

Systematic Optimization of Enterprise Process and Progress Management: From Fragmented Execution to Intelligent Collaboration

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Abstract: In complex project management, the coordinated optimization of process and schedule management has become the core engine for improving engineering efficiency. Research shows that enterprises are currently facing the three dilemmas of process fragmentation, schedule black box and organizational collaboration fragmentation, which leads to cost overruns due to delayed progress feedback. This paper constructs a "three-layer process optimization + agile schedule control" system, implements technology, organization and system innovation simultaneously, forms a digital circuit with neuroplasticity, enables the management system to continuously evolve like a living organism, and supports engineering projects to achieve efficient delivery and controllable risks.

Keywords: Three-layer process optimization; Agile progress control; Intelligent collaboration.

1. Introduction

In modern enterprise management, process management and progress management are like the double helix structure of an organization, jointly supporting the efficient advancement of projects and the realization of strategic goals. Process management focuses on the optimization of the logical sequence and rules of business activities, and improves overall efficiency by eliminating redundant links and reducing resource waste; progress management focuses on the precise control of the time dimension, and ensures the on-time delivery of projects through key node monitoring and dynamic resource allocation. The two are interdependent: the process is the carrier of progress, and the progress is the temporal expression of the process. In complex engineering fields such as major scientific and technological infrastructure, process management has become the core guarantee for standardizing engineering construction and improving construction efficiency, which is directly related to the speed and quality of building national strategic scientific and technological forces.

The management challenges currently faced by enterprises are: the process design and execution are out of touch, forming a "two-skin" phenomenon; the progress feedback is

delayed, resulting in a deviation between decision-making and actual on-site; cross-departmental collaboration is inefficient, and resources are difficult to dynamically optimize. According to industry research, more than 60% of project delays are caused by process monitoring failure and slow progress response. Therefore, building an integrated control system for process and progress is not only the key to improving the efficiency of a single project, but also the core proposition of enterprise digital transformation.

This article systematically discusses methods, technology empowerment and guarantee mechanisms, providing organizations with a complete optimization path from theory to practice.

2. Systematic Approach

2.1. Hierarchical Optimization Method of Process Management

The process management framework based on the three-time optimization theory provides enterprises with a complete optimization path from top-level design to operational specifications, which can systematically solve the problem of management fragmentation:

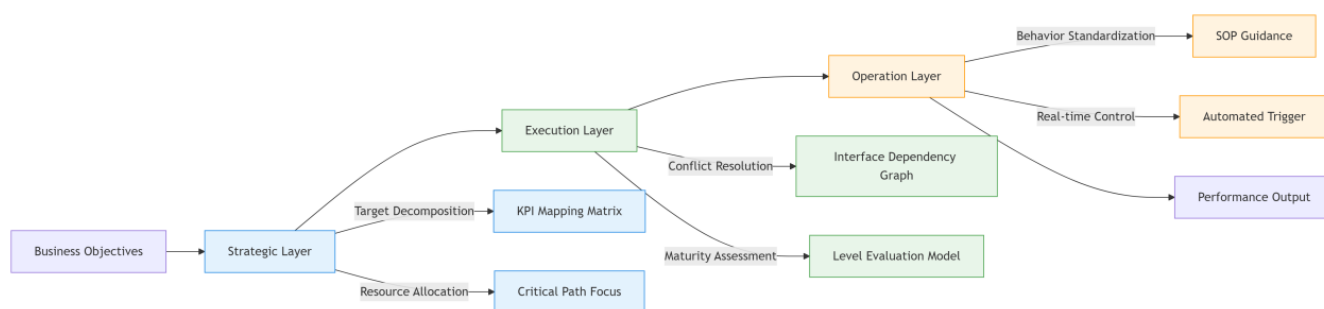


Figure 1. Illustration of hierarchical optimization method of process management

Strategic layer: Framework system optimization, reconstruction of business model and resource allocation logic. By drawing a "strategy-process" mapping diagram, the R&D cycle compression target is decomposed, resources are pushed to the key path, and the R&D cycle is shortened.

Execution layer: Process network optimization, using dynamic knowledge graph technology to analyze cross-system collaboration relationships. Establish a process dependency matrix, identify interface conflicts, and introduce maturity level assessment (levels 1-9) to quantitatively evaluate dimensions such as progress, quality, and cost to achieve accurate problem location.

Operation layer: Operation standard optimization, solidify best practices into reusable SOP templates. The process is broken down into three stages: sample preprocessing-data analysis-report generation, and embedded guidance tools are developed to reduce the error rate of operation.

2.2. Agile Control Method for Progress Management

Schedule management needs to break through the limitations of static plans and establish a dynamic closed loop of "prediction-monitoring-adjustment". Its core methods include:

Multi-level plan nesting mechanism: adopt a hierarchical control model of "general control plan-stage plan-rolling weekly plan". The total construction period is decomposed according to milestone nodes, and then the process-level tasks are refined. The floating time is calculated in real time through the CPM critical path algorithm, and resources are dynamically allocated.

Data-driven early warning system: Build a digital twin of the progress based on the BIM model. When the progress is 3 days behind the plan, the system automatically triggers an early warning and generates a rush work plan to avoid delays.

Buffer resource pool strategy: Set up 5%-10% of mobile resources (personnel/equipment/budget) to deal with sudden risks.

2.3. Tool Integration: Low-Code Platform and Intelligent Engine

The new generation of technical tools is becoming the core carrier of management implementation, and its outstanding value lies in breaking through the data barriers between processes and progress:

Low-code management system: Through visualization, WBS task decomposition, progress planning, output value accounting and other modules are built. Automatic update of process completion status, real-time reminder of delays, dynamic budget deduction and other functions are realized to improve the efficiency of progress feedback.

Process mining technology: Automatically restore the real process path based on system logs.

3. Current Situation Analysis

3.1. The Fragmentation Dilemma of Process Management

Current enterprise process management generally has three major pain points: separation of design and execution, data islands, and insufficient dynamic adaptability:

Process drawings are out of touch with on-site execution: In the process manual of L Company, equipment procurement requires approval in 5 links, but in actual implementation, 12

variant paths are generated due to "special handling of special matters", resulting in 43% of purchase orders not being circulated according to standard processes, and frequent supplier settlement disputes. The root cause is that business personnel focus on process design, and the IT team is responsible for system development, and the two lack a collaborative mechanism.

Unstructured data blocks automation: 80% of the key information on the construction site exists in unstructured carriers such as drawing scans, WeChat voice, and acceptance handwritten forms, which cannot be automatically extracted and analyzed by traditional systems. A project was delayed by 11 months due to the failure to enter the system in time for hidden engineering records.

Rigid architecture is difficult to cope with changes: When the external environment suddenly changes, such as the supply chain interruption caused by the epidemic, the preset process often fails. A project needs to replace the model urgently due to shortage, but the procurement process needs to go through 15 days of approval again, missing the production window.

3.2. Black Box Challenges of Progress Management

Insufficient visualization and delayed feedback of progress control lead to serious lags in decision-making:

Progress updates rely on manual reporting: The survey shows that 57% of engineering companies only update the Gantt chart once a week or even a month. In the construction of a commercial complex, the progress of the fire protection pipeline network was delayed by 3 weeks and was not synchronized to the security platform, resulting in the forced dismantling and rework of the security wiring after completion, resulting in an additional storage fee of 6.8 million yuan.

Cost control is seriously delayed: In the traditional mode, cost data can only be obtained after the end of the month. In a security and fire integration project at an airport, the over-consumption of cables was not discovered during construction, and the budget was over-budgeted until the completion audit, which could not be remedied.

Lack of risk warning mechanism: Delays in critical paths are often caused by a breakdown in cross-departmental collaboration. During the installation of equipment in a certain project, the civil engineering and electromechanical teams did not share progress data, resulting in the installation of equipment before the basic maintenance was up to standard, causing rework losses.

3.3. Mechanism Defects in Organizational Collaboration

Functional barriers and incentive misalignment further aggravate management failure:

"Outsiders managing insiders" phenomenon: In the early stage of the construction of a certain light source device, the scientific research team underestimated the accuracy requirements for equipment installation, resulting in 3 reworks and a 5-month delay in progress.

The assessment indicators deviate from the process goals: The procurement department uses "low-price bid" as the KPI and ignores the reliability of supplier delivery. In a hospital project, the elevator supplier abandoned the bid midway due to a too low quotation, and the re-bidding delayed the construction period by 106 days.

4. Optimization Comparison

4.1. Efficiency Transition of Intelligent Upgrade

Table 1. Comparison of core indicators of traditional mode and intelligent optimization mode

Evaluation dimensions	Traditional management mode	Intelligent optimization mode	Improved results
Process design cycle	2-3 months	2 weeks (low-code platform rapid prototype verification)	Efficiency increased by 75% 10
Progress feedback delay	7-30 days	Real-time (IoT + automatic collection)	Decision-making accelerated by 90% 4
Process compliance rate	68%-75%	99.6% (blockchain evidence enforcement)	Risk reduced by 85% 4
Cross-system collaboration efficiency	Manual docking, 3-5 days/time	Automatic API call, minute-level response	Cost reduced by 94% 4
Exception response speed	24-72 hours after the problem occurs	Predictive warning, 14-day advance intervention	Losses reduced by 70%

4.2. Benchmark Practice Analysis

Case 1: Process management optimization of the integrated security and fire protection project

The project adopts a maturity level assessment model and sets 1-9 evaluation standards in 10 dimensions. The 2024 assessment found that the organizational structure maturity was only level 4 (the definition of responsibilities was unclear), and immediately promoted the signing of the overall-sub-overall task responsibility letter, and clarified 132 interface specifications. After implementation, the engineering change processing time was reduced from 22 days to 7 days, becoming a model of process management.

Case 2: Low-code practice of a central enterprise infrastructure project

By building a "WBS-progress-acceptance" full-link system: WBS decomposition: The project is disassembled into 7583 process units

Automatic output value accounting: After the process is completed and reported, the output value is calculated in real time and the budget is deducted

Acceptance closed loop: The mobile terminal pushes the electronic acceptance form, and multiple parties sign simultaneously

The system improves progress transparency by 90%, the overspending warning advance rate reaches 85%, and the project profit margin increases by 2.3 percentage points.

5. Guarantee Strategy

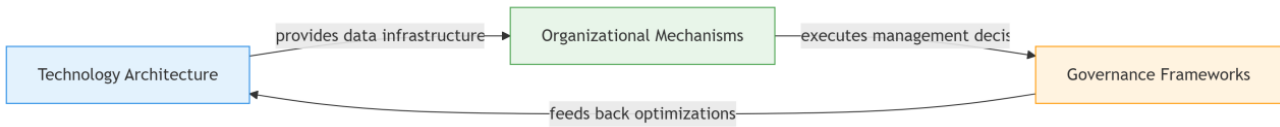


Figure 2. Internal logic framework diagram of strategy guarantee

5.1. Technical Architecture Guarantee: Building Digital Neural Circuits

By building an intelligent engine fusion architecture to form a digital neural circuit, it provides a technical foundation for the integration of process and progress. Deploy a process mining center (such as Celonis) to analyze system logs, automatically generate compliance heat maps to accurately locate high-frequency deviation points; at the same time, use dynamic knowledge graphs to establish an equipment-process-resource association network. When a key equipment failure occurs in a vehicle manufacturer, the system automatically adjusts the 37 process plans within the affected range, reducing production stoppage losses by 25%; in addition, based on the federated learning framework, cross-organizational data collaboration is achieved in the TEE trusted environment.

5.2. Organizational Mechanism Guarantee: Breaking Collaborative Barriers

Establishing an organizational model of human-machine collaboration to break management barriers, the core is the "three-in-one" governance architecture: the technical iron triangle composed of business department process owners, process management BP experts and IT engineers. In the transformation of a fire safety project, the team completed the

adaptation of 22 system functions in just 2 weeks, and the decision-making efficiency increased by 5 times. Further, the digital twin workshop is used to realize process preview, virtually verify the production scheduling plan, and avoid production line conflicts in advance. For real-time decision-making scenarios, the "AI suggestion-manual ruling" hybrid mechanism is adopted, and the manual one-click correction feedback is used to promote the continuous improvement of the accuracy of the AI model and form a self-evolution closed loop.

5.3. System and Norm Guarantee: Driving Continuous Evolution

Design a closed-loop system to drive continuous evolution, focusing on the implementation of a three-dimensional mechanism: first, establish an incremental review system, with monthly meetings focusing on three types of problems: process design defects, execution deviations, and system failures; second, implement resilient progress control, set a graded floating buffer strategy - milestone nodes ± 15 days, critical paths ± 7 days, ordinary tasks ± 3 days, and bind the automated warning threshold; finally, through incentive-compatible assessments, the process compliance rate and node punctuality rate are included in the department's KPI (weight $\geq 30\%$) to achieve a spiral increase in management efficiency.

6. Conclusion

The goal of process and progress management is to build an intelligent system with neuroplasticity - it can respond to changes in real time through dynamic topology adjustments, and can continuously absorb industry best practices through group intelligence optimization. Current technology has shown a clear path: process mining deconstructs the status quo, low-code platforms quickly iterate, and intelligent engines achieve predictive control. In super projects such as the Sichuan-Tibet Railway and the construction of the space station, such systems are showing strong vitality.

The competitive focus of future management systems will be on the agility of digital neural circuits. Companies that can first deeply integrate process and progress management into the digital genes of the organization will continue to evolve and lead in complex environments like living organisms with autonomous consciousness. The core task of managers is to accelerate this "silent revolution" and make process and

progress truly become the dual engines of organizational innovation rather than the shackles of development.

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