Nikoletta Kaszás**, Ildiko Ernszt***, Balint Jakab****

THE EMERGENCE OF ORGANIZATIONAL AND HUMAN FACTORS IN DIGITAL MATURITY MODELS

ABSTRACT

Digital maturity encompasses a company's performance on the path to digital transformation. Various barriers can hinder the improvement of companies on the path to digital maturity – such as organizational culture and various human elements. The starting point for this study was that, regardless of digitization, the human factor is becoming an increasingly important resource in organizations and that digital maturity models (DMM) also focus on these aspects. The purpose of this study is twofold: to investigate the emergence of organizational culture and the human factor in DMMs through a comparative analysis and conduct empirical research in Hungary. In this study, we also aim to investigate the different factors of digital maturity of Hungarian companies and find a correlation with digital maturity based on the characteristics of a learning organization. According to our hypothesis, companies with the characteristics of a learning organization achieve a higher level of digital maturity. To prove this, we surveyed 776 Hungarian companies using a structured questionnaire. Based on our survey, we confirmed the hypothesis using three variables: the business organization anticipates and predicts change, focuses on long-term impacts when making organizational decisions; employees can achieve personal success.

KEYWORDS: *digital maturity; digital maturity models; learning organization; human resources*

1. INTRODUCTION

Digitization has become an expectation for for-profit and non-profit organizations in recent years, partly because of labor shortages and partly to meet rapidly changing consumer needs. Digital transformation is a continuous process that involves both technological transitions and changes in the organizational culture, attitude, and vision that support this. This requires new skills and knowledge from management and employees (Ghosh et al., 2022). The experience of recent years due to the Covid-19 epidemic notably accelerated the digitalization process and confirmed that even in these unusual circumstances, those or-

**   Nikoletta Kaszás, University of Pannonia, University Center for Circular Economy, Nagykanizsa, Hungary, H-8800 Nagykanizsa, Zrínyi street 18, E-mail: kaszas.nikoletta@pen.uni-pannon.hu
***   Ildikó Ernszt, University of Pannonia, University Center for Circular Economy, Nagykanizsa, Hungary, H-8800 Nagykanizsa, Zrínyi street 18, E-mail: ernszt.ildiko@pen.uni-pannon.hu
****   Bálint Jakab, University of Pannonia, University Center for Circular Economy, Nagykanizsa, Hungary, H-8800 Nagykanizsa, Zrínyi street 18, E-mail: jakab.balint@pen.uni-pannon.hu

ganizations that adapted to rapidly changing conditions remained flexible and were willing and able to learn was able to remain successful. However, the rapid introduction of digital technologies during this period did not give organizations a chance to adapt their culture and organization to this fundamental change, so organizational elasticity is needed more than ever (Reuschl et al., 2022).

From the literature, we have concluded that those characteristics that distinguish the so-called learning organization may be essential on the path to maturity and during its implementation. Numerous studies have examined digital maturity and the factors that support it. However, a large-scale study on the learning organization, examining the relationship between its characteristics and digital maturity, has not yet been carried out in Hungary. Some prior research on this has only been conducted in education. (Fazekas, 2021). Our study addresses critical questions about supporting factors of digital maturity. It can provide exciting lessons for organizations complementing the few articles that explore the relationship between the characteristics of a learning organization and digital transformation.

To date, digital maturity models have not considered the characteristics of the learning organization. Their' soft' measurement methods focused on organizational culture and human resource competencies. With our research, we wanted to verify whether companies with the characteristics of a learning organization are ahead in the digital transition process and whether they have a higher maturity level. If this assumption is correct, it may be necessary to include these characteristics in the indicators of digital maturity models.

In the study, we analyzed the digital maturity models, with particular attention paid to their organizational and human elements, with the lack of learning organizational characteristics. We analyzed the digital maturity level of organizations (Digital Toolkit) by surveying Hungarian companies. This sample served as a valid basis for the study of the identified research gap, in which we investigated the relationship between the characteristics of the learning organization and the level of digital maturity. Finally, we formulated suggestions for the organizational characteristics supporting digital transition.

2. DIGITAL MATURITY MODELS

All organizations must respond to the rapid changes of the digital rush in the environment. Digital transformation and maturity are no longer a competitive advantage for organizations and companies but ba-

sic requirements for their survival. The term 'maturity' usually means a "state of being complete, perfect, or ready" (Simpson & Weiner, 1989) or "the ability to respond to the environment appropriately through management practices" (Bititci et al., 2015). In this case, we accept Schumacher et al.'s (2016) extension that maturity includes some improvement in the development of a system. Several approaches in the literature represent this process.

Mittal et al. (2018) highlight the difference between maturity models, roadmaps, and frameworks. Frameworks are a collection of available procedures, methods, and tools (Storey, 2005). Based on Mittal's understanding, roadmaps are concrete plans that help achieve short-term and long-term goals using specific technology solutions. According to Greissbauer et al. (2016), the first step of a digital transformation roadmap starts with assessing the current digital maturity level. It aims to identify the organization's strengths. This allows the company to select the relevant processes and maturity models. (Machado et al., 2019).

Maturity models can also be viewed as mechanisms for increasing the maturity of the company by determining the process to be used (Mettler, 2011). Readiness is often referred to as a synonym for maturity. A readiness assessment is an *"evaluation tool to analyze and determine the level of preparedness of the conditions, attitudes, and resources, at all levels of a system, needed for achieving its goal(s)"* (Benedict et al., 2017).

Schumacher et al. (2016) pointed out that a distinction must be made between readiness and maturity. According to the authors, readiness is about assessing the status before starting the process, while maturity assessment intends to evaluate the current, actual state in the maturation process. In our study, we focus on the digital maturity models.

Digital maturity is a standardized path to digital transformation (Kane et al., 2017). It is a mirror that shows where the organization is on the path to digital transformation. It defines the organization's success in terms of transformation but also includes its future actions to adapt to an increasingly digital environment (Chanias-Hess, 2016).

Digital maturity indicates the degree of acceptance and implementation of digital technologies in corporate business models (Rossmann, 2018). It is important to note that digital maturity goes beyond technological innovations and ICT-based information handling. It also reflects an entirely new management perspective encompassing changes in products, services, business processes, required competencies, organizational culture, and capabilities related to managing change processes (Chanias-Hess,

2016). Shahiduzzaman et al. (2017) also emphasized that digital maturity encompasses management and technological aspects and can be viewed as a comprehensive approach. Consequently, organizations can reach the highest level of maturity if they have the right digital foundations in place but also recognize how to build a business model and advantage on these foundations (Teichert, 2019).

Although the concepts of digitalization and digital maturity of companies have existed for many years, they are still abstract. The absence of a specific and widely shared definition leads to some ambiguity about the essential function of DMMs (Thordsen et al., 2020). Digital transformation is a transformative progress toward Industry 4.0 (Kagermann et al., 2013), and digital maturity models imply several successive digital phases defined by increasing digital integration complexity (Colli et al., 2018). Maturity models are multi-stage schemes for defining a common improvement path (Poeppelbuss et al., 2011).

Maturity models claim to help by ensuring full navigation and providing a roadmap (Gökalp et al., 2017). Teichert (2019) also mentioned that digital maturity models help companies assess their competencies for digital transformation following predefined aspects. According to Williams et al. (2019), relying on a maturity model is not necessarily to learn the absolute truth but to provide a valuable tool for understanding and accomplishing the digital transformation task.

Digital maturity models consist of dimensions and criteria in the dimensions that describe different types of areas that indicate the development path toward maturity. The maturity level of a company describes its performance and can be a transformative station to develop the organization's maturity (Teichert, 2019).

3. ORGANISATIONAL AND HR ASPECTS IN DMMS

Organizational and HR aspects are vital in digital maturity, including performance management, KPIs, developing digital competencies, and the fear of job loss due to digitization (Obermayer et al., 2022). Mittal presented maturity models in his study and highlighted the dimensions of maturity that deal with people, such as employees' ICT competencies, openness to new technology, and employee autonomy (Mittal et al., 2018). Tortora et al. (2021) also emphasized that investing in technology alone does not guarantee the industry 4.0 maturity and gaining and maintaining competitive advantage. Employees must also receive sufficient information and be trained to achieve the

organization's strategic goals.

The digital maturity models we examined integrate human resources, skills, competencies, development, and collaboration to varying degrees. Table 1 summarizes how these different HR aspects appear in the elements of each digital maturity model and in the factors they describe,

In five cases of the examined models, no detailed information could be found about the HR dimensions that determine maturity, nor whether they include any HR themes. In the other three models, no indicator elements directly affect HR. In the remaining 17 models, the HR themes can be grouped around three main themes.

The importance of a change in attitude: for a successful digital transformation, all employees must recognize how their performance contributes to what is set out in the digitization strategy. Similarly, Gökalp et al. (2017) have articulated that workers should be aware of the positive consequences of smart manufacturing, which requires a skilled workforce (primarily in IT). According to Land, a creative work environment needs to be created, and human resource innovation is vital in digital transformation, as it can enable new products and services. (*The Digital Maturity Model (DMM)*, 2017). Furthermore, organizational agility positively impacts digital transformation (Al-nuaimi et al., 2022).

Skills and learning: Regarding resources required for digital maturity, Schuh et al. (2020) stated that, concerning the resources required for digital maturity, the workforce must have specific competencies (Schuh et al., 2020). Training and knowledge management within the organization are essential (Valdez-de-Leon, 2016), such as specific skills needed for the digital transition, highlighting digital skills, the importance of training, and the learning organization (Colli et al., 2018). Managers' coherence plays a significant role in adopting digital transformation (Porfírio et al., 2021). In addition, senior managers have a changing role in talent management (Fernandez-Vidal et al., 2022). In Gubán and Sándor's (2021) model, human ICT appears as an independent dimension, and within it, capabilities such as agility, knowledge application, adaptability, and ability to innovate are mentioned. Klötzer and Pflaum (2017) defined particular knowledge and competencies that a digitally mature organization must possess. These competencies in the areas of Technology and Innovation Management (TIM), Embedded Systems (ES), Service engineering and design, Service Systems Engineering (SEE), and data analyses are necessary. Schumacher et al. (2016) highlighted ICT competencies, and Lichtblau et al. (2015) formulated the speed of acquiring new skills as a criterion. Brandl (2016) addressed the digital

TABLE 1. Analyzed digital maturity models and the emergence of human resources (2015-2020)

Maturity models	Authors	Human factor issue
Digital Maturity Model Universität St. Gallen	(Berghaus et al., 2016)	Collaboration and communication between employees
360 Digital Maturity Assessment	(Colli et al., 2018)	• Digital competencies • Training culture • Learning culture
Digital Readiness Assessment Maturity (Dreamy)	(De Carolis et al., 2017)	No HR topics
Forrester's digital business maturity model 4.0	(Gill & VanBoskirk, 2016)	Employees understand how their performance relates to digital goals.
Industry 4.0-MM	(Gökalp et al., 2017)	• Knowledge of the advantages of smart manufacturing; • IT staff skill set and other essential human resource requirements
DÉTA (technical architecture of digital maturity)	(Gubán & Sándor, 2021)	• Agility • Application of knowledge • Adaptability • Ability to innovate
Smart Manufacturing Readiness Level (SMSRL)	(Jung et al., 2017)	Human is responsible for the process
Maturity Model for Digitalization	(Klötzer & Pflaum, 2017)	Competences in • Technology and innovation management (tim) • Embedded systems (es) • Service engineering and design • Service systems engineering (see) • Data analyses
Digital Transformation Index	Land (2015)	Development of innovative products and services
SIMMI 4.0	(Leyh et al., 2016)	No HR topics
IMPULS – Industry 4.0 Readiness	(Lichtblau et al., 2015)	Skill acquisition
Digital Maturity Measurement Model	(Rossmann, 2018)	Sufficient experts on digital core issues
ACATECH Industry 4.0 Maturity Index	(Schuh et al., 2020)	The workforce must have specific competencies to use best the information collected.
A maturity model for Industry 4.0 Readiness	(Schumacher et al., 2016)	ICT competences
Adoption Maturity Model (AMM)	(Scremin et al., 2018)	No specific topic addressed
Maturity and readiness model	(Ustundag & Cevikcan, 2018)	Real-time data-sharing E-learning
Maturity Levels for Cyber-Physical Systems	(Westermann et al., 2016)	No specific topic addressed
Digital Maturity Models for SME-s	(Williams et al., 2019)	No specific topic addressed
Models developed by consultant companies		
Digital Maturity Model	(Anderson & Ellerby, 2018)	Talent management
Industry 4.0 / Digital Operations Self-Assessment	(Geissbauer et al., 2016)	No specific topic addressed
Digital Maturity Model (DMM)	(*The Digital Maturity Model (DMM)*, 2017)	Employee empowerment
Sector-specific models		
I 4.0 Maturity Model for Manufacturing and Logistics Sector	(Angreani et al., 2020)	No specific topic addressed
Manufacturing Operations Management Capability Maturity Model (MOM)	(Brandl, 2016)	Formalized training
Digital Maturity Model for Telecommunications Service Providers	(Valdez-de-Leon, 2016)	Training and knowledge management
Maturity Model for Data-Driven Manufacturing (M2DDM)	(Webera et al., 2017)	No HR topics

Source: Authors, based on the listed references.

maturity of manufacturing companies as formalized, modernized training with received documents showing a high level of maturity among employees.

Cooperation: Berghaus et al. (2016) highlighted collaboration and communication among employees, while Anderson and Ellerby (2018) highlighted the importance of talent management. Ustundag and Cevikcan (2018) noted that employee cooperation might be necessary for real-time data-sharing and e-learning issues. Tuukkanen et al. (2022) emphasized the importance of cooperation within the organization, which includes collaboration, participation, and knowledge sharing. In Jung et al.'s (2017) model, a human factor is a tool responsible for processes. As indicated above, the various organizational and HR aspects are crucial for success in digital maturity. In addition, organizational learning also receives a high priority (Mengü & Aslan, 2021). Some authors emphasize the importance of developing a culture of innovation, thus contributing to a learning organization (Gimpel et al., 2018; Berger et al., 2020; Konopik et al., 2022).

According to Copulsky (Rader, 2019), tolerance, agility, willingness to experiment, and risk tolerance create good conditions for digital transformation. Moreover, digitally mature companies emphasize that these core values should be integrated into the organization's operations.

4. MATERIALS AND METHODS

As a result of the literature review, we concluded that organizational characteristics (especially culture) and the knowledge and competencies of the learning organization appear significant in digital maturity models, so we conducted an empirical study. Our objective was to validate our prior hypothesis and investigate whether learning organization characteristics can support digital maturity. According to our hypothesis, companies with the characteristics of a learning organization achieved higher levels of digital maturity. Our research used a structured questionnaire to observe Hungarian companies from March 11, 2021, to the end of April 2021. The companies' contact information was filtered from the Orbis database. There were 2,468,656 companies in the database filtered for Hungary.

We did not analyze the companies in the service and education sectors due to the lack of recent financial data. We examined medium-sized, large, and giant manufacturing companies that might have already addressed the topic of Industry 4.0. The essential list of the companies was obtained from the Orbis database, which contained 54,291 entries. As the

survey was conducted online, companies that did not have electronic contact information did not participate in the survey. In several cases, additional emails were identified as contact information, so we contacted 56,520 companies via email. We had 776 fully completed responses and 2,350 partially completed responses. IBM SPSS Statistics (version 22) was used for statistical analysis.
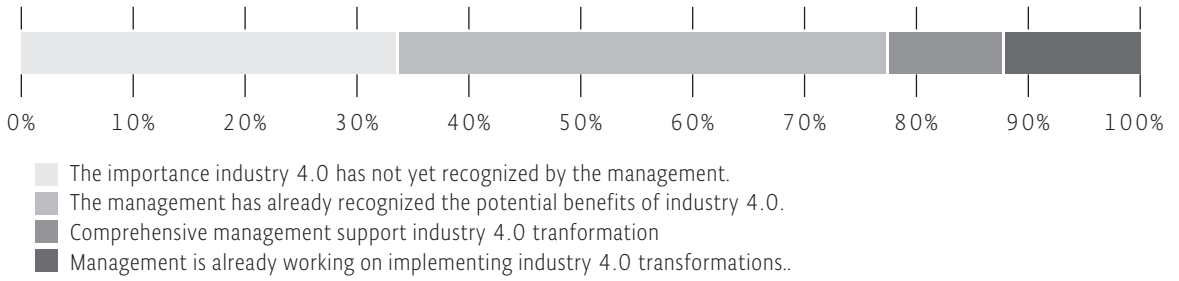
The focus of our study was, on the one hand, on the analysis of organizational culture. Specifically, we looked for the characteristics of the learning organization in the Hungarian companies we studied. On the other hand, we used a 7-point analysis for the digital maturity measurement (Digital Toolkit), based on which we performed data reduction. Responding companies completing the questionnaire rated their digital maturity level on a four-point scale.

To identify a latent variable summarizing the responses to the seven questions above, we conducted a factor analysis using the principal component method. The Kaiser-Meyer-Olkin (KMO) criterion is applied as one of the leading significant indicators for factor analysis. It shows the variables' suitability for factor analysis (Sajtos-Mitev, 2009; Malhotra, 2009). Possible values for the metric include KMO ≥ 0.9 – excellent; KMO ≥ 0.8 – very good; KMO ≥ 0.7 – adequate; KMO ≥ 0.6 – moderate; KMO ≥ 0.5 – weak; KMO < 0.5 – unacceptable. The KMO value should be greater than 0.5, while the significance of Bartlett's test should be below 0.05. The values of the communalities must also be checked since we need to know that the variables involved contribute significantly to the factors. The communalities should reach 0.25. To carry out a final statistical control, we also evaluated the degree of retention of the new aggregated variables compared to the information content of the original variables were also evaluated. When forming the factors, a minimum aggregate variance (50%) was set as a target value (Székelyi- Barna, 2004).

5. RESULTS

Based on the results of our research, it can be concluded that Hungarian companies are lagging in digital maturity. Although the importance of Industry 4.0 has been chiefly recognized (44%), only a few have initiated the change by introducing various developments (14%). Regarding human resources, it can be noted that in the case of ¾ of the companies, there are not or only a few digitally skilled employees. The various development pieces of training are either not at all (23%) or mostly (60%) professional and not focused on developing digital competencies. Most companies have only the most basic ICT tools avail-

Recognizing the importance of Industry 4.0

The importance industry 4.0 has not yet recognized by the management.
The management has already recognized the potential benefits of industry 4.0.
Comprehensive management support industry 4.0 tranformation
Management is already working on implementing industry 4.0 transformations..

Development for Industry 4.0

128

Industry 4.0 developement have not yet taken place at the company.
Some industry-related developements have already taken place in one or two areas (e.g., robotics, cloud based solutions).
Extensive industry 4.0 technology developments have taken place in several areas
A complex, technological and organizational development industry 4.0 program has been implemented for the entire organization.

Employee ICT expiriences

Employees have minimal experiences in ICT and digital devices / solutions.
There are some digitally trained collegues working primarly in technical areas.
Collegues with advanced ICT and digital competencies work in several areas.
Experts with outstanding and continuously trained digital and analytical skills work on all areas of the organization.
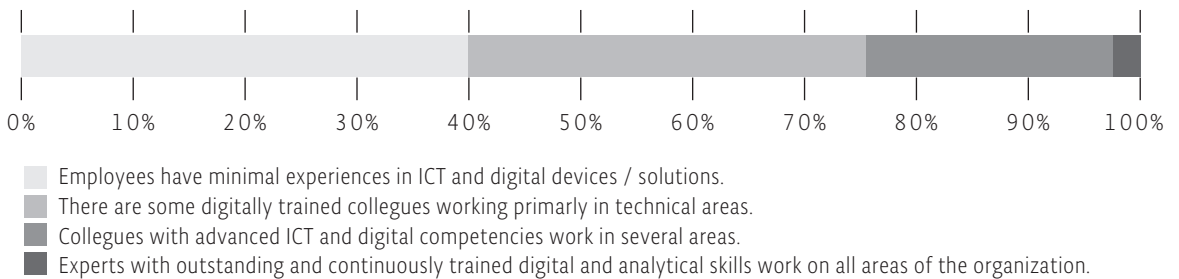
FIGURE 1. Digital maturity of enterprises in the seven examined aspects
Source: Authors.

able (e.g., email, spreadsheets) or have invested in some business support programs. Automated equipment control is rare (20%); most are controlled manually. Machine-to-machine communication has been implemented on some devices in half of the companies, but full integration is rare.

Based on the digital maturity items, we assumed a correlation between these variables, so a Digital Toolkit factor was created by the data reduction method using principal component analysis. The KMO value is 0.856, and the significance is 0.00, so the set is suitable for analysis.

TABLE 2. Results of KMO and Bartlett's test (Digital Toolkit)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		,856
Bartlett's Test of Sphericity	*Approx. Chi-Square*	1750,038
	df	21
	Sig.	,000

Source: Authors.

TABLE 3. Communalities (Digital Toolkit)

	Initial	**Extraction**
Importance of Industry 4.0	1	.461
Status of Industry 4.0 developments	1	.659
Experience of ICT employees	1	.500
Current status of training	1	.482
Status of ICT developments	1	.568
Status of automated control	1	.441
M2M communication status	1	.389

Source: Authors.
NOTE: Extraction Method: Principal Component Analysis.

TABLE 4. Total variance explained (Digital Toolkit)

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	3.500	50.000	50.000	3.500	50.000	50.000
2	.876	12.512	62.512			
3	.730	10.423	72.935			
4	.539	7.700	80.635			
5	.521	7.440	88.075			
6	.494	7.052	95.128			
7	.341	4.872	100.000			

Source: Authors.
NOTE: Extraction Method: Principal Component Analysis.

The values of the communalities must also be checked since we need to know that these seven variables contribute significantly to this created factor. The results show that the value of communality exceeds the mentioned threshold (0.25), so we did not have to pronounce any of the variables.

Reducing the number of variables is possible only at the cost of losing information. Our new aggregated variable retained 50% of the information content of the original variables (Table 4), which is an acceptable amount based on the rule of thumb.

As a result, we obtained a Digital Toolkit factor that compresses all the previously mentioned variables. This data reduction was necessary to examine the relationships between digital maturity and the characteristics of the learning organization as an aspect of organizational culture. The organizational culture schema required the companies to indicate their characteristics in the following nine variables (1 - not characteristic at all - 4 - entirely characteristic, I don't know), which are presented below:

1. The organization is open to environmental change.
2. The organization eagerly anticipates change.
3. The organization is innovative, seeks out the new, and is not constrained by old habits and routines.
4. The organization also focuses on long-term effects when making decisions.
5. The impact of change on other parts and groups of the organization is also considered as the organization operates and improves.
6. The goal is to improve the learning and development skills of the organization's members group learning.
7. The organization cares about incorporating personal employees' visions into the vision of the organization.

TABLE 5. Regression model

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
The organization proactively anticipates change.	.324	.056	.288	5.761	.000
It also focuses on long-term impacts when making organizational decisions.	.197	.057	.166	3.444	.001
Employees can act to achieve their vision, i.e., free self-realization.	-.091	.046	-.085	-1.970	.049

Source: Authors.

8. Employees know how their efforts contribute to achieving the organization's goals.
9. Employees can take action to achieve their vision, i.e., free self-actualization.

According to our hypothesis, companies with the characteristics of a learning organization achieved a higher level of digital maturity. To justify this hypothesis, we examined the influence of the learning organization components on the created Digital Toolkit factor and the percentage they contribute to the creation of the factor. For this purpose, a linear regression analysis was performed.

In regression models, the behavior of a dependent variable (Digital Toolkit) is explained by independent variables (9 characteristics of organizational culture) with a high measurement level. In the study, the 'backward' method was used (Székelyi & Barna, 2004). The regression analysis results show that the organizational culture variables describe 14.2% (R-squared = 142) of the companies' Digital Toolkit and that three

variables significantly contribute to the development of the companies' Digital Toolkit (the other six variables were not significant). The value of column 'B' in Table 5 shows the slope of the regression value: a negative/inverse relationship can be found between the employees' vision and the toolkit.

"The organization proactively anticipates change" contributes 32.4% to the Digital Toolkit in a positive direction. Similarly, "The organization also focuses on long-term impacts when making decisions" positively contributes 19.7% to the Digital Toolkit factor. Self-actualization as an activity carried out by employees to achieve their vision contributes to the Digital Toolkit (negative sign). In summary, Figure 2 shows that three of the variables of a learning organization influence the Digital Toolkit factor we created.

According to our hypothesis, companies with the characteristics of a learning organization achieved higher levels of digital maturity. We included nine characteristics in our analysis that a learning organi-
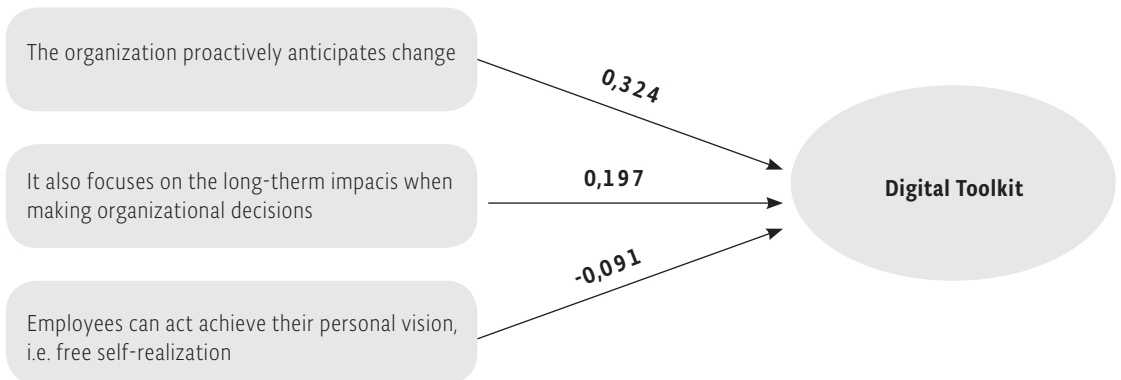

FIGURE 2. Impact of learning organization characteristics on digital maturity
Source: Authors.

zation typically exhibits. Regression analysis showed a significant, statistically demonstrable correlation with digital maturity levels for three characteristics. Based on the results, it can be concluded that:

- organizations that proactively anticipate change are more advanced in terms of digital maturity;
- organizations that focus on the long-term impacts of organizational decisions are more developed in terms of digital maturity;
- organizations whose employees can take action to realize their vision are less developed in digital maturity.

The latter may be because digitalization often restricts employees' scope for decision-making, undermining the individual vision and approach and resulting in less support.

6. DISCUSSION AND CONCLUSION

Our research focused on the factors of digital maturity that are increasingly counted in the literature as factors hindering digital transformation: organizational culture and human factors. Firstly, we conducted a literature review of currently known and published digital maturity models, covering the main points and dimensions that are most common in the study of digital maturity. As a result of our review, these elements are technology, strategy, people, organization, product, culture, management/leadership, business processes, and customers. In summary, we obtained a result that overlaps with the results of previous similar overview studies. Among the digital maturity models, scientific, practical, industrial, and consulting approaches pay close attention to organizational characteristics. However, we also found that people/competencies and organizational dimensions are the third and fourth most frequently included factors in the models, while organizational culture is ranked sixth. This means that digital maturity cannot be achieved by developing equipment and changing technological processes. The soft factors of the organization, such as culture or the preparation and development of human resources, proved to be at least as necessary. Our empirical research has shown that the individual and organizational culture factors included in the digital maturity models indeed impact the maturity level, which we have investigated and validated using the example of Hungarian companies.

As a practical, new implication of our study, it can be concluded that organizational characteristics such as the characteristics of a learning organization influence the digital maturity of entrepreneurs, so the strategy of organizations planning digital transition must also be prepared for a change in the orga-

nizational culture. Therefore, a novel approach from this research can be helpful for management. Digital transformation is more than purchasing and implementing new smart devices or transferring the supply chain to an online platform. A company's strategy for planning digital transition must also focus on changing organizational culture. By prioritizing the human factor and implementing the characteristics mentioned above, it could provide companies with guidelines for increasing their level of digital maturity.

Our study can be seen as a call to attention for Industry 4.0 researchers. The topic primarily dominates the field of engineering and IT. However, as an added value of our study, it is clear that researchers should take a close look at human resources and organizational culture, as these also impact digital maturity. At the same time, our study can lay the foundation for future research: the digital transition of organizations can be supported by analyzing other organizational (e.g., culture) characteristics.

We need to mention three critical points as limitations of the research. The literature review analyses the models included in studies published up to 2021. Considering the dynamic development of the field, many new types of research have been conducted on this topic in the recent period. On the other hand, the empirical study was conducted in Hungary, so the interpretation of the results cannot be applied to other countries, as it specifically describes the characteristics of the Hungarian economy. Finally, since the research was conducted in the shadow of the Covid-19 pandemic, it can be assumed that survival and not development were the focus of the company's operations.

REFERENCES

1. AlNuaimi, Bader, K., Singh, S. K., Ren, S., Budhwar, P. & Vorobyev, D. (2022). Mastering digital transformation: The nexus between leadership, agility, and digital strategy, Journal of Business Research, Volume 145, 636-648, ISSN 0148-2963, https://doi.org/10.1016/j.jbusres.2022.03.038.

2. Anderson, C., & Ellerby, W. (2018). Digital Maturity Model. *Deloitte*, *February*, 9–12.

3. Angreani, L. S., Vijaya, A., & Wicaksono, H. (2020). Systematic literature review of industry 4.0 maturity model for manufacturing and logistics sectors. *Procedia Manufacturing*, 52(2019), 337–343. https://doi.org/10.1016/j.promfg.2020.11.056

4. Benedict, N., Smithburger, P., Donihi, A. C., Empey, P., Kobulinsky, L., Seybert, A., Waters, T., Drab, S., Lutz, J., Farkas, D., & Meyer, S. (2017). Blended Simulation Progress Testing for Assessment of Practice Readiness. *American Journal of Pharmaceutical Education*, 81(1). https://doi.org/10.5688/AJPE81114

5. Berger, S., Bitzer, M., Björn, H.; Voit, C. (2020). Approaching digital transformation - development of a multi-dimensional maturity model. Research Papers. 181, Twenty-Eighth European Conference on Information Systems (ECIS2020) – A Virtual AIS Conference.

6. Berghaus, S., Back, A., & Kaltenrieder, B. (2016). *Digital Maturity & Transformation Report 2016*. https://www.digitaleschweiz.ch/wp-content/uploads/2016/06/digital-maturity-transformation-report-2016-mit-best-practices.pdf

7. Bititci, U. S., Garengo, P., Ates, A., & Nudurupati, S. S. (2015). Value of maturity models in performance measurement. *International Journal of Production Research*, 53(10), 3062–3085. https://doi.org/10.1080/00207543.2014.970709

8. Brandl, D. (2016). *MESA MOM Capability Maturity Level - White paper*.

9. Chanias, S., & Hess, T. (2016). *How digital are we? Maturity models for assessment of a company's status in digital transformation*. https://www2.deloitte.com/content/dam/insights/us/articles/3678_achieving-digital-maturity/DUP_Achieving-digital-maturity.pdf

10. Colli, M., Madsen, O., Berger, U., Møller, C., Wæhrens, B. V., & Bockholt, M. (2018). Contextualizing the outcome of a maturity assessment for Industry 4.0. *IFAC-PapersOnLine*, 51(11), 1347–1352. https://doi.org/10.1016/j.ifacol.2018.08.343

11. De Carolis, A., Macchi, M., Negri, E., & Terzi, S. (2017). A Maturity Model for Assessing the Digital Readiness of Manufacturing Companies. *IFIP Advances in Information and Communication Technology*, 513, 13–20. https://doi.org/10.1007/978-3-319-66923-6_2

12. Fazekas, N. (2021). *Learning Organizations and Organizational Digital Competencies in the Field of Public Education. Conference Proceedings. New Horizons in Business and Management Studies.* Corvinus University of Budapest, Budapest, 25-36. ISBN 978-963-503-867-1 DOI 10.14267/978-963-503-867-1_03

13. Felch, V., Asdecker, B., & Sucky, E. (2019). Maturity Models in the Age of Industry 4.0 – Do the Available Models Correspond to the Needs of Business Practice? *Proceedings of the 52nd Hawaii International Conference on System Sciences*, 6, 5165–5174. https://doi.org/10.24251/hicss.2019.620

14. Fernandez-Vidal, J., Perotti, F. A., Gonzalez, R. & Gasco, J. (2022). Managing digital transformation: The view from the top. Journal of Business Research, Volume 152, 29-41, ISSN 0148-2963, 29-41, https://doi.org/10.1016/j.jbusres.2022.07.020.

15. Geissbauer, R., Vedso, J., & Schrauf, S. (2016). *Industry 4.0: Building the digital enterprise - 2016 Global Industry Survey*. https://www.pwc.com/gx/en/industries/industries-4.0/landing-page/industry-4.0-building-your-digital-enterprise-april-2016.pdf

16. Gill, M., & VanBoskirk, S. (2016). The Digital Maturity Model 4 . 0. *Forrester*, 0–17.

17. Gimpel, H., & M. Röglinger (2017). "Künstliche Intelligenz, Deep Learning & Co." Wirtschaftsinformatik & Management 9 (5), 6–14.

18. Gökalp, E., Şener, U., & Eren, P. E. (2017). Development of an assessment model for Industry 4.0: Industry 4.0-MM. *Communications in Computer and Information Science*, 770(September), 128–142. https://doi.org/10.1007/978-3-319-67383-7_10

19. Ghosh, S., Hughes, M., Hodgkinson, I., Hughes, P. (2022). Digital transformation of industrial businesses: A dynamic capability approach, Technovation, Volume 113, May, 102414, ISSN 0166-4972, https://doi.org/10.1016/j.technovation.2021.102414.

20. Gubán, Á., & Sándor, Á. (2021). A kkv-k digitálisérettség-mérésének lehetőségei. *Vezetéstudomány*, 52(3), 13–28.

21. Jung, K., Kulvatunyou, B., Choi, S., & Brundage, M. P. (2017). An Overview of a Smart Manufacturing System Readiness Assessment. *IFIP Advances in Information and Communication Technology*, 488, 705–712. https://doi.org/10.1007/978-3-319-51133-7_83

22. Kagermann, H., Wahlster, W., & Helbig, J. (2013). *Recommendations for implementing the strategic initiative INDUSTRIE 4.0 April 2013 Securing the fu-*

*ture of German manufacturing industry Final re-
port of the Industrie 4.0 Working Group.*

23. Kane, G. C., Palmer, D., Phillips, A. N., Kiron, D.,
    & Buckle, N. (2017). *Achieving Digital Maturi-
    ty - Adapting Your Company to a Changing World.*
    https://www2.deloitte.com/content/dam/in-
    sights/us/articles/3678_achieving-digital-matu-
    rity/DUP_Achieving-digital-maturity.pdf

24. Klötzer, C., & Pflaum, A. (2017). Toward the De-
    velopment of a Maturity Model for Digitalization
    within the Manufacturing Industry's Supply Chain.
    *Proceedings of the 50th Hawaii International Con-
    ference on System Sciences*, 4210–4219.

25. Konopik, J., Jahn, C., Schuster,T., Hoßbach, N. &
    Pflaum, A. (2022). Mastering the digital trans-
    formation through organizational capabilities: A
    conceptual framework, Digital Business, Volume
    2, Issue 2, 2022, 100019, ISSN 2666-9544, https://
    doi.org/10.1016/j.digbus.2021.100019.

26. Leyh, C., Bley, K., Schaffer, T., & Forstenhausler, S.
    (2016). SIMMI 4.0-a maturity model for classi-
    fying the enterprise-wide it and software land-
    scape focusing on Industry 4.0. *Proceedings of
    the 2016 Federated Conference on Computer Sci-
    ence and Information Systems, FedCSIS 2016,*
    1297–1302. https://doi.org/10.15439/2016F478

27. Lichtblau, K., Stich, V., Bertenrath, R., Blum, M.,
    Bleider, M., Millack, A., Schmitt, K., Schröter, M.,
    & Schmitz, E. (2015). *Industrie 4.0 readiness.* Co-
    logne Institute for Economic Research (IW).

28. Machado, C. G., Winroth, M., Carlsson, D., Alm-
    ström, P., Centerholt, V., & Hallin, M. (2019). In-
    dustry 4.0 readiness in manufacturing compa-
    nies: Challenges and enablers towards increased
    digitalization. *Procedia CIRP*, *81*, 1113–1118. https://
    doi.org/10.1016/j.procir.2019.03.262

29. Mengü, S. – Aslan, P. (2021). The Aspects of Digi-
    tal Transformation for Learning Organizations, In:
    *Entrepreneurial and Communicative Mind in Ac-
    tion*, Ed.: Gole, P. A. Pearson Education Limited,
    Essex, p. 81

30. Mettler, T. (2011). Maturity assessment models: a
    design science research approach. *Internation-
    al Journal of Society Systems Science*, *3*(1/2), 81.
    https://doi.org/10.1504/IJSSS.2011.038934

31. Mittal, S., Khan, M. A., Romero, D., & Wuest, T.
    (2018). A critical review of smart manufactur-
    ing & Industry 4.0 maturity models: Implica-
    tions for small and medium-sized enterprises
    (SMEs). *Journal of Manufacturing Systems*, *49*(No-
    vember), 194–214. https://doi.org/10.1016/j.
    jmsy.2018.10.005

32. Obermayer, N., Csizmadia, T., & Máté Hargitai, D.
    (2022). Influence of Industry 4.0 technologies on
    corporate operation and performance manage-

ment from human aspects. *Meditari Accountancy
Research*, 30(4), 1027-1049

33. Poeppelbuss, J., Niehaves, B., Simons, A., Becker,
    J., & Pöppelbuß, J. (2011). Maturity Models in In-
    formation Systems Research: Literature Search
    and Analysis. *Communications of the Association
    for Information Systems*, *29*, 505–532. http://aisel.
    aisnet.org/cais/vol29/iss1/27

34. Porfírio, J. A., Carrilho, T., Felício, J. A. & Jardim,
    J. (2021). Leadership characteristics and digi-
    tal transformation. Journal of Business Research,
    Volume 124, 2021, 610-619, ISSN 0148-2963,
    https://doi.org/10.1016/j.jbusres.2020.10.058.

35. Rader, D. (2019). Digital maturity - The new com-
    petitive goal. Strategy & Leadership, OL. 47 NO. 5,
    28-35, ISSN: 1087-8572 DOI 10.1108/SL-06-2019-
    0084)

36. Reuschl, A. J., Deist, M. K. & Maaloui, A. (2022).
    Digital transformation during a pandem-
    ic: Stretching the organizational elasticity. Jour-
    nal of Business Research. Vol. 144. May, 1320-1332.
    https://doi.org/10.1016/j.jbusres.2022.01.088

37. Rossmann, A. (2018). Digital maturity: Conceptu-
    alization and measurement model. Internation-
    al Conference on Information Systems 2018, ICIS
    2018, 1–9.

38. Sajtos, L. and Mitev, A. (2007)'SPSS kutatási és
    adatelemzési kézikönyv' [Research and data
    analysis manual for SPSS] Alinea Kiadó, Budapest

39. Schuh, G. G., Anderl, R., Gausemeier, J. J., ten
    Hompel, M. M., Wahlster, W. (Eds. ., Ander, Lr.,
    Gausemeier, J. J., ten Hompel, M. M., & Wahlster,
    W. (Eds. . (2020). Industrie 4.0 Maturity Index.
    Managing the Digital Transformation of Compa-
    nies. *Acatech Study*, 64. www.acatech.de/pub-
    likationen.

40. Schumacher, A., Erol, S., & Sihn, W. (2016). A Ma-
    turity Model for Assessing Industry 4.0 Readiness
    and Maturity of Manufacturing Enterprises. *Pro-
    cedia CIRP*, *52*, 161–166. https://doi.org/10.1016/j.
    procir.2016.07.040

41. Scremin, L., Armellini, F., Brun, A., Solar-Pelle-
    tier, L., & Beaudry, C. (2018). Towards a frame-
    work for assessing the maturity of manufac-
    turing companies in industry 4.0 adoption.
    *Analyzing the Impacts of Industry 4.0 in Mod-
    ern Business Environments*, 224–254. https://doi.
    org/10.4018/978-1-5225-3468-6.CH012

42. Shahiduzzaman, M., Kowalkiewicz, M., Bar-
    rett, R., & McNaughton, M. (2017). *Digital busi-
    ness: Towards a value centric maturity model.*
    https://w7g6c8m4.stackpathcdn.com/wp-con-
    tent/uploads/2018/11/DIGITAL-MATURITY-MOD-
    EL-PART-A.pdf

43. Simpson, J. A., & Weiner, E. S. C. (1989). *The Ox-*

ford English dictionary (Oxford University Press (Ed.); 2nd edition). New York: Clarendon Press.

44. Storey, M. A. (2005). Theories, methods and tools in program comprehension: Past present and future. *Proceedings - IEEE Workshop on Program Comprehension*, 181–191. https://doi.org/10.1109/WPC.2005.38

45. Székelyi, M. and Barna, I. (2004) 'Túlélőkészlet az SPSS-hez, Többváltozós elemzési technikáról társadalomkutatók számára' [Survival Kit for SPSS, Multivariate Analysis Techniques for Social Researchers], Typotex, Budapest, ISBN: 9789639326422, p. 454

46. Teichert, R. (2019). Digital transformation maturity: A systematic review of literature. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, *67*(6), 1673–1687. https://doi.org/10.11118/actaun201967061673

47. *The Digital Maturity Model (DMM)*. (2017). TM Forum. https://www.tmforum.org/digital-transformation-maturity/

48. Thordsen, T., Murawski, M., & Bick, M. (2020). How to Measure Digitalization? A Critical Evaluation of Digital Maturity Models. In H. M., M. M., S. H., P. I., D. Y., & M. M. (Eds.), *Responsible Design, Implementation and Use of Information and Communication Technology: Vol. 12066 LNCS* (pp. 358–369). Springer. https://doi.org/10.1007/978-3-030-44999-5_30

49. Tortora, A. M. R., Maria, A., Valentina, D. P., Iannone, R., & Pianese, C. (2021). A survey study on Industry 4.0 readiness level of Italian small and medium enterprises. *Procedia Computer Science*, *180*, 744–753. https://doi.org/10.1016/j.procs.2021.01.321

50. Tuukkanen, V., Wolgsjö, E., Rus, L. (2022). Cultural Values in Digital Transformation in a Small Company. Procedia Computer Science 196, 3–12 DOI: 10.1016/j.procs.2021.11.066

51. Ustundag, A., & Cevikcan, E. (2018). *Industry 4.0 Managing The Digital Transformation* (Issue September). Springer. https://doi.org/10.1007/978-3-319-57870-5

52. Valdez-de-Leon, O. (2016). A Digital Maturity Model for Telecommunications Service Providers. *Technology Innovation Management Review*, *6*(8), 19–32. https://www.timreview.ca/sites/default/files/article_PDF/Valdez-de-Leon_TIMReview_August2016.pdf

53. Webera, C., Königsbergera, J., Kassnera, L., & Mitschanga, B. (2017). M2DDM – A Maturity Model for Data-Driven Manufacturing. *The 50th CIRP Conference on Manufacturing Systems*, 173–178.

54. Westermann, T., Anacker, H., Dumitrescu, R., & Czaja, A. (2016). Reference architecture and maturity levels for cyber-physical systems in the mechanical engineering industry. *2016 IEEE International Symposium on Systems Engineering (ISSE)*, 1–6. https://doi.org/10.1109/SysEng.2016.7753153.

55. Williams, C., Schallmo, D., Lang, K., & Boardman, L. (2019). Digital Maturity Models for Small and Medium-sized Enterprises : A Systematic Literature Review Daniel Schallmo Luke Boardman. *ISPIM Innovation Conference, June*.

POJAVA ORGANIZACIJSKIH I LJUDSKIH ČIMBENIKA U MODELIMA
DIGITALNE ZRELOSTI

SAŽETAK

Digitalna zrelost obuhvaća uspješnost tvrtke na putu digitalne transformacije. Razni prepreke mogu spriječiti napredak tvrtki na putu digitalne zrelosti - poput organizacijske kulture i raznih ljudskih elemenata. Polazna točka ovog istraživanja bila je da, bez obzira na digitalizaciju, ljudski faktor postaje sve važniji resurs u organizacijama, kao i da se digitalni modeli zrelosti (Digital Maturity Models) također usredotočuju na ove aspekte. Cilj ovog istraživanja je dvojak: istražiti pojavu organizacijske kulture i ljudskog faktora u digitalnim modelima zrelosti kroz komparativnu analizu te provesti empirijsko istraživanje u Mađarskoj. U ovom istraživanju, također želimo istražiti različite čimbenike digitalne zrelosti mađarskih tvrtki i pronaći povezanost s digitalnom zrelošću na temelju karakteristika učeće organizacije. Prema postavljenoj hipotezi, tvrtke s karakteristikama učeće organizacije postižu viši stupanj digitalne zrelosti. Kako bi se navedeno i dokazalo, anketirali smo 776 mađarskih tvrtki koristeći strukturirani upitnik. Na temelju našeg istraživanja, potvrdili smo hipotezu, koristeći tri varijable: poslovna organizacija predviđa promjene, usredotočuje se na dugoročne učinke pri donošenju organizacijskih odluka, a zaposlenici imaju priliku postići osobni uspjeh.

KLJUČNE RIJEČI: *digitalna zrelost; modeli digitalne zrelosti; učeće organizacije; ljudski resursi*