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The Role of Leadership in Digital Learning Organizations

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Abstract

The study aims to examine the relationship and interaction between learning organization culture and the factors influencing digital transformation (leadership style, training, digital readiness, and trust), as well as identify factors that significantly influence learning organization functioning by exploring the extension of a grounded theory framework. The survey was conducted using an online questionnaire. The survey population was composed of managers of Eastern European manufacturing companies who were reached through the Orbis database. The survey yielded 618 evaluable responses (n = 618). The PLS-SEM method was used because the structural model is complex, with many constructs (some of which are formatively measured) and model relationships. Leadership behavior and a supportive management style inspire the development and training of employees, through which the level of readiness for digitalization and Industry 4.0 technologies can be increased. Training in these skills will increase confidence in digitalization technologies. Leadership support also influences digital trust and employee response to the use of digital technologies, as does participation in training, which directly supports digitalization and I4.0 readiness. The results of the research not only support previous research findings but also complement them by focusing specifically on the impact on the learning organization in the context of digitalization. This study provides evidence that leadership that is supportive of the learning organization's culture plays a key role. Overall, leadership is a dominant influence in the digital transformation of organizations and in shaping the learning organization culture this requires, but all the relationships represented in the model have a significant positive relationship.

Keywords:

Learning Organization;
Digitalization;
Industry 4.0;
PLS-SEM;
Technology.

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1- Introduction

Digital transformation, which may be viewed as meeting the requirements of Industry 4.0 (I4.0), is one of the biggest challenges for all industries. The change involves rethinking technology, developing new business models, acquiring and integrating new digital tools into processes, and transforming customer service [1–4]. Fast-paced competition has begun in international markets, where winning means building new core competencies and new skills that lead to sustainable competitive advantage [5]. Developing the capabilities of an organization and enhancing its innovativeness demand continuous learning by both employees and managers [6–8]. The digital evolution of organizations thus requires the development of new organizational solutions, forms of leadership, leadership styles, and management systems [9–12]. Organizational learning is critical to ensuring continuity of development, as only prepared people can produce a rapid response to change.

The knowledge of individuals therefore needs to be upgraded to an organizational level, which is significantly easier to achieve under learning organization conditions. This is because there is trust, teamwork, mutual support, and leadership commitment to ensuring these are part of the workplace culture [13–16]. Guidance is provided by Basten and

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Haamann [17], a literature review-based tool for designing organizational learning processes. Their study envisages the application of its model, with adaptations, to organizational processes and culture. However, it currently lacks practical testing, meaning that its propensity to achieve a successful outcome cannot yet be demonstrated. Similarly, research on digital trust is only theoretically developed in the work of Pietrzak and Takala [18], which, based on a literature analysis, suggests further research directions. Here too, practical testing is lacking. Zghenti and Chkareuli [19] examined the building of digital trust at three levels in their study in a developing economy where the idea of a learning organization is still unimaginable. Luo et al. [20] meanwhile investigated the impact of digital development on leadership style, also at a theoretical level, focusing mainly on leadership competences and skills. They also conducted a theoretical study focusing on the relationship between leadership attention and IT, already referring to the necessary support for collaborative learning and teamwork, but here again, practical investigation was lacking. Van Wart et al. [21] and Chamakiotis et al. [22] identified the elements of e-leadership, also based on literature. Several studies have theoretically investigated the relationship between the level of digitalization development in terms of leadership decisions, leadership style, and organizational design [23–27]. The research gaps and lack of practical studies demonstrate that there is a justification for research (such as the current investigation) based on practical studies, which look for salient determinants of the cultural conditions of the learning organization in order to implement digitalization changes and sustain success.

This research aims to address the missing research findings by examining the relationship and interaction between learning organization culture and the factors influencing digital transformation (leadership style, training, digital readiness, and trust). The goal is to identify factors that significantly influence learning organization performance by exploring the extension of a grounded theory framework.

The paper reviews managerial expectations under conditions of digitalization, followed by the characteristics of culture and organizational learning. After the theoretical foundations, empirical studies are presented, results are evaluated, and the paper concludes with a comparison with previous research and conclusions.

2- Literature Review

2-1- Leadership during Digital Changes – Leadership 4.0

In a survey [28] conducted by the Frankfurt Institute for Leadership Culture in the Digital Age, 46% of the executives surveyed agreed completely and 31% agreed partially that the increasing digitalization of the economy and human communication is increasing the pressure on leadership as the pressure to decide and act increases in both temporal and volume terms. Almost two-thirds of respondents fully agreed with the statement that networked thinking and action will be a prerequisite for successful leadership in the future. Most respondents felt that, in addition to a high level of media competence, managers also needed a high level of social competence and an especially high level of empathy. The main task of relationship managers is to shape the relationships in the organization's social system so that employees can work together effectively. This is necessary, inter alia, in order to organize people and generations into a network, to gain the trust of employees, and to motivate them. The study shows that most managers believe that leadership needs to change in the digital age. There is also agreement that, in increasingly networked structures, the social and emotional intelligence of managers is increasingly crucial to success. Younger managers see a significantly greater need for companies to actively shape their organizational culture to meet the demands of the digital age [29]. To successfully manage digital change, it is also worth exploring areas such as people management, knowledge valorization, changing competencies, changing leadership styles, the need for digital strategy making, shaping culture, encouraging organizational learning, etc. [30].

Based on the results of a 2016 study, we can highlight four qualities that leaders need to possess in order to triumph over the challenges of digitalization [31]: traditional leadership, diversity, agile leadership, and ethical responsibility. Bowles' recommendation [32] emphasizes the importance of lifelong learning alongside different competences. Boesenberg [33], meanwhile, mentions the areas where leaders need to think differently in the digital world.

In addition to accountability, results, information sharing/transfer, goals and evaluation, and conflicts, she also emphasizes change and innovation. Although further expectations will be a task for the period ahead, a new concept has emerged called Leadership 4.0. The concept highlights critical points that are definitely subject to different judgments in management. According to Boesenberg [34], Leadership 4.0 requires a very fast, cross-hierarchical, flexible, collaborative, and team-oriented mindset. These expectations are in harmony with the thinking of Herold [31]. According to Stoffel [35], in the future there will no longer be a leader in corporate management, but an organization will emerge that inspires the best. Management structures, tools, and employee roles play a key role in this. This means that for organizations to succeed in the future, they need to form an employee-centered organization where the commitment of employees and managers is not in doubt; they share the responsibility of creating a trustworthy organizational culture [36].

Oxford Leadership's research has identified a further seven areas for improvement in organizations, one of which, in addition to the above, is worth highlighting as a necessary shift in leadership thinking from IQ to weQ (weQuality). This means they give up control, lend confidence in problem solving, and support the collective intelligence of teams [36].

Their researchers also implicitly assume organizational characteristics that have been focused on in previous years as characteristics of learning organization culture/operation: trust, teamwork, the ability to learn continuously, knowledge sharing, innovation, and willingness to change [37, 38].

2-2- Learning Organizations in the Digital Age

The ideology of the learning organization is attributed to Senge [37], who in his well-known work "5 Principles" formulated the expectations that have been the hallmark of learning organization operation in management thinking and practice ever since. Such organizations are able to adapt to constantly changing environmental challenges over the long term while learning and performing at their best. In the process, processes are put in place that facilitate change, continuous learning, and knowledge acquisition in organizations.

Most research on learning organizations [39] almost completely lacks a technological perspective. Watkins & Marsick [40] argue that technology is relevant to the learning organization in that organizations need systems that capture and provide the platforms needed to share learning. According to Marquardt [41], technology is one of many subsystems of the learning organization; the technology subsystem consists of supporting, integrated technology networks and information tools that enable access to and sharing of information and learning. It includes collaboration, technical processes, systems, and structures for coaching, coordination, and other knowledge skills. In our view, this approach overlooks two key aspects. To begin with, learning organizations in the age of smart machines will rely heavily on the capabilities offered by artificial intelligence (AI) (big data sets will make this a necessity), so smart tools will become increasingly dominant (even without human intervention). However, collaboration between humans and smart tools and the learning required to enable it are essential to realizing the potential performance gains from collaboration [42].

As described above, while I4.0 and the developmental expectations of digitalization demand innovative technical advances, the human factor is being marginalized. In contrast, in an organization that requires continuous learning, flexibility, and openness (a learning organization), technology takes a back seat. It is necessary to reduce the distance between the two necessary organizational characteristics by focusing on mutual inclusion and the synthesis of thinking and tools. In the course of this research, we will point out the interdependence of the two areas and the necessary supportive role of leadership in facilitating this mutual inclusion. Organizational learning (building on the opportunities provided by technology) supports creativity, inspires new knowledge and ideas, increases their understanding and application, fosters organizational intelligence, and fosters the drive for innovation [43]. The complexity of I4.0 technologies can also encourage the development of certain learning capabilities within the organization [5], suggesting a synergistic relationship with OL development. This confirms the positive correlation between I4 and OL. Some authors [44, 45] point out that inadequate integration of I4.0 technologies can negatively impact organizational routines, thwarting further digital operations and automation initiatives. A mismatch in existing learning organizational capabilities can compromise the successful adoption of I4.0, triggering aversion and mistrust towards the technology, which can overshadow its benefits. Results from international research [5, 46] have shown that I4.0-based technologies and digitalization efforts can significantly contribute to the development of learning organizational capabilities at all levels (individual, team, and organizational), i.e., organizations that adopt I4.0 technologies are more likely to prefer knowledge sharing within the organization. According to Popper and Lipshitz [47], leadership is the critical factor that influences organizational learning. Leaders have the ability to create an organizational structure that adapts to digital change and to shape organizational culture through different actions and services, thus effectively influencing organizational learning. Several research studies [48–50] have shown that leadership and organizational learning are related and that leadership can improve the process and outcome of organizational learning. Leithwood et al. [51] highlight that transformational leadership can effectively influence the learning capacity of an organization and have a significant positive impact on encouraging a spirit of teamwork and participation. Based on these findings, we can say that the requirements of leadership 4.0 are in line with the expectations for the assertion of learning organization characteristics based on the technical conditions provided by I4.0 and digitalization. A further expectation to be highlighted is the creation of a climate of trust in the functioning of the learning organization, which emphasizes not only the building of personal trust but also impersonal trust relationships. A learning culture of trust guarantees the continuous flow of innovation that is necessary for organizations to be competitive [52]. However, mistrust of technology and a refusal to use it can be obstacles to this development.

2-3- Training and Trust in Technology

In today's organizations (regardless of the organizational framework), trust between employees, in workplace management, and in technology is increasingly valued. In order to be able to meet new requirements and to adapt with sufficient flexibility to the demands of change, the need for continuous learning and training needs to be met [53]. This requires both managerial support and the openness and willingness of employees. If continuous learning is present, staff preparedness can be ensured. Skilled and knowledgeable employees are less frustrated, more adaptable, and more open to new technical solutions. Such organizational behavior is also part of the traits of a learning organization's culture [54]. Organizational learning—the preparation of employees for new ways of working in the digital world—is a fundamental requirement. This means making friends with the tech-human collaboration and embracing mutual support.

Two types of hybrid activities can be distinguished in digital organizations [55]:

(1) Activities where :humans complement intelligent machines can be dichotomized, among others:

- Accepting and training the performance of machines (data discovery, cleaning and tagging, error correction);
- Providing explanations to different stakeholders and interpreting outputs;
- Maintaining machines by controlling them and keeping them running and performing well.

(2) Activities where intelligent machines enhance human capabilities:

- Enhancing analytical capabilities by identifying trends in data;
- Enabling voice access to information and services;
- Enhancing the ability to see or hear.

According to Wilson & Daugherty [55], in order to carry out hybrid activities, specific skills are needed on the part of people.

In addition, training opportunities for the acquisition of these skills should be considered, which is primarily the task of the organizational leadership but also the expectation of self-improvement in the behavior of the learning organization. However, self-development is difficult to achieve in situations where people are full of doubt, frustration, fear of the level of technical requirements to be met, or are made to use new tools that are constantly challenging [47]. Although these problems are not to be expected in a learning organization, they need to be addressed. In many cases, they manifest themselves even in latent ways, such as in the tension caused by techno-stress. This kind of fearful mistrust can manifest itself in various forms in the workplace, and recognizing it is also a managerial task.

2-4- Conceptual Model and Hypotheses Development

Research questions based on the literature reviewed above and our own experience:

RQ1: *What is the relationship between digitalization, industry 4.0 technical readiness, and the shaping of organizational culture?*

RQ2: *How can the provision of training help the adoption of technology?*

RQ3: *Does technical readiness/training influence trust in the use of technology and tools?*

RQ4: *What supportive role does organizational leadership play in the adoption of technology and digitalization?*

RQ5: *Which of the influencing factors identified has the greatest impact on the development and operation of the learning organization's culture?*

The empirical studies aim to identify factors that significantly influence the functioning of the learning organization, building on the theoretical foundations. Smart PLS4 and SPSS Statistics 22 software were used for the research. The interpretation of the model constructs is summarized in Table 1.

Table 1. Operationalization of latent variables

Construction	Definition
The supporting role of leadership (SL)	A leader's responsibility is to help followers achieve their goals, set direction, provide support, and ensure that their goals are well aligned with the goals of the organization. Supportive leaders create a work environment conducive to fostering respect, trust, collaboration, and emotional support [56, 57].
I4.0 Readiness (I4)	Lichtblau et al. [58] investigated I4.0 readiness in six dimensions: (1) organizational strategy, which is the basis for Industry 4.0 design and control; (2) the smart factory, which is a highly automated environment; (3) smart operations, which aim to integrate physical and virtual reality; (4) smart products, which aim to automate and efficiently manage production; (5) data-driven services that support operational efficiency and revenue streams; and (6) employees to help achieve digital transformation.
Digital Readiness (DI)	Digital readiness is the willingness and ability to make the transition to digital technology and the readiness to use this technology to create new innovative opportunities to enable an organization or industry to achieve its goals faster and to a greater extent [59].
Training (T)	This practice refers to the various training activities that management organizes during and after the adoption of I4.0 to teach employees how to manage and interact with technologies [60].
Digital Trust (DT)	Industry 4.0 technologies are also shaping digital trust. The initial adoption of technology is in line with the research on initial trust. Researchers have drawn attention to the importance of studying initial trust, especially for new technologies where users need to overcome perceptions of risk and uncertainty before using the technology [61].

Learning organization (LO)	The dimensions of a learning organization encompass the essential elements of leadership, strategy, participatory policy making, continuous learning, dialogue, group learning, empowerment, and facilitating processes and structures [38, 62].

The following hypotheses were formulated on the basis of the relationship framework of the model:

H1. *Supportive leadership encourages digital trust, both directly and through support for digital readiness.*

H2. *Supportive leadership ensures employees participation in training.*

H3. *Training contributes to digital readiness and, through this, to the development of digital trust.*

H4. *Training increases the level of I4.0 readiness both directly and through digital readiness.*

H5. *Supportive leadership influences the functioning of the learning organization both directly and through all indirect relationships.*

H6. *The digital trust and I4.0 readiness of employees support the learning organization.*

The correlations and relationships between the hypotheses were tested using statistical analyses, the results of which are presented below. In our hypothesized model (Figure 1), we measured the supportive role of leadership by statements that support the adoption of a new technology and are consistent with the characteristics of transformational leadership [63]. That is, the role of information (ideal effect), the opportunity to express employee opinions (individual consideration), the incorporation of new ideas (intellectual stimulation), and the expression of personal development provided by technology (inspirational motivation).

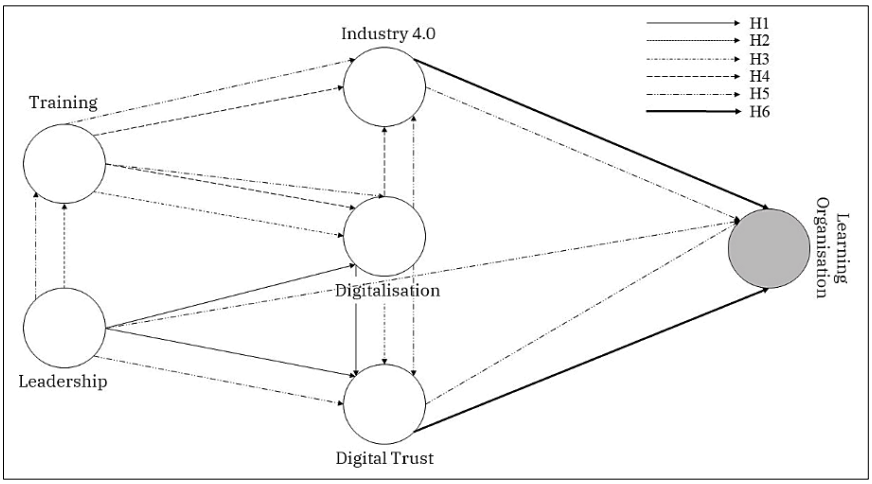

Figure 1. Theoretical model for research

3- Materials and Methods

3-1- Method

The PLS-SEM method is now widely used in various fields of management, including organizational management, human resource management, marketing, and strategic management [64, 65]. The popularity of the method is due in part to the fact that it allows the estimation of complex models on small samples without imposing distributional constraints on the data. The PLS-SEM variance-based method estimates parameters based on the total variance and shapes partial model structures by combining principal component analysis with least squares regressions [66]. The model is composed of two parts: the measurement (external) model measures the relationships between the indicator and the latent variables, while the structural (internal) model measures the relationships between the latent variables using regression paths. Based on the direction of the relationship between the manifest variables and the latent variables, one can speak of a reflective or formative measurement model. In the former case, the relationship is directed from the latent variable to the indicator and can therefore be considered the cause of the latent variable, while in the formative measurement model, the manifest variables are the causes behind the latent variables.

The PLS-SEM method was used in the present research because our structural model is complex; it contains many constructs, several of which are formatively measured, and models relationships; a previous similar research model [67] was developed from the perspective of organizational learning. The use of PLS overestimation is justified for our model based on organizational culture of learning, as the normality condition is not met for some items constituting the constructs (Kolmogorov-Smirnov test for all variables, $p<0.05$). Figure 2 illustrates the analysis flow. The bold lines indicate the analysis steps that appear in the study.

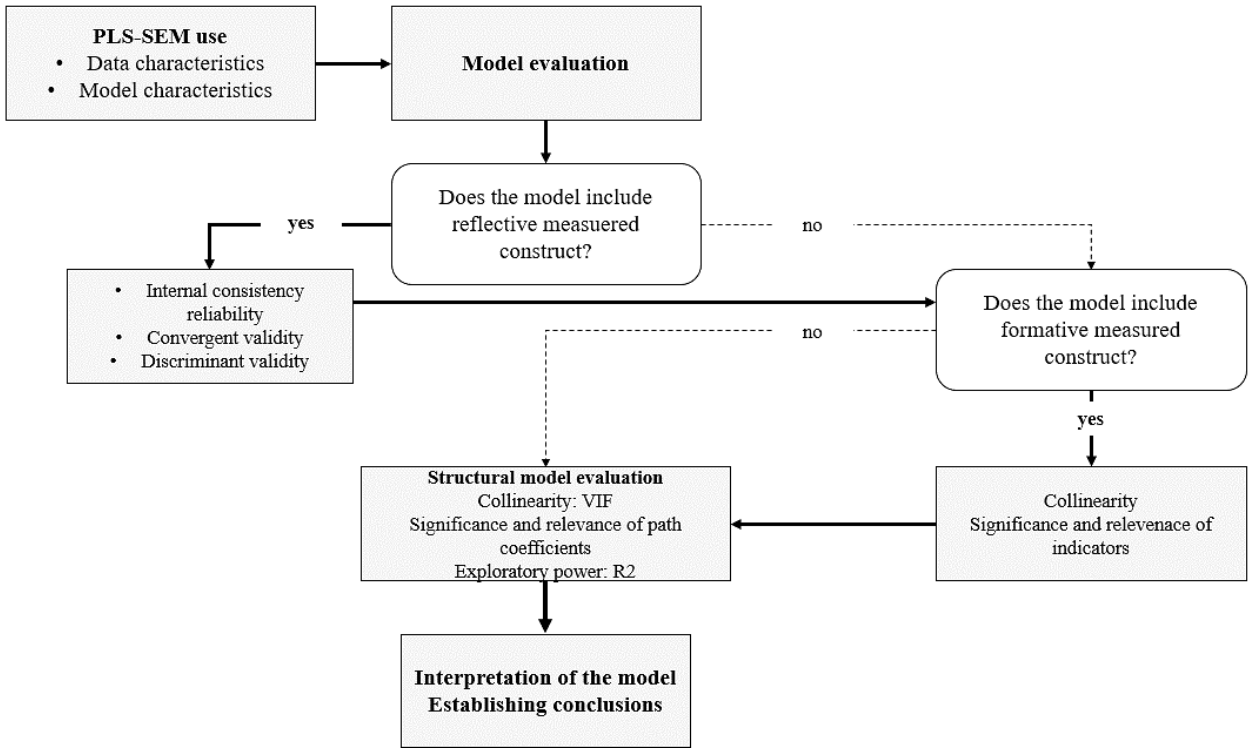

Figure 2. A systematic procedure for reporting PLS-SEM results

3-2- Measurement Items

Based on the research of Oztemel and Gursev [68], the digital readiness of companies was measured by the level of utilization of components related to Industry 4.0 (cyber physical systems, cloud systems, M2M communication, IoT, augmented reality, data mining, and enterprise resource planning). The assessment of organizational readiness for Industry 4.0 was measured by seven questions, which appeared as key components in the research of Sony and Naik [69] (top management involvement and commitment, readiness of organizational strategy, employee adaptability with Industry 4.0, smart products and services, extent of digitization of the supply chain, and level of digitization of the organization). The construct of education was used to assess the different competency development and technology-related training (whether standardized or customized) that is conducted in the company. We hypothesized that these factors, which are interrelated, influence the organizational culture of the learner, as measured by statements on the five principles of personal mastery (personal mastery, personal perception, mental model, shared visions, team learning) as defined by Senge [37]. The measured variables of the constructs are shown in Table 2.

Table 2. Measurement items

Construct	Item	Measurement Item	Reference
Supporting role of leadership	SL1	Management explains to employees the importance of introducing new technology.	[56, 57]
	SL2	Before introducing new technology, management shall also seek the opinion of the employee concerned.	
	SL3	Management sets a good example in the use of new technology.	
	SL4	Management will explain to employees that the new tool will ensure their personal development.	
	SL5	The new ideas of the employees are incorporated by management into the work process.	
	SL6	The introduction of the new tool is assisted by a specialist, to whom employees can turn with questions at any time.	
Digital Trust	DT1	Workers have confidence in modern technology.	[61]
	DT2	Workers are confident that new technology will make their jobs easier.	
	DT3	Workers are open to new technology.	
	DT4	The organization's management is open to new technology.	
	DT5	Management accepts that employees will make mistakes when introducing new technology.	
Training	T1	The organization provides mandatory online competence development training.	[60]
	T2	Employees can register for these courses on a voluntary basis.	
	T3	The organization provides training for employees before the introduction of new, modern technology.	
	T4	There is an individualized training program that includes modern technologies.	

Learning organization	LO1	The organization is open to environmental changes.	[38, 62]
	LO2	The organization proactively faces changes.	
	LO3	The organization has an innovative mindset, looks for new solutions, and is not limited by habit.	
	LO4	The organization also focuses on long-term effects when making decisions.	
	LO5	In the operation and development of the organization, they take care of the effects of changes on other organizational units.	
	LO6	The goal is the joint development of the learning and development abilities of the organizational members, group learning.	
	LO7	It is important for the organization to integrate individual employee visions into the organizational vision.	
	LO8	Employees are aware of how their work contributes to the achievement of organizational goals.	
	LO9	Employees can act to achieve their personal vision; self-realization is free.	
Industry 4.0 readiness (Which statement is true about the organization you currently represent?)	I4_1	Recognizing the importance of Industry 4.0: 1) did not recognize 2) recognized 3) extensive management support 4) management is working on the implementation.	[69, 70]
	I4_2	Developments for the purpose of Industry 4.0: 1) It hasn't happened yet; 2) A couple of areas 3) widely in several areas; 4) complex I4 development program.	
	I4_3	Employee experience in relation to ICT: 1) minimal experience; 2) among workers in technical fields; 3) colleagues with advanced ICT work in several areas; 4) in all areas of the organization.	
	I4_4	Training: 1) does not organize; 2) necessary professional training; 3) also digital training and/or human competence development training; 4) regular training sessions with digital tools.	
	I4_5	Developments for ICT purposes: 1) the most basic ICT tools; 2) ICT support of several business processes 3) ICT support for all business processes; 4) business process ICT support using an integrated system.	
	I4_6	Automatic control: 1) No machines are automated; 2) Some machines are automated; 3) Most machines are automated; 4) All machines are automated.	
	I4_7	M2M communication: 1) the machines do not communicate with each other; 2) some machines communicate with each other; 3) most machines communicate with each other; 4) full integration of the machines has been achieved.	
Digital readiness (To what extent does digitization exploit the following opportunities in the organization you represent?) 1: not at all 4: completely	DI1	Decision support based on digital data.	[44]
	DI2	Digital tracking of raw materials and products.	
	DI3	Supply chain integration and transparency.	
	DI4	Equipment park Industry 4.0 compatibility (digital data service).	
	DI5	Use of cloud-based solutions.	
	DI6	Production automation.	
	DI7	M2M - Communication between machines.	
	DI8	Application of artificial intelligence.	
	DI9	Automated error detection and prediction (e.g., maintenance scheduling).	
	DI10	Real-time inventory management (automated entries).	

3-3- Data Collection

The research was conducted using primary data, which was collected through an online questionnaire in 2021. In order to avoid the influence of different socio-economic contexts, we targeted respondents who work for companies in the same country [71]. The study population consisted of managers of Eastern European manufacturing companies. The Orbis database, which contains business information on 400 million companies, was used to access the respondents. The online survey and data collection were conducted through the Lime survey platform, which respondents completed anonymously in approximately 15–20 minutes. The main theme of the questionnaire was sustainable regional industrial development. The extent to which organizations and their employees are prepared for the digitalization challenges of Industry 4.0 (perception of digitalization, use of digital tools, human-machine interaction) and how this affects the learning organizational culture (supportive role of leadership, learning organization).

4- Results and Discussion

4-1- Sample Characteristics

The survey provided an evaluable sample of 618 respondents (n = 618), but not all questions were mandatory. Likert-scale questions had the option to tick "don’t know," which was treated as a missing value in the analyses. According to the organizational characteristics of the sample (Table 3), respondents were typically senior executives (71%). The proportion of middle-level (14.6%) and lower-level (14.4%) managers was significantly lower in the sample. The highest rate of limited liability companies (84.3%) by company type. It was followed by the closed joint stock company form (10.9%). In terms of the number of employees, more than 2/3 of respondents work in small enterprises (less than 50 employees), while 1/3 work in medium-sized enterprises (20.6%) or large enterprises (10.2%). The empirical research was based on small and medium-sized enterprises (89%).

Table 3. Characteristics of the sample

Variable Name		Number of Respondents	Distribution (%)
Operation form	Limited liability company	521	84.3
	Limited partnership	20	3.20
	Public limited company	2	0.30
	Sole proprietor	7	1.10
	Closed joint stock company	68	10.9
Position	Senior executive	438	70.9
	Middle-level manager	56	14.6
	Lower-level manager	15	14.4
Employees' number	10 persons or less	100	16.2
	Between 11–50 persons	319	51.6
	Between 51–250 persons	125	20.2
	Above 250 persons	62	10.0
	Missing data	12	1.90

4-2- The Results of the Research

Reflective constructs of the measurement model can be assessed for reliability and validity (Table 4). The reliability of latent variables can be determined using the Cronbach's alpha (α) index, whose value is assumed to be above 0.7 [72]. Convergent validity and reliability can be measured by the average variance extracted (AVE) and the composite reliability (CR). For internal consistency, a CR value greater than 0.7 is acceptable in SEM-PLS. In addition, AVE values above 0.5 indicate robust convergent validity. The reliability of the indicators can be checked by examining the factor loadings, with a minimum value of 0.6 [73]. Discriminant validity can be defined as a set of factors that distinguish one variable from another, meaning that discriminant validity is achieved when the construct is different from other constructs. To check for discriminant validity, Cepeda-Carrion et al. [74] propose tracking the HTMT correlation ratio, which is the average of the total correlations of variables measuring the difference constructs relative to the (geometric) average of the mean correlations of variables measuring the same construct. The value of the HTMT is accepted below a threshold of 0.85, which shows how conceptually different the constructs in the path model are [75]. The values obtained were below the threshold. PLS-SEM modeling prefers to include formative constructs in the structural model [76]. There are not as many standard metrics for evaluating formative measurement models as there are for formative models. The appropriateness of constructs is assessed by collinearity between indicators (VIF indicator value less than 5), significance, and indicator weights, the conditions of which are met by the elements of the construct.

Table 4. Reflective constructs reliability and validity

	Cronbach's Alfa	Composit Reliability	Average Variance Extracted	Item	Factor Loadings
Supporting role of leadership (SL)	0.915	0.934	0.704	SL1	0.846
				SL2	0.760
				SL3	0.869
				SL4	0.904
				SL5	0.861
				SL6	0.783
Digital Trust (DT)	0.816	0.871	0.577	DT1	0.802
				DT2	0.809
				DT3	0.798
				DT4	0.763
				DT5	0.609
Training (T)	0.857	0.903	0.699	T1	0.851
				T2	0.807
				T3	0.854
				T4	0.832
Learning Organization (LO)	0.917	0.931	0.601	LO1	0.787
				LO2	0.796
				LO3	0.823
				LO4	0.795
				LO5	0.762
				LO6	0.791
				LO7	0.804
				LO8	0.729
				LO9	0.681

Before reviewing the results of the structural model, it is necessary to test the significance (hypotheses) of the path coefficients set up, which can be tested by t-tests using the bootstrap distribution. To ensure the robustness of the results, the number of subsamples should be sufficiently large—at least 5,000, according to Hair et al. [77]. The p-values in Table 5 show that at the five percent significance level, each explanatory variable has a significant effect on its corresponding explained variable. The ranges of the effect size were categorized by Gefen et al. [78]: for a small effect, f^2 ranges from 0.020 to 0.150, while 0.150-0.350 is considered a medium effect, and above 0.350 has a significant effect. The F-squared values indicate that all values are higher than 0.020, indicating a significant impact on the validity of the model and constructs. The table clearly shows that all the relationships examined are significantly correlated at $p<0.05$.

Table 5. Testing of hypotheses

Hypothesis	Effects	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P *Values*
H1	SL → DT	0.434	0.431	0.042	10.376	0.000
H1	SL → DI → DT	0.126	0.129	0.024	5.332	0.000
H2	SL → T	0.498	0.499	0.029	17.173	0.000
H3	T → DI	0.339	0.345	0.044	7.764	0.000
H3	T → DI → DT	0.094	0.097	0.020	4.676	0.000
H4	T → I4	0.403	0.401	0.042	9.607	0.000
H4	T → DI→ I4	0.149	0.154	0.026	5.813	0.000
H5	SL → LO	0.560	0.559	0.040	13.874	0.000
H5	SL → T & DI & DT & I4 → LO	0.160	0.161	0.023	6.995	0.000
H6	DT → LO	0.185	0.184	0.046	4.013	0.000
H6	I4 → LO	0.142	0.145	0.036	3.906	0.000

The summary of the model results is shown in Figure 3. The most significant direct effect on the development of employees' trust in technology is the supportive role of leadership ($\beta_{SL\rightarrow DT} = 0.434$), with an indirect effect of digital readiness and education ($\beta_{SL\rightarrow DI\rightarrow DT} = 0.126$) (H1). As shown in the research model, the utilization of digital tools ($\beta_{DI\rightarrow I4} = 0.440$) has a significant effect on industry 4.0 readiness, but in any case, education and training programs should not be ignored in the adaptation process. Training programs have a significant impact on both digital asset utilization ($\beta_{T\rightarrow DI}\ \beta = 0.339 + \beta_{T\rightarrow DI\rightarrow DT} = 0.094$) (H3) and Industry 4.0 ($\beta_{T\rightarrow I4} = 0.403 + \beta_{T\rightarrow DI\rightarrow I4} = 0.149$) (H4). As a result, a supportive environment is needed to ensure these conditions. In the interpretation of the model, this is a significant effect of the supportive role of leadership on training ($\beta_{SL\rightarrow T} = 0.498$) (H2).

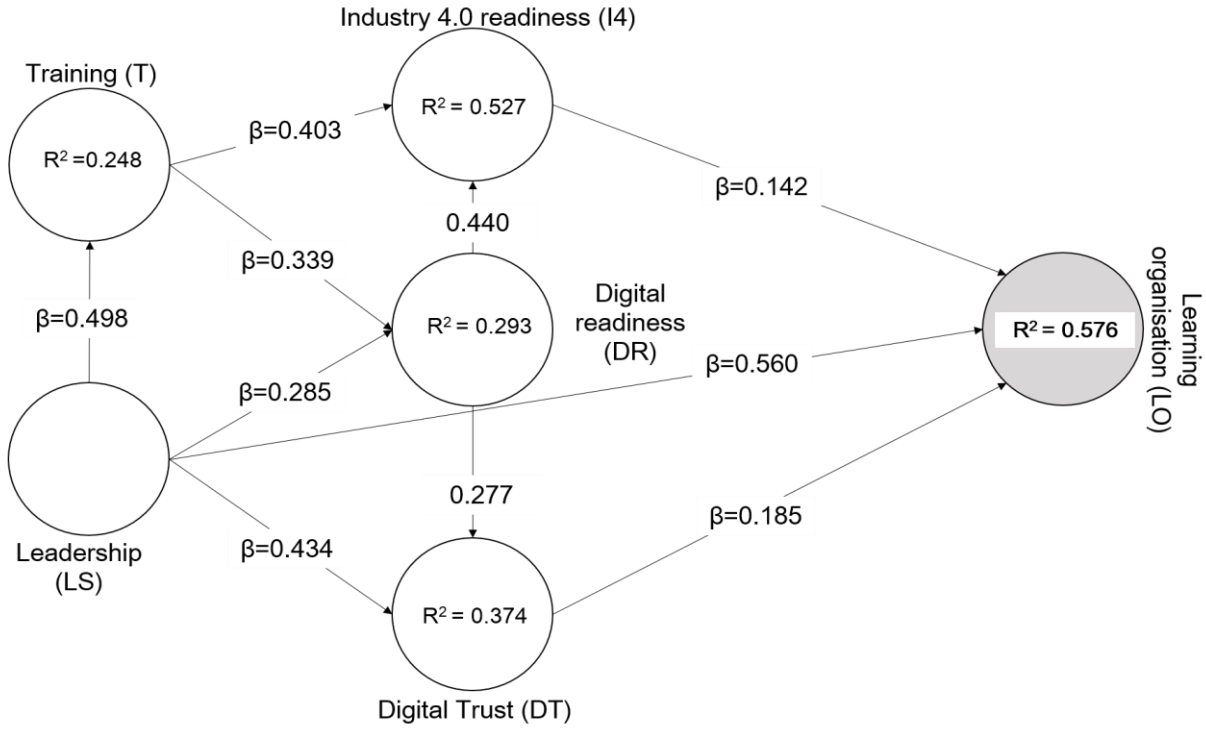

Figure 3. Summary of the model results

The most direct impact on learning organization culture is through the supportive role of leadership ($\beta_{SL \rightarrow LO} = 0.560$) and indirectly through digital and I4.0 readiness ($0.285 \times 0.440 \times 0.142$) and trust in technology (0.434×0.185) (H5). To a lesser extent, digital trust ($\beta_{DT \rightarrow LO} = 0.185$) and the direct effect of industry 4.0 readiness ($\beta_{I4 \rightarrow LO} = 0.142$) play a role in shaping culture (H6), but all relationships have a significant positive relationship. The predictive power of the construct is measured by the indicator R^2, which is considered significant when its value is higher than 26% [79]. The explanatory power of the analyzed parameters is good (57.6%). In other words, in today's manufacturing companies, a high priority should be given to establishing trust in technology, digital and industry 4.0 readiness, and supportive leadership in order to achieve a higher level of learning organization culture.

4-3- Discussion

The analysis carried out demonstrates that the culture of the learning organization and its functioning are primarily a function of the supportive behavior of its leaders. Schuh et al. [5] argue in favor of work-based learning solutions in their study, while Faller & Feldmüller [80] present three different forms of learning in their research to raise the level of digital readiness. Sony & Naik's [69] research, as well as that of Veile et al. [7] and Fatorachian and Kazemi [6], also emphasize the importance of training and education programs, indicating that technological skills are a means to facilitate digital transformation. These findings partially confirm our own research, as they only emphasize the importance of education and training. Shamim et al. [44] and Hecklau et al. [45] have demonstrated in their research that if technology is not integrated well enough, it will have a negative impact on organizational functioning, collaborative learning, human performance, and the innovation climate. Our own results show a similar picture in this area, moving on to the importance of trust in technology. Leadership is also the most influential factor in building employee trust in technology, as our previous research has shown. In this study, we showed that although education and training can be major contributors to digital readiness and increase trust in technology, their influence lags behind that of leadership behavior [67].

Based on the presentation of the literature and the results of the research mentioned here, it can be said that recent research on the relationship between digitalization and culture is incomplete. Most of the research emphasizes and confirms the importance of training, education, and learning but does not go beyond this. In exploring the relationship between culture and digital readiness, Pradana et al. [15] investigated the relationship between digital culture, digital strategy, and performance, while Imran et al. [10] investigated the relationship between leadership, structure, culture, and digital transformation based on socio-technical systems. Franco et al. [11] looked at the relationship between agility in the context of culture and technology, while Butt and colleagues looked at digital cultural readiness. Leadership was relevant to all studies, but their analyses were conducted using organizational culture in a general sense. These findings reinforce the validity of our own research, partly because of their intersectionality and partly because of their shortcomings. In other contexts, mainly theoretical studies have been produced (sometimes with suggestions regarding managerial decisions, style, and organizational design), but they cannot be considered proven successful due to their lack of testing [1-4, 23–26]. Therefore, the results of our research are particularly relevant to the impact of leadership on human capital. This characteristic is the factor that most influences the shaping and functioning of learning organization culture, group learning, and collaboration. At the same time, by supporting continuous learning to acquire new competences required by digitalization, it enhances not only professional competence but also confidence in technology. This confidence helps to use the tools of Industry 4.0 and thus feeds back into the effectiveness of a digitally-ready learning organization. In the study model, these relationships show a significant correlation, demonstrating the crucial importance of managerial preferences for building and operating a learning organization culture.

5- Conclusion

The analysis of the correlations in the model under study confirmed our hypotheses, according to which the relationships represented in the model are significantly related to each other. This means that leadership behavior and a supportive leadership style inspire the development and training of employees, through which the level of readiness for digitalization and Industry 4.0 technologies can be increased. It is the acquisition of these skills that boosts confidence in digital technologies. Leadership support also influences digital trust and employee response to the use of digital technologies, as does participation in training, which directly supports digitalization and I4.0 readiness. Leadership support influences the building and running of the learning organization both directly and indirectly, which is the strongest influence (significant link) in ensuring digital readiness.

5-1- Research Limitations and Future Directions

In this research, we aimed for a representative sample by sending out questionnaires to a credible database of tens of thousands of respondents. However, due to the low response rate, the results are not fully generalizable. Nevertheless, the results illustrate the interplay of the factors under study that help guide managerial decisions in an organization. The other limitation is that it would be worthwhile to investigate the interaction of significantly more influencing factors and to show precisely how they affect each element of the learning organization's culture. This would help shape the most supportive culture. These limitations also point to further research directions that, aside from increasing the sample size, the next period will provide an opportunity to explore.

6- Declarations

6-1- Author Contributions

Conceptualization, D.M.H. and A.B.; methodology, D.M.H.; software, D.M.H.; validation, D.M.H. and A.B.; formal analysis, D.M.H.; investigation, D.M.H. and A.B.; resources, D.M.H. and A.B.; data curation, D.M.H. and A.B.; writing—original draft preparation, D.M.H. and A.B.; writing—review and editing, D.M.H. and A.B.; visualization, D.M.H. and A.B.; supervision, D.M.H. and A.B.; funding acquisition, D.M.H. and A.B. All authors have read and agreed to the published version of the manuscript.

6-2- Data Availability Statement

The data presented in this study are available on request from the corresponding author.

6-3- Funding

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6-4- Institutional Review Board Statement

Not applicable.

6-5- Informed Consent Statement

Not applicable.

6-6- Conflicts of Interest

The authors declare that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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