Management

UDC 330.4:004.9:658.152

DOI https://doi.org/10.5281/zenodo.18383231

Smart technologies in investment management

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Accepted: 14.01.2026 | Published: 27.01.2026

Abstract. *The article explores the theoretical, methodological and applied principles of implementing smart technologies in investment management in the context of digital transformation of the economy. It is substantiated that the current stage of investment management development is characterized by the transition from traditional planning and control tools to intelligent decision support systems based on big data technologies (Big Data), machine learning, artificial intelligence, cloud computing and the Internet of Things. The emphasis is on the role of intelligent data analysis. It is proven that the digitalization of investment management is not limited to the automation of individual business processes, but forms a qualitatively new management paradigm, within which decisions are made on the basis of integrated information and analytical platforms that provide synchronization of financial,*

production, marketing and risk-oriented data in real time. The article proposes a conceptual model of smart investment project management that combines modules of predictive analytics, intelligent risk management, digital controlling and automated visualization of management information.

Keywords: *digitalization of management, business analytics, data mining, artificial intelligence, investment project risk, investment project management, information technology, Big Data, digital platforms.*

Смарт-технології в управлінні інвестиційною діяльністю

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Анотація. *У статті досліджено теоретико-методологічні та прикладні засади впровадження смарт-технологій в управління інвестиційною діяльністю в умовах цифрової трансформації економіки. Обґрунтовано, що сучасний етап розвитку інвестиційного менеджменту характеризується переходом від традиційних інструментів планування й контролю до інтелектуалізованих систем підтримки прийняття рішень, заснованих на технологіях великих даних (Big Data), машинного навчання, штучного інтелекту, хмарних обчислень та Інтернету речей. Акцент зроблено на ролі інтелектуального аналізу даних. Доведено, що цифровізація*

управління інвестиційною діяльністю не обмежується автоматизацією окремих бізнес-процесів, а формує якісно нову управлінську парадигму, в межах якої рішення приймаються на основі інтегрованих інформаційно-аналітичних платформ, що забезпечують синхронізацію фінансових, виробничих, маркетингових і ризик-орієнтованих даних у режимі реального часу. У статті запропоновано концептуальну модель смарт-управління інвестиційними проєктами, що поєднує модулі прогнозної аналітики, інтелектуального управління ризиками, цифрового контролінгу та автоматизованої візуалізації управлінської інформації.

Ключові слова: *цифровізація управління, бізнес-аналітика, інтелектуальний аналіз даних, штучний інтелект, ризик інвестиційних проєктів, управління інвестиційними проєктами, інформаційні технології, Big Data, цифрові платформи.*

Statement of the problem. The current stage of development of the world economy is characterized by deep transformation processes caused by the digitalization of almost all spheres of social production and management. Investment activity, which was traditionally considered as a sphere of financial and economic analysis and strategic planning, is increasingly acquiring the features of a high-tech management process based on the integration of information systems, analytical platforms and artificial intelligence tools. In these conditions, classical approaches to investment project management, oriented on linear forecasting models and expert assessments, lose the ability to adequately reflect the dynamics of complex socio-economic systems.

Deepening globalization processes, increasing turbulence in financial markets, increased competition for investment resources and an increased role of institutional investors necessitate a transition to new formats of investment management based on the use of smart technologies. This is not only about

automating financial calculations or electronic document management, but also about the formation of intelligent systems capable of analyzing large amounts of structured and unstructured data in real time, identifying hidden patterns, predicting the results of investment decisions and supporting managers in choosing the best alternatives.

The problem is particularly relevant for economies in transition and countries undergoing structural adjustment and post-crisis recovery. In conditions of limited investment resources and high risk, there is a growing need to improve the quality of management decisions, transparency of the selection and support processes of investment projects, as well as to build trust among domestic and foreign investors. It is smart technologies integrated into the investment management system that can ensure the transition from intuitive and expert models to an evidence-based and analytical paradigm of decision-making.

However, despite the active implementation of digital tools in the financial sector and project management, the issues of systematic use of data mining in investment management processes remain underdeveloped both in theoretical and applied aspects. Existing research often focuses on individual technological solutions – such as business analytics, blockchain or project management platforms – without forming a holistic vision of the transformation of management models in the digital economy [1; 2].

At the same time, the practice of leading international corporations and financial institutions shows that competitive advantages are increasingly formed not due to the volume of capital raised, but due to the ability to effectively manage information flows and knowledge. In this context, smart technologies are not an auxiliary tool, but a strategic resource for increasing the effectiveness of investment activities. The lack of scientifically sound approaches to their integration into management systems limits the potential of digital transformation and reduces the return on investment in digital infrastructure.

ISSN: 2786-9431

Thus, the objective need to understand the processes of digitalization of investment management, the formation of conceptual foundations for the application of smart technologies and intelligent data analysis in the field of investment management determines the relevance of this study. Solving this problem has important theoretical significance for the development of modern economic science and practical value for investment entities seeking to increase the efficiency of investment project implementation in the digital economy.

Analysis of recent research and publications. The issue of introducing smart technologies into the sphere of investment management is actively developing within several interdisciplinary scientific areas: digital economics, investment management, business analytics and artificial intelligence in management. Modern research increasingly emphasizes that digital transformation changes not only the tools, but also the logic of investment decision-making, creating the prerequisites for the transition from intuitive-expert models to data-driven management [3].

The role of big data and analytics in investment portfolio management has received considerable attention in the literature. Machine learning (ML) is a powerful tool for forecasting financial indicators and risks, as confirmed by numerous studies, including analytical reviews of its application in the financial sector to improve forecast accuracy and optimize management decisions [4]. The use of hybrid ML -models for forecasting financial market volatility demonstrates a significant increase in the accuracy of risk assessment compared to traditional approaches, which makes machine learning promising for investment management [5].

A separate layer of research concerns the introduction of smart technologies into the field of investment project management. Thus, modern research shows that the integration of business -analytics systems (Business Analytics, BI) and predictive analytics tools in project management processes contribute to increasing the efficiency of decision-making, improving control over the duration of task

execution, optimizing resource use, and reducing risks. In particular, empirical studies have shown that the use of BA -solutions in project processes allows for increasing the degree of adaptation of projects to the requirements of a dynamic environment and effectively coordinating project activities using real-time data [6; 7]. At the same time, researchers emphasize that the potential of such solutions is fully realized only if they are integrated into the strategic contour of the organization's management.

In domestic scientific literature, the issues of digitalization of investment activities are increasingly considered through the prism of the development of financial technologies, the digital economy and electronic governance. Thus, the works of O. Manoilenko and S. Kuznetsova emphasize the importance of digital financial instruments and automated systems in increasing the efficiency of investment processes at the national level [8]. The analysis of the role of digital platforms in the project management system was carried out in the research of I. Petrova, who considers the conditions for the formation and functioning of digital management platforms at the level of enterprises and territorial communities, taking into account local institutional features [9].

Special attention in modern research is paid to the problems of digital maturity of organizations and their readiness to implement smart technologies. The works of international consulting companies (McKinsey, Deloitte, PwC) prove that the key barriers to the digital transformation of investment management are not technological limitations, but institutional and organizational factors: a shortage of digital competencies of management personnel, fragmentation of information systems, resistance to change [2; 10].

At the same time, in most scientific publications smart technologies are considered fragmentarily - as separate tools for automation or information support of management decisions. Much less often, researchers turn to a comprehensive analysis of the intellectualization of investment management as a systemic process

ISSN: 2786-9431

covering all stages of the investment cycle. In works devoted to the application of artificial intelligence in economics, the high potential of deep learning algorithms in forecasting financial indicators is emphasized, however, the issues of their practical integration into investment management systems remain debatable [11; 12].

Thus, the analysis of scientific sources confirms the presence of a significant body of research devoted to individual aspects of the digitalization of investment activities, but at the same time reveals the need to form a holistic scientific concept of smart management of investment projects based on intelligent data analysis.

Highlighting previously unresolved parts of the general problem. Despite the active development of research in the field of digital transformation of investment management, a number of conceptual and applied issues remain insufficiently developed. First of all, this concerns the lack of unified approaches to interpreting the concept of "smart technologies in investment management". In the scientific literature, this term is used in various contexts - from automated information systems to complex intellectual decision-making support platforms, which complicates the formation of a single methodological basis for research.

The problem of integrating intelligent data analysis into the strategic investment management system remains underdeveloped. Most existing solutions are focused on solving local problems - financial forecasting, risk analysis or project implementation control - but do not form a single analytical circuit capable of ensuring synchronization of management decisions at different levels - from operational to strategic.

Special attention is required to the problem of adapting smart technologies to the specifics of national economies and the institutional conditions of their functioning. A significant part of scientific publications is based on the experience of developed countries with an established digital infrastructure and a high level of institutional trust. In contrast, other challenges are characteristic of transitional economies: fragmentation of information resources, uneven access to digital

services, insufficient data standardization, which significantly affects the possibilities of implementing intelligent investment management systems [13].

Summarizing the above, we can state that the current state of scientific research does not provide for the formation of a comprehensive vision of smart investment management as a systemic process that combines technological, organizational, and institutional components.

Formulation of the objectives of the article (task statement). The purpose of the article is to substantiate the theoretical and methodological principles and develop applied recommendations for the implementation of smart technologies in investment management based on intelligent data analysis in the context of the digital transformation of the economy. To achieve the goal, the article provides for the solution of the following main tasks: to summarize modern scientific approaches to interpreting the essence of smart technologies in the field of investment management and determine their place in the system of digitalization of management; to analyze the role of intelligent data analysis as a tool for increasing the validity of investment decisions at different stages of the life cycle of investment projects; to formulate practical recommendations for the implementation of intelligent analytical platforms in the activities of enterprises, investment funds and public administration bodies. The implementation of these tasks will allow forming a holistic scientific vision of the processes of digitalization of investment management and identifying promising areas of further research in this area.

Presentation of the main material of the study. Based on the systemic and structural-functional approaches, we will build a conceptual model of smart investment management. Generalization of empirical data using economic and statistical methods and methods of intelligent data analysis will allow us to substantiate the effectiveness of the use of digital analytical tools in investment management processes.

Over the past decades, investment management has undergone a significant evolution - from classical financial and economic models based on deterministic forecasts and regulated control procedures to flexible, adaptive systems focused on the use of digital technologies and intelligent data analysis. This transformation reflects the general trends of the transition from an industrial to a digital economy, within which information and knowledge become key factors in creating value [3; 7].

The traditional investment management model assumed a linear logic of decision-making: analysis of financial indicators → formation of investment alternatives → expert risk assessment → project selection → implementation control. In conditions of high dynamics of the external environment, such a model is increasingly proving to be insufficiently effective, as it does not provide a prompt response to changes in market conditions, regulatory requirements and technological trends.

Digitalization of management processes creates the prerequisites for the transition to a nonlinear, network model of investment management, which is based on the integration of heterogeneous information flows into unified analytical circuits. In such a system, management decisions are based not only on retrospective analysis of financial statements, but also on predictive models that take into account the multifactorial nature of investment risks and opportunities.

smart management (smart) is increasingly used in scientific literature. management), which characterizes a new type of management activity based on the use of intelligent information systems capable of self-learning, adaptation and support for decision-making in real time [10; 11]. In the field of investment activity, smart management means the integration of artificial intelligence technologies, machine learning, big data analytics and digital platforms into all stages of the investment cycle.

ISSN: 2786-9431

Smart technologies in investment management should be considered as a set of digital tools and solutions that provide automated processing of large data sets, intelligent support for management decisions, and integration of functional management subsystems into a single information and analytical environment. Unlike traditional information systems, focused mainly on accounting and reporting, smart technologies have the following key characteristics:

– adaptability, which provides the system with the ability to change its functioning algorithms depending on the dynamics of the external environment;

– proactivity, which is manifested in the ability not only to record events, but also to predict their consequences;

– integration, which involves combining financial, operational, marketing and risk-oriented data;

– interactivity, which ensures continuous interaction between users and analytical modules of the system.

In investment management practice, smart technologies are implemented through the use of solutions such as investment portfolio management platforms (Portfolio Management Systems), predictive analytics systems (Predictive Analytics), intelligent risk management modules (AI- based Risk Management), digital dashboards and cloud environments for collaborative project work [14; 15; 16].

A special place among these tools is occupied by data mining systems (Data Mining, Machine Learning, Deep Learning), which allow you to identify hidden patterns in large arrays of financial, production and market information. They form the analytical core of smart management, ensuring the transition from descriptive to predictive and prescriptive analytics. Intelligent data analysis in the field of investment management performs the function of not only information support, but also the active formation of management decisions. Its role is especially growing in conditions of increasing complexity of investment projects, an increase in the

number of data sources (financial markets, social networks, open state registers, corporate information systems) and the need for prompt response to changes in the external environment.

Within the framework of smart investment project management, intelligent data analysis is implemented in several key areas:

1. Forecasting financial results – using regression analysis algorithms and neural networks to estimate future cash flows and project profitability indicators.

2. Risk management – the application of machine learning models to identify the probability of risk events and their potential impact on investment performance.

3. Investment portfolio optimization – the use of evolutionary algorithms and multi-criteria optimization methods to form balanced investment portfolios taking into account the "return-risk" ratio.

4. Monitoring project implementation – application of stream analytics systems (stream analytics) to track the performance of project indicators in real time.

Thanks to this, investment management acquires the features of intellectualized management, within which the key resource becomes not only financial capital, but also the analytical potential of the organization.

In the practice of modern investment management, digitalization takes the form of creating multi-level information and analytical architectures that integrate various functional management subsystems into a single digital circuit. A typical architecture of a smart investment management system includes the following levels:

1) level of data collection – corporate information systems, open state registers, financial markets;

2) storage and processing level – cloud platforms, data centers, distributed storage);

3) analytical level – business analytics tools, predictive and prescriptive analytics, machine learning modules;

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4) management level – decision support systems, digital dashboards, mobile applications for managers.

The integration of these levels ensures the formation of a continuous analytical cycle, within which management decisions are based on current data and adapt to changes in the environment in real time. A special role in this architecture is played by intelligent modules that implement the functions of forecasting, optimization and risk identification. They form the core of smart management, transforming information flows into a source of management value.

The change in the technological basis of management entails a transformation not only of the tools, but also of the management logic. To illustrate these changes, it is advisable to compare the key parameters of the traditional and smart investment project management models (Table 1).

Table 1

Comparative characteristics of approaches to investment project management

Comparison criterion	Traditional model	Smart model
Sources of information	Limited, mostly internal	Integrated internal and external
Analytics type	Descriptive, retrospective	Predictive and prescriptive
Decision making	Expert-intuitive	Data-driven, algorithmic
Risk management	Reactive	Proactive
Execution control	Periodic	Continuous real-time
Management flexibility	Limited	Tall, adaptable
The role of IT	Auxiliary	Strategic

Source: summarized by the authors based on [3; 6; 9; 10; 14; 16]

The above comparison demonstrates that smart management changes the very nature of investment management, transferring it from the plane of administrative control to the plane of intelligent coordination and predictive and analytical management. The effectiveness of digitalization of investment management is largely determined by how deeply intelligent data analysis is integrated into all stages of the investment process. In modern practice, the following key areas of application of analytical tools can be identified (Table 2).

Table 2

Application of intelligent technologies in the process of managing investment projects

Stage of the investment cycle	Main management tasks	Intelligent tools
Project initiation	Opportunity identification, pre-selection	Data Mining, clustering
Preliminary examination	Feasibility assessment, risk analysis	Neural networks, decision tree, scenario method
Planning	Cash flow forecast, budget optimization	Regression models, optimization algorithms
Realization	Monitoring deadlines and costs	Stream analytics, BI systems
Completion	Performance evaluation	KPI analysis, machine learning

Source: summarized by the authors based on [14; 16; 17; 18; 19]

The systematic use of such tools allows to ensure transparency and manageability of investment processes, reduce information asymmetry between project participants, and increase investor confidence.

According to the International Monetary Fund and the World Bank, in 2020–2024, investments in digital project management solutions increased by an average of 18–22% annually, with the segments of predictive analytics and cloud-based investment portfolio management platforms demonstrating the greatest dynamics [13]. OECD analytical reviews show that in EU countries, more than 60% of large companies are already using business analytics and machine learning tools in financial and investment planning processes, while in 2018 this figure did not exceed 35% [20]. Smart technologies are being implemented particularly actively in such industries as infrastructure construction, renewable energy, logistics, and high-tech mechanical engineering.

Despite the obvious advantages of digitalization, the practice of implementing smart technologies in investment project management is accompanied by a number of systemic limitations, including: institutional barriers (insufficient regulatory support, lack of data standards); organizational barriers (staff resistance to change,

lack of digital competencies); technological barriers (fragmentation of IT infrastructure, cyber risks); financial barriers (high initial cost of digital transformation projects). Overcoming these barriers requires not only investments in technology, but also the formation of a digital management culture, which involves changing managerial thinking, developing analytical competencies, and institutionalizing data-driven processes. management.

For a systematic description of digitalization processes, the following conceptual model of smart management is proposed (Figure 1).

Main components of the model:

1. Data sources are internal (ERP, financial, production systems) and external (market, regulatory, social data).

2. Analytics modules – forecasting, portfolio optimization, risk management.

3. Dashboards – interactive visualization of KPIs, scenario modeling.

4. Digital management contours – strategic, tactical, and operational project management.

5. Feedback – updating models and algorithms based on new data.

The diagram shows the data flows from sources to analytical modules, then to management decisions and feedback of the system. Each block is interconnected and operates in real time.

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Figure 1. Conceptual model of smart investment project management

Source: developed by the authors based on [21; 22]

For the practical implementation of smart management, a multi-layered architecture of a digital platform is proposed (Figure 2):

1. Integration layer – provides connection to corporate and external data sources (ERP, CRM, public databases).

2. Analytical layer – implements machine learning algorithms, statistical and optimization models.

3. Interface layer – digital dashboards, mobile applications, tools for teamwork.

4. Security loop – cyber protection modules, data encryption, and access control.

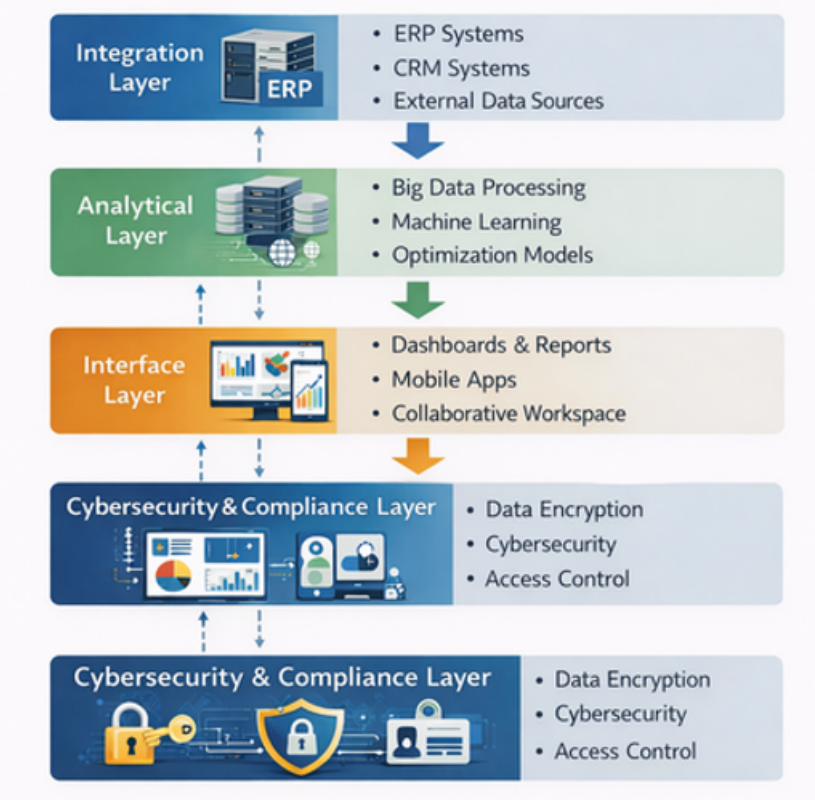

Figure 2. Architecture of a digital investment management platform

Source: developed by the authors

The diagram shows the relationship between the platform layers and the main functional blocks: data collection → processing → analytics → management decisions → feedback.

In the implementation of smart technologies in the management of investment projects:

– renewable energy: implementation of a smart platform for managing a portfolio of solar and wind projects, which is aimed at reducing the time to prepare projects and ensuring increased accuracy of revenue forecasts, as well as mitigating risks from external market fluctuations;

– infrastructure projects: the use of BI systems and predictive analytics modules in the implementation of transport investment projects, which can ensure resource optimization and budget reduction while simultaneously increasing the transparency of the process for public investors.

Conclusions. The conducted research allowed us to identify the following modern directions for the development of smart investment management:

1. Smart technologies as a driver of the transformation of investment project management. The introduction of digital platforms, analytical modules and machine learning tools allows to significantly increase the efficiency of management decisions, reduce project implementation times and reduce financial risks. Smart management becomes not just an automation tool, but a strategic resource for increasing the competitiveness of enterprises and state institutions.

2. Data mining as a key component of digitalization. Using Data tools Mining, Machine Learning and Deep Learning allows you to integrate disparate sources of information, predict risks, optimize investment portfolios, and monitor performance in real time. This enables the transition from descriptive analytics to predictive and prescriptive analytics.

3. Architectural integrity of the smart system. The creation of a multi-level infrastructure, including data collection, analytics, and management levels, ensures the formation of a continuous analytical cycle and an adaptive decision-making system. The conceptual model and digital platforms allow for scenario modeling and operational project management.

4. Implementation challenges and barriers. The main constraints are institutional, organizational, technological, and financial barriers. Overcoming them requires the formation of a digital management culture, the development of analytical competencies, and the standardization of data exchange.

Further development prospects include deepening the integration of smart technologies into state investment projects and public-private partnerships; introducing artificial intelligence to automate strategic portfolio management and forecast the macroeconomic consequences of investments; forming national smart management ecosystems to ensure digital independence and high efficiency of

ISSN: 2786-9431

management processes. The development of intelligent digital twins of projects for scenario modeling and risk management is also promising.

Thus, smart technologies become the foundation of modern investment management, ensuring intellectualization of decision-making, transparency of processes, and adaptability to changes in the external environment.

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