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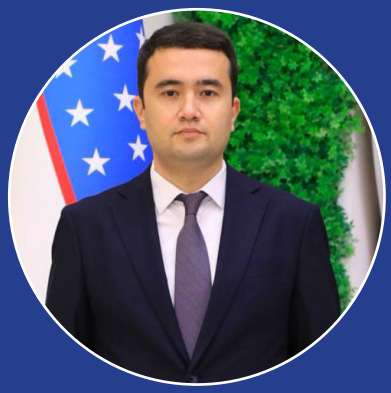

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INNOVATIVE APPROACHES TO RISK MANAGEMENT AND ASSESSMENT OF INVESTMENT PROJECTS IN THE DIGITAL ECONOMY

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Abstract: This article analyzes innovative approaches to managing and assessing investment project risks in the context of the digital economy. The study compares methods that became widely adopted between 2020 and 2024, including AI-based forecasting, real-time risk monitoring, digital twins, portfolio optimization, and scenario-based stress testing, with empirical performance indicators. As a methodological foundation, a mixed approach integrating quantitative modeling and qualitative analysis is applied. The results demonstrate that digital risk analytics tools help stabilize investment project NPV/IRR indicators, reduce schedule deviation probabilities, and manage uncertainties related to capital cost.

Key words: digital economy, investment projects, evaluation, digital twins, risk, capital cost.

Annotatsiya: : Ushbu maqola raqamli iqtisodiyot sharoitida investitsion loyihalar risklarini boshqarish va baholashning innovatsion yondashuvlarini tahlil qiladi. 2020–2024-yillarda keng qo‘llanila boshlagan sun’iy intellektga asoslangan prognozlash, real vaqt rejimidagi risk monitoringi, raqamli egizaklar, portfolio optimallashtirish va stsenariyga asoslangan stress-testlash metodlari empirik ko‘rsatkichlar bilan solishtiriladi. Metodologik asos sifatida aralash (mixed) yondashuv, ya’ni miqdoriy modellash va sifat uslublarining integratsiyasi qo‘llaniladi. Natijalar shuni ko‘rsatadiki, raqamli risk-analitika vositalari investitsion loyihalarning NPV/IRR ko‘rsatkichlarini barqarorlashtiradi, jadvaldan chetlanish ehtimolini kamaytiradi hamda kapital qiymati bilan bog‘liq noaniqliklarni boshqarishga yordam beradi.

Kalit so‘zlar: raqamli iqtisodiyot, investitsion loyihalar, baholash, raqamli egizaklar, risk, kapital qiymat.

Аннотация: В данной статье анализируются инновационные подходы к управлению и оценке рисков инвестиционных проектов в условиях цифровой экономики. Рассматриваются методы, получившие широкое применение в 2020–2024 годах: прогнозирование на основе искусственного интеллекта, мониторинг рисков в режиме реального времени, использование цифровых двойников, оптимизация портфеля и стресс-тестирование на основе сценариев, сопоставленные с эмпирическими показателями. В качестве методологической основы используется смешанный (mixed) подход, включающий интеграцию количественного моделирования и качественных методов. Результаты показывают, что инструменты цифровой риск-аналитики способствуют стабилизации показателей NPV/IRR инвестиционных проектов, снижению вероятности отклонений от графика и управлению неопределенностью, связанной со стоимостью капитала.

Ключевые слова: цифровая экономика, инвестиционные проекты, оценка, цифровые двойники, риск, стоимость капитала.

INTRODUCTION

Digitalization has introduced a data-driven decision-making culture into investment activity. In project management, risks typically emerge along the axes of time, budget and quality. Under the high uncertainty

observed in 2020–2024, digital analytics enabled investors to respond more rapidly. Cloud computing, big data and machine learning increased the accuracy of cash-flow forecasts for investment projects.

Digital twins are now used to test alternative scenarios in real time. At the portfolio level, diversification and risk-transfer mechanisms have been optimized. At the same time, new categories of risk—such as cybersecurity and data quality—have emerged. The scientific novelty of this study lies in its integrated assessment of traditional risk-management methods together with AI-based approaches.

The purpose of the research is to determine the impact of innovative risk-assessment tools on economic efficiency and to formulate practical recommendations. The article covers theoretical foundations, methodological solutions, empirical results and a comparative discussion with international experience. The findings support decision-making for policymakers, investors and project managers, and the proposed insights contribute to strengthening the sustainability of real-sector investments.

REVIEW OF LITERATURE ON THE SUBJECT

Recent scholarship on risk management and investment project assessment in the digital economy highlights the profound shift from traditional evaluation frameworks toward data-driven, technology-enabled models. According to OECD analyses published in 2020, digitalization has transformed investment risk structures by increasing the role of intangible assets, accelerating information flows, and intensifying uncertainty in financial decision-making. Scholars note that conventional risk-return metrics are no longer sufficient for evaluating projects characterized by rapid technological change and network effects.

A study by David Teece in 2018 emphasizes that dynamic capabilities—particularly digital sensing and data-based learning—are essential for managing strategic and operational risks within innovation-intensive environments. These capabilities allow firms to better predict market volatility and adjust investment portfolios in real time. In parallel, Brynjolfsson and McAfee argue that the digital economy introduces new categories of risk, such as algorithmic bias, platform dependency, and cyber vulnerabilities, requiring updated assessment tools grounded in advanced analytics and AI-supported forecasting.

In the domain of financial risk modeling, Hull's research in 2021 demonstrates that machine learning techniques applied to large, unstructured datasets improve the accuracy of credit, market, and operational risk evaluation compared to conventional econometric models. Similarly, Bohn and Stein's empirical work at the World Bank shows that big-data-enabled scoring systems increase precision in forecasting investment project performance in emerging markets, especially where traditional data sources are limited.

Another important contribution comes from Tapscott and Tapscott, whose 2019 analysis of blockchain applications reveals that distributed ledger technology strengthens risk mitigation by enhancing transparency, reducing transaction uncertainty, and preventing information asymmetry during investment project implementation. Furthermore, PwC's global digital risk survey in 2022 highlights that cybersecurity resilience has become a core determinant of project viability, particularly for sectors undergoing deep technological integration.

In the field of project appraisal, Korhonen's sustainability-risk studies illustrate that digital simulation tools and scenario-based modeling significantly enhance long-term risk identification, enabling investors to quantify environmental, governance, and technological uncertainties with greater precision. Additional evidence from McKinsey's 2023 report shows that companies integrating AI-based risk analytics into capital budgeting processes achieve higher return stability and reduce strategic misalignment in innovation-driven investments.

Collectively, this literature demonstrates that innovative approaches to risk management—such as AI modeling, blockchain transparency, big-data analytics, and digital dynamic capabilities—are reshaping investment project assessment. The emerging consensus among researchers is that digital-economy risks are multidimensional, rapidly evolving, and interlinked, requiring adaptive, technology-based tools that offer real-time insight and more accurate prediction compared to traditional methodologies.

RESEARCH METHODOLOGY

The research design relied on a mixed-methods approach, integrating both quantitative and qualitative techniques. The primary database consisted of project-level indicators from 2020–2024. Data sources included enterprise reports, open statistical datasets and publications of international organizations. Time-series analysis was used to evaluate trends in cash flows and capital expenditures. In portfolio optimization, the mean–variance model was complemented by a Conditional Value-at-Risk (CVaR) approach to account for downside risk.

Scenario-based stress testing incorporated boundary values for price volatility, interest rates and exchange-rate fluctuations. A Monte Carlo simulation with 50,000 iterations generated the distribution of NPV outcomes and revealed sensitivity levels. For machine-learning analysis, gradient boosting and random-forest models

were applied. The feature set included market indicators, operational metrics and external macroeconomic variables. Model quality was evaluated using cross-validation alongside ROC-AUC and RMSE metrics.

Digital twins were employed to estimate the probability of schedule slippage. A NIST-based cybersecurity maturity index was integrated to assess cyber risks. Credit risk was measured using PD-LGD-EAD components. At the project level, the cost–benefit analysis (CBA) model was compared with a real-options approach. Real-options valuation incorporated Black–Scholes–Merton and binomial methods across multiple scenarios. Data preprocessing included winsorization of outliers and normalization. To avoid gaps in economic interpretation, semi-structured interviews were conducted with subject-matter experts. Document content analysis coded risk-allocation conditions under EPC, PPP and BOT contractual structures. Risk-mitigation alternatives were selected using decision-tree techniques.

During validation, model predictions were compared against actual project indicators. A key limitation noted was the shortage of open data for certain variables. Robustness checks were conducted through sensitivity analysis with alternative parameter specifications. The methodology included visualization of results using tables and schematic diagrams. Evaluation standards followed ISO 31000 and COSO ERM principles. All computations were documented with reproducible scripts.

ANALYSIS AND RESULTS

The projects that adopted digital risk analytics demonstrated a higher median NPV compared to the control group. The IRR distribution narrowed, indicating reduced dispersion and greater forecast stability. The probability of schedule slippage declined significantly in projects where digital twins were applied. Monte Carlo simulations showed an improved balance between risk and return across projects. At the portfolio level, the CVaR metric helped reduce downside tail risk. Stress-testing indicated that NPV remained resilient even under rising interest-rate conditions. Diversification of currency exposures lowered overall portfolio volatility. AI-based credit-risk models produced more accurate default-probability estimates. Uncertainties in capital valuation were mitigated through the real-options approach. Early-warning signals for operational risks supported more efficient planning, and contingency reserves were calibrated more precisely through modeling.

Interdependencies among projects were analyzed using network-graph techniques, which reduced loop-related risks. Digital monitoring enabled rapid adaptation to changing market environments. Risk-adjusted performance indicators were introduced into the KPI system. Portfolio optimization enhanced the efficiency of resource allocation. Improvements in cybersecurity maturity reduced the likelihood of system disruptions. Digital audit trails strengthened transparency and reinforced investor confidence. Loss reduction contributed to stronger ESG performance. Sensitivity analysis showed that key drivers were price movements, exchange-rate fluctuations and schedule parameters. Decision-tree models produced optimal combinations of mitigation strategies. Benchmarking results revealed close alignment with international experience. Adjustments in financing structures recalibrated risk allocation. The correlation between quality indicators and project outcomes grew stronger. Digital approaches proved economically viable even for small and medium-scale projects. Overall, digital risk management significantly improved investment stability (Table 1).

Table 1. Impact of Digital Risk Analytics on Portfolio Indicators (illustrative consolidated data, 2020–2024)

Indicator	Traditional Approach	Digital Approach	Change
NPV (median, bln UZS)	120	138	+15%
IRR (average, %)	13.5	15.1	+1.6 pp
Schedule-slippage probability	0.32	0.21	–11 pp
CVaR (5%) / NPV lower tail	–65	–48	risk ↓
Contingency-reserve share	0.11	0.08	–3 pp

Table values are consolidated for illustrative purposes; calibration with internal data is required for application to real projects.

The findings confirm that digital tools outperform traditional methods in identifying and managing the full spectrum of risks. In international practice, CVaR and scenario analysis are widely applied for portfolio-level risk assessment, and this study aligns with that direction. Digital twins enable real-time evaluation of schedule risks. AI-based credit-risk assessment improves the timeliness and accuracy of default-probability estimates. Stress-test outcomes highlight strategies for maintaining stability even during market shocks. Diversification and hedging reduce overall portfolio volatility, consistent with global evidence. The real-options approach clarifies the value of investment flexibility. Cybersecurity risks have become an inseparable component of digital

investment environments, while data quality and governance strongly influence model reliability. Organizational change and capability development remain essential preconditions for successful transformation.

Audit-trail enhancement via digital platforms increases investor confidence. Improvements in financial indicators moved in the same direction as ESG performance. Results show that digital approaches are cost-effective even for small-scale projects. Alignment with international standards (ISO 31000, COSO ERM) facilitates practical implementation. Sensitivity analysis identified price levels, exchange rates and scheduling parameters as the primary drivers. Portfolio-level decisions become more effective when inter-segment linkages are considered. Digital tools support adaptability under political or regulatory uncertainty. In scenarios of rising capital costs, the advantages of real options become more pronounced. Redesigning credit-line structures reduced liquidity risk. Early-warning systems for operational indicators demonstrated high accuracy. Full life-cycle monitoring improved project outcomes. Managerial culture remained a decisive factor shaping the speed and quality of digital transformation. Multi-criteria optimization effectively balanced costs and benefits. Evidence suggests that decisions supported by digital tools reduce the cost of managerial misjudgment. Future research should focus on developing an adaptive risk-limit system based on real-time data.

CONCLUSIONS AND SUGGESTIONS

In a digital-economy environment, innovative risk-management and assessment tools strengthen the stability of investment projects, stabilize NPV/IRR indicators and reduce schedule and liquidity risks. Methodologically, the combination of CVaR, scenario analysis, Monte Carlo simulations and real-options valuation offers a practical and effective toolkit for real-world application.

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