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ASSESSMENT OF ENTERPRISE DIGITAL MATURITY

Introduction

The changes observed in the functioning of business organizations in the recent years are closely linked to the processes of intensive digitization, automation and robotization. These processes have accelerated rapidly as a result of the changes triggered by the global COVID-19 pandemic [Spremić et al., 2022]. The intensive development of the e-commerce market, the provision of online services, and business communication based on remote channels are just some of the trends currently shaping both B2C and B2B relationships. Additionally, emerging technologies such as artificial intelligence, big data and analytics, blockchain, and cloud computing drive the digital transformation of the business sphere worldwide [Saeed et al., 2023].

The aforementioned changes bring many positive effects to the operations of enterprises; however, they simultaneously give rise to numerous risks that require effective management procedures. We primarily mean cyber threats, which, not only pose a significant risk to the continuity of business operations but are also particularly costly to mitigate – costs that are increasing dramatically worldwide [Sharif, Mohammed, 2022]. Another challenge associated with the digitization of operations is the weakening of supervision and control systems in enterprises that carry out certain operational processes using digital tools.

The changes resulting from the need for companies to adapt to the level of digitization characteristic of developed economies, continuously progressing societies, or individual sectors of the economy are inevitable. Environmental conditions often force business organizations to use digital solutions in their everyday operations and processes. Failure to adapt to the requirements of the environment

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can lead to a deterioration in market position and a loss of competitive advantage [Zhang et al., 2022].

Enterprises aiming to meet the challenges of a rapidly digitizing economy must be adequately prepared and possess necessary resources. These include not only financial resources but also technological and infrastructural resources, as well as know-how and competences. Different enterprises have varying capabilities and opportunities to adapt to the conditions of a digitally developing economy, resulting in differing levels of digital maturity [Hortovanyi et al., 2020]. However, the interpretation of an enterprise's level of digital maturity can vary. Factors influencing this interpretation include the size and market position of the enterprise, sector, access to and ability to use advanced technologies, scope of external support, etc.

Measuring digital maturity is therefore becoming a particularly important issue in the management of enterprises [Kupilas et al., 2023; Cognet et al., 2023], as the results of such measurements can be of crucial importance, for example, when correcting development strategies, redefining business models or modifying management processes. The results of maturity measurements often become a starting point for the development of a digital strategy by enterprises that plan to digitally transform their operations [Pataci et al., 2022].

The purpose of this paper is to classify selected enterprise digital maturity assessment models, compare them and propose a conceptual framework of an enterprise digital transformation model.

1. Theoretical background

1.1. Digitization and digital maturity of organizations

Digitization is an extremely intensive process stimulating the development of the global economy and serving as a powerful engine for economic growth. This is evidenced by the fact that enterprises undergoing digital transformation accounted for USD 13.5 billion of global GDP in 2018, a figure that rose to USD 53.3 billion in 2023 – over half of the total nominal GDP [Calderon-Monge, Ribeiro-Soriano, 2023]. Regardless of the sector or size of an enterprise, digitization, digital transformation, and digital technologies are inextricably linked to a long-term growth strategy.

However, not every business organization can adapt to the digitized environment to the same extent or within the same time frame as the most competitive ones. Differences in the level of enterprise digitization are often represented on a digital maturity scale. At the same time, it is widely acknowledged that a company's digital maturity level is closely related to its overall performance [Peng, Tao, 2022; Thordsen, Bick, 2023].

The topic of digital maturity has gained significant popularity in the social and business spheres over the past decade [Thordsen, Bick, 2023]. Digital maturity can be understood as the integration of organizational operations and human capital into digital processes, and vice versa – the integration of digital processes into organizational operations and human capital [Westerman et al., 2014]. Achieving progressively higher levels of digital maturity requires the implementation of digitization tools across core business dimensions, such as strategy, market, operations, culture and technology [Salume et al., 2021].

One determinant of an enterprise's level of digital maturity is the effectiveness of its digital transformation process. Currently, digital transformation is one of the most important aspects of the development of modern enterprises (regardless of the sector), due to the trends related to digitalization established and developed after the COVID-19 pandemic and the unstoppable development of new technologies, including automation processes and artificial intelligence.

However, the term digital transformation has recently been somewhat overused or misused, as not every integration of digital technology into an organization's operations can be referred to as a digital transformation process. Digital transformation should be understood as the integration of digital solutions into existing business systems, accompanied by the creation of action plans that enable the full development of technology across all functions of an enterprise [Grossman, 2018], with the goal of continuously improve efficiency [Aslanova, Kulichkina, 2020]. This understanding of digital transformation served as starting point for our research in this area.

Some researchers associate the term digital transformation directly with the achieved level of digital maturity. Dominguez [2017] points out that digital maturity (specifically, the highest level of digital maturity) is the final stage of the digital transformation process. The determinants of this process's effectiveness include significant improvements in enterprise operations and increased levels of customer satisfaction. However, it should be noted that achieving the highest level of maturity may be an unattainable goal due to the ever-advancing development of technology and unstoppable global changes in the enterprise environment (social, economic, political, environmental, etc.).

For the digital transformation process to be successful, a company must create an up-to-date action plan and use effective tools to manage the transformation process [Aras, Büyüközkan, 2023], which is not easy in a highly volatile and turbulent environment. Digital transformation poses a particular challenge to the sector of micro and small enterprises (MSEs), which often face resource constraints. This problem is readily visible in emerging markets [da Costa et al., 2022].

1.2. Objectives of assessing digital maturity

Assessing digital maturity is the first step to a successful digital transformation of modern enterprises. Besides reliable measurements, the success of the digital transformation process depends also on the awareness of the need for change, the availability of high-quality IT support and digital competences, a workforce highly skilled in big data analytics, as well as the availability of a strategy of comprehensive digital transformation for the enterprise [Avdel, 2021]. Assessing digital maturity enables managers of both public and private organizations to get to know their current digital maturity level, so that they can diagnose the entry points from which, in their individual cases, a digital transformation implementation program should start [Barry et al., 2022]. Measuring digital maturity is also needed when monitoring the effectiveness of implementing new management concepts, such as Lean Management [Bąk, 2021; Bąk, 2022].

One of the most general yet important objectives of measuring digital maturity is certainly to maintain competitive advantage [Thordsen et al., 2020] and support the sustainability of an enterprise [Baihaqy, Subriadi, 2023] in the digital economy. However, in order for this main objective to be achieved, several specific intermediate objectives need to be met. Firstly, assessing digital maturity should enable the identification of the progress of an enterprise's digital transformation process and its comparison in this respect with the leading competitors in the sector [Evans, 2017]. Secondly, assessing digital maturity on a cyclical basis should support the making of subsequent decisions along the implementation path of an enterprise's phased digital transformation procedure. By measuring maturity at each stage, it is possible to identify the benefits of the transition to the next stage of transformation, as well as the dangers and risks that are inextricably linked to the intensification of digitization, such as cybersecurity or data protection issues [Grover, Damle, 2020].

The broader information community and its currently observed trend towards a qualitative change in organizations taking advantage of the opportunities offered by digitization constitute another reason to measure digital maturity. This is because knowing the digital maturity level allows managers to implement new and improve existing processes in order to make their companies more attractive from the digital point of view [Ilin et al., 2020]. This knowledge also makes it possible for them to identify their companies' weaknesses and shortcomings, for example in their digital transformation strategies or their understanding of the digital environment and the foundations of digital transformation processes [Merdin et al., 2023].

3. Research methodology

The aim of this text was to classify and compare selected digital maturity assessment models created since the outbreak of the global COVID-19 pandemic, i.e. between 2020 and 2023. We decided to analyze the models developed in that particular period because the pandemic definitely intensified digitization processes, and thus many enterprises started to develop digitally, making their digital sophistication, i.e. digital maturity, one of the leading elements of their strategies. Therefore, during and after the pandemic, there was a significant increase in interest in tools for measuring digital maturity. The tools developed during this time also represent a different focus to that characteristic of the tools used earlier. The main difference is that the digital maturity models developed before the pandemic were specifically aimed at checking technical digital skills, such as operation of advanced hardware and software, implementation of cloud solutions, 3D printing, remote communication, etc. In the models created during and after the pandemic, one may additionally notice a more holistic approach to the assessment of digital maturity, which manifests itself in the inclusion of such dimensions as digital strategy, digital culture, staff experience, processes integration, etc. We were looking for scientific texts presenting assessment models in the field of digital maturity in the EBSCO database, which is a database integrating the content of many smaller databases in the area of economics and management. Another criterion for the selection of specific models to be included in the analysis was the possibility of becoming familiar with the full procedure of their development and application. This criterion was fulfilled by models presented in scientific texts published in the open access system.

To sum up, the inclusion criteria for texts presenting digital maturity assessment models that we used are:

- EBSCO database,
- publication date: 2020–2023,
- texts from peer-reviewed journals or peer-reviewed conference proceedings,
- Open Access formula.

Taking into account the aforementioned criteria, we eventually qualified twelve models of digital maturity assessment for further analysis.

In the research process, we posed the following questions:

RQ1: What are the characteristics of the digital maturity assessment models developed in the years 2020–2023?

RQ2: What dimensions are assessed in the digital maturity assessment models created between 2020 and 2023?

RQ3: What should be the key stages in the implementation of digital transformation in an enterprise?

In the research process, we decided to classify and compare the models selected for analysis in terms of the following four characteristics: type, using, application and assessment result. We recognized these four characteristics as key factors in describing assessment models used in management, as they allow enterprises to compare individual models and, based on the results of such comparison, make informed decisions about which model is most appropriate for their business environment and objectives.

Type determines whether qualitative or quantitative tools, or a combination of both, are needed to use a model.

Using determines how a model can be used – whether an enterprise can implement it independently or if it requires the expertise of professionals. A third option includes models designed for use in surveys targeting different groups of enterprises, such as assessing the level of digital maturity in specific sectors or regions. Some models can also function as hybrid tools, combining two or three of the indicated forms of use.

Application, on the other hand, makes it possible to assess whether a given model is dedicated to be used only in a specific sector and is strongly tailored to its specificities, or it is a tool that has the qualities of universality and applicability to any sector.

The last characteristic is assessment result, which is the ultimate outcome of assessing digital maturity. It directly indicates what final metric has been used in the model to grade the digital maturity result obtained in accordance with the adopted methodology.

In the next step, we collated and analyzed how often the dimensions undergoing assessment in the digital maturity assessment process occurred in individual models.

To achieve the set research objectives, we used the following research methods and tools: a comparative analysis method [Esser, Vliegenthart, 2017], a comparative approach to the models under analysis and their changes over time [Pennings et al., 2006] and a simple numerical data analysis [Babbie, 2010; Muijs, 2010] in terms of the frequency of occurrence of the selected dimensions in the analyzed models. In the process of developing the conceptual framework of enterprise digital transformation model, we applied exploratory research [Saunders et al., 2009].

3. Results

3.1. Features of the digital maturity assessment models

The results of the comparison of the selected digital maturity assessment models with respect to the four dimensions mentioned above, presented as a taxonomy, are presented in Figure 1.

6 of the compared models measure digital maturity qualitatively, 2 of them are quantitative in character and the remaining 4 represent a mixed (qualitative and quantitative) approach. Qualitative models assess the selected dimensions qualitatively only, e.g. using qualitative tools such as interviews with enterprises' representatives, questionnaire surveys and case studies. Quantitative models, on the other hand, assess digital maturity by means of mathematical, statistical and econometric tools such as mathematical models (e.g. linear programming model), Fuzzy methods, multi-criteria decision-making methods (e.g. the TOPSIS, MOORA, VIKOR) and entropy methods. Mixed models are characterized by the combined use of both qualitative and quantitative assessment tools. Qualitative tools are most often used in the first stage of an assessment process, while quantitative ones are used in the second stage as statistical or mathematical support for the results obtained by means of qualitative methods.

11 of the analyzed models are sophisticated tools the application of which require specialist knowledge. Only 3 of the models are designed to be used by enterprises themselves, without any external assistance and on a self-assessment basis. 2 of the models were used within the scope of a respondent survey. Among the models under comparison, there are a few that can be used in different forms, for example for self-assessment or as part of a respondent survey conducted in a specific group of enterprises [Safiullin et al., 2020], i.e. they belong to more than one category. This situation also occurs in the case of the possibility of using models both as part of self-assessment and expert assessment [Varnavskyi et al., 2020; Tubis, 2023] or both as part of respondents survey and expert assessment [Mezlov et al., 2022].

With regard to the criterion of application of the selected models, half of them can be used successfully in enterprises of all sectors, while the remaining models are tools dedicated to specific industries, e.g. the agricultural sector [Safiullin et al., 2020], public health sector [Doctor et al., 2023] or construction sector [Wernicke et al., 2023]. Some of the analyzed tools are tailored exclusively to the specificities of micro and small enterprises [Ka et al., 2023], while others are adjusted to the requirements of small and medium enterprises [Sandor, Guban, 2021; Li, 2022]. Among the models applicable to all sectors, there is 1 [Voss et al., 2022] that can actually be applied by an enterprise in any business sector, but only to B2B projects.

In the case of the criterion of assessment result, it turned out that the majority of the models allowed for an assessment of digital maturity using digital maturity levels, i.e. the classic maturity assessment scale. However, there are models for which assessment results are different. Using different assessment results, these models also make it possible to assess digital maturity, but establishing slightly different final metrics of this maturity. These metrics are, for example, digital leadership levels [Varnavskyi et al., 2020], digital readiness levels [Brodny, Tutak, 2021] or digital maturity development phases [Ka et al., 2023].

Figure 1. Taxonomy of the digital maturity assessment models
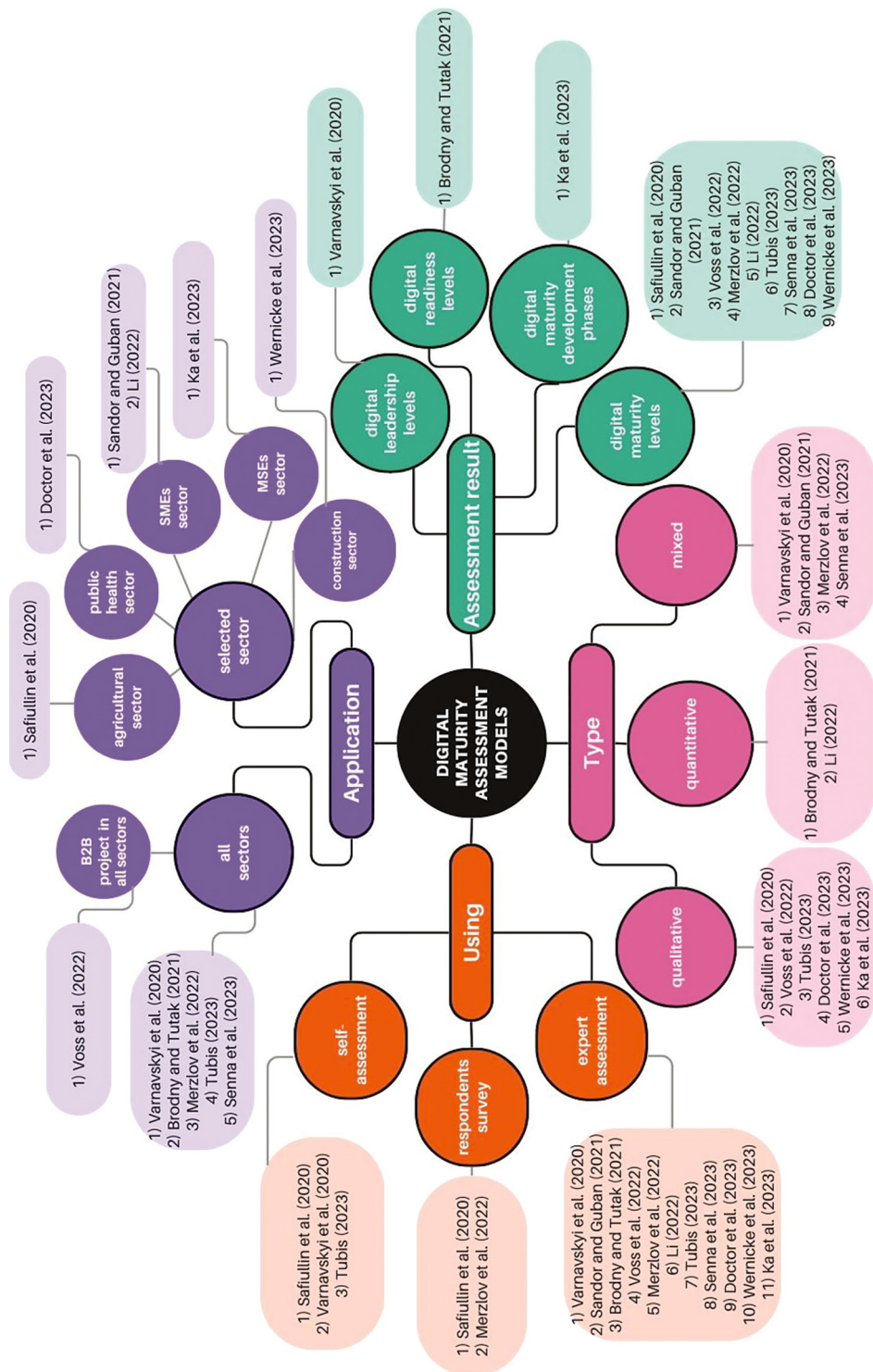
Source: own study.

3.2. Dimensions assessed in the digital maturity assessment models

When analyzing the selected digital maturity measurement models, we found considerable differences concerning the assessed dimensions, which showed little similarity among the models subject to analysis (Table 1).

In the 12 models compared, we identified a total of 31 dimensions assessed, with only some of them repeated across the models. Taking the recurrence of the assessment dimensions as a criterion of their importance in the digital maturity measurement process, it can be concluded that the following dimensions are the most important in diagnosing digital maturity levels:

- orgware (contacts with stakeholders, decision making, IT strategy) – the criterion appeared in 9 models,
- infrastructure, hardware, technology and tools – the criterion appeared in 8 models,
- staff experience / peopleware / responsibility / digital skills – the criterion appeared in 8 models,
- corporate culture / digital culture – the criterion appeared in 7 models,
- data and big data analytics – the criterion appeared in 7 models,
- processes integration and products – the criterion appeared in 6 models.

The other assessed dimensions appeared incidentally, i.e. in not more than 3 models.

To sum up (4.1 and 4.2 section), it is necessary to indicate the strengths and weaknesses of the analyzed models, the identification of which may constitute a starting point for improving these tools and searching for new ones, adapted to changes in the environment. The strengths of the models compared in this research include: 1) precise presentation of the recommended assessment procedure (technical and methodological) in individual models, which significantly facilitates the use of the models, e.g. in the self-assessment of enterprises, and 2) presentation of a wide range of perspectives in relation to the dimensions assessed in them (increasing the level of reliability of the assessment process).

As for the weaknesses of the analyzed models, they are mainly: 1) large differences between models, both in terms of recommended assessment tools and dimensions subject to assessment, and 2) lack of unification of the method of assessing digital maturity (many models, different approaches, lack of systematization).

Table 1. Dimensions assessed in the digital maturity assessment models

Dimensions under assessment	Models												Total
	Safiullin et al. [2020]	Varnavskyi et al. [2020]	Sandor & Guban [2021]	Brodny & Tutak [2021]	Voss et al. [2022]	Merzlov et al. [2022]	Li [2022]	Tubis [2023]	Senna et al. [2023]	Doctor et al. [2023]	Wernicke et al. [2023]	Ka et al. [2023]	
Infrastructure, hardware, technology, tools	■		■		■	■	■	■	■			■	8
Processes integration and products	■		■			■	■	■	■				6
Data and big data analytics	■		■	■			■	■	■		■		7
Models	■												1
Staff experience/ peopleware / responsibility/ digital skills	■	■	■					■	■	■	■		8
Corporate culture /digital culture	■		■			■	■	■	■				7
Educational activity		■											1
Scientific activity		■											1
Digital operations maintenance		■											1
Control and reporting		■									■		2
Online presence			■										1
Software			■							■			2
Technical solutions /digital capabilities				■								■	2
Orgware (contacts with stakeholders, decision making, IT strategy)				■	■	■	■	■	■	■		■	9
Artificial intelligence				■									1
Cloud computing				■									1
3D printing				■									1
Robotics				■									1
Integration with customers /suppliers, supply chain management				■							■		2
Internet of things				■									1
Organization ecosystem						■							1
Safety / cybersecurity								■		■	■		3
Management (design and performance)								■	■	■			3
Environment (legal, interorganizational)									■		■		2
IT provision										■			1
Citizen focus										■			1
Interoperability										■			1
Scheduling											■		1
Contract management											■		1
Information management											■		1
Integrated business												■	1

Source: own study..

3.3. Conceptual framework of an enterprise digital transformation model

Based on the results of our analysis of the selected digital maturity assessment models and on our own experience in designing maturity assessment models [Bąk, Jedynak, 2023], we developed a conceptual framework for an enterprise digital transformation model (Figure 2). However, our model differs from those focused on assessing digital maturity. Instead, it presents a conceptual framework for the digital transformation process, aimed at fostering continuous efforts to enhance digital maturity. Therefore, the model we propose is not an alternative to the models analyzed in the research part of this work but should function with models for assessing digital maturity in symbiosis, i.e. the digital transformation process carried out in an enterprise (e.g. in accordance with the recommendations of our model) determines the achievement of a high level of digital maturity, which needs to be assessed periodically and reliably to find out what level of digital advancement the company is in, and thus to obtain confirmation whether the digital transformation process is effective – and if it is not effective, what are its shortcomings and in what direction it should be done.

Figure 2. Conceptual framework of an enterprise digital transformation model
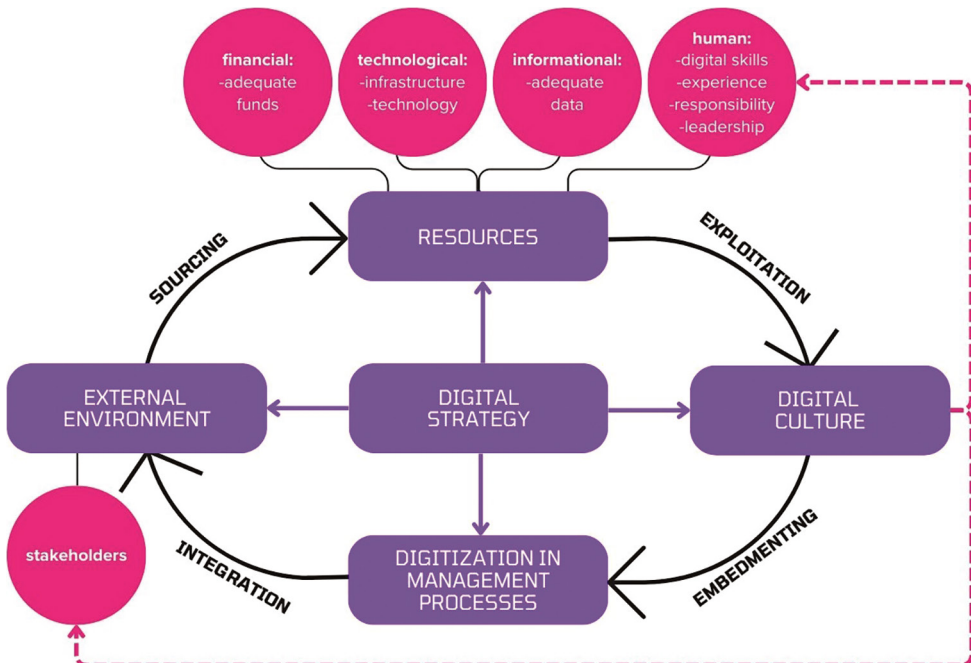
Source: own study.

In our view, the transformation of an enterprise towards a higher level of digital maturity should be based on the foundations of process management. The entire digital transformation process should start with the development of a clear, measurable and implementable digital strategy. In the next step, the enterprise should ensure the necessary resources to pursue the strategy. These resources should especially include: 1) financial resources, 2) technological resources (infrastructure and technology), 3) information resources (adequate data), and 4) human resources (digital skills, experience, responsibility, leadership). Resources from all the above categories should be used in parallel to the gradual digitization of operations, not only for technical purposes, but also to promote the digital culture both within the enterprise and among its key external stakeholders. The next stage of the digital transformation of the enterprise should, in our opinion, be the embedding of the digital culture in the core management processes. The gradually digitized management processes should be strongly integrated with the external environment, where the enterprise can find the main sources of resources necessary to continue and intensify the digital transformation process. Therefore, we consider digital transformation to be a continuous, uninterrupted and iterative process.

Conclusion

Enterprise digital transformation is currently an unstoppable process developing dynamically in many sectors of the economy. Business organizations need guidance, recommendations, and best practices to plan and appropriately manage the transformation process [Aras, Büyüközkan, 2023], taking into their capabilities and available resources. This allows them to gradually digitize their operations and evolve into digital enterprises. However, not every enterprise implementing a digital development strategy will be able to fully adapt to the conditions of a rapidly changing digital environment. Therefore, tools are needed to enable enterprises to reliably assess their current level of digital maturity [Hortovanyi et al., 2020].

The conceptual framework of an enterprise digital transformation model proposed by us reflects what an enterprise's digital development process path should look like and identifies the dimensions to be considered in planning the step-by-step implementation of a digital strategy.

Our research has both theoretical and practical implications. The most important theoretical contribution is the proposed categorization method for developing a taxonomy of the analyzed maturity assessment models. The classification procedure we used can also be adopted to categorize and analyze other assessment or measurement tools in management. It is also worth emphasizing that our enterprise digital transformation model can be used by business organizations functioning in all sectors

of the economy, representing the broadest practical implications of our research. A prerequisite for the effective implementation of the recommendations of our model is cyclical measurements of digital maturity. Such measurements allow managers to, first, evaluate the effectiveness of the digital transformation processes implemented thus far and, second, fine-tune specific plans for advancing to the next stage of the digital transformation path. Further research is necessary to develop effective tools for measuring digital maturity. These tools should be adaptable to various, often rapidly changing, business conditions. Our comparative analysis of existing measurement tools shows that they are highly diverse and lack a standardized assessment method adequate for small and large enterprises across all sectors, whether in normal or crisis conditionsMany tools are desined for specific business sector [cf. Safiullin et al., 2020; Doctor et al., 2023; Wernicke et al., 2023]. Therefore, future research should focus on designing and testing digital maturity measurement tools dedicated to specific groups of enterprises, differentiated by size or sectors. These tools should capable of evolving and adapting to dynamic changes in the business environment.

The limitations of our research relate to the fact that the comparative analysis comprised only the digital maturity assessment models developed between 2020 and 2023. The models created during and after the COVID-19 pandemic differ from those proposed earlier, due to the dynamic digitization of the economy and the consequent strong demand for such tools during that period. Nevertheless, already on the basis of our analysis of the twelve selected models, it was possible to present their taxonomy and identify their characteristics with respect to type, using, application and assessment result. These four criteria appear to be useful for analyzing both existing and future models. And their number will be increasing in view of the business world's demand for a "perfect" tool for assessing digital maturity.

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ASSESSMENT OF ENTERPRISE DIGITAL MATURITY

Abstract

The digital transformation of enterprises has gained in intensity in recent years, helped by phenomena such as the COVID-19 pandemic. The executives of digitally developing enterprises need both guidance for effectively implementing a digital transformation process and measurement tools that enable them to assess digital maturity, and the results of such assessment can provide hints for improvements in the process. The purpose of this paper is to classify and compare a selection of existing enterprise digital maturity assessment models and to propose a conceptual framework of enterprise digital transformation model. For our analyses, we selected digital maturity measurement models developed between 2020 and 2023. We classified them, taking into account four criteria: type, using, application and assessment result. We then compared the dimensions assessed in all analyzed models, with particular emphasis on those dimensions that appeared the most frequently. In the final part of the study,

we proposed a conceptual framework of an enterprise digital transformation model consisting of five key dimensions: digital strategy, resources, digital culture, digitization in management processes and external environment.

Keywords: digital transformation, digital maturity, assessment model, enterprise

JEL Classification codes: M15, O31, O33

POMIAR CYFROWEJ DOJRZAŁOŚCI PRZEDSIĘBIORSTWA

Streszczenie

Transformacja cyfrowa przedsiębiorstw zyskała na intensyfikacji w ostatnich latach, do czego przyczyniły się takie zjawiska jak pandemia COVID-19. Kierownictwa przedsiębiorstw rozwijających się cyfrowo potrzebują zarówno wskazówek dotyczących wdrażania efektywnego procesu transformacji cyfrowej, jak i narzędzi pomiarowych umożliwiających im ocenę dojrzałości cyfrowej, której wyniki mogą być wskazaniami dla doskonalenia transformacji. Celem niniejszego tekstu jest klasyfikacja i porównanie wybranych spośród istniejących modeli pomiaru dojrzałości cyfrowej przedsiębiorstw oraz zaproponowanie struktury ramowej modelu transformacji cyfrowej przedsiębiorstwa. Do analiz wybrano modele pomiaru dojrzałości cyfrowej powstałe w latach 2020–2023. Dokonano ich klasyfikacji przy uwzględnieniu czterech cech: typ, sposób użycia, zastosowanie oraz rezultat pomiaru. Następnie dokonano porównania wymiarów poddawanych ocenie we wszystkich analizowanych modelach, ze szczególnym akcentem na te wymiary, które pojawiały się najczęściej. W finalnej części opracowania zaproponowano model transformacji cyfrowej przedsiębiorstwa, składający się z pięciu kluczowych wymiarów: strategia cyfrowa, zasoby, kultura cyfrowa, digitalizacja w procesach zarządczych oraz środowisko zewnętrzne.

Słowa kluczowe: transformacja cyfrowa, dojrzałość cyfrowa, model pomiaru, przedsiębiorstwo

Kody klasyfikacji JEL: M15, O31, O33