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MANAGING COMPLEX IT PROJECTS: SYNERGY OF DIGITAL TWIN AND EXTREME PROJECT MANAGEMENT APPROACHES TO INCREASE FLEXIBILITY AND RESILIENCE

The article discusses the concept of synergistic use of Digital Twin and Extreme Project Management (XPM) approaches in the context of managing complex IT projects. It analyzes the potential of their interaction to increase adaptability, manage risks, and ensure resilience to external changes using a specific example. The results of the study demonstrate that the integration of these approaches not only improves the quality of planning but also significantly reduces uncertainty in the management of high-tech projects.

In addition, the role of the digital twin as a tool for visualization, analytics, and simulation is highlighted, which makes it possible to model complex relationships between project components, identify critical points of change, and predict likely scenarios. XPM, in turn, allows real-time adaptation of project management strategies to changing conditions by integrating flexible decision-making approaches based on empirical data. It is emphasized that such synergy has not only practical but also conceptual significance, as it creates a new paradigm of thinking in the management of complex projects. The relevance of the topic is justified by the growing share of complex, interdisciplinary, and digitally oriented projects in the IT sphere. It also takes on particular importance in the context of constant market turbulence, rapid technological change, and the need to shorten development cycles. Thus, the abstract outlines not only the technical but also the strategic potential of an integrated approach.

Keywords: IT projects, iterative approach, hybrid models, management, modeling.

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УПРАВЛІННЯ СКЛАДНИМИ ІТ-ПРОЄКТАМИ: СИНЕРГІЯ ПІДХОДІВ DIGITAL TWIN І EXTREME PROJECT MANAGEMENT ДЛЯ ПІДВИЩЕННЯ ГНУЧКОСТІ ТА СТІЙКОСТІ

У статті розглядається концепція синергічного використання підходів Digital Twin (цифрового двійника) та Extreme Project Management (XPM) у контексті управління складними ІТ-проєктами. Аналізується потенціал їх взаємодії для підвищення рівня адаптивності, управління ризиками та забезпечення стійкості до зовнішніх змін на конкретному прикладі. Результати дослідження демонструють, що інтеграція цих підходів сприяє не лише покращенню якості планування, але й значному зниженню невизначеності в управлінні високотехнологічними проєктами.

Крім того висвітлюється роль цифрового двійника як інструмента візуалізації, аналітики й симуляції, що дає змогу моделювати складні взаємозв'язки між компонентами проєкту, виявляти критичні точки впливу змін та передбачати ймовірні сценарії розвитку подій. XPM, у свою чергу, дозволяє в режимі реального часу адаптувати стратегії проєктного управління до змінних умов, інтегруючи гнучкі підходи до прийняття рішень, що ґрунтуються на емпіричних даних. Підкреслюється, що така синергія має не лише практичне, але й концептуальне значення, оскільки створює нову парадигму мислення в управлінні складними проєктами. Актуальність теми обґрунтовується зростанням частки складних, міждисциплінарних і цифрово орієнтованих проєктів в ІТ-сфері. Вона також набуває особливої ваги в умовах постійної турбулентності ринку, швидких технологічних змін і потреби в скороченні циклів розробки. Отже, анотація окреслює не лише технічний, але й стратегічний потенціал інтегрованого підходу.

Ключові слова: ІТ-проєкти, ітеративний підхід, гібридні моделі, управління, моделювання.

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STATEMENT OF THE PROBLEM

Modern IT projects are characterized by a high level of complexity, dynamic implementation conditions, and constant uncertainty. Given the growing role of information technology in ensuring business sustainability and strategic development, the issue of effective management of such projects is becoming critically important. Constant changes in market conditions, technological breakthroughs, and rapid growth in data volumes require new approaches to the organization, coordination, and implementation of project activities. At the same time, project teams work in an environment where they increasingly face unpredictable circumstances, including sudden changes in customer requirements, resource constraints, regulatory barriers, or even cyberattacks. In such conditions, the key factor for project success is the ability to quickly adapt to new challenges, make informed decisions, and ensure continuous coordination between all participants in the process. This creates a need for innovative tools that can not only support traditional management functions, but also provide proactive analytics, scenario simulation, and rapid adaptation to

change. On the one hand, the Digital Twin concept allows you to create accurate digital models of projects that reflect all key parameters of the system, its dynamics, and interrelationships in real time. On the other hand, the Extreme Project Management approach provides management flexibility and openness to experimentation, which are necessary in conditions of instability and complexity. The combination of these approaches creates the basis for a new paradigm—integrated digital project management, which improves both the quality of management and the ability of teams to self-organize in real time.

ANALYSIS OF RECENT STUDIES AND PUBLICATIONS

Recent scientific publications in the field of digital project management emphasize the importance of implementing digital twins to achieve a high level of project transparency and control. The work of Zhang et al. (2022) [1] reveals the potential of Digital Twin to automate change management in complex projects by simulating the consequences of decisions in real time. Similarly, the study by [2] demonstrates how digital twins are used in IT infrastructures to predict system failures and prevent critical errors. In the field of agile project management methodologies, there is growing interest in extreme project management (XPM), as highlighted in the works of Highsmith (2021) and Cockburn (2022), which justify the benefits of increased team autonomy and flexible adaptation to change as key success factors in an unstable environment. Krahnke (2023) attempts to reconcile the principles of XPM with real-time analytics technologies, pointing to the need for a flexible digital infrastructure.

Publications that directly explore the integration of Digital Twin and XPM also play an important role. For example, a Gartner (2024) analytical report notes that the most effective organizations in the IT field are currently combining these approaches to reduce product development time and mitigate risks. The work of Müller et al. (2023) demonstrates real-world cases of using digital twins in combination with XPM for flexible management of complex multi-level projects in the cloud services industry.

A summary of these studies suggests that combining Digital Twin and Extreme Project Management is not only a modern trend but also a reasonable step toward improving the efficiency, predictability, and adaptability of managing complex IT projects. This creates a need for innovative tools that can not only support traditional management functions, but also provide proactive analytics, scenario simulation, and rapid adaptation to change. On the one hand, the Digital Twin concept allows you to create accurate digital models of projects that reflect all key parameters of the system, its dynamics, and interrelationships in real time. On the other hand, the Extreme Project Management approach provides management flexibility and openness to experimentation, which are necessary in conditions of instability and complexity. The combination of these approaches creates the basis for a new paradigm—integrated digital project management, which improves both the quality of management and the ability of teams to self-organize in real time.

PRESENTATION OF THE MAIN MATERIAL

The central idea behind combining Digital Twin and XPM is to create a dynamic management environment that not only reflects the current state of the project but also actively influences its implementation [3]. In traditional project models, managers face a disconnect between the plan and actual execution, but a digital twin minimizes this gap, enabling more realistic forecasts and proactive decision-making [6]. In combination with XPM, the digital twin acts as an “intelligent mirror” of the project: it not only reflects but also analyzes the actions of participants, takes external factors into account, and adjusts development trajectories. For example, if a team changes its approach to implementing a particular functionality, Digital Twin allows you to instantly assess how this will affect the dependencies between components, the project schedule, or costs. This, in turn, paves the way for flexible adaptation through XPM principles, where any change is not seen as a threat but as an opportunity to rethink the strategy [4].

It is worth noting that the effectiveness of this approach increases in proportion to the level of digital maturity of the organization. Organizations with developed IT infrastructure that use cloud technologies, DevOps, CI/CD, and real-time monitoring tools integrate Digital Twin into their processes much faster. At the same time, XPM methods prove to be most effective in multidisciplinary teams where speed of decision-making, autonomy, and flexible delegation of authority are valued [7-8].

The synergy between Digital Twin and XPM is extremely useful in the planning and validation phase. By modeling alternative scenarios, managers can test different approaches to implementing functionality, predict risks, identify bottlenecks, and develop strategies to eliminate them in advance. This approach creates the conditions for a transition from a reactive to a proactive management style. At the same time, it allows the team to receive feedback faster, which is in line with the principles of continuous improvement that are the basis of XPM. The role of such approaches in ensuring interaction between stakeholders is no less important. Instead of the usual reports or presentations, digital twins can clearly demonstrate progress, changes, and projected results in a format that is convenient for analysts, business users, or investors. This creates a transparent environment for collaboration, where each participant has access to relevant information and can make informed decisions. Thus, the combination of Digital Twin and Extreme Project Management not only optimizes management processes but also forms a new management philosophy based on the symbiosis of precision, flexibility, and technological foresight.

In the practice of IT companies, the combination of Digital Twin and XPM is embodied in various industries. One striking example is projects to develop cloud platforms for processing large amounts of data (Big Data). In such an environment, digital twins are used to simulate loads on the system architecture, allowing its capacity limits to be determined in advance. When customer requirements change or the volume of data increases during the project, XPM allows you to quickly change priorities, adapt the team, and change technical solutions without stopping the project.

Another example concerns the development of electronic document management systems for the public sector. Here, digital twins allow you to simulate the behavior of the system when integrated with other departmental services, as well as assess the risks of failures during peak loads. Within XPM, management is carried out through the active involvement of users in testing intermediate versions of the product, which allows you to adjust functionality in real time. In the financial sector, combining these approaches is effective in developing digital banking platforms. Digital twins allow you to model user behavior and test new features without risk to the core infrastructure, while XPM enables short development iterations and rapid response to regulatory changes.

Thus, examples of Digital Twin and XPM implementations demonstrate their ability to increase efficiency, reduce risks, and ensure adaptability in a wide range of IT projects — from government to commercial, from technically complex to socially oriented.

Comparative table of Digital Twin and XPM applications in various IT scenarios

Area of application	Role of Digital Twin	Role of XPM	Expected effect
Cloud computing	Load modeling, failure prediction	Flexible response to changing requirements and priorities	Increased scalability and stability
Government e-governance	Simulation of integration processes, analysis of performance during peak loads	Involvement of users in testing, rapid updating of functionality	Reduction in the number of failures, increased transparency of implementation
Financial IT solutions	Analysis of user behavior, modeling of new features	Short development iterations, quick response to regulatory changes	Reduced time to market
Healthcare software development	Testing compatibility with medical devices, checking compliance with standards	Flexible adaptation to regulatory requirements, integration with clinical systems	Increased reliability, compliance with standards

Thus, the optimal combination of Digital Twin and XPM creates a powerful toolkit that simultaneously provides technical reliability, management flexibility, and accelerated innovation, which is critical in today's IT environment.

IMPLEMENTATION OF A COMBINATION OF DIGITAL TWIN AND XPM APPROACHES

As part of the study, a project to create software at European Regional Agency LLC [9] was selected. This company is a regional leader in the development and integration of business process management solutions. In recent years, the company has successfully implemented a number of projects for domestic and foreign clients in the financial sector, telecommunications, tourism, and transportation. One of its main areas of activity is the creation of software for business process automation and project management support. This company was chosen because of its extensive experience and expertise in IT project management. This allows for the exploration of a wide range of methodologies and practical approaches to project management. The high professional competence of the company's employees ensures the high-quality execution of tasks, which is particularly important for the analysis of the experience gained.

The decision to choose a specific project was based on several factors: its scale, complexity, specific features, and existing challenges. It involves the creation of a large software system consisting of numerous modules that different teams are working on. This necessitates the coordination of a large number of resources: human, time, technological, and financial. In addition, the project faces tight deadlines, strict budget constraints, and high requirements for the reliability and quality of the final product. In this context, the implementation of Digital Twin and XPM can be an effective tool for overcoming these difficulties and improving project management performance.

Thus, by implementing digital twins, we have achieved cost reduction, product quality improvement, implementation time reduction, and increased transparency of interaction with users and regulators.

CONCLUSIONS

The integration of Digital Twin and Extreme Project Management concepts opens a new era in managing complex IT projects. This approach is based not only on the technical advantages of digital modeling, but also on the flexibility of management decisions, which allows organizations to quickly adapt to changing conditions and improve the quality of products and services. In the context of digital transformation, companies face increasing challenges related to market dynamics, rapid technological development, cyber threats, and the complexity of user interaction. In this context, the synergy between Digital Twin and XPM allows not only to respond quickly to events, but also to proactively form scenarios of events, increasing the accuracy of forecasts and the effectiveness of implementation.

The use of digital twins in IT projects allows you to create highly accurate virtual models that reflect the current state of the project, identify deviations from expected results, and form simulations of “what-if” scenarios. This, combined with XPM principles, enables adaptive planning, reduces decision-making time, and mitigates risks

at all stages of the project lifecycle. The successful implementation of such a management model depends on the digital maturity of the organization, the level of interdisciplinary interaction, and openness to innovation. The examples from the real sector—cloud computing, e-government, financial platforms, and healthcare—confirm the broad applicability of an integrated approach. All these industries demonstrate similar benefits: reduced costs, improved product quality, shorter implementation times, and increased transparency in interactions with users and regulators. Thus, the effectiveness of combining Digital Twin and XPM can be considered proven from both a theoretical and practical point of view.

The scientific and practical value of the topic lies in its ability to create a new management culture — a culture in which inevitable change is seen as an opportunity for innovation rather than a threat. By integrating digital modeling and agile management, organizations gain powerful tools that support them in strategic thinking, daily activities, and long-term development.

In the future, it will be advisable to further study the economic effect of implementing this approach, develop industry standards for the integration of Digital Twin and XPM, and study their application in crisis management, cybersecurity, and cross-industry IT projects. The issues of digital management ethics, data protection, and ensuring fair access to technology are also important. Thus, the proposed model not only contributes to the transformation of project management but also creates conditions for more responsible, sustainable, and innovative development of the IT industry as a whole.

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