CCC 2025 **Proceedings of the Creative Construction Conference** (2025)
Edited by: Miroslaw J. Skibniewski & Miklós Hajdu & Žiga Turk
https://doi.org/10.22260/CCC2025/0020

DIGITAL PROCESS MANAGEMENT IN MEGA-PROJECTS WITH THE SOFTWARE *DIGICON*

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Abstract
Innovative Project Delivery models have been introduced in Germany and Austria to mitigate inefficiencies in major infrastructure projects, which often suffer from cost and schedule overruns. These new approaches emphasize risk-sharing, partnership-based collaboration, and innovative contract structures. However, traditional project management and calculation methods lack the necessary transparency, making them unsuitable for effectively implementing these models. Furthermore, partnership-based collaboration requires a structured, standardized, and digital approach to process management.
To address this challenge, the *DigiCon* software has been developed. *DigiCon* enables digital process visualization and management, offering a user-friendly platform to digitize management processes, represent them in a visually intuitive manner, and monitor workflow execution.
This study presents fundamental concepts of process management and modeling through a literature review. It then compares various project management models applied in Germany and Austria, analyzing the methodologies used. These methods are systematically structured as independent and autonomous processes and are subsequently digitized within *DigiCon*.
As a result, this research contributes to the development of a digital collection of innovative project management methods, providing a transparent, structured, and standardized framework to support efficient project execution.

Peer-review under responsibility of the scientific committee of the Creative Construction Conference 2025.

Keywords: mega projects, process management, software development.

1. Introduction

Major infrastructure projects across Europe have long been plagued by inefficiencies, manifesting in substantial cost overruns, time delays, and diminished public trust [1, 2]. Bent Flyvbjerg, in his seminal work *Survival of the Unfittest* [3], highlights how the worst-performing infrastructure projects often get selected due to systemic optimism bias and strategic misrepresentation. Such systemic issues lead to project environments characterized by underestimated risks, unrealistic timelines, and fragile stakeholder cooperation.

In response, several European countries have begun transitioning from traditional design–bid–build approaches to more collaborative frameworks. In Germany and Austria Innovative Project Delivery (IPD) models, such as the Progressive Partnership Model and the Allianz model , emphasize collaborative project governance, early contractor involvement (ECI) , joint risk management, joint and transparent cost estimation, integrated planning processes and incentive mechanisms [4–6]. These models shift the paradigm from adversarial contracting towards cooperative engagement, promoting a culture of transparency, shared incentives, and mutual accountability. [7]

However, realizing the full potential of these innovative models requires more than contractual adjustments. Traditional project management methods — often grounded in rigid work breakdown structures, fragmented documentation, and linear execution thinking — are ill-equipped to handle the

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dynamic interdependencies and multi-stakeholder complexities of modern infrastructure projects [8]. In particular, a critical shortcoming lies in the lack of transparent, structured, and digitized process management systems that can orchestrate the collaborative workflows demanded by IPD environments [9]. As shown in Fig. 1 the combination of misaligned incentives in the contract, the fragmentation in the project and overwhelming lack of transparency, as well as other aspects, lead to cost overruns und delays.

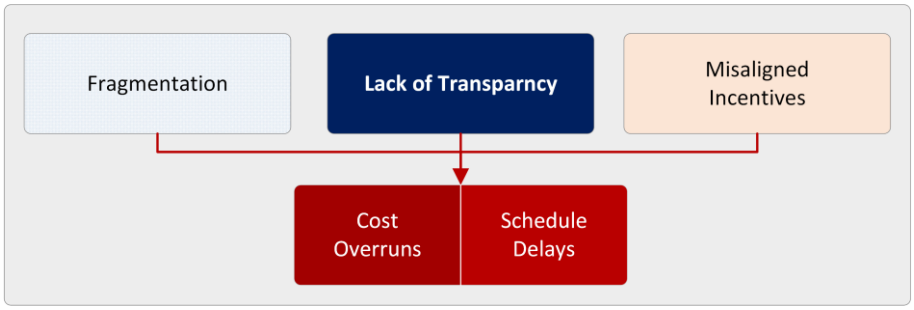

Fig. 1. Challenges in Traditional Infrastructure Project Delivery

To bridge this gap, the *DigiCon* software was developed as a digital process management tool tailored for the needs of complex, partnership-based projects. *DigiCon* enables the modelling, execution, and monitoring of project processes in a transparent, role-specific (when necessary), and standardized digital environment. This contribution builds upon established norms such as DIN 69901 for process structuring and leverages methodologies from business process management (BPM) and total quality management (TQM) to offer a framework through the software application for supporting efficient and accountable infrastructure delivery.

Regarding this paper section 2 presents the research design, including the literature review, normative modelling, and implementation strategy. Section 3 outlines the normative and methodological foundations of digital process management based on standards such as DIN 69901 and BPMN. Section 4 discusses the theoretical and practical relevance of transparency in innovative project delivery. Section 5 introduces the *DigiCon* software and describes its modular architecture and process modelling capabilities. Section 6 illustrates *DigiCon's* application using representative project workflows. Section 7 offers a discussion on benefits, limitations, and future developments. Finally, Section 8 summarizes the main findings and outlines directions for future research and implementation.

2. Methodology

This study applies a multi-layered research design combining literature analysis, normative modelling, applied case study evaluation, and software-driven implementation. The approach is guided by the need to bridge the gap between theoretical frameworks for collaborative project delivery and the digital tools required to operationalize them in practice.

The first phase consists of a structured literature review focused on transparency, process management, process visualisation and innovative delivery models. Key sources include international standards (e.g., DIN 69901-1 to -5 [10–14], ISO 21500 [15] , and ISO 9001:2015 [16]), as well as scholarly work on total quality management (TQM), learning organizations, and process integration in megaproject governance. This review forms the theoretical foundation for defining the requirements of a digital process management system in the infrastructure sector.

The second phase involves the construction of a normative framework based on DIN 69901-2 [11], which outlines the standard process model for project management in German-speaking countries. The DIN model is complemented by BPMN (Business Process Model and Notation) to allow for precise graphical modeling of processes and their associated decision logic, roles, and events. The integration of SIPOC (Supplier, Input, Process, Output, Customer) diagrams and PDCA (Plan–Do–Check–Act) cycles further enables structured and iterative process development.

In the third phase, empirical process models from three academic theses are used as foundational case examples and to underline the findings of the second phase: a Bachelor thesis by Choholka (2025) [17], which developed interactive process structures for the implementation of a generic IPD model in *DigiCon*, a Master thesis by Weber (2024) [18], which compared traditional and agile project governance and management methods, and a Master thesis by Abel (2024) [19] to validate to process depiction capacity of *DigiCon*. The findings from the work influence the structure of the process representation with *DigiCon*.

The fourth phase focuses on the software-based implementation of these processes and methods to support IPD. *DigiCon*'s internal logic enables project specific process design. The implementation is tested against infrastructure use cases such as tunneling and energy corridor projects, allowing for practical validation of the process logic and transparency objectives.

3. Normative and Methodical Foundations

Efficient project delivery in complex infrastructure environments demands more than operational excellence; it requires adherence to normative standards that govern process structures, decision-making hierarchies, and risk transparency [9]. This section outlines the normative and methodological frameworks that inform the development of a digital process management system suitable for innovative project delivery models.

The backbone of structured project management in Germany and Austria is the DIN 69901 series. Part 2 of this standard refers to: Processes, Process Model [11] and establishes a universally applicable process model that structures projects into defined phases: initialization, definition, planning, execution, controlling, and closure. Each phase is associated with specific management processes, decision gates, and documentation requirements, providing a reference architecture for project governance.

Complementary to DIN 69901 is the ISO 21500 standard, which offers global guidance on project management, emphasizing the integration of stakeholder engagement, resource management, and project control into coherent, repeatable frameworks [15]. The broader quality assurance principles of ISO 9001:2015 further underpin the need for standardized, auditable processes that prioritize customer satisfaction, continual improvement, and evidence-based decision-making [16]. As shown in Fig. 2 the industry standards build the foundation of the software application.

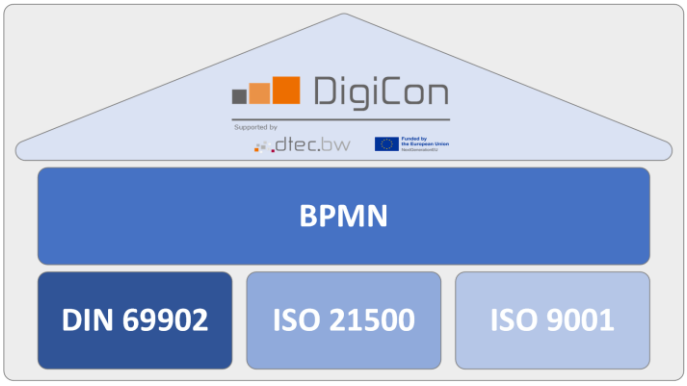

Fig. 2. Normative Framework for Digital Process Modeling [own drawing]

Beyond formal standards, methodical frameworks such as Business Process Model and Notation (BPMN) are essential for translating abstract processes into executable digital models. BPMN 2.0 provides a standardized graphical syntax for depicting tasks, events, gateways, and actors, enabling the precise definition of workflows and facilitating role-based task assignments. This notation is particularly suited for the visualization of complex, iterative, and conditional processes in collaborative project environments. [20, 21]

Additionally, different variant of process visualisation, e.g. Supplier–Input–Process–Output–Customer (SIPOC) are into account. SIPOC diagrams are utilized to frame processes within their broader

organizational and contractual context. SIPOC modelling clarifies the relationships between suppliers, inputs, outputs, and end customers, ensuring that each process step is aligned with strategic project objectives [22].

For continuous process improvement, quality management tools such as PDCA cycles and DMAIC (Define–Measure–Analyze–Improve–Control) structures provide the necessary methodological discipline to refine workflows based on observed performance and stakeholder feedback [23]. These methods have long been used in manufacturing and are increasingly applied to construction and infrastructure delivery to support lean construction principles and performance-based contracts.

Furthermore, recent research on intelligent process management has emphasized the importance of embedding learning loops, compliance monitoring, and feedback mechanisms into process environments [24]. This includes tracking deviations, monitoring handover points, and enabling adaptive reconfiguration based on context-specific triggers.

The integration of these methodological tools and norms ensures that process models implemented in *DigiCon* are not only executable, but also auditable, adaptable, and aligned with industry-wide best practices. By aligning software-based process management with recognized standards and best practices, projects can achieve not only compliance but also enhanced collaboration, reduced ambiguity, and greater resilience in the face of complexity.

4. Transparency in Project Delivery

Transparency plays a critical role in shaping trust, accountability, and performance within complex infrastructure projects. It is not merely an ethical or administrative ideal but a structural requirement for effective collaboration under innovative delivery models [25]. In traditional project environments, transparency is often reduced to the timely exchange of documents. However, in partnership-based frameworks—where risk, responsibilities, and incentives are shared—transparency becomes an operational necessity for aligning expectations, mitigating disputes, and ensuring coherent decision-making across all project actors [26].

Theoretical discourse on transparency has evolved significantly in recent decades. Heald (2006) [27] identifies four dimensions of transparency: upwards (accountability to authorities), downwards (accountability to the public), inwards (within organizations), and outwards (toward external stakeholders). In infrastructure delivery, all four must be addressed simultaneously due to the high visibility, public interest, and multilateral structure of projects. [27]

Flyvbjerg (2009) [3] underscores that a core contributor to infrastructure failure is strategic misrepresentation—the systematic understatement of costs and overstatement of benefits in business cases. His analysis shows that optimism bias and inadequate risk disclosure result in what he terms “the survival of the unfittest”. Transparency, in his view, is a systemic corrective to decision-making asymmetries. The introduction of reference class forecasting and externally auditable project performance systems is among his proposed remedies. [3]

In partnership-based models such as the Progressive Partnership Framework or the Allianzmodell, structured transparency mechanisms are a essential part of the collaborative framework [28, 29]. Unlike traditional models with rigid contractual silos, these approaches require inter-organizational workflows, joint review procedures, and co-developed risk registers [30]. Without shared visibility into processes and decision points, accountability dissolves and the incentives for cooperation degrade.

Other research further reinforces the link between transparency and successful project outcomes. Meskendahl (2010) [31] argues that inter-organizational transparency reduces the perceived complexity of megaprojects by clarifying roles, dependencies, and decision rights. Similarly, Bakker et al. (2010) [32] found that transparency in cost control and change management directly reduces the incidence of disputes in large-scale construction contracts.

Digital tools can help operationalize these transparency ideals. Process visualization, automated logging of decision points, and role-based access control enable teams to align not only on project outcomes,

but also on how those outcomes are achieved. Transparency is thus embedded into the execution environment, not appended as a reporting layer.

Within this context, the *DigiCon* software acts as both an organizational memory and a procedural interface. It enforces workflow visibility through project specific process modelling based on standards such as BPMN, captures audit trails through time, and ensures access to documents, tasks, and metrics. This creates a digitally supported “shared mental model” across all actors, which research has identified as essential for collaborative team performance in high-stakes project environments [33].

In sum, transparency is not a soft concept but a structural component of successful project delivery. Its implementation must be deliberate, norm-driven, and digitally enabled to support the collaborative mechanisms upon which innovative delivery models depend.

5. The *DigiCon* Software

The *DigiCon* software represents a structured digital solution developed to address the growing need for transparency, traceability, and process standardization in the management of infrastructure projects using innovative delivery models. Recognizing the shift from adversarial contracting to collaborative partnerships in modern project environments, *DigiCon* enables stakeholders to design, execute, and monitor project workflows in a unified and norm-compliant environment.

The structure of *DigiCon* is grounded in the normative framework of DIN 69901-2, which outlines a standard process model for project management in Germany. This model was extended and translated into a digital logic that supports modular and scalable process structures, enabling project organizations to customize workflows while preserving alignment with national standards [11]. The framework for visual representation, allows complex process logic to be communicated clearly to all stakeholders [20].

DigiCon consists of three interconnected modules [34]:

- Modul Designer: A visual modelling tool to present the work steps in a clear interactive way.
- Process Designer: A visual modelling tool that enables users to define reusable process templates.
- Process collection: A central library housing validated process templates. This enables organizations to maintain standardized workflows while allowing project-specific customization through configuration rather than manual remodelling.

Fig. 3 depicts the basic workflow of the software. First, the moduls are set-up. The combination of several Moduls in the Process Designer creats a process. The special feature is, the modules can be used for different projects. However, they are only added to a process if they are relevant to it. This results in numerous different project-specific processes

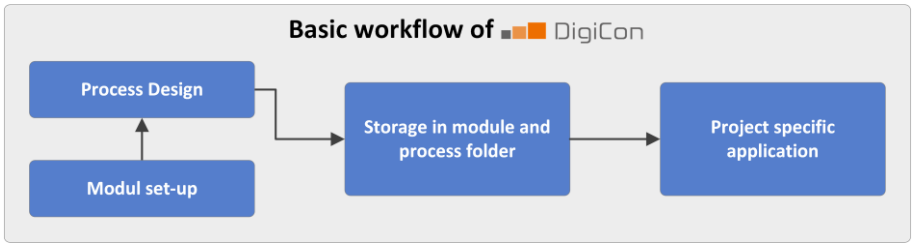

Figure 3: Basic workflow of *DigiCon [own drawing]*

While full-scale application of *DigiCon* in real-world infrastructure projects remains a forthcoming task, initial evaluations within academic environments and controlled pilot scenarios have confirmed its ability to model critical process chains typical for large infrastructure projects, including stakeholder kick-off coordination, design validation procedures, multi-stage approvals, and quality gate reviews.

The theoretical foundations of *DigiCon*’s design draw from established literature on business process management. Christ (2015) emphasizes the necessity of intelligent process management systems that allow for adaptive, norm-based, and user-centered process execution in dynamic project contexts [24].

Furthermore, Dumas et al. (2018) highlight the critical role of modularity, role assignment, and event monitoring in scalable business process environments [35]. These principles are fully embedded in *DigiCon*'s sturcutre, ensuring that the software is not merely a digital documentation tool, but an active enabler of transparent, collaborative project execution.

Details of the tool's development can be found in the associated publication [36, 37]

6. Application of *DigiCon*

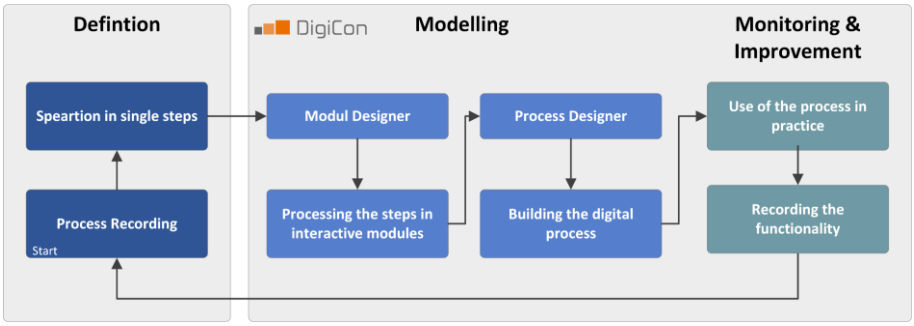

Fig. 4. Procedure of the process implementation in DigiCon *[own drawing]*

Fig. 4 shows the conventional use case of *DigiCon*. A process is recorded and separated into its components and steps. These are mapped as individual modules. The modules are then recombined in the process designer to form a process. The process is then applied and validated and, if necessary, adjustments are made to modules or the process itself.

Although large-scale deployment of *DigiCon* in full infrastructure project environments is planned for the near future, significant groundwork has already been laid in terms of practical application readiness. The software has been configured to support specific project phases, contractual frameworks, and delivery methodologies commonly encountered in German and Austrian infrastructure projects.

The main key area of application right now is the risk management. Using the Project Risk Twin (PRT) concept embedded within *DigiCon*, project teams can align process steps directly with identified cost, schedule, and opportunity risks. Risk identification workshops, mitigation planning, and approval of countermeasures are structured into standardized workflows, providing decision-makers with a clear overview of residual risks at each project milestone.

Preliminary applications of *DigiCon* have been carried out in academic and institutional simulation environments. These test environments have modeled critical process chains typical for large infrastructure projects, including stakeholder kick-off coordination, design validation procedures, multi-stage approvals, and quality gate reviews. The outcomes of these applications demonstrate *DigiCon*'s capability to significantly enhance process clarity, role transparency, and decision traceability.

In summary, *DigiCon* is positioned not only as a theoretical framework but as a fully operational tool ready to support critical workflows in partnership-based infrastructure projects. Its configuration flexibility allows adaptation to diverse delivery models, while its compliance with recognized norms ensures its suitability for public-sector and regulated private-sector projects.

7. Discussion

The digital transformation of project governance is no longer a theoretical ambition but an operational necessity, especially in the context of increasingly complex and collaborative infrastructure delivery models. *DigiCon* represents a practical response to this shift by providing a norm-based, modular, and transparent environment for modelling and executing project processes. However, as with any systems-level innovation, both the benefits and challenges of its implementation must be critically considered.

One of *DigiCon*'s key contributions lies in its ability to enforce process transparency as a structural feature rather than a managerial afterthought. *DigiCon* operationalizes the transparency principles

outlined by Heald (2006) and Flyvbjerg (2009) [3, 25]. This approach aligns with findings in organizational research that show how transparency enhances coordination, reduces information asymmetries, and strengthens accountability in multi-actor environments [31, 32].

Furthermore, *DigiCon*'s alignment with established norms, such as DIN 69901-2, BPMN, and ISO 9001, enhances its potential for acceptance in regulated infrastructure contexts. Public-sector clients and contractors are increasingly required to demonstrate process traceability, compliance, and auditability - features that are native to *DigiCon*'s architecture. This alignment may lower the barriers to adoption, particularly for organizations already subject to standardization and procedural rigor. [11, 15, 16]

Despite its advantages, the successful adoption of *DigiCon* will depend heavily on organizational readiness and change management. One potential barrier is the cultural resistance to digital tools that shift decision-making visibility and reduce informal power dynamics. Transparency, while beneficial from a governance standpoint, may be perceived as a threat in hierarchical or risk-averse project environments. Research in construction management has shown that digital tools are most successful when paired with structured onboarding, training, and stakeholder alignment efforts .

Another challenge lies in the integration of *DigiCon* into existing IT and process ecosystems. *DigiCon* is a .NET application designed to run on every windows desktop – no installation required. It's focus is the the management processes only, and therefore no interoperability is necessary.

Looking forward, further development is needed in the direction of data-driven process improvement. By capturing large volumes of structured process data over time, *DigiCon* could support predictive analytics, performance benchmarking, and risk forecasting. This would position it not only as a workflow engine but as a learning system that continuously refines project governance strategies. Aligning with the principles of total quality management and continuous improvement cycles (e.g., PDCA), *DigiCon* has the potential to support adaptive delivery models that evolve in response to real-time insights.

Finally, while the tool's readiness has been demonstrated in academic and simulated environments, its full potential can only be realized through real-world implementation in ongoing or upcoming infrastructure projects. Such pilots would provide the empirical data necessary to refine user experience, validate risk control assumptions, and scale the tool across different project types and organizational cultures.

8. Conclusion

The increasing complexity of infrastructure projects, combined with the shift toward collaborative delivery models, demands a new approach to project governance and process management. Traditional methods characterized by fragmented workflows, opaque decision-making, and rigid contractual divisions are ill-suited to environments where trust, transparency, and dynamic coordination are essential for success.

This paper has demonstrated that structured, norm-based digital process management - exemplified by the *DigiCon* software - can serve as a foundational enabler of transparency, accountability, and collaboration in major project environments. By aligning process architectures with recognized standards such as DIN 69901-2, BPMN, and ISO 9001, *DigiCon* ensures compliance while providing the flexibility needed to accommodate diverse project delivery strategies, from conventional models to progressive partnership frameworks.

Through its modular structure *DigiCon* moves beyond simple workflow documentation toward active project governance support. Its embedded transparency mechanisms, monitoring features, and traceable decision structures operationalize key theoretical principles from transparency theory, governance research, and business process management literature.

While preliminary applications in controlled environments have confirmed the software's readiness for critical project processes - such as early contractor involvement, change management, and risk management - full validation in large-scale real-world projects remains an essential next step. Future

work will focus on piloting *DigiCon* in complex, high-value infrastructure projects, evaluating its impact on process efficiency, stakeholder collaboration, and overall project outcomes.

The broader implication of this work is clear: the digitization of project processes is not merely an administrative upgrade but a strategic necessity. Tools like *DigiCon* offer a pathway toward more transparent, resilient, and collaborative infrastructure delivery—addressing some of the deepest-rooted inefficiencies identified in major project research. In doing so, they contribute to a more trustworthy and sustainable construction industry, better equipped to meet the challenges of the future.

Acknowledgement

This research paper “Digital Process Management in Mega Projects with the Software DigiCon” of the research project DigiPeC - Digital Performance Contracting Competence Center is funded by dtec.bw – Digitalization and Technology Research Center of the Bundeswehr. dtec.bw is funded by the European Union – NextGenerationEU.

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