Information and communication technologies for assessing the maturity of digital transformation⋆

Nataliya Vnukova[1,2,†], Sergii Lysenko[3,†] and Oksana Makovoz[3,†]

[1] *Scientific and Research Institute of Providing Legal Framework for the Innovative Development of the National Academy of Law Sciences of Ukraine, Chernyshevska St., 80, Kharkiv, 61002, Ukraine*

[2] *Simon Kuznets Kharkiv National University of Economics, Nauki Pr., 9-A, Kharkiv, 61064, Ukraine*

[3] *National Technical University «Kharkiv Polytechnic Institute», 61002, 2, Kyrpychova Str., Kharkiv, Ukraine*

Abstract

The article substantiates the need to develop a flexible and context-sensitive methodology for assessing the digital maturity of business process transformation using information and communication technologies (ICT). A critical analysis of current digital maturity models (such as DCF, DMI, CMMI) has revealed their limited adaptability to different types of enterprises. Based on conceptual modelling of digital technologies and expert validation, a multi-stage methodology is proposed and tested on three types of enterprises: a large industrial enterprise, a medium-sized IT company, and a small service-oriented logistics business. The assessment was carried out using the Digital Maturity Model (DMM), which encompasses five key domains: analytics, artificial intelligence, cybersecurity, process automation, and the strategic integration of digital initiatives. The results demonstrated significant differences among the enterprises, confirming both the sensitivity and versatility of the model. The article concludes with recommendations for further development of the model and the creation of digital tools for systematic monitoring of digital transformation.

Keywords

information and communication technologies, digital transformation, cybersecurity, maturity assessment models, strategy, business process management, digital maturity model

1. Introduction and problem statement

Digital transformation is viewed as a process of fundamentally reshaping traditional business models and operations through digital technologies, aimed at increasing the efficiency, competitiveness, and adaptability of enterprises to changing market conditions [1]. In today's context, characterized by the Industry 4.0/5.0 paradigm and globalization, the successful digitalization of business has become a key factor in the competitiveness of both individual enterprises and national economies [2].

It is important to emphasize that digital transformation is not merely the implementation of modern ICT but a dynamic process of profound organizational change that encompasses all business processes of an enterprise [3]. Research indicates that digital transformation is more closely linked to the process of organizational change (including culture and mindset) rather than just the adoption of digital tools [4]. Information and communication technologies (ICT) serve as a driving force behind these changes, as modern digital tools enable enterprises to restructure their processes based on new principles. The implementation of digital solutions allows companies to respond more swiftly to changes, manage risks more effectively, and reduce costs.

Researchers note that the adoption of automation, cloud services, big data analytics, artificial intelligence, and the Internet of Things (IoT) impacts key aspects of operations – productivity, innovation, flexibility, responsiveness, decision-making efficiency, and competitive advantages. Thus, ICT acts as a catalyst for improving business processes: digital tools make it possible to re-engineer processes, eliminate inefficiencies, make data-driven decisions, and quickly adapt to customer needs.

One of the key aspects of digital transformation is data collection and analysis–digital technologies enable the processing of vast volumes of information about consumers, markets, and operations, which deepens analytics and enhances the quality of management decisions. As a result, enterprises with a high level of digital maturity establish new digital processes, interaction models, and products that ensure resilience and success in the market.

Digital maturity reflects the extent to which an enterprise has adopted and integrated digital technologies into all aspects of its activities and essentially serves as an indicator of the «state» of digital transformation within the organization.

Digital transformation of business processes is one of the key trends in the modern development of enterprises, enabling not only increased productivity and improved management quality but also long-term competitiveness. ICT serves as the foundation for transformational change, integrating into all functional subsystems of the enterprise – from production to strategic management.

However, the effectiveness of implementing digital solutions directly depends on an enterprise's ability to assess its digital development: determining its current level of digital maturity, identifying critical gaps in transformation, and forming a well-founded strategy for change. Technologies such as cloud computing, artificial intelligence, IoT, mobile applications, and automation tools can significantly enhance the flexibility, scalability, and productivity of business processes.

Despite the substantial body of research on digital transformation and information technologies, there remain several important unresolved issues in academic discourse that determine the relevance of this study (Table 1).

Thus, there is a clear need within the academic space to develop an applied, flexible, and context-sensitive methodology for assessing the digital transformation of enterprises based on ICT. This methodology should consider the dynamics of change, security risks, institutional constraints, and the specific characteristics of the Ukrainian business environment. The proposed study aims to address these challenges by creating a scientifically grounded foundation for monitoring and managing digital changes within enterprises.

2. Literature review

In academic literature, digital maturity is defined as the level of completeness and readiness of an organization to achieve a desired future state in the context of digitalization [5]. In other words, it reflects the status of a company's digital transformation, demonstrating the progress achieved in implementing digital initiatives and capabilities. Digital maturity characterizes the readiness of business processes for digital change and largely determines an enterprise's innovativeness, competitiveness, and financial performance [6]. Studies show that a higher level of digital maturity is correlated with better performance indicators: increased productivity, innovation, customer service quality, and financial outcomes (such as profitability and revenue) [7]. Conversely, companies lagging in digital development risk losing competitive ground to more digitally mature market players.

Table 1

Justification for the Need to Develop a New Methodology for Assessing the Digital Transformation of Enterprises Based on ICT

Problem	Essence of the Problem	Justification for the Need for Research
Limited adaptability of existing models	Current frameworks (DCM, CMMI, DMI) are designed for stable economies with strong digital infrastructure	They do not account for the specifics of the Ukrainian context: martial law, instability, limited resources
Lack of unified criteria	Different models use divergent approaches: some focus on technical aspects, others on managerial or cultural ones	There is a need to systematize indicators that integrate both "hard" and "soft" factors
Lack of empirical validation	Existing studies are mainly theoretical or based on surveys	Factual data is needed to assess the impact of digital maturity on enterprise KPIs
Neglect of information security	Security, resilience, and reliability are critically important but not evaluated	Heightened relevance due to martial law, cyber threats, and supply chain disruptions
Underestimation of ICT as an assessment tool	ICT is viewed only as a driver of change, not as a means of monitoring	BI/analytics tools based on real data are not being utilized
Lack of interdisciplinary approach	There is a gap between managerial, technical, and economic aspects	Integration of different scientific approaches is required for a comprehensive assessment

Most digital maturity concepts envision the step-by-step development of an enterprise from an initial (low) level to a high one. A classic example is the CMMI (Capability Maturity Model Integration), which outlines five sequential levels:

– initial (characterized by ad hoc, unstructured processes);

– managed (reactive process management).

– defined (proactive and standardized processes);

– quantitatively managed (data-driven management using metrics);

– optimizing (continuous process improvement) [8].

This logic is also evident in other digital maturity models: from basic digital capability levels to the highest level, where digital technologies are fully integrated into the enterprise's strategy, structure, and culture, enabling continuous innovation. Modern economic trends underscore the need for the algorithmization of business processes to enable further improvement through the application of artificial intelligence [9]. Maturity models and criteria are used to assess where the enterprise currently stands on this path and how close it is to the "digital ideal."

The need to assess digital maturity stems from the importance for enterprises to understand their starting point and measure their progress in digital transformation. As researchers note, assessment tools «provide the necessary framework for systematic analysis» of a business's digital state and the development of an effective action plan [2]. Essentially, the evaluation of an enterprise's digital maturity and readiness for change forms the foundation for crafting a digital transformation strategy and identifying investment priorities.

The use of formalized methodologies enables measurement across multiple indicators (key digital development areas) and helps identify gaps between the current level of the enterprise and industry best practices [10]. Typical dimensions (indicators) of digital maturity include:

- the presence of a comprehensive digital strategy and leadership support;

- development of the technological infrastructure;

- level of process automation and optimization;

- use of data and analytics for decision-making;

- digital skills of personnel and an innovation-driven culture;

- focus on customer digital experience, etc.

A comprehensive assessment across these criteria provides the enterprise with a clear reflection of its digital development, highlighting strengths and weaknesses in the digital domain and enabling the formulation of a transformation roadmap. Therefore, regular digital maturity assessments are essential for tracking transformation progress, adjusting strategies in a timely manner, and ensuring sustainable development in the digital era [11].

In recent years, numerous models and frameworks have been developed and adapted for assessing digital maturity, both globally and within Ukraine. These models act as normative frameworks (reference models) designed to comprehensively assess an enterprise's current digital development state across various dimensions and levels. They make it possible to measure and analyze a company's existing capabilities in areas such as technology, processes, structure and culture, workforce competencies, and management practices [6] and compare the results to the desired level.

These models serve as digital development roadmaps: in addition to diagnostics, they suggest the next steps needed to achieve higher maturity levels (i.e., what specifically needs to be improved). There are both universal models applicable to most industries and sector-specific or specialized approaches. For instance, major consulting and IT firms offer their own frameworks (MIT CISR, Gartner, Deloitte, McKinsey, KPMG, etc.), while in Europe, maturity assessment methods have been integrated with digital innovation hub initiatives.

Below, we will examine several of the most well-known enterprise digital maturity assessment models and their key characteristics (Table 2).

Thus, assessing the level of digital maturity using modern models is a critically important tool for managing digital transformation within an enterprise [12].

First, it allows organizations to identify the readiness of their business processes for digitalization and to pinpoint weak areas that require attention.

Second, the use of maturity models establishes a shared «language» between management and IT professionals when discussing digital strategy, ensuring alignment in the vision for development.

Third, the assessment results serve as a starting point for developing a digital transformation roadmap [13], a clear plan of action for modernizing ICT infrastructure, optimizing business processes, enhancing employees' digital skills, and more.

Table 2
Key Models for Assessing the Digital Maturity of Enterprises

Tool	Brief Description	Connection to Digital Transformation Goals
DCF (Digital Capability Framework)	Assesses digital strategy, infrastructure, analytics, and culture	Helps identify technological gaps and shape strategic directions for change
DMI (Digital Maturity Index)	Quantitative ranking across 90 criteria, 6 maturity levels	Supports benchmarking and helps set development priorities to improve efficiency
CMMI (Capability Maturity Model Integration)	Five-level model of process maturity	Focuses on business process optimization and change management
Digital Transformation Assessment Frameworks	Comprehensive assessment of digital readiness across multiple domains	Provides a holistic audit of the company's digital state and helps build a roadmap for development

Ultimately, improving a company's digital maturity is a continuous process, and regular reassessment using a chosen model allows for monitoring the dynamics of change and fostering a culture of continuous improvement in the enterprise's digital development.

3. Purpose

The aim of this study is to justify the need for and to develop a context-sensitive methodology for assessing the digital transformation of enterprise business processes. The proposed methodology is designed to account for the specific characteristics of the business environment, including economic instability, limited resources, and information security risks, while also integrating both «hard» (technological) and «soft» (managerial and organizational) aspects of digital maturity.

The objectives of the study are as follows:

–   to systematize existing approaches to assessing digital transformation.

–   to identify key gaps in current models, particularly regarding their adaptability to Ukrainian realities.

–   to develop a practical assessment toolkit that enables enterprises to track the dynamics of digital changes over time.

–   to create ICT-based analytical solutions to support informed decision-making in the area of digital strategy.

The relevance of this research is driven by the growing need for Ukrainian enterprises to understand their level of digital maturity, optimize transformation strategies, and ensure long-term competitiveness through the effective use of digital technologies.

4. Methodology

The methodology for developing a model to assess the digital maturity (Fig.1) of enterprises consisted of several stages, combining literature analysis, conceptual modeling, expert involvement, and empirical validation (Table 3). This approach aligns with the commonly accepted phases of maturity model development (scope definition, design, population, testing, implementation) [14].
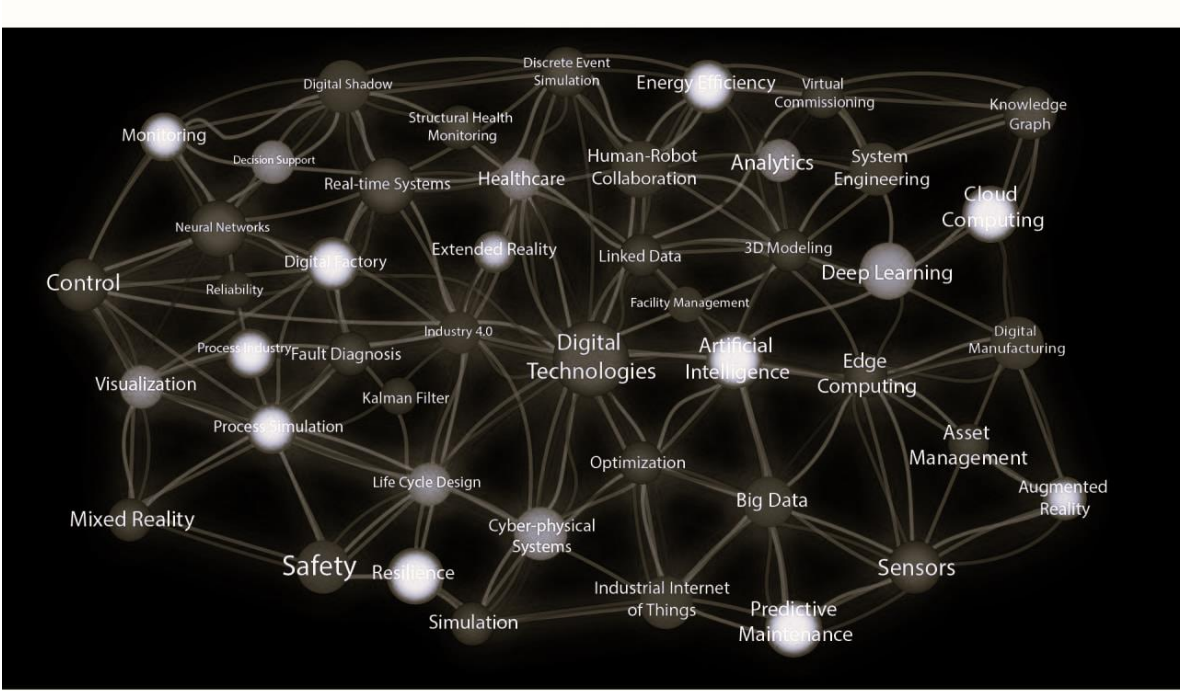

Figure 1: Conceptual map of digital technologies, illustrating the main technological domains (nodes) and the connections between them.

Key areas – such as Artificial Intelligence, Cloud Computing, Analytics, Safety, Edge Computing, and Monitoring – are highlighted as prominent nodes, while the lines represent informational or functional interrelationships between the technologies. Source: Authors' development.

5. Results

To assess the digital maturity of a large industrial enterprise, a medium-sized IT company, and a small logistics business, the Digital Maturity Model (DMM) – developed by the TM Forum consortium in collaboration with Deloitte – was used [15].

The assessment results for the selected enterprises are presented in Table 4.

The model evaluates digital maturity across key domains, including data analytics, the use of artificial intelligence (AI), cybersecurity, process automation, and the integration of digital strategy into management. Each enterprise was analyzed based on these criteria using expert evaluations and case analysis, which helped identify the strengths and weaknesses of their digital transformation efforts.

Table 3
Stages of Developing the Enterprise Digital Maturity Assessment Model

Stage	Description
1. Analysis of existing models	Examination of well-known digital maturity assessment approaches (e.g., DCF, DMI, CMMI), identifying their strengths and limitations in the context of Ukrainian businesses.
2. Conceptual Modeling	Development of a map of digital technologies and their interconnections (see Fig. 1) to identify key domains of digital transformation (AI, Cloud, Security, Monitoring, Analytics, etc.).
3. Definition of criteria and indicators	Maturity indicators were defined for each domain. The indicators cover both technological availability and the level of integration between subsystems.
4. Expert validation and content analysis	Expert surveys conducted (semi-structured interviews, Delphi method) and case study content analysis performed to refine and supplement the indicators.
5. Model testing (Pilot)	Pilot testing on enterprises of various sizes and industries. Feedback on applicability was collected, and necessary refinements were identified.
6. Results consolidation	Final model development: assessment scales, maturity levels, weighting factors were defined; a questionnaire, assessment profiles, and methodological guidelines were created.

As shown in Fig. 2, the IT company has the most balanced and highest digital maturity profile, the industrial enterprise displays a medium-level profile with strengths in security and automation, while the small business lags behind in nearly all indicators.

The model evaluates digital maturity across key domains, including data analytics, the use of artificial intelligence (AI), cybersecurity, process automation, and the integration of digital strategy into management. Each enterprise was analyzed based on these criteria using expert evaluations and case analysis, which helped identify the strengths and weaknesses of their digital transformation efforts.

The graphical profile confirms the results described above: the curve for the large industrial enterprise (blue area) extends moderately along the «Security» and «Automation» axes but is less pronounced on the «Analytics» and «AI» axes. In contrast, the medium-sized IT company (green area) demonstrates nearly maximum values in «Analytics» and «AI», along with high values in «Strategy»; its profile is the broadest and most balanced, corresponding to a high level of digital maturity. The profile of the small service enterprise (red area) is compact and does not extend far from the center of the chart: its highest values are around 2 (out of 5) in most domains, reflecting a low maturity level.

This visual analysis clearly differentiates the three enterprises: the IT company outperforms in analytics and AI; the industrial company holds a uniquely strong position in security and automation (likely due to the need to protect production systems and use of robotics); and the small business lags in all areas, especially in AI adoption and strategic digital transformation.

Table 4
Digital Maturity Assessment Results Based on the DMM Model

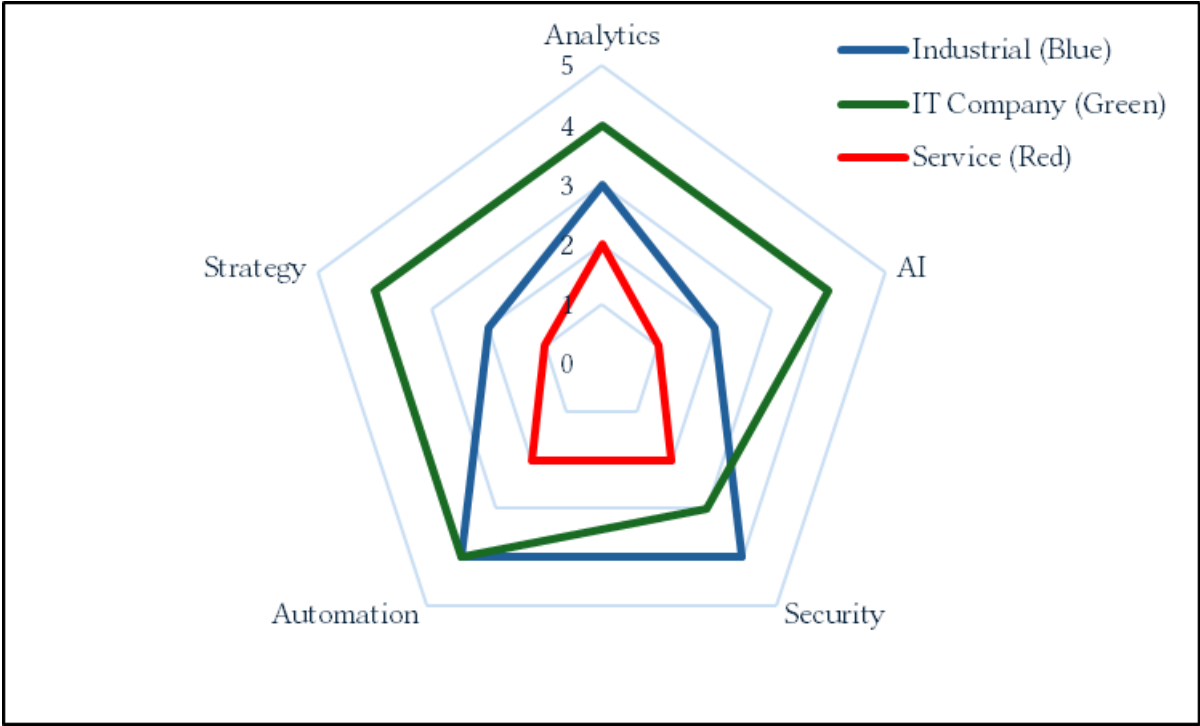| Selected Enterprises	Assessment / Digital Maturity Level	Comments / Conclusions from Applying the Model
Large industrial enterprise	Medium level ($\approx$ 2 out of 5)	High level of automation and cybersecurity. Weak adoption of AI and analytics. Digital strategy is partially implemented but does not cover all departments. Strategic transformation management needs to be strengthened.
Medium-sized IT company	High level ($\approx$ 4 out of 5)	Strong analytics, active AI adoption, automated processes. High integration of digital strategy. Cybersecurity is at a moderate level—requires improvement. The model confirmed the company's high digital maturity.
Small service enterprise (Logistics)	Low level ($\approx$ 1–2 out of 5)	Basic level of digitalization: weak analytics, no AI, minimal automation. No clear digital strategy. The model revealed critical areas for development. External support is recommended for digital growth.

Figure 2: Digital maturity profiles of three enterprises across key domains. Source: Authors' development.

The comparison indicates that the assessment model is sensitive enough to capture these differences: even visually, one can distinguish the «profile» of each case, which aligns with its industry and scale.

The findings are consistent with expectations based on industry trends: technology firms are leaders in digital maturity [16], industrial businesses are somewhere in the middle with gradual progress, and small enterprises require support to reach even a basic level [17]. Thus, the comparative analysis validates the model's effectiveness: it can differentiate maturity levels across various types of enterprises and provide an informative profile for discussion.

An important aspect is the universality of the digital maturity assessment model when applied to different industries and business sizes. The results show that the model's core domains (analytics, AI, security, automation, strategy, etc.) are relevant to all the enterprises studied, though the degree of development varies. In other words, the model demonstrated the ability to capture key areas of digital transformation in both manufacturing and service/IT sectors. This indicates the model's broad applicability: its criteria are general enough to be used in diverse contexts.

For example, domains like data analytics and cybersecurity are essential for any modern business, from a factory to a small logistics company – the only difference lies in the scale and complexity of implementation.

At the same time, the pilot test also revealed industry-specific characteristics that the model should account for. For instance, in an industrial enterprise, the automation domain largely refers to industrial technologies (e.g., robotics, IoT in production), whereas for a service business, automation relates more to digitizing office workflows. The model is clustered into functional blocks flexibly enough to accommodate such distinctions, but the interpretation of results requires an understanding of the industry context.

Another example is AI: in manufacturing, its use may be limited to specific applications (e.g., defect detection on a conveyor), while in an IT company, AI may be the core of the product. The model evaluates the overall level of AI adoption, but an analyst must understand that a low AI score in manufacturing doesn't necessarily indicate underperformance if the technology is still emerging in that sector.

Thus, the model is largely universal but sensitive to industry-specific nuances. When comparing different enterprises, one must consider the characteristics of their respective industries. Literature notes that some digital maturity models are tailored to specific sectors to better reflect their unique needs [18].

Our model, however, produced valid results across three different sectors without the need for significant modification, which indicates its wide applicability. Nevertheless, there is potential for future enhancement or adaptation of the model – for example, adding specific subdomains such as «Industry 4.0» for manufacturing or «Customer Experience» for service enterprises could improve assessment accuracy for certain sectors.

Overall, the results of the pilot study confirm that the developed model can serve as a cross-industry tool for assessing digital maturity, provided that results are interpreted with attention to the specific context of each business sector.

6. Conclusion

Based on the conducted study, it can be concluded that information and communication technologies for assessing digital transformation maturity should be viewed through the lens of the

following components: analytics, artificial intelligence, cybersecurity, automation, and strategy. The experiment carried out is promising and may be used as a foundation for further research.

However, the evaluation of the three enterprises is illustrative in nature and does not capture the full diversity of real-world business scenarios. Each enterprise was assessed using expert judgment, which introduces an element of subjectivity. Nevertheless, for the purpose of this study, it was necessary to validate the developed conceptual approach. The model focuses on selected digital technology domains identified through literature and case analysis. However, there is potential for expanding the assessment components that are not fully addressed in the current model. For example, organizational culture and employee readiness for change are indirectly reflected within the strategic domain but are not separately distinguished. In some cases, «soft» factors – such as innovation culture and leadership – can be the decisive elements for the success of digital transformation. The absence of an explicit parameter for these aspects could be a limitation of the model.

Furthermore, the digital environment is dynamic: digital maturity is not a static characteristic. Enterprises evolve rapidly, and the model can be applied at various stages of transition. In the future, automated change tracking could be introduced as a valuable indicator for monitoring maturity levels and enabling proactive interventions. Ongoing refinement of the model may create the foundation for adapting it to evolving enterprise conditions.

The discussion is grounded in conceptual frameworks and experimental findings; the next step should be empirical validation – conducting digital maturity assessments across dozens of enterprises in various sectors and analyzing statistical patterns. This would allow for evaluating whether the identified domains remain equally relevant for different types of enterprises or whether sector-specific variations emerge. Such insights could support the introduction of weighted parameters by industry or the addition of new criteria.

The current limitations of existing maturity models have also been noted by other researchers – no single model provides universal answers, and some may be overly abstract [19]. The model presented here is no exception: it offers a structured framework for assessment, while the analytical conclusions are inherently evaluative and may evolve over time. Despite certain assumptions, the proposed conceptual solution introduces innovation into the methodological toolkit for assessing digital transformation. It demonstrates how a combination of technology analysis, functional clustering, expert evaluation, and case analysis can be implemented in a practical model. Future research will focus on improving the model – both by expanding the list of domains (e.g., adding «Customer Digital Experience» or «Business Model Agility») and through deeper industry-specific adaptation (e.g., creating sub-models for individual sectors). A promising direction includes the development of a digital tool (e.g., an online questionnaire based on the model), which would automate data collection and the calculation of a maturity index for enterprises – making the assessment more scalable and reducing subjectivity.

The developed digital maturity model serves as a useful diagnostic tool for evaluating the state of digital transformation in various types of enterprises. The observed differences between the experimental cases confirmed the model's informativeness. The discussion of results highlighted the model's flexibility and its ability to accommodate the specific characteristics of different enterprises. Furthermore, it outlined pathways for further development to meet practical business needs and to contribute to a scientific foundation for evaluating digital maturity in the era of digital transformation.

Declaration on Generative AI

The authors have not employed any Generative AI tools.

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