

Performance enhancement of Discrete Event Simulation in Project Management for Optimal Project Results

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Abstract

The key to project success is having clear objectives. A lot of projects fail because their outcomes are not clear and the processes required to achieve them are not clear. Conventional methods of project management often operate on fixed schemes and simplifying assumptions which do not convey what actually happens in production or operation management. Ways of working of similar systems use caution in their assessment; the claim is that this undermines efficient deployment of resources and excess capacity in the systems. This study focuses on the use of Discrete Event Simulation (DES) with an aim to improve scope management in projects. Simulation modeling approaches provide dynamic and flexible ways for project managers to study how a system behaves, evaluate options and make informed choices during project implementation. A study shows how adding simulation techniques into the project management framework can improve planning and reduce risk and outcomes. Project management developed as a discipline in the 20th century and has its roots in different fields of application: construction, engineering and defense. In the United States two forefathers of project management are Henry Gantt, known as the father of planning and control techniques, who is best known for his use of the Gantt chart (as a project management tool), and Henri Fayol for establishing functions of management—six (6) which form the basis for the bodies of knowledge associated with project and program management.

Keywords: Discrete event simulation (DES), project management, project scope management, resource optimization, event chain methodology (ECM)

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Received Date: July 02, 2026

Accepted Date: August 14, 2026

Published Date: August 31, 2026

Citation: Sajid Raza, Manoj Kumar, Viqar Ahmad, Roshan Zehra, Shiraj Ahmad. Performance enhancement of Discrete Event Simulation in Project Management for Optimal Project Results. Journal of Production Research & Management. 2026; 16(2): 20–25p.

INTRODUCTION

Project management plays an essential role in meeting the project deadlines, scope, budget, and quality requirements. An effective project team that is well-coordinated and focused on project objectives guarantees success. Many projects underperform despite the correct application of project management methods [1, 2]. Failure is mainly attributed to vague project objectives, poor planning, and inadequate understanding of project delivery processes. Traditional project management approaches are characterized by a lack of flexibility and the use of oversimplified assumptions [3, 4].

The complexity of the managed systems is significantly underrated, leading to inappropriate project management practice. Ineffective management results in poor project performance

that manifests in poor resource allocation, project delays, and budget overruns [5]. In addition, project managers tend to design processes around worst-case scenarios, resulting in the creation of unnecessary capacity and increased costs [6, 7]. To address these issues, simulation approaches are implemented in managed systems, which are significantly underrated, leading to inappropriate project management practices. Ineffective management results in poor project performance, which manifests as poor resource allocation, project delays, and budget overruns [8, 9]. In addition, project managers tend to design processes around worst-case scenarios, resulting in the creation of unnecessary capacity and increased costs [10, 11]. Simulation approaches have been implemented to address these issues.

LITERATURE REVIEW

Past research on the topic establishes the potential ability of using simulation to create more efficient project management decisions by project managers. The authors also specified that traditional planning methods using deterministic techniques that do not consider various factors of randomness have already identified a number of inherent limitations [12]. D.E.S. is broadly applied in manufacturing, health services, transportation, construction, and other fields to test different hypotheses to optimize complex processes. Such methodology enables process analysis, modeling, and experimentation with systems to avoid disruptions in their practical implementation. Simulations can discover process bottlenecks, test various alternatives, and predict performance. It allows the project manager to implement the improved risk management process and gain the possibility to better understand the general course of events of his/her project. It is also possible to conduct experiments with the system and calibrate its ongoing or completed effectiveness [6].

The Four Elements of Project Management

A successful PM should be able to manage all four project fundamentals: resources, time, cost, and scope. All of these factors should be controlled and maintained properly. Each of the four is a critical element of project management, and any project, as well as the project manager, is only successful if all elements are managed successfully.

Managing Resources

A successful Project Manager should be able to manage the resources allocated to the project effectively. This includes the labor hours of the project team. In addition, managing human resources involves labor subcontracts and vendors. The process of managing human resources consists of getting the right people with the required skills, tools, and number at the necessary time. However, people are not always the subject of project management and its resources. The project manager also manages equipment (such as cranes, trucks, and other equipment) and materials (such as pipes, insulation, computers, manuals, and many others) used for the project [7].

Managing Time and Schedule

Time management is perhaps one of the most fundamental techniques that any project manager should master. The biggest threat to a project being completed within the budget is poor scheduling. Fortunately, there is an abundance of software designed specifically to assist project managers in managing schedules. A project can be decomposed into discrete tasks that must take place, and to schedule a project, the project manager needs to determine what those tasks are, how long each one will take, what resources they require, and in what order they have to be performed.

Managing Costs

The success of a Project Manager is often measured by whether they drove the project under budget. The costs consist of the estimated, actual, and variation costs. Contingency costs consider weather, suppliers, and design allowances.

Project Development Stages

In traditional project development, there are many components, such as four to five stages and a

control system. Regardless of the employed methodology, each step in project development has key stages that are similar across different methodologies.

1. Initiation,
2. Planning
3. Production or Deployment
4. Monitoring and Coordinating
5. Closing.& Concluding
6. Activation & Finalizing

Initiating Process Group Processes

The initiation phase establishes the type and extent of the advancement work. If this phase is poor for a future condition. There is a very low chance that the project will accomplish what the business needs. The main project controls needed are business environment understanding and ensuring that all necessary controls are embedded in the project. Deficiencies must be reported, and recommendations for remediation must be made. The initiation stage should comprise the following categories:

- Review of the Existing process & planning
- Concept and Frame work of the operation of the final product.
- Resources and contracting requirements including an review of 'long-lead time.
- Financial assessment involves cost analysis, profit margins, anticipated benefits, and budgetary considerations.
- Stakeholder & Contributor analysis, including users, and support Professionals for the project
- Project charter Encompassing & Covering costs, tasks, deliverables, and schedule

Scheduling Process of Group Activities

Subsequent to the initiation stage, the system is created and designed, and a micro-scale version of the final product is constructed and tested. Testing is often conducted jointly by testers and users and may take place at the end of the design or during its course. In addition, control tests must be introduced to ensure that the final product meets the requirements of the project charter. The design process must result in a product that meets all the requirements listed in the project charter.

- meeting the expectations of the project sponsor, end user and business;
- Is consistent with its intended purpose.
- Can be manufactured to the required quality.
- Can be manufactured on time and within the budget.

The execution phase encompasses the activities required to carry out the tasks outlined in the project management plan and fulfill the established objectives. It comprises coordinating people and resources and carrying out the activities of the project to meet the requirements of the project management plan. Project achievements are produced through the execution of the project management plan.

Monitoring and Controlling

Monitoring and controlling involve systematically tracking project activities and progress to assess performance against the established project management plan. It enables the identification of deviations, supports performance evaluation, and facilitates the implementation of corrective measures, whenever necessary. The main benefit of this process is the regular assessment of project performance, which helps identify variations from the planned objectives and maintain effective control over project execution.

The Monitoring and Controlling phase involves the following key activities:

- Assessing and measuring the progress of ongoing project activities.
- Tracking important project parameters, such as cost, resources, and effort, against the established project management plan is essential.

- Identifying suitable corrective measures to address emerging issues and potential risks effectively.
- Managing factors that support integrated change control, ensuring that only authorized and approved changes are incorporated into a project.

For projects consisting of multiple stages, the Monitoring and Controlling process facilitates continuous feedback across different project phases. This enables the implementation of appropriate corrective and preventive measures to keep project activities aligned with the approved project-management plan.

Project Maintenance is a continuous activity that encompasses the following key processes:

- Continuous support of end users
- Correction of errors
- Updating of the software over time span

Monitoring and Controlling Cycle Process

When it comes to making changes, there are a lot of value engineering and impacts from third parties to think about. In addition to implementing changes during the construction process, all modifications must be properly documented to provide an accurate record of the work that was ultimately completed. This activity is commonly known as Change Management. Therefore, the project owner generally requires comprehensive final documentation that reflects all approved alterations and modifications, particularly those affecting the visible or completed components of the project. These records are typically prepared using mandatory project documents, including design drawings and related technical documentation. The final documentation is commonly referred to as as-built drawings or actual-built records, and their preparation and submission are standard requirements in most construction contracts. Whenever changes are introduced, their potential impact on the overall project must be reassessed to ensure that the project remains consistent with its objectives, requirements, and management plans.

MAIN RESEARCH OBJECTIVES

The objectives of this research are as listed follows:

- Review or Critique of the Restriction of initiative project management approaches
- Revive or evaluation of the Discrete Event Simulation in scope development
- Awareness of simulation modeling capabilities in decision making
- Review of the step in which simulation technique can be implementing [7].

Methodology and Approaches

Event chain approaches and methodologies are the latest advancements in the critical path method and critical chain project management strategies. Event chain approaches are frameworks for modeling and scheduling network analysis concepts that emphasize event and event chain identification and synchronization. The event chain methodology helps minimize the negative impact of psychological biases and provides the opportunity to perform a quantitative analysis of schedule uncertainty. The main principles of the event chain methodology are as follows:

- *Probabilistic moment of risk*: In real-life projects, the implementation of each activity is not a continuous function. Activities can be interrupted by events that can negatively impact the project schedule. These events can occur at any moment during the implementation of an activity.
- *Event chains*: Events can occur one after another, creating interrupting event chains. The cumulative impact of such event chains should be evaluated using quantitative analysis.
- *Critical events or event chains*: Each project has critical events or event chains that have the biggest negative impact on the project schedule and costs. These events should be identified and isolated.

- *Project tracking with events:* For already implemented project parts, having information about time spent, costs incurred, and events occurred allows for updating the project schedule and provides the opportunity to estimate the schedule impacts of future events. The chain of events can be presented in a project schedule in the form of a Gantt chart.

The methodology of the simulation modeling application in project management consists of the following steps: Identify a project management area of interest are

1. Build a simulation model which represents the project management process
2. Execute the simulation model
3. Compare the results of simulation model with the results of conventional project management
4. Apply the results of the simulation model for project management process improvement.”

Discrete Event Simulation models represent a system as a set of events at a particular point in time when they occur. Each event changes the state of the modeled system [8].

DISCUSSION

There are several advantages of using Discrete Event Simulation in project management. For example, the method helps create a dynamic model of the project processes, which allows the project manager to assess the performance of the project's system throughout the implementation process. Simulations reduce the risks of improper planning because they allow managers to test the planned project. In addition, the simulation helps optimize project processes by detecting inefficiencies and constraints. Thus, the manager will be able to properly configure the project and allocate resources to ensure that the project's system achieves maximum performance. It is also worth noting that this simulation method is more effective than traditional methods because it is based on a realistic model of project processes.

CONCLUSION

In conclusion, proper project management is vital for the successful implementation of any project. Traditional project management methods and techniques are not sufficiently effective for managing complex projects because they are based on simple models and assumptions that do not always work in real projects. This may lead to scope creep, schedule delays, and cost overruns. Discrete-Event Simulation is a great method for project management that helps overcome the critical challenges that projects face. It is based on a dynamic and flexible model that allows the project manager to control project processes and analyze different scenarios to find the optimal ones. Proper project management does not guarantee that nothing will go wrong, but it does ensure that if something goes wrong, there are established procedures for managing project changes and responding to project risks. Project management processes and techniques allow for the coordination of all resources to achieve project objectives while ensuring that everything goes according to plan. Nevertheless, it should be considered that project management is not an exact science, and there is no Reliable method for managing projects. This is because projects are managed by people, and there is always an element of human unpredictability. Thus, project management is both a science and an art. It is a science because it involves a systematic and objective approach based on proven project management methodologies, processes, and techniques. It is an art because it often involves dealing with people and their unpredictable behavior, which means that a project manager must use intuition when making managerial decisions. Finally, a good project management methodology provides the necessary framework that offers guidance and support throughout the project's life cycle and aids in maximizing the project performance. It provides organizations with the framework needed to maximize the value of the project to stakeholders while minimizing exposure to project risks.

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