

UDC 303:372

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<https://doi.org/10.25313/3083-7782-2026-5-17>

## DIGITAL TRANSFORMATION OF PROJECT MANAGEMENT: THE ROLE OF BUSINESS PROCESS MANAGEMENT SYSTEMS

**Summary.** Introduction. In the era of rapid digital transformation, geopolitical instability, and increasing organizational complexity, achieving efficiency, adaptability, and control in project implementation has become a major managerial challenge. Traditional project management methodologies, such as the PMBOK® Guide and PRINCE2, as well as agile approaches, remain fundamental for project governance; however, they often fail to fully integrate with dynamic business processes and modern digital infrastructures. In this context, Business Process Management (BPM) is increasingly viewed as a promising framework for improving project governance through structured process modeling, analysis, optimization, and automation.

**Purpose.** The purpose of this research is to substantiate the possibilities of integrating BPM approaches into project management and to develop methodological principles for correct business process decomposition based on the coordinated separation of data and activities.

**Materials and methods.** The study applies methods of system analysis, comparative analysis of scientific literature, conceptual modeling, and generalization of modern BPM approaches. The research reviews recent studies related to BPM maturity models, process modeling techniques, agile BPM, value-oriented process portfolio management, and emerging digital technologies such as process mining, cloud-based BPM platforms, and artificial intelligence.

**Results.** The research proposes methodological principles for correct business process decomposition based on the coordinated separation of data and activities, the use of state variables, control and data flows, and coupling and cohesion criteria between subprocesses. The proposed approach aims to ensure subprocess independence, minimize interdependencies, and accurately reflect system dynamics. The results demonstrate that the integration of BPM principles with project management contributes to improved governance transparency, organizational resilience, and value creation, particularly in volatile and rapidly changing environments.

**Prospects.** Future research should focus on developing hybrid BPM–project management models, designing tailored BPM maturity frameworks for project-oriented organizations, and establishing metrics for evaluating the effectiveness of BPM implementation in project environments.

**Key words:** IT, project management, business process management, digital transformation, artificial intelligence.

**Problem statement.** Amid growing organizational system complexity and increasing demands for formalized management practices, the challenge of accurate business process modeling has gained critical importance. Process models support analysis, optimization, reengineering, and automation. Yet, no universal, unambiguous methodological



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principles exist for their structuring. Consequently, decomposition is frequently intuitive, resulting in subjective models, omission of essential system properties, or introduction of redundant elements.

Conventional decomposition approaches often treat activities and data independently, failing to ensure coordinated partitioning. This creates hidden dependencies among subprocesses, compromises state variable integrity, duplicates functions, and complicates analysis of control and data flows. Without formalized criteria for "correct" decomposition, achieving model completeness, non-redundancy, and consistency remains elusive.

The scientific problem thus lies in developing methodological principles for business process structuring based on coordinated decomposition of data and activities. These principles should promote subprocess independence, minimize mutual influence, and faithfully represent system dynamics — particularly valuable in project-based and digitally transforming environments.

**Review of the last research and publications.** Numerous studies by prominent scholars have defined business processes, advanced modeling, analysis, and optimization techniques, and established the foundations of process-oriented management, thereby institutionalizing Business Process Management (BPM) as a scientific and managerial discipline. However, most studies primarily focus on operational and repetitive processes, while the integration of BPM into project-based environments remains insufficiently explored.

Classical BPM research emphasizes process regulation, reengineering, standardization, and digital enablement. At the same time, issues related to the structural correctness of process decomposition, model integrity, and the minimization of interdependencies between subprocesses receive relatively limited attention in the literature.

A comprehensive conceptual foundation of BPM is presented in the work of Dumas et al., which systematizes approaches to process modeling, analysis, redesign, and automation, forming the methodological basis for modern BPM research and practice [1].

Research by Plattfaut analyzes the role of project management capabilities in ensuring sustainable BPM outcomes, emphasizing that project management knowledge supports discrete process changes and contributes to BPM success, particularly in the context of digital transformation [2].

The study by Indihar Štemberger et al. highlights BPM maturity models and capability areas — such as BPM project execution and governance — providing insights into the systematic development of organizational capabilities [3].

Another significant direction of research concerns the application of advanced analytical technologies within BPM. A systematic literature review by Weinzierl et al. synthesizes how machine learning has been applied to BPM tasks across lifecycle phases, including predictive analytics, anomaly detection, and resource optimization [4].

The role of process data analysis has also been emphasized in the work of van der Aalst, who developed the concept of process mining, enabling organizations to discover, monitor, and improve real processes using event data from information systems [5]. This approach significantly enhances process transparency and supports data-driven decision-making in process management.

Research by Martín Navarro et al. investigates how user perceptions of the usefulness of Business Process Management Systems (BPMS) are influenced by system quality and information quality, highlighting the importance of user-centered design and usability considerations in BPM tools and platforms [6].

Recent studies also examine BPM as a key enabler of organizational digital transformation. Kerpedzhiev et al. analyze how BPM capabilities support organizations in adapting business processes to rapidly changing digital environments and highlight the growing role of automation and intelligent technologies in BPM initiatives [7].

Furthermore, Mendling, Pentland, and Recker discuss emerging research directions in business process management, including the impact of artificial intelligence, data-driven process analysis, and socio-technical perspectives on process design and governance. Their work emphasizes the need for more integrated approaches combining BPM, data analytics, and organizational change management [8].

Despite these contributions, several research gaps remain evident. While studies such as [2] and [3] address BPM capabilities and project management, limited attention is given to how project execution aligns BPM initiatives with strategic objectives in volatile or digitalized environments. Although [4] discusses machine learning applications in BPM, the literature does not comprehensively explain how artificial intelligence, digital twins, or process automation can be effectively integrated into project-driven BPM contexts. Furthermore, practical frameworks for predictive analytics and resource optimization in project environments remain underdeveloped.

In addition, although [6] explores user perceptions of BPMS, the role of human behavior, organizational culture, and change management in the successful adoption of BPM within project-oriented organizations is still insufficiently understood.

**Task of the research:** to develop methodological principles for correct business process decomposition based on the coordinated separation of data and activities, incorporating state variables, control and data flows, as well as coupling and cohesion criteria between subprocesses.

**The basic material of research.** A system’s structure is defined by relationships among subsystems emerging from a chosen decomposition method. The same system admits multiple decompositions depending on analysis purpose and perspective.

Three primary decomposition strategies exist:

- Functional — based on functions and objectives.
- Structural — based on organizational or territorial divisions.
- Temporal — based on lifecycle stages or execution sequence.

Mixing bases at the same level causes logical inconsistencies and undermines model integrity. A business process should be viewed dually: as a sequence of activities and as transformation of an informational/material object.

Traditional methods decouple activity and data decomposition, leading to misalignment between behavioral and data models.

The proposed approach advocates coordinated decomposition, synchronizing process breakdown with analysis of transformed objects.

Decomposition divides a set into subsets logically. For model correctness, observe:

- Level consistency (progressive refinement).
- Proportionality (each level elaborates meaningfully on the prior).
- Completeness (all original elements represented).
- Non-redundancy (no extraneous elements added).
- Unity of division basis (single strategy per level).
- Mutual exclusivity (no overlap at the same level).

Process execution equals successive state changes of the managed object. Introduce state variables with finite value sets.

Distinguish:

- Quantitative changes (attribute modifications).
- Qualitative changes (transitions to new aggregated states).

This yields model hierarchy (fig.1):

Action — minimal activity altering a quantitative parameter.

Operation — actions group causing qualitative change.

Subprocess — operations affecting one state variable.

Process — full object transformation cycle.

Within the considered hierarchical model, different types of connections are employed to ensure the structural and functional integrity of the system. In particular, the following types of connections are distinguished:

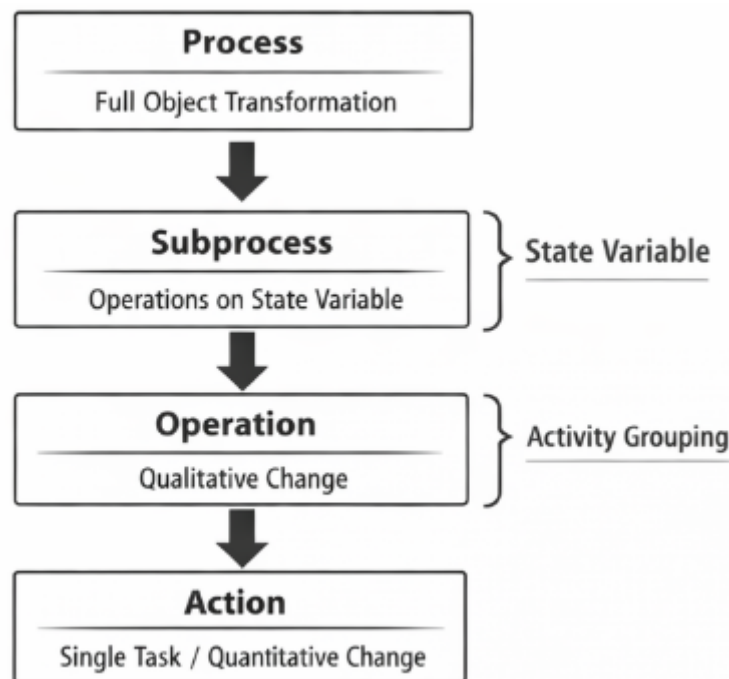


Fig. 1. Coordinated Decomposition Hierarchy

Source: developed by the authors

Data flow — represents the processes of transmission, transformation, or change in the state of objects between elements of the hierarchy. This type of connection describes the movement of information and captures dependencies arising from data processing and transformation.

Control flow — characterizes the sequence of execution of operations or the activation of system components. Usually, this type of connection is determined by execution logic and may be event-driven in nature, ensuring coordination and synchronization of processes.

The use of these types of connections makes it possible to formalize both informational and control interactions between elements of the hierarchy, thereby increasing the transparency of the model and enabling a more precise description of the system's functioning.

The coincidence of flows is considered a condition for initiating a subsequent operation through a change in the system state, whereas their divergence is interpreted as a synchronization mechanism that does not involve substantive data transfer.

The quality of decomposition is assessed based on the following criteria:

Coupling — the degree of inter-component interdependence resulting from the use of shared data;

Cohesion — the level of internal integrity and functional consistency of subprocesses.

A decomposition is considered correct if it satisfies the following requirements:

- ensuring the independence of subprocesses;
- absence of shared state variable elements;
- elimination of cross-subprocess object influence;
- preservation of the original events, data, and transformations;
- avoidance of introducing artificial elements not present in the original model.

Thus, a valid decomposition is characterized by the absence of data loss, redundancy, and undesirable inter-process influence, thereby ensuring the structural and semantic integrity of the model.

The method of coordinated decomposition is aimed at structuring a complex managed object by partitioning it into independent and functionally complete components. The primary objective of the method is to ensure the structural integrity of the model while simultaneously reducing inter-component coupling and preserving the semantic correctness of the original system.

The implementation procedure includes the following stages:

1. Partitioning the complex managed object into independent sub-objects that possess functional completeness and minimal external dependencies.
2. Assigning dedicated state variables to each sub-object, thereby ensuring localization of changes and preventing shared state usage.
3. Grouping operations around the corresponding state variables, forming logically consistent subprocesses.
4. Verifying the absence of cross-subprocess impacts, aimed at eliminating hidden dependencies and implicit interaction channels.

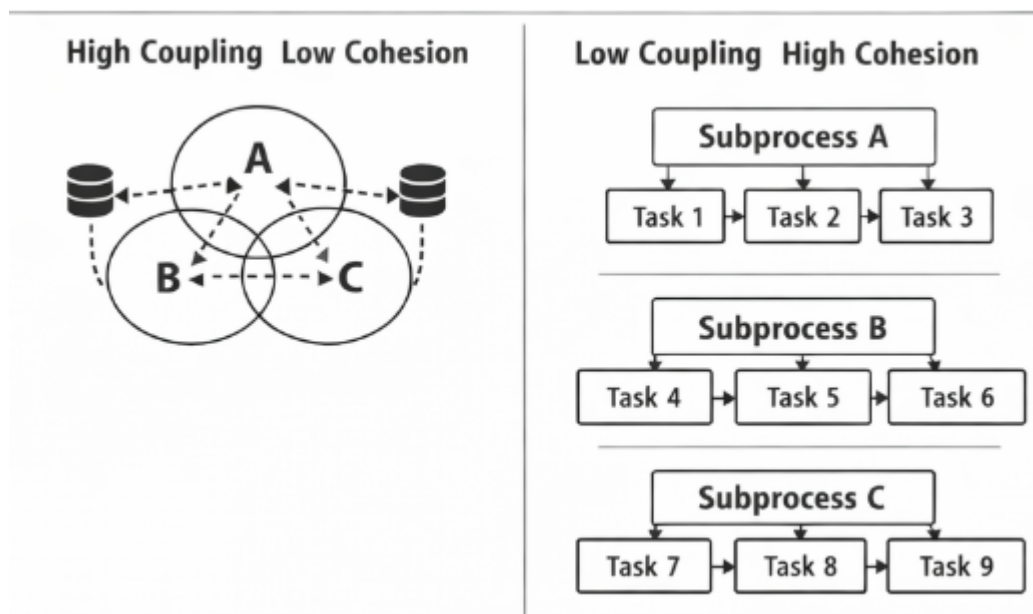


Fig. 2. Coupling and Cohesion Evaluation  
Source: developed by the authors

5. Evaluating coupling and cohesion metrics in order to confirm the correctness of the performed decomposition.

The application of the coordinated decomposition method ensures subprocess independence, enhances the structural transparency of the system, and provides a formally grounded basis for further analysis and model optimization. Transition points for subprocess division are determined by changes in the state of the managed object, which allows logically and functionally complete elements of the system to be identified.

But in real-world systems, complete inter-process independence is often unattainable. The most common situations include:

- the presence of shared data elements across state variables;
- modification of the same object by multiple subprocesses;
- execution of operations affecting objects in different subsystems.

To mitigate the impact of these limitations, approaches such as sequential execution of processes, the use of object copies, and joint analysis of interdependencies between subprocesses are employed.

The proposed coordinated decomposition method offers a range of significant advantages for the modeling and analysis of complex systems. Its application provides a formal and objective procedure for identifying subprocesses, ensuring that each component of the system is clearly delineated and functionally coherent. This formalization reduces the likelihood of logical errors during system modeling, contributing to higher reliability and accuracy of the resulting model.

Furthermore, the method enhances the suitability of models for automation and digital transformation by creating a clear, modular structure that can be readily implemented in computational systems. By decomposing complex systems into independent and well-defined subsystems, it also enables detailed analysis and evaluation of each component in isolation while preserving the overall structural and functional integrity of the original model. This balance between independence and integrity makes the method particularly effective for managing, analyzing, and optimizing large-scale or intricate systems.

Distinguishing structural correctness from cognitive readability yields models that are both comprehensible and faithful to real process dynamics — particularly beneficial for adaptive project governance, where uncertainty demands robust, modular process representations integrable with AI-driven tools (e.g., predictive analytics, process mining).

### **Application of Coordinated Decomposition in Project-Oriented Environments**

Project-oriented organizations operate in conditions characterized by temporary structures, evolving objectives, and a high degree of uncertainty. Unlike operational processes, which are typically repetitive and well-defined, project processes involve unique combinations of tasks, resources, and stakeholders. This creates additional challenges for modeling and managing project workflows within the BPM paradigm.

The coordinated decomposition method provides a systematic approach for structuring project-related processes by identifying logically independent subprocesses based on state variables and object transformations. In a project environment, the managed object can represent various entities, including project deliverables, informational artifacts, or decision states. Each state variable reflects a measurable attribute or condition of the project system, such as task completion status, resource allocation, document approval, or milestone achievement.

By associating subprocesses with specific state variables, the proposed method enables clear separation of responsibilities and minimizes unintended interactions between project components. For instance, in a software development project, separate subprocesses may correspond to requirements validation, system design, implementation, testing, and deployment. Each subprocess modifies a particular state variable representing the maturity or readiness level of the project artifact.

This structuring approach enhances transparency and traceability within the project lifecycle. Since each subprocess is responsible for modifying only its designated state variable, the evolution of the project can be monitored through state transitions. As a result, managers can identify bottlenecks, detect deviations from planned progress, and implement corrective actions more effectively.

Furthermore, coordinated decomposition supports modular project governance. Subprocess independence enables distributed teams to work concurrently on different aspects of the project without introducing excessive interdependencies. This is particularly valuable in large-scale or geographically distributed projects where coordination overhead can significantly impact project performance.

The application of the method also aligns with agile and hybrid project management frameworks. In such contexts, iterative cycles and incremental delivery require flexible process structures that can adapt to evolving requirements. The decomposition hierarchy allows subprocesses to be reorganized, extended, or refined without compromising the integrity of the overall process model. Consequently, the proposed approach facilitates the integration of BPM principles with contemporary project management practices.

### **Integration with Digital BPM Technologies**

The effectiveness of coordinated decomposition increases significantly when combined with modern digital technologies supporting business process management. Contemporary BPM platforms provide capabilities for automated workflow execution, data integration, monitoring, and process analytics. When process models are constructed according to the principles of coordinated decomposition, these technologies can be utilized more efficiently.

One important technological direction is process mining, which enables the discovery and analysis of real process flows based on event logs generated by information systems. Process mining tools can identify deviations between designed models and actual execution patterns. When subprocesses are clearly defined through coordinated decomposition, process mining algorithms can more accurately detect inconsistencies and performance issues at specific hierarchical levels.

Another promising direction involves the use of artificial intelligence and machine learning in process management. AI-based methods allow predictive analysis of process performance, early detection of bottlenecks, and intelligent resource allocation. In the context of the proposed decomposition method, machine learning models can analyze transitions between state variables and forecast the likelihood of successful completion of specific subprocesses.

Cloud-based BPM platforms further enhance the scalability and accessibility of process management solutions. These platforms allow organizations to implement process models across distributed environments and integrate them with enterprise information systems. The modular structure created by coordinated decomposition simplifies the deployment of such solutions because each subprocess can be implemented as an independent workflow module.

Digital twins of organizational processes represent another emerging technology closely related to BPM. A digital twin replicates the behavior of real-world processes in a virtual environment, enabling simulation and scenario analysis. When processes are decomposed according to the principles described above, digital twin models can more precisely reproduce system behavior and support decision-making in complex organizational contexts.

Overall, the integration of coordinated decomposition with digital BPM technologies creates a powerful analytical framework for managing complex systems. It enhances process transparency, supports automation, and enables advanced analytical capabilities that are essential for organizations undergoing digital transformation.

### **Practical Implications and Methodological Limitations**

Despite its advantages, the coordinated decomposition method must be applied with careful consideration of organizational context and system complexity. In practice, organizations often operate with legacy systems, fragmented data sources, and informal process structures. These factors may complicate the identification of state variables and the precise delineation of subprocess boundaries.

One potential limitation arises from the difficulty of determining appropriate state variables for highly abstract or knowledge-intensive processes. In such cases, qualitative indicators or proxy variables may need to be used, which can reduce the precision of the model. Additionally, the identification of subprocess independence may require extensive domain expertise and collaboration among process stakeholders.

Another challenge concerns the dynamic nature of modern organizational systems. Business environments characterized by rapid technological change and evolving regulatory requirements may require frequent updates to process models. Although the hierarchical structure of coordinated decomposition facilitates modifications, maintaining consistency across multiple levels of the model may require additional governance mechanisms.

Nevertheless, the practical benefits of the method outweigh these limitations. By providing formal criteria for decomposition correctness, the approach reduces ambiguity in process modeling and improves communication among analysts, managers, and system developers. It also supports the development of reusable process components, which can significantly reduce the effort required for designing new organizational workflows.

From a managerial perspective, the method contributes to improved decision-making by providing a clearer understanding of system structure and interdependencies. Managers can analyze the impact of changes within specific subprocesses without affecting the entire system, enabling more targeted interventions and efficient resource allocation.

In addition, the method supports continuous improvement initiatives. Since subprocesses are explicitly defined and associated with measurable state variables, organizations can systematically monitor process performance and implement incremental optimizations. This capability is particularly valuable in project-based environments where adaptability and responsiveness are critical success factors.

### **Implications for Future Research**

The presented methodological framework opens several directions for future scientific investigation. One promising avenue involves the development of quantitative metrics for evaluating decomposition quality,

including formal measures of coupling, cohesion, and structural complexity. Such metrics could provide objective criteria for comparing alternative decomposition strategies.

Another research direction concerns the integration of coordinated decomposition with artificial intelligence–driven decision-support systems. By combining structured process models with predictive analytics, organizations could create intelligent management systems capable of dynamically adjusting workflows in response to changing conditions.

Finally, further empirical studies are required to validate the effectiveness of the proposed method in real organizational environments. Case studies across different industries — such as software development, manufacturing, healthcare, and public administration — would help assess the practical applicability and scalability of the approach.

**Conclusion.** System analysis provides a rigorous methodological framework for structuring business processes and identifying management invariants, accounting for both shared and unique properties, as well as the relationships between whole systems and their components. A process-oriented approach, grounded in clearly defined principles, enhances organizational efficiency by enabling systematic management and informed coordination of interrelated activities.

Effective implementation of process management requires robust information support. Given the inherent complexity of designing and managing business processes, enterprises increasingly rely on software tools based on standardized methodologies and modeling languages. These tools facilitate automation, comprehensive analysis, and monitoring of processes, even in highly complex systems.

Consequently, the integration of system analysis and process-oriented approaches, supported by advanced information technologies, is essential for modern organizations. In project-based environments, the application of these principles ensures that BPM initiatives are aligned with strategic objectives, adaptable to digital transformation, and capable of handling the temporary, multidisciplinary, and uncertain nature of projects. Further research into the development and optimization of digital tools for project-driven process management remains a valuable avenue for enhancing organizational adaptability, efficiency, and value creation.

### ДОДАТКОВА ІНФОРМАЦІЯ

**ВНЕСОК АВТОРІВ:** Усі автори зробили внесок порівну.

**ФІНАНСУВАННЯ:** Автори не отримували фінансування для цього дослідження.

**ЗАЯВА ПРО ДОСТУПНІСТЬ ДАНИХ:** Не застосовується.

**КОНФЛІКТ ІНТЕРЕСІВ:** Автори заявляють про відсутність конфлікту інтересів.

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Дата першого надходження статті до видання: 29.03.2026

Дата прийняття статті до друку після рецензування: 29.04.2026

Дата публікації: 05.05.2026

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## ЦИФРОВА ТРАНСФОРМАЦІЯ УПРАВЛІННЯ ПРОЄКТАМИ: РОЛЬ СИСТЕМ УПРАВЛІННЯ БІЗНЕС- ПРОЦЕСАМИ

**Анотація.** Вступ. В умовах стрімкої цифрової трансформації, геополітичної нестабільності та зростання складності організаційних систем досягнення ефективності, адаптивності та керованості під час реалізації проєктів стає одним із ключових управлінських викликів. Традиційні методології управління проєктами, зокрема PMBOK® Guide та PRINCE2, а також гнучкі підходи залишаються важливою основою проєктного менеджменту, проте часто не забезпечують достатньої інтеграції з динамічними бізнес-процесами та цифровою інфраструктурою організацій. У цьому контексті управління бізнес-процесами (Business Process Management, BPM) розглядається як перспективна концепція підвищення ефективності управління проєктами завдяки використанню інструментів моделювання, аналізу, оптимізації та автоматизації процесів.

**Мета.** Метою дослідження є обґрунтування можливостей інтеграції підходів BPM у систему управління проєктами, а також розроблення методологічних принципів коректної декомпозиції бізнес-процесів на основі узгодженого розділення даних і діяльностей.

**Матеріали і методи.** У дослідженні використано методи системного аналізу, порівняльного аналізу наукових джерел, концептуального моделювання та узагальнення сучасних підходів у сфері BPM. Проаналізовано наукові праці, присвячені моделям зрілості BPM, методам моделювання бізнес-процесів, гнучкому BPM, управлінню портфелем процесів, орієнтованому на створення цінності, а також сучасним цифровим технологіям, зокрема process mining, хмарним BPM-платформам та технологіям штучного інтелекту.

**Результати.** У результаті дослідження запропоновано методологічні принципи коректної декомпозиції бізнес-процесів, що базуються на узгодженому розділенні даних і діяльностей, використанні змінних стану, потоків керування та даних, а також критеріїв зв'язності та згуртованості підпроцесів. Запропонований підхід спрямований на забезпечення незалежності підпроцесів, мінімізацію міжпроцесних залежностей і адекватне відображення динаміки функціонування системи. Обґрунтовано, що інтеграція принципів BPM з управлінням проєктами сприяє підвищенню прозорості управління, організаційної стійкості та ефективності створення цінності, особливо в умовах турбулентного зовнішнього середовища.

**Перспективи.** Подальші дослідження доцільно спрямувати на розроблення гібридних моделей інтеграції BPM та управління проєктами, формування адаптованих моделей зрілості для проєктно-орієнтованих організацій, а також створення системи показників для оцінювання ефективності використання BPM у проєктному середовищі.

**Ключові слова:** інформаційні технології (IT), управління проєктами, управління бізнес-процесами, цифрова трансформація, штучний інтелект.