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Digital cost-control systems in international project activities and investment decision-making

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Abstract: The purpose of the article *is to deepen approaches to cost management and investment decision making in international projects through the development of an integrated digital model capable of overcoming the time and information gap between the emergence of financial deviations and managerial response by combining data, predictive risk analytics, and formalized managerial imperatives.* ***Methods:*** *The study applies systemic and structural functional analysis, comparative analysis of contemporary standards and digital cost management tools, as well as methods of predictive analytics and risk oriented modeling, which formed the basis for the development of the author's framework concept «Cyber Physical Investment Governance» (CPIG) using vector cost decomposition and the «Multidimensional Adaptive Investment Control» algorithm (MAIC).* ***Results:*** *The concept of «Cyber Physical Investment Governance» (CPIG) has been developed, which implements an end to end cyber physical architecture for managing the investment cycle through sensory, cognitive, protocol, and execution layers. Five cost vectors are defined as the basis for causal interpretation of deviations, and a system of six investment imperatives is formed, strictly linked to forecasted risk levels and the phases of the international project life cycle.* ***Conclusion:*** *The proposed model ensures a transition to more effective, proactive, evidence based, and partially automated investment decision making, expanding theoretical perspectives on digital investment management and creating practical prerequisites for improving the validity, speed, and resilience of managerial decisions under conditions of high uncertainty in the international environment. The*

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proposed concept also makes it possible to formalize the cause and effect relationship between risk, costs, and managerial action in real time, creating a foundation for scaling the CPIG framework in complex multi project and transnational investment portfolios.

Keywords: *cyber physical investment governance, digital cost control systems, international projects, investment decision making, vector cost decomposition, predictive risk analytics, CPIG framework, MAIC algorithm.*

Цифрові системи контролю витрат у міжнародній проєктній діяльності та прийняття інвестиційних рішень

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Анотація: Метою статті є *поглиблення підходів до управління витратами та прийняття інвестиційних рішень у міжнародних проєктах шляхом розроблення інтегрованої цифрової моделі, здатної подолати часово-інформаційний розрив між виникненням фінансових відхилень і управлінським реагуванням через поєднання даних, прогнозної аналітики ризиків і формалізованих управлінських імперативів.* ***Методи****: У роботі застосовано системний і структурно-функціональний аналіз, порівняльне дослідження сучасних стандартів і цифрових інструментів управління вартістю, методи предиктивної аналітики та ризик-орієнтованого моделювання, що лягли в основу побудови авторської концепції фреймворку «Управління кіберфізичними інвестиціями» (CPIG), із використанням векторної декомпозиції витрат і алгоритму «Багатовимірного адаптивного інвестиційного контролю» (MAIC).* ***Результати:*** *Розроблено концепцію «Управління кіберфізичними інвестиціями» (CPIG), який реалізує наскрізну кібер-фізичну архітектуру управління інвестиційним циклом через сенсорний, когнітивний, протокольний і виконавчий рівні, а також визначено п'ять векторів витрат як базу причинної інтерпретації відхилень і сформовано систему шести інвестиційних імперативів, жорстко пов'язаних із прогнозними рівнями ризику та фазами життєвого циклу міжнародного* *проєкту.* ***Висновок:*** *Запропонована модель забезпечує перехід до більш ефективного випереджального, доказового й частково автоматизованого прийняття інвестиційних рішень, розширюючи теоретичні уявлення про цифрове управління інвестиціями та створює практичні передумови для підвищення обґрунтованості, швидкості та стійкості управлінських рішень в умовах високої невизначеності міжнародного середовища. Запропонована концепція також дозволяє формалізувати причинно-наслідковий зв'язок між ризиком, витратами та управлінською дією в реальному часі, що створює основу для масштабування фреймворку CPIG у складних багатопроєктних і транснаціональних інвестиційних портфелях.*

Ключові слова: *кіберфізичне управління інвестиціями, цифрові системи контролю витрат, міжнародні проєкти, прийняття інвестиційних рішень, векторна декомпозиція витрат, предиктивна аналітика ризиків, фреймворк CPIG, алгоритм MAIC.*

Problem statement. In contemporary international project practice, digital cost-control systems are developing unevenly, which creates a substantial temporal and informational gap between the moment investment deviations arise and the moment managerial decisions are made. Existing standards, methodologies and management systems such as «PMBOK», «EVM», «Balanced Scorecard», «ERP», «SaaS», «Blockchain», «AI-based forecasting» and «RAMP» address individual aspects of cost management, yet they do not provide a continuous and causally integrated mechanism for transitioning from data to investment action. The core problem lies in the absence of a digital architecture capable of ensuring synchronized data collection, vector interpretation, predictive risk assessment and instantaneous formation of a normatively justified investment decision. As a result, international projects face cost overruns, delays, subjective decision making and the inability to respond to risks proactively, which underscores the need for a new digital model for managing the investment cycle of international projects.

Analysis of recent research and publications. Analysis of contemporary scientific approaches to project cost management and digital cost-control systems shows that existing models interpret the relationship among cost, data and managerial accountability in different ways. Each system emerged as a response to specific managerial challenges, therefore standards, methods and digital platforms should be viewed as autonomous, albeit potentially synergistic, elements within the context of international projects. This position is empirically reinforced by Varajão J., Marques R. P., Trigo A. [1], who demonstrate that the success of information systems projects is directly linked to the maturity and integration of project management processes, including cost control, governance structures and formalized feedback loops. Their findings confirm that digital tools applied in isolation, without an embedded decision-making logic and managerial accountability, do not generate sustainable performance effects, especially in complex and international project environments. The foundational methodological structure is defined by «A Guide to the Project Management Body of Knowledge» (PMBOK Guide) issued by the Project Management Institute [2], where cost management is presented as a regulated process of budgeting and deviation control that ensures normative consistency, yet retains a retrospective character. Its applied instrument is the «Earned Value Management» (EVM) system, which increases the accuracy of comparing planned and actual expenditures, although it does not provide a strategic interpretation of results [2]. The strategic approach of the «Balanced Scorecard» developed by Kaplan R. S., Norton D. P., Ansari S. [3] establishes a causal logical link among costs, operational processes and the long-term objectives of an organization, integrating financial and non-financial indicators. In contrast, integrated «Enterprise Resource Planning» (ERP) systems conceptualized by Laudon K. C., Laudon J. P. [4] focus on the centralization and standardization of financial data, creating the infrastructural basis for cost management without a strategic analytical module. Further development of this logic is demonstrated by cloud-based «Software as a Service» (SaaS) platforms described by Westerman G., Bonnet D., McAfee A. [5], which ensure the availability of financial data through continuous synchronization but do not change the decision-making mechanism itself. Sector-specific evidence of this limitation is provided by Pentury C., Karsaman R. H., Rahman H., Rosmansyah Y. [6], who analyze the application of digitalization and computerization technologies in road construction projects. While these technologies significantly improve operational transparency, cost traceability and execution efficiency, the authors emphasize that strategic cost governance and anticipatory investment control remain weakly formalized and largely external to prevailing digital construction platforms. The decentralized approach proposed by Iansiti M., Lakhani K. [7] in the concept of Blockchain and Smart Contracts guarantees immutability of transactions, although it does not address forecasting or cost-modelling tasks. AI-oriented cost-prediction models presented by Davenport T. H. [8] within the framework of «AI-Driven Cost Prediction Models» enable proactive risk identification, yet they leave open the question of how to integrate these forecasts into a regulated decision-making process. A similar structural gap is identified in the analysis of business intelligence applications conducted by Golestanizadeh M., Sarvari H., Chan D. W., Banaitienė N., Banaitis A. [9]. Their study shows that BI systems enhance managerial insight, analytical depth and forecasting accuracy in construction companies, while functioning primarily as advisory instruments that lack an internalized mechanism for converting analytical outputs into obligatory managerial or investment actions. The risk-oriented logic of «Risk Analysis and Management for Projects» RAMP, developed by Flyvbjerg B., Bruzelius N., Rothengatter W. [10], explains the behavioral nature of cost overruns but does not propose a digital architecture for their systemic mitigation. The concept closest to an integrated model is the «Digital Twins of Organization» (DTO) framework described by Marr B. [11], which allows simulation of management scenarios, although it does not form a normative mechanism for converting

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analytical results into concrete investment actions. In summary, the conducted analysis of research and publications indicates that the reviewed approaches should be regarded as complementary but conceptually distinct instruments that describe individual components of cost management, whereas international projects require a unified model capable of integrating data, analytics, forecasting and an enforceable mechanism of managerial action.

Highlighting previously unresolved parts of the general problem. The scientific sources analyzed in the article provide an integrated understanding of the evolution of cost-management instruments, yet each of them addresses only specific aspect-level tasks and does not eliminate the core problem of the temporal and logical-informational gap between the emergence of costs in international projects and the adoption of investment decisions. The «PMBOK» Guide and «EVM» systematize planning and deviation control, but they retain a predominantly retrospective character, while the Balanced Scorecard does not ensure automatic transformation of analytics into concrete investment scenarios. «ERP», «cloud platforms» and «Blockchain» technologies increase the accessibility and reliability of data, yet they do not resolve forecasting challenges or the need for managerial action, and «AI», «RAMP» and behavioral approaches either explain or predict risks without integrating them into a continuous digital algorithm. The same applies to the «Digital Twins of Organization» concept, which does not establish a normatively binding transition from operational simulation to effective automated decision-making measures. This gap is addressed by the author's concept of «Cyber Physical Investment Governance» (CPIG) supported by the «Multidimensional Adaptive Investment Control» (MAIC) algorithm, which enables a transition from recommendation-based analytics to an imperative management model. Vector decomposition of costs ensures clear identification of the sources of financial deviations, the cognitive core provides predictive risk assessment in the form of a

Risk Score and the protocol and execution layers transform it into a normatively compliant decision with minimal temporal delay for managerial action.

Formulation of the objectives of the article (task statement). The purpose of the article is to conceptualize and justify the «Cyber Physical Investment Governance» (CPIG) framework as an integrated model of continuous cyber physical investment management in international projects. To achieve this aim, the following tasks are defined: 1) Conduct a critical analysis of modern digital cost control systems and identify the limits of their functional applicability in the context of investment management; 2) Determine the systemic barriers to their implementation and the logic of interaction among technological, organizational and regulatory factors; 3) Develop the architectural model of CPIG that includes the sensory, cognitive, protocol and execution levels; 4) Justify the use of vector decomposition of costs and the MAIC algorithm for predictive risk assessment and for converting this assessment into a formalized investment imperative; 5) Demonstrate how the CPIG model eliminates the temporal gap between the emergence of risk and managerial action and provides a coherent foundation for decision making in international projects.

Presentation of the primary material of the study. Since investment decision making is based on explicit metrics, and digital systems do not change the calculation formula itself but rather the quality of input data and the speed of their processing, it is necessary to examine how digital tools and control technologies influence the accuracy of investment metrics, see Table 1

Table 1

Impact of digital tools and control technologies on the accuracy of investment metrics

Investment metric	Traditional calculation	Digital approach	Impact on investor decisions
NPV	Calculated at the start, rarely revised	Dynamic NPV updated with each transaction	The ability to stop the project early if the NPV becomes negative.

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IRR	Based on assumptions and historical data	Based on predictive models and Big Data	More realistic assessment of the return on capital.
PBP	Static forecast	Rolling Forecast	More accurate understanding of the terms of return on investment.
ROI	Often calculated post factum	Online ROI monitoring in dashboards	Prompt reallocation of resources to more profitable stages.
EBITDA проєкту	Reported quarterly/monthly	Real-time reports	Instant response to a decrease in operational efficiency.
CAPEX / OPEX ratio	Fixed in budget, difficult to change	Flexible management, Everything as a Service model	Optimization of the tax burden and cost structure.
Burn Rate	Controlled upon statement of account	Forecast based on contractual obligations	Prevention of premature exhaustion of financing.
WACC	Static discount rate	Rate adjustment according to current risks	Adequate assessment of the cost of capital raised.

Source: created by the author based on [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15]

The analysis presented in Table 1, clearly demonstrates how the logic of investment analysis changes under the influence of digital control tools and data processing technologies, within which classical financial metrics such as net present value (NPV) and internal rate of return (IRR) cease to function as static reference points and gradually transform into continuously updated managerial indicators [12]. The shift from a one time calculation to dynamic indicator revision means that these metrics no longer reflect a conditional outcome of initial assumptions but instead capture the current financial state of the project, taking into account ongoing transactional flows and changes in the risk profile. This is especially evident in the real time revision of NPV in data driven analysis [12, 13]. Within this context, the integration of predictive models and streaming data significantly reduces the gap between planned and actual IRR values. This ensures a more realistic assessment of capital profitability and increases the sensitivity of managerial decisions to early signals of deviation. A similar logic can be observed in the transformation of the payback period (PPB) and return on investment (ROI). In a digital environment these metrics lose their inertial character and begin to function as operational reference points for reallocating resources among project phases according to their actual efficiency [14]. The growing importance of real time reporting changes the approach to interpreting operational metrics, particularly the EBITDA indicator, because its management shifts from post factum monitoring to immediate reaction when efficiency declines. In parallel, the relationship between CAPEX and OPEX is no longer a rigid budgetary parameter. It evolves into a flexible instrument of financial management that optimizes cost structure and tax exposure. Control of the burn rate, which in a digital model is based on forecasting contractual obligations, reduces the risk of premature depletion of funding and strengthens the financial resilience of the project. The final element of this transformation is the adjustment of the weighted average cost of capital that accounts for current risks. This provides a more accurate representation of the cost of mobilized financial resources [15].

Despite these advantages, the implementation of digital systems in international project activities encounters several barriers that must also be considered, see Table 2.

Table 2

Barriers to the implementation of digital cost control systems in international projects

Barrier category	Problem description	Cause of occurrence	Ways to overcome
Technological gaps	Incompatibility of IT landscapes in different countries	Different levels of development of branch infrastructure	Using cloud solutions and API integrators
Staff resistance	Sabotage of new systems, unwillingness to be transparent	Fear of job loss, «shadow» income, habits	Change Management, motivation system, training
High cost	Significant initial investment in licenses and hardware	Complexity of Enterprise systems architecture	Switching to a subscription model (SaaS), phased implementation
Data security	Threat of cyberattacks and industrial espionage	Vulnerability of data transmission channels	Encryption, Blockchain, cybersecurity policies
Legal conflicts	GDPR and local data retention laws	Requirement to store personal data on local servers	Hybrid clouds, local data centers
Data quality	The principle of «GIGO» (Garbage In, Garbage Out)	Lack of data entry standards (MDM)	Implementing Master Data Management, data cleansing

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Cultural differences	Different perceptions of control in different cultures	Mental characteristics (Asia vs Europe vs USA)	Adapting interfaces and procedures to the local mentality
Complexity of support	Vendor dependency, complexity of updates	Uniqueness of customized processes	Using standard configurations (Best Practices)

Source: created by the author based on [1, 4, 6, 9, 10, 11, 12, 13, 14, 15]

The data in Table 2 show the system of barriers to digital cost control in international projects, where each factor influences technical, organizational and legal decisions at the same time. This creates situations in which adjusting one element alters the operation of others and determines the limits of further integration. Technological fragmentation among countries generates infrastructure asymmetry, limits data compatibility and narrows the set of tools that can be used for coordinated cost control [12]. As a result, companies shift to cloud platforms and API solutions that stabilize data exchange and form the technical foundation on which the configuration of managerial processes and the logic of personnel work already depend. Employee resistance arises because of changes in access to information and redistribution of responsibility. Digital control therefore reshapes behavioral models and reduces informal room for maneuver. This turns workforce reactions into a critical factor capable of halting digital transformation even when the infrastructure is technically ready [13]. Financial constraints introduce additional factors, since the cost of licenses and equipment affects investment behavior of management and reduces readiness for large scale changes in complex enterprise systems. SaaS models and phased implementation become instruments that redistribute financial risks, reduce cost concentration and create greater flexibility in selecting the technical architecture. Data security determines the level of trust in digital platforms and shapes a decision making border in which even significant technological advantages lose relevance without protected communication channels. Cyber threats and industrial espionage risks change the criteria for system selection and force companies to apply encryption, access control and protective protocols that influence the overall architecture of the digital environment [1, 14]. Legal requirements define the limits within which an organization can operate and determine parameters for data storage and processing. Digital control is therefore implemented under external regulatory constraints that require combining cloud services with local data centers and adjusting information flow routes. Data quality sets the boundary for the accuracy of managerial decisions, because lack of standardization, input errors and uneven data structures create systemic distortions that undermine the benefits of analytical tools. Master data management and information integrity control thus become fundamental conditions for the functioning of the entire system. Cultural differences among regions change the logic of interaction with digital tools, since managerial styles in Asia, Europe and the USA interpret user autonomy and procedural discipline in different ways. This makes the adaptation of interfaces, algorithms and regulations an essential part of implementation and directly affects the speed of technology adoption. System support complexity arises from process customization and vendor dependence. Excessive modification of a digital platform creates long term risks for scalability and stability, while reliance on standard configurations and proven practices ensures manageability of the technical landscape and reduces maintenance costs [6, 15].

After analyzing digitalization barriers, the author developed the conceptual framework of cyber physical investment management known as CPIG (Cyber Physical Investment Governance). This framework aims to initiate a transition from discrete cost control to continuous regulation of the investment cycle.

To visualize the operational logic of the CPIG concept, a demonstration scheme of vertical integration of data flows is developed, see Fig. 1.

The concept of the Cyber Physical Investment Governance (CPIG) framework in Fig. 1 illustrates an end-to-end data flow through four functional levels. Each level performs an essential role in transforming an initial signal into a mandatory investment imperative. The defining feature of the concept is vertical causal logical interdependence, where no subsequent level can function independently of the one that precedes it: ***Level 1. The sensory layer (Data Sensorium)*** forms the empirical foundation of the system through synchronized aggregation of financial, physical, market and regulatory data. The ERP core captures internal transactions and structures costs by organizational responsibility centers. Supply Chain IoT translates physical events into digital signals and removes the gap between accounting records and the actual movement of resources. Global market data and banking and compliance modules introduce external macroeconomic variables into the model, including exchange rates, market interest rates, sanction restrictions and ESG requirements. ***Level 2. The cognitive core (Cognitive Core)*** performs analytical interpretation of aggregated data and converts them into a formalized risk assessment. Data preprocessing ensures cleansing, temporal coherence and information protection. After this, the MAIC engine moves from description to prediction through machine detection of patterns. The risk scoring system condenses multidimensional uncertainty into a numerical scale from 1 to 10. The digital twin provides scenario modelling of alternative project trajectories and dynamic calculation of NPV and IRR before physical implementation of decisions. ***Level 3. The governance protocol layer (Governance Protocol)*** transforms the analytical result into a normatively acceptable managerial decision. Stage gate logic aligns decisions with the phase of the project life cycle. The budget validator checks budgetary and currency constraints. The decision matrix determines a single permissible scenario of action known as the imperative. Compliance guard filters legal, anti corruption and ethical risks. ***Level 4. The actuator layer (Actuator Layer)*** completes the managerial action by converting the investment imperative into a physically executable operation. The fintech actuator influences financial flows. Smart contracts automate contractual obligations. The procurement bot implements changes in procurement. Physical control provides direct physical influence on managed assets.

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The analytical logic of CPIG is based on five cost vectors that form the complete space for causal interpretation of deviations:

Vector 1. The macroeconomic vector (Macro Economic Vector) separates systemic external shocks from internal managerial errors.

Vector 2. The supply chain vector (Supply Chain Vector) links financial overruns to physical disruptions in supply.

Vector 3. The technological vector (R&D Vector) identifies losses caused by the loss of technological relevance of the product.

Vector 4. The operational vector (Operational Vector) reveals internal managerial dysfunctions without changes to strategic parameters.

Vector 5. The regulatory vector (Regulatory Vector) enables early diagnostics of legal and compliance risks.

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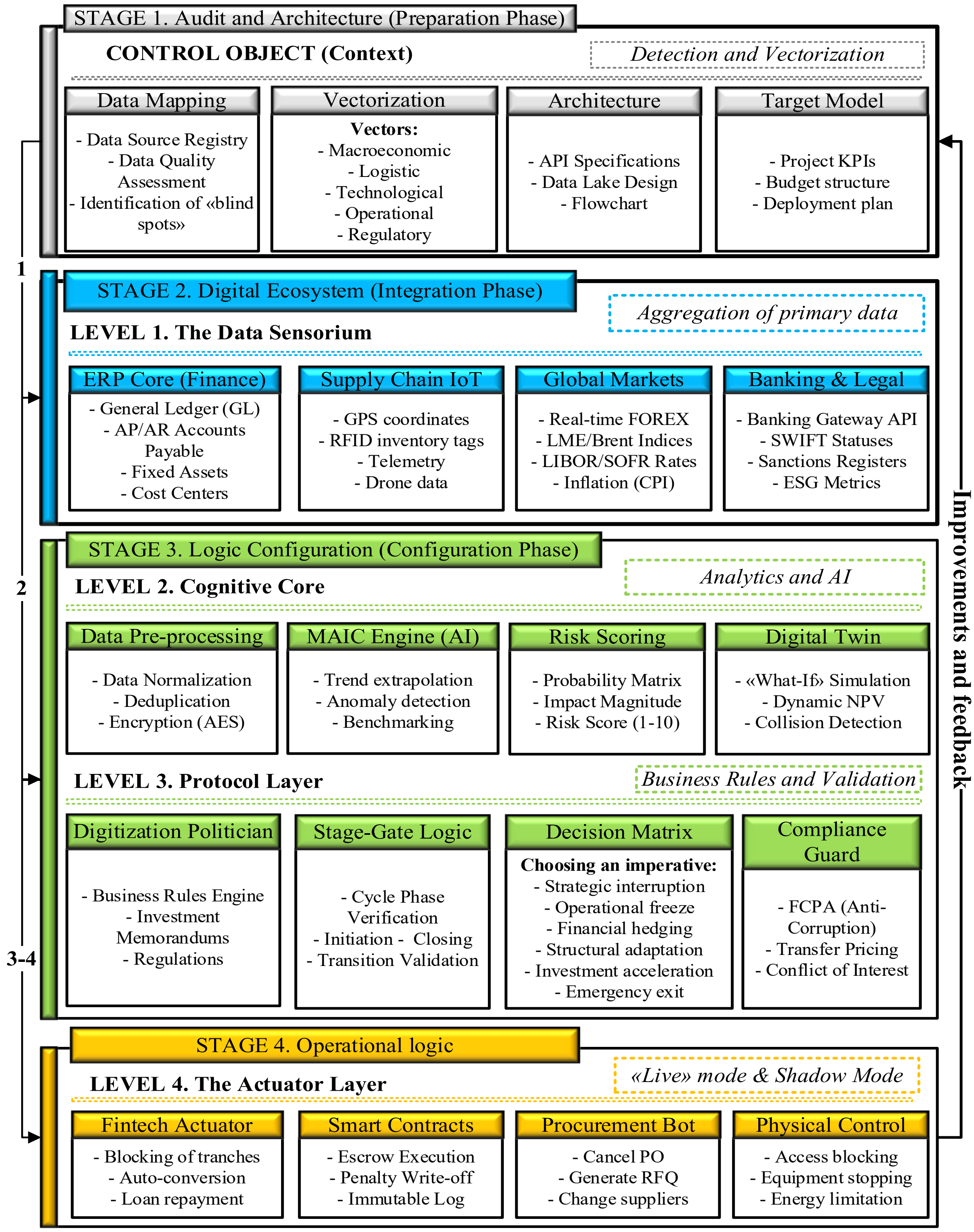

Fig. 1 Concept of the cyber physical investment governance framework (CPIG)

Source: created by the author

The output of the cognitive core is the formation of one of six investment imperatives that are strictly linked to the risk score and the life cycle phase:

Imperative 1. Strategic interruption (INTERRUPTION). Applied when the risk score ranges from 9 to 10 at early life cycle stages. This occurs when cumulative risk has a systemic nature and is simultaneously driven by several vectors, particularly macroeconomic, regulatory or technological ones. Under such conditions the projected cost trajectory demonstrates irreversible growth of capital loss risk and the possibility of neutralizing this risk within other imperatives is absent. The managerial logic of INTERRUPTION is the controlled discontinuation of the project in order to minimize future non recoverable losses when preservation of the asset itself becomes a source of additional risk. ***Imperative 2. Operational freeze (FREEZE).*** Triggered when the risk score ranges from 7 to 8 in situations where risk is high but has a temporary or cyclical nature and is concentrated mainly within the macroeconomic or supply chain vectors. This refers to scenarios where adverse external conditions significantly increase uncertainty but do not undermine the internal investment viability of the project. FREEZE allows the system to lock the current level of risk by suspending financial and operational flows and prevents its escalation to critical values. ***Imperative 3. Financial hedging (HEDGE).*** Applied at medium risk score levels from 5 to 6 when the risk has a clearly defined financial origin and is concentrated within the macroeconomic or supply chain vectors, particularly due to currency, interest rate or price volatility. The structural, technological and operational components of the project remain stable. The analytical essence of HEDGE is the neutralization of the identified financial risk through capital market instruments without intervening in the physical execution of the project. ***Imperative 4. Structural adaptation (PIVOT).*** Triggered at risk score levels from 7 to 8 and driven by technological or market vectors. It manifests itself through loss of product relevance, changes in the competitive environment or increased technological uncertainty. In such scenarios risk is caused not by external shocks but by internal misalignment of the initial architecture with new conditions. PIVOT aims to transform the source of risk by modifying the technological, product

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or business model without fully halting the investment process. ***Imperative 5. Investment acceleration (ACCELERATE).*** Applied in situations with risk score levels from 4 to 6 associated with future cost escalation. The risk appears as a latent threat within the supply chain or operational vectors. In this case passive waiting increases the probability of deterioration of the project's economic parameters. ACCELERATE reduces expected risk through advance financing or price and resource fixation and converts temporal uncertainty into a controlled investment advantage. ***Imperative 6. Emergency exit (DIVEST).*** Triggered at late life cycle stages when the risk score increases persistently from 6 to 9 and risk becomes cumulative, concentrated in the operational and regulatory vectors. Under these conditions continued retention of the asset leads to rising losses and declining liquidity. DIVEST limits the scale of risk through controlled conversion of the asset's residual value into liquid forms and minimizes secondary financial and legal consequences.

As the final step, we examine the operational decision making model MAIC in more detail, see Table 3.

Table 3

Operational MAIC (Model of multidimensional adaptive investment control) for decision making based on the synergy of vector analysis, predictive analytics and risk levels at the stages of the project life cycle

Architecture level	Methodological function of MAIC	Data transformation	Action algorithm	Imperatives
Stage 1-2. Sensory data aggregation	**Flow Vectorization** The system identifies the nature of the origin of each transaction and classifies it according to the corresponding cost vector.	The unstructured flow of primary data is transformed into standardized and validated digital packages.	Automated gateways clean incoming information from noise and assign meta tags to the context of the event.	N/A (Data collection only)
	Risk quantification The system calculates the	Standardized vector data is transformed into a single	A neural network model engine compares current	

Stage 3. Cognitive analysis	mathematical probability of a negative scenario occurring in the future.	quantitative indicator of the threat level (Risk Score).	trends with historical patterns of anomalies to detect deviations.	Alarm signal (Alert)
Stage 3. Protocol validation	**Imperative Selection** The system selects the only permissible response strategy according to the approved regulations.	The quantitative risk assessment is converted into a directive management instruction (Investment Imperative).	A decision matrix algorithm compares the calculated threat level with the business rules valid for the current stage of the project.	**Choosing the imperative:** FREEZE, PIVOT, HEDGE, INTERRUPTION ACCELERATE DIVEST
Stage 4. Executive Implementa-tion (Operational Logic)	**Automated action** The system ensures instant execution of the approved decision without involving human resources.	The digital instruction is implemented through an actual change in the financial or physical state of the management object.	Software robots and smart contracts initiate bank transactions or change order statuses in the accounting system.	**Action:** Account Blocking, Purchase, IoT Stop or other

Source: created by the author

The described algorithm for transmitting a managerial signal within the CPIG architecture generates investment decisions based on continuous causal structural analysis that transforms the system into an instrument of anticipatory management. Rejection of post factum reactions creates the foundation for constructing decisions that incorporate the projected dynamics of risks before consequences emerge. The stage of sensory data aggregation ensures early detection of deviations, and early detection allows each deviation to be immediately linked to a specific cost vector. This linkage establishes the structure of initial causal hypotheses that subsequently guide the analytical block of the system and determine the boundaries of managerial response even before formal analysis begins. The constructed field of causal hypotheses transitions into predictive scoring where the cognitive core produces a quantitative risk assessment. This assessment defines the expected trajectory of the situation, and the trajectory provides the basis for comparing alternative scenarios. Preliminary risk score indicators become a mechanism that shifts management from

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reacting to events toward managing expectations. The assessed risk profile directly enters the stage of forming an investment imperative where selection of the optimal scenario occurs within an already narrowed space of possibilities. This space is shaped by the decision matrix that replaces uncertain choice with a structured set of logically admissible managerial actions. Management works not with hypothetical options but with validated scenarios supported by analytical justification. The defined investment imperative immediately proceeds to the execution phase known as operational logic where the system prepares technical solutions for its implementation. The prepared solution transforms a managerial recommendation into a set of operational commands that are activated after management confirmation which minimizes the interval between decision and execution without removing human oversight. The implemented scenario activates the mechanism of cyclical stabilization in which the change in the state of the project returns to the risk profile model and the updated profile generates refined proposals. The managerial process therefore acquires a closed loop character in which each decision becomes not a final event but an element of continuous adjustment of the investment system. In conclusion the CPIG concept operates as an evidence based managerial mechanism that integrates data, forecasts and formalized rules into a unified decision making cycle, and investment management shifts from intuitive judgement to structured scenario modelling with emphasis on anticipatory formation of the optimal trajectory of action.

Conclusions. The study confirms that modern digital technologies do not by themselves create a complete system of investment management if they remain fragmented across the functions of data collection, analytics and decision making. **The scientific novelty of the work** lies in addressing this issue through a fundamental shift in the approach to controlling international projects. Instead of traditional passive ex post cost monitoring, the study substantiates a transition to anticipatory cyber-physical investment governance (CPIG). The proposed framework, for the first time, integrates data acquisition, risk analysis, and decision execution into a single continuous cycle, enabling responses to financial threats before their actual materialization. **The author's personal contribution** is reflected in the development of the system's core engine through the MAIC algorithm, which, using vector decomposition of costs and six rigid investment imperatives, automatically converts a forecasted risk level into a specific and mandatory managerial action. As a result, the approach not only eliminates the factor of human doubt and the time lag between the emergence of a deviation and the response, but also establishes a conceptual foundation that enables international companies to build resilient, fast, and evidence based investment control systems suitable for scaling under conditions of increasing global uncertainty.

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