Rolling wave planning complements this by providing detailed planning of near-term activities while keeping overall high-level planning at the iteration level. This balance maintains the agility of the Agile approach while giving the project the type of schedule visibility for which CPM is known [8].

Uses

The critical path method applies to different project management methodologies, but the approach differs considerably. In Waterfall environments, CPM is the foundation for comprehensive project scheduling from initiation through closure. This clear visibility of the tasks' dependencies helps identify the risks that are likely to affect the schedule and take corrective measures when such risks occur [9].In Agile environments, the CPM concepts are used iteratively while keeping an eye on critical dependencies. When release planning, the teams can determine other inter-sprint dependencies that may affect the delivery of certain goals. Some organizations use a "critical chain" variant that includes resource constraints and the tasks' dependencies, especially when specialized skills become a source of potential constraints [3].

The allocation of resources is also defined differently in the methodologies. In Waterfall implementations, CPM is used at the beginning of the project to plan the resources needed and to predict the time of maximum load and resource contention. This allows for resource loading to be done in advance to ensure that resources are well distributed throughout the project duration. Agile approaches are closer to just-in-time decision-making, and CPM helps decide which part of the team should work on which user stories within the specific sprint due to the dependencies and expertise. Both approaches are advantageous since CPM helps to identify activities where more resources would be most useful in boosting delivery [6].

Impact

The principles of CPM also influence the project outcomes in traditional and new methodologies but in different ways. Thus, in Waterfall environments, CPM implementation leads to better schedule control and, therefore, more accurate estimation of the completion date. The structured approach to dependency management allows for identifying schedule risks and proper planning and decision-makingregarding resource usage. Research shows that organizations with a higher level of CPM practice in traditional projects have less variability and better performance in terms of time [7]. The critical path analysis also helps enhance the schedule's visibility and communication with the stakeholders on the progress and the effects of the schedule.

Adopted CPM concepts in agile projects enhance the coordination of multiple teams and the synchronization of the activities within a sprint to that of a program level. Understanding cross-iteration dependencies prevents cases where some user stories are already delivered but cannot be implemented because of the lack of some dependencies. Companies claim they are now better placed to predict when the feature sets will be completed in the different sprints, a criticism made on pure Agile measures [5]. This increased predictability helps to enhance the release planning and keep the advantages of iterative and frequent reassessment.

Conclusion

The Critical Path Method is still one of the most effective tools for scheduling in any project management methodology. However, it has to be adjusted for a certain environment. The basic CPM methodology used in Waterfall methodology gives a full picture of the schedule and accurate dependency control in the stable requirements that are, in turn, followed by sequential activities. The use of scaled Agile methodologies provides better integration between iterations and, at the same time, retains the flexibility that is characteristic of Agile environments for fast-paced projects. Hybrid approaches show that it is possible to

integrate CPM with iterative development when the two are scaled and applied to the right dependencies. It is, therefore, important for project managers to understand the type of their projects, requirement volatility, time constraints, and team distribution when applying critical path concepts.

Bibliography

[1] J. A. Hüllmann, K. Kimathi, and P. Weritz, "Large-Scale Agile Project Management in Safety-Critical Industries: A Case Study on Challenges and Solutions," *Information systems management*, pp. 1–23, May 2024, doi: https://doi.org/10.1080/10580530.2024.2349886.

[2] M. Mirzaei, V. J. Mabin, and O. Zwikael, "Customising Hybrid project management methodologies," *Production planning & control*, pp. 1–18, May 2024, doi: https://doi.org/10.1080/09537287.2024.2349231.

[3] H. Li, Q. Hui, and Y. Wang, "Preemptive Software Project Scheduling Considering Personality Traits," *Systems*, vol. 12, no. 10, pp. 407–407, Sep. 2024, doi: https://doi.org/10.3390/systems12100407.

[4] N. F. Ginikanwa, "A Comparative Analysis of Agile and Traditional Project Management Methodologies and their Impact on Information System Development Projects: A Case Study of Nigerian Banking System," *International Journal of Science and Research (IJSR)*, vol. 13, no. 8, pp. 1682–1702, Aug. 2024, doi: https://doi.org/10.21275/sr24826210929.

[5] I. Lishner and A. Shtub, "Enhancing Strategic Planning of Projects: Selecting the Right Product Development Methodology," *Information*, vol. 14, no. 12, p. 632, Dec. 2023, doi: https://doi.org/10.3390/info14120632.

[6] A. Agbejule and L. Lehtineva, "The Relationship between Traditional Project Management, Agile Project Management and Teamwork Quality on Project Success," *International Journal of Organizational Analysis*, vol. 30, no. 7, pp. 124–136, 2022, doi: https://doi.org/10.1108/ijoa-02-2022-3149.

[7] D. V. Perrucci *et al.*, "Using the critical path method (CPM) for evaluating allocation potential of temporary housing units," *Journal of Housing and the Built Environment*, Mar. 2025, doi: https://doi.org/10.1007/s10901-025-10196-z.

[8] M. Nagib, M. Sunny, M. Balayet, H. Sakil, A. Al Nahian, and J. Atayeva, "Project Management and Visualization Techniques A Details Study," *International Refereed Journal of Engineering and Science (IRJES) ISSN (Online)*, vol. 13, no. 5, pp. 28–44, 2024, Available: https://www.irjes.com/Papers/vol13-issue5/13052844.pdf

[9] K. B. Bagshaw, "PERT and CPM in Project Management with Practical Examples," *American Journal of Operations Research*, vol. 11, no. 04, pp. 215–226, 2021, doi: https://doi.org/10.4236/ajor.2021.114013.