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A Digital Maturity Model for Organizations: An Approach to Assessment and Case Study

Igor Merzlov[1*], Elena Shilova[1]
[1]Management Department, Perm State National Research University, Perm, Russia
* Corresponding author e-mail: imerzlov@ya.ru

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Abstract

The issues of digital transformation and digital maturity have continued to be relevant over the past few decades. It is difficult to state that there is a universal digital maturity model (DMM) simultaneously applicable for organizations, industries, regions, and countries. We have tried to develop a universal DMM. It is based on the assessment of the digitalization level of the core business processes, including internal and external. The model includes 5 levels. We tested the DMM on 126 organizations. The results showed that 45% of the organizations belong to the second level ("partial digitalization"). The advantages of the model are simplicity of use, applicability for organizations of different sizes and forms of ownership, and a relatively high degree of objectivity. Further testing of the DMM will be aimed at assessing the level of the digital maturity of industries and regions.

Keywords: Digital maturity model, digitalization, digital transformation.

1. Introduction

Digital transformation is a process that has affected all sectors of our society (Galindo-Martín et al., 2019; Shen et al., 2018). Most researchers consider it as a tool for improving the efficiency of the businesses by optimizing business processes, reducing operating costs, increasing the understanding of the customer experience, developing the professional competencies of employees, and enhancing the level of the corporate culture (Bellakhal and Mouelhi, 2020; Martín-Pena et al., 2019; Nambisan et al., 2019). In addition, digitalization forms a completely new approach to management (Díaz-Chao et al., 2015; PwC, 2016). Digital technologies have become the basic determinants of competitiveness (Bertani et al., 2021; De Pablos and Edvinsson, 2020) and help to increase the value of companies (Salvi et al., 2021).

A lot of studies related to digitalization and digital transformation have appeared in the last decade. The number of papers on it has been growing rapidly from year to year (Reis et al., 2018). The researchers explore different aspects (for instance, the capabilities of different Information and Communication Technologies (ICTs), digital skills, effectiveness of ICTs, new business models, etc.) and levels (for instance, digitalization of countries, regions, cities, sectors, and organizations) of this phenomenon (Santoalha et al., 2021; Ballestar et al., 2021; Kijek and Kijek, 2019; Kraus et al., 2019; Yang et al., 2021).

Some studies try to evaluate the level of digitalization and to provide a vision for future development. In other words, the researchers try to measure digital maturity. As a result, a large number of digital maturity models (DMMs) have appeared in recent years (DESI, 2021; UK Consumer Digital Index, 2021; Grebe et al., 2021; Dell Technologies, 2018; Berghaus, 2016; Friedrich et al., 2011; Westerman, 2012; Berger, 2015; Gill andVanBoskirk, 2016; Valdez-de-Leon, 2016; Salviotti et al., 2019; Ifenthaler and Egloffstein, 2019). The models are based on the analysis of the certain groups of the criteria. Each of them has its strengths and limitations. However, several common gaps can be highlighted. Most of these models can hardly be regarded as universal, i.e., at the same time applicable for organizations, sectors, regions, and countries. The other limitation of some DMMs is the subjectivity of evaluations and application complexity. Besides, usually, DMMs have been developed by practice-oriented consultants. As a result, this fact limits the existence of their theoretical basis (Thordsen et al., 2020). Thordsen

et al. analyzed 17 existing DMMs and noted that they do not have enough measurement validity.

In this context, the study tried to develop a new DMM which will be characterized by the following features: universality (i.e., applicable for organizations, industries, regions, and countries), maximum objectivity, theoretical basis and easy handling.

To develop the model, we made a literature review in the context of (1) the theoretical understanding of digitalization and Information and communications technologies (ICTs), (2) the existing DMMs including criteria for measurement, and (3) exploring the role of business processes in the digital transformation of the enterprises. At the next step, we designed our DMM and tried to conceptualize it theoretically. We also tested it on 126 organizations.

As a result, we concluded that the developed DMM operated with only objective criteria – the fact of the implementation of the specialized ICT in the key business processes of the organizations. Besides, the DMM can be applied for the levels of sectors, regions, and countries.

2. Literature Review and Theoretical Background

2.1 The Concept of Digitalization

Currently, there are many variants of the definition of digitalization (digital transformation). For example, Stolterman and Fors (2004) have noted that digitalization is a business model driven by changes associated with the application of digital technology in all areas of human society. Gassmann et al. (2014) have got the alternative definition of digital transformation: it is the ability to transform existing products or services into digital counterparts and thereby create advantages over tangible products.

In their literature review, Emily et al. (2015) have identified four main aspects of digitalization: digital capacity, business models, operational processes, and ICT user experience.

Several scientists have identified key types of technologies that underlie digital transformation. They include cyber-physical systems, smart factories, digital twins, the Internet of Things, big data, artificial intelligence, and cloud computing (Liao et al., 2017; Brynjolfsson and McAfee, 2014; Schwab et al., 2018; Li, 2018; Xu et al., 2018; Roblek et al., 2016).

Rossato and Castellani (2020) analyzed some companies and concluded that digitalization has the following positive effects: increased efficiency of business processes, improved understanding of the customer experience, developed professional competencies, and improved corporate culture.

Emily et al. (2020) suggested that such evolution can bring competitive advantages to a company in the form of more efficient business processes and, consequently, higher performance.

One of the key features of digitalization is the capacity to change and transform an organization's business processes and ecosystem (Legner at al., 2017; Parviainen at al., 2017).

Much less research has been devoted to quantifying the impact of digitalization on business development. In particular, Calvino and Criscuolo (2019) conducted statistical analysis for 15 different countries. As a result, the researchers concluded that technological factors provide positive dynamics for business development with an average 40 percent. At the same time, there are significant differences between countries in the dynamics of high-tech industries. It is associated with institutional and political factors.

Some researchers noted that digitalization has become a strategic priority for many companies, but their movement in this direction is rarely a simple process (Legner at al., 2017; Zangiacomi at al., 2020).

The digital transformation is inextricably linked to government policy. The most frequently mentioned one is the German government program “Industry 4.0”. At the same time, similar initiatives have been launched in other countries. For example, “Made-in-China 2025” in China, “Industrial Internet and Smart Manufacturing” in the US, “Intelligent Manufacturing Systems” in Japan, “Factories of the Future” in the EU, and “Future of Manufacturing” in the UK (Liao et al., 2017; Schneider, 2018). The underlying approaches and ideas of these programs are at the intersection of many disciplines, including electronics, business and management, computer science, business and information systems engineering, and mechanical engineering (Lasi et al., 2014).

Companies involved in digital transformation not only gain opportunities to add value to their products and services but, more importantly, bring radical changes to their business models (Köbnick, 2020).

At the same time, the changes in business models associated with digitalization lead to additional risks. Thus, Kovaitė and Stankevičienė (2019) distinguish six types of such risks at the micro-level: technical, competence, accepted by personnel, accepted by customers and partners, financial, and data privacy and security.

Many organizations report success in their digitalization or at least declare their intentions to start the

process (Galindo-Martín et al., 2019). Therefore, organizations need to understand both their current level of digitalization and to set the right goals for moving forward on this path. We suppose it is the key point of "true/real" digital transformation for achieving more efficiency.

2.2 Review of Digital Maturity Models

Digital maturity is the term that shows the current level of the organization's digitalization (Chanias and Hess, 2016). Thordsen et al. (2020) analyzed 17 DMMs. The authors noted a lot of differences between the models. First of all the DMMs used different indicators to measure the level of digitalization. Nine of the analyzed models do not provide any theoretical base. In most cases, developers of DMMs do not provide any arguments in terms of the general logic theory.

In addition to the 17 DMMs that have been analyzed by Thordsen et al. (2020), we consider more models.

In our opinion, the most comprehensive approach to the digital maturity assessment is the Digital Economy and Society Index (DESI) (DESI, 2020). It is developed by the European Commission and used to assess the level of digitalization of the EU countries. The calculation of this index is based on the evaluation of indicators included in 5 main subindexes: (1) availability and quality of communications (including the level of use of fixed broadband access and its coverage, mobile broadband access, and the level of prices for broadband access), (2) human capital (including the level of digital skills of the population), (3) level of Internet penetration among the population, (4) level of ICT used by business, (5) level of public services provided in digital form.

For our study, the subindex (the level of ICT used by business - Digital Intensity Index) deserves special attention. It is based on the following indicators: using information security systems in business, staff awareness of information security requirements, maximum Internet connection speed at least 30 Mb/s, using ERP system, using at least one social network, using CRM system, over 50% of employees use computer and Internet at work, over 20% of employees use portable gadgets in their work and sales in an online format. Each of these indicators is calculated as a percentage of the total number of surveyed organizations, separately for large and small-medium businesses.

Some DMMs characterize certain aspects of the digitalization process. One of these indicators is the Digital Capital Index (Ragnedda et al., 2019). The index is socially focused. It shows the readiness of the population to interact effectively with ICT.

One more DMM is the UK Consumer Digital Index (2021). This index has been used for the last six years to assess the level of ICT usage by the UK population. The Index is based on a structured survey of residents of the country. The questions include 3 blocks: (1) how a person makes payments, (2) how a person uses digital services and products, and (3) how digital technology is used in daily life. The Index values are ranked in four levels: (1) very low (a respondent does not use an email or a personal computer), (2) low (a respondent uses an email and has a personal computer), (3) high (a respondent uses online banking and uses various online services), and (4) very high (a respondent uses various online services and makes payments online very often).

The Digital Acceleration Index (DAI) (Grebe et al., 2021) measures an organization's digital development in 36 categories, such as customer journey, digital supply chain, and personalization of marketing. Unfortunately, more information on the methodology of this Index is not publicly available.

The Digital Transformation Index (Dell Technologies, 2018) is based on surveys of companies from various business areas. Based on the results a respondent can be classified in one of five groups: "Digital laggards" (such organizations have no plan for digitalization, changes in digital technologies and investments in them are very rare), "Digital followers" (investments in ICT are not significant, there are preliminary plans for digitalization), "Digital professionals" (they implement a gradual digital transformation and there is the planning of this process), "Adherents of digitalization" (a detailed plan for digital transformation is developed, relevant investments are allocated) and "Digital leaders" (digitalization is the basis of corporate culture). The DMM takes into account both the current level of digitalization and the future development plans. The model uses a mix of qualitative and quantitative indicators.

We made a content analysis of the selected DMMs by their core elements (table 1).

Table 1. Content Analysis of the Selected DMMs

Name of the DMM	Dimensions of the assessment	Criteria of the assessment	Method of the assessment	Object of the assessment	Source of the data	Result of the assessment
Digital Economy and Society Index (DESI) (DESI, 2020)	5 dimensions: connectivity, human capital, use of internet, integration of digital technology, digital public services	Set of statistical indicators corresponding to the dimensions	Quantitative	Countries	Eurostat data	Total score
UK Consumer Digital Index (2021)	3 dimensions: digital payments, digital services, digital technology in daily life	Set of questions corresponding to the dimensions	Structured survey	Population	Population	four levels: very low, low, high, very high
Digital Transformation Index (Dell Technologies, 2018)	4 dimensions: IT strategy, digital future, competition, investment	Set of questions corresponding to the dimensions	Mix of qualitative and quantitative (online-questionnaire based on 6-step Likert-scale)	Organizations	Management of organizations	5 groups: digital laggards, digital followers, digital professional, adherents of digitalization, digital leaders
Digital maturity and transformation report (Berghaus and Back, 2016)	9 dimensions: customer experience, product innovation, strategy, organization, process digitization, collaboration, information technology, culture and expertise, transformation management	60 criteria (e.g., experience design, business segment extension, strategic innovation, etc.)	Quantitative (online-questionnaire based on 5-step Likert-scale)	Organizations/ sectors	Management of organizations	5 maturity stages: promote and support, create and build, commit to transform, user-centered and elaborated processes, data-driven enterprise
Industry digitization index (Friedrich et al., 2011)	4 dimensions (across business process): input, processing, output, infrastructure	Volume of investments in ICT, digital services for customers, value chains, computing infrastructure	Quantitative (no detailed description is provided)	Sectors	Eurostat data	Total score
Digital maturity matrix (Westerman et al., 2012)	2 dimensions: digital intensity, transformation management intensity	3 groups: customer experience, operational process, business model	Qualitative (interview)	Organizations	Management of organizations	4 groups: beginners, conservative, fashionistas, digirati
Digital transformation index (Berger, 2015)	4 dimensions: digital data, automation, connectivity, digital customer access	The question: what is the current level of digital maturity of your organization?	Qualitative (self-assessment)	Organizations	Management of organizations	3 levels: very high, high, low
Digital maturity model 4.0 (Gill and VanBoskirk, 2016)	4 dimensions: culture, technology, organization, insights	28 questions (corresponding to the dimensions)	Quantitative (interview based on 4-step Likert-scale)	Organizations	Management of organizations	4 maturity segments: skeptics, adopters, collaborators, differentiators

Name of the DMM	Dimensions of the assessment	Criteria of the assessment	Method of the assessment	Object of the assessment	Source of the data	Result of the assessment
Digital maturity model for telecom (Valdez-de-Leon, 2016)	4 dimensions: strategy, organization, customer, ecosystem, operations, technology, innovation	126 questions (corresponding to the dimensions)	Qualitative (the Delphi method)	Telecom organizations	Management of organizations	6 levels: not started, initiating, enabling, integrating, optimizing, pioneering
Strategic factors enabling digital maturity (Salviotti, Gaur and Pennarola, 2019)	10 dimensions: IT infrastructure, human resource management, research and development, administration, finance and control, procurement, inbound logistics, operations, outbound logistics, marketing and sales, post-sales services	10 questions (corresponding to the dimensions)	Quantitative (interview based on 5-step Likert-scale)	Organizations	Management of organizations	Total score
Maturity model of technology (Ifenthaler and Egloffstein, 2019)	6 dimensions: infrastructure, strategy and leadership, organization, employees, culture, and educational technology	22 questions (corresponding to the dimensions)	Quantitative (interview based on 5-step Likert-scale)	Educational organizations	Management of organizations	5 levels: digitally minimalist, digitally conservative, digitally pragmatist, digitally advanced, digitally trailblazing

Thus, the reviewed DMMs considerably differ in the following ways:

(1) By the approach. The quantitative one is dominant.

(2) By the object. The level of organizations is prevailing.

(3) By the vision. A combination of descriptive and prescriptive visions prevails.

Researchers note the following advantages of the models: (1) an objective performance assessment (i.e., maturity level) (De Bruin et al., 2005; Lahrmann and Marx, 2010), (2) the base for a roadmap to increase the digital level in the future (Mettler and Rohner, 2009), and (3) comparison and benchmarking with other organizations (Berghaus and Back, 2016).

The disadvantages of the DMMs are (1) the lack of suggestions to improve the current maturity level (Berghaus and Back, 2016) and (2) the lack of attention to human resources and too much focus on organizational processes (Poeppelbuss et al., 2011). Besides, we note that there is some subjectivity in the most of reviewed DMMs. For example, when a respondent is asked about a certain aspect of digitalization of his organization, the answers "we are planning" or "we have just started" are taken into account. In our view, there is a risk that the respondent may slightly "sugarcoat the picture" when, for example, the answer "we plan" will be realized only after a few years.

That is why we plan to find more objective dimensions and criteria for assessing digital maturity. And we hypothesize that it is the business processes of organizations.

2.3 Digitalization and Business Processes on Micro-Level

The above literature review allows us to argue that at the micro-level digitalization is inextricably linked to changes in business processes. In particular, Gates and Hemingway (1999) noted that ICT is a powerful tool for business process management and business transformation.

Appel et al. (2014) found that business process modeling and execution are widespread in various enterprises. Business experts are simulating processes and translate them into executable work operations.

Davenport (1993) defined a business process as a structured and measurable set of activities designed to achieve an outcome for a particular customer or market. It shifts a focus from the end product to an assessment of work quality. In other words, a business process is a specific sequence of work activities in time and space, with a beginning and an end, and clearly defined resources and results expressed in an action plan.

There are several classifications of business processes in the literature. Usually, they have many common attributes (Earl, 1994; Edwards and Peppard, 1994; Rockart, 1988). Thus, Earl's classification (Earl, 1994) is the most capacious. It summarizes the main ideas of other researchers. This classification identifies four types of business processes according to their role in the value chain:

1. The core business processes ensure the main activities of the organization. They are directly related to the service of external customers. Usually, they are the main part of the value creation process.

2. Supporting processes include servicing internal customers. They imply the performance of auxiliary activities. Typically, these are processes related to the administration of the organization's core activities.

3. “Business environment” processes go beyond the organization. They involve organizing interactions with suppliers, clients, and partners.

4. Management processes include planning, organizing, and controlling the organization's activities.

Singh (2012) highlights that a typical organization should have no more than 15 core business processes. They will depend, among other things, on the scope and objectives of the organization.

Consulting company AchieveIt (2014) identifies three types of business processes: (1) management processes, including corporate governance and strategic management, (2) operational processes (for example, in an industrial company they are purchasing, manufacturing, marketing, and sales), (3) supporting processes, including accounting, human resources, and information technology.

Dickmann (2019) offers a similar classification. He distinguishes three categories of business processes:

1. Primary processes, which include operations such as production, marketing, and sales. These processes are designed to provide an external customer with an added value based on the delivery of products and services.

2. Secondary processes do not directly provide an external customer with added value. But they are vital for the existence of the organization. They support the smooth functioning of the primary business processes and contribute to the smooth workflow of the business. Such processes are implemented, for example, in the accounting department, human resources department, and helpdesk.

3. A management process includes planning, monitoring, and controlling the activities of the organization. Examples of such business processes are internal communications, budgeting, and infrastructure operations.

For further study, it is important to understand what core business processes are. Thus, the Quality Management System Standard ISO 9001 (2017) gives the next definition: core business process (Core process) is a process that is strategically important for the company. Core processes are characterized by the following aspects: (1) they create value, (2) the external customer is at the beginning and at the end of the process, (3) they make a significant contribution to the success of the company and customer satisfaction, (4) they are directly related to the customer and have a direct impact on the customer, and (5) the customer is willing to pay for the result of the process.

Typically, the researchers identify five to ten major business systems and corresponding business processes. Among them are the next (The New Paradigm Team, 2021; Bizmanualz, 2021):

1. Marketing strategy and customer relations.
2. Attracting customers (sales).
3. Development and satisfaction of the employees (human resource management).
4. Information technologies.
5. Quality management, process improvement, and change management.
6. Product manufacturing.
7. Logistics.
8. Accounting.
9. Financial management and management accounting.
10. Strategic management.

Business processes materialize in various forms, including technology, product development, employee training, customer service, etc. (Dickmann, 2019).

As a result of the literature review, we conclude that despite DMMs variety there is no universal approach. Each model has some advantages and disadvantages. Each DMM assesses the stage of digitalization at a certain level: company, sector, region, or country. Models based on qualitative assessments are more subjective because the results depend on the willingness of respondents to show the real picture of their business.

According to these conclusions, we tried to develop a universal methodology i.e., allowing to measure the digital maturity for organizations, industries, regions, and countries. The model should be based on the most objective dimensions and criteria.

3. Methodology

3.1 Design of the Digital Maturity Model for Organizations

As we tried to show above, digital transformation primarily affects the business processes of

organizations. That is why our DMM is based on an assessment of the implementation of the specialized ICT in the key business processes. In doing so, we do not consider as specialized ICT widely used software, such as Word, Excel, e-mail, etc.

The literature review helped us to distinguish six groups of key business processes that are typical for most organizations. Each of the groups includes some relevant key business processes (appendix 1). We have identified groups of business processes on a functional basis. Together they include all types of business processes according to the above-mentioned classifications.

The core element of our DMM is the specially designed questionnaire (appendix 2).

During the interview process, we sequentially asked the respondents a series of questions concerning each business process. Each answer is transformed into a point (1 or 0) (figure 1).

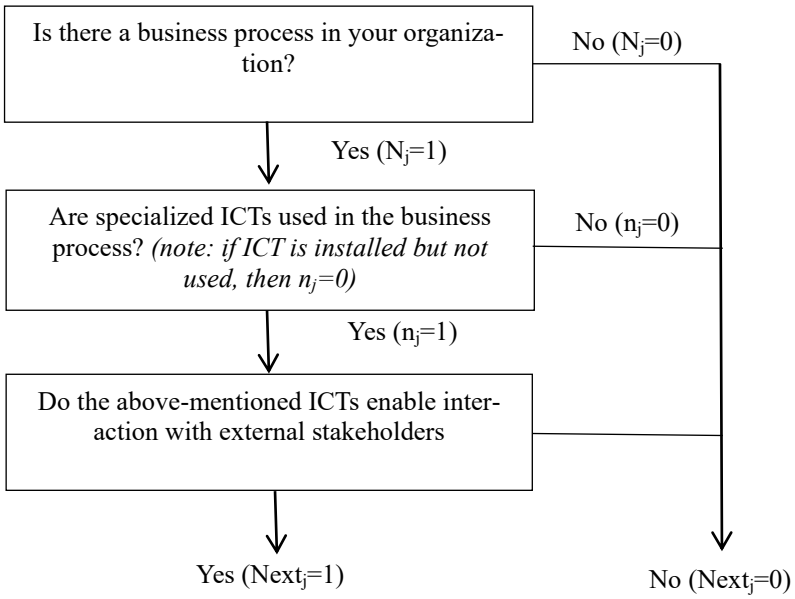

Figure 1. Structured Questionnaire and Score for the Answers

Then we calculated the levels of digitalization of the internal and external business processes separately. We made it using the following formulas:

$$LoD_{int} = \frac{\sum n_j}{\sum N_j} * 100\% \quad (1)$$

LoD_{int} – the level of digitalization of the internal business processes in the organization;

n_j – the key business processes that use specialized ICTs;

N_j – the key business processes that exist in the organization.

$$LoD_{ext} = \frac{\sum Next_j}{\sum N_j} * 100\%$$

LoD_{ext} – the level of digitalization of the key business processes with external stakeholders;

$Next_j$ – the key business processes that use specialized ICTs in interactions with external stakeholders;

N_j – the key business processes that exist in the organization.

As a result, we can classify the organization into one of the five levels of digital maturity (figure 2). The evaluation criteria are shown in table 2.

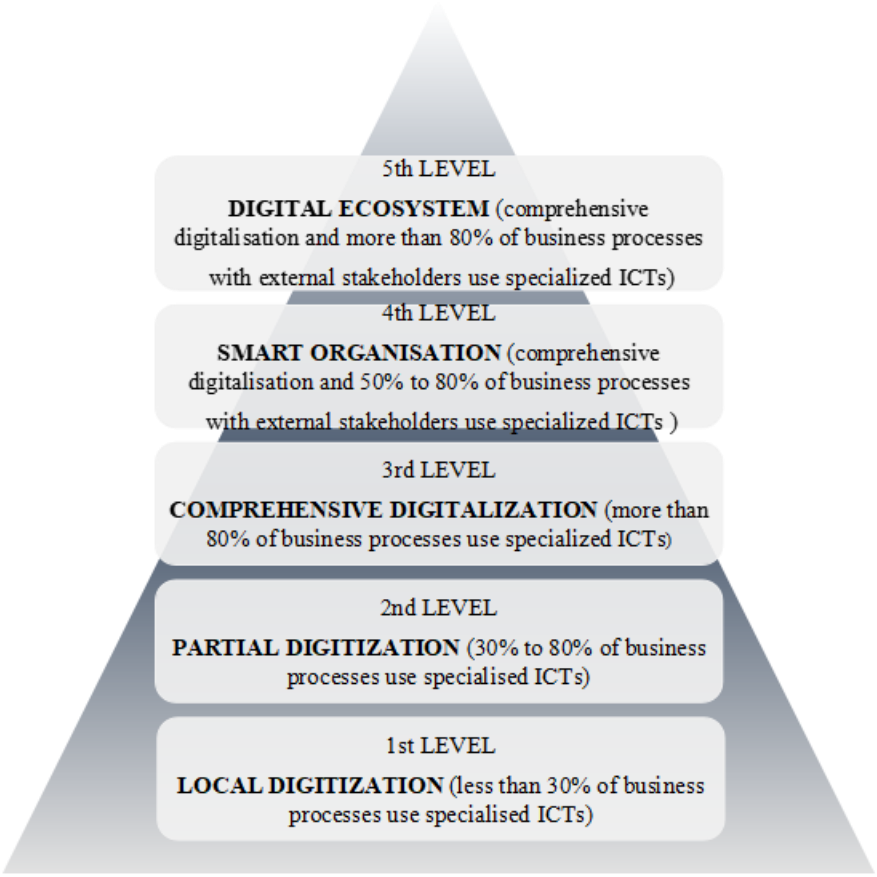

Figure 2. Levels of Digital Maturity of an Organization

Table 2. The Evaluation Criteria for Classifying the Organization into One of Five Levels of Digital Maturity

		Digitalization of the key business processes with external stakeholders		
		Less than 50% of the key business processes with external stakeholders use specialized ICTs	50% to 80% of the key business processes with external stakeholders use specialized ICTs	More than 80% of the key business processes with external stakeholders use specialized ICTs
Digitalization of the internal key business processes	More than 80% of business processes use specialized ICTs	COMPREHENSIVE DIGITALIZATION	SMART ORGANISATION	DIGITAL ECOSYSTEM
	30% to 80% of business processes use specialized ICTs	PARTIAL DIGITIZATION	-	-
	Less than 30% of business processes use specialized ICTs	LOCAL DIGITIZATION	-	-

3.2 Questionary Survey

The study was carried out from September 2020 to July 2021. We used a questionnaire (appendix 2) to conduct structured interviews. The respondents were the top managers of the investigated organizations, responsible for the relevant business processes.

126 organizations participated in the study. The sampling was random and included organizations from various business sectors: healthcare, construction, retail and wholesale trade, manufacturing, mineral extraction, education, activities of restaurants and cafes, etc. (figure 3). 76% of respondents are small businesses, 9.8% - medium-sized businesses, and 14.2% - big businesses.

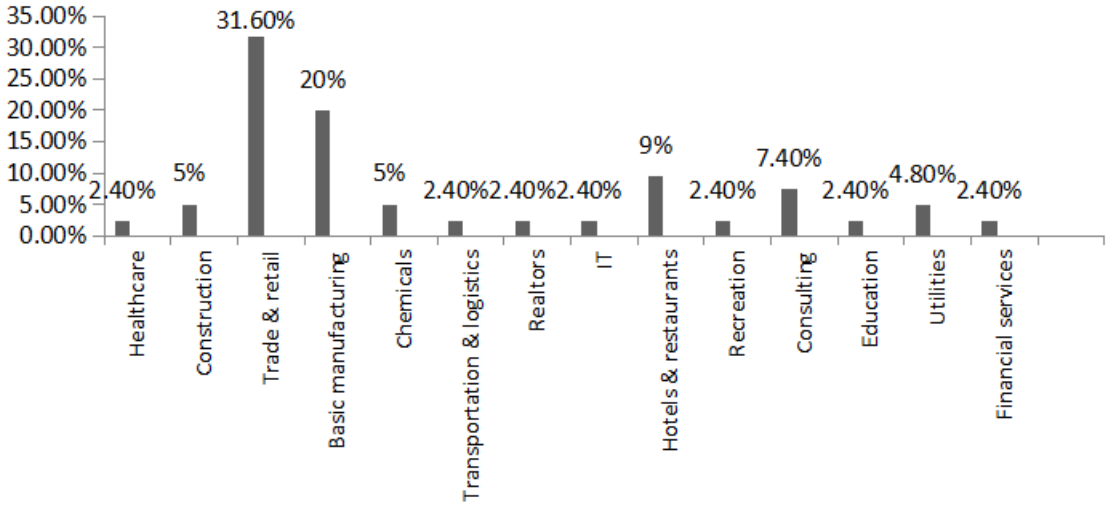

Figure 3. Spread of Respondents by Industry, Percent of Their Total Number Organizations

4. Results of the Survey

The aggregated results of the survey showed that 57 organizations (45%) have "partial digitalization" of the level of digital maturity and 26 organizations (21%) belong to the level "local digitalization" (table 3). The distribution among the small and medium enterprises largely corresponds to the above-mentioned results (table 4). Among the big businesses the third ("comprehensive digitization") and the fourth ("smart digitization") levels (table 5) dominate. We assume that the reason for this is that such organizations have more resources to implement new ICTs.

Table 3. Distribution of Total Respondents by the Level of Digital Maturity

		Digitalization of the key business processes with external stakeholders		
		Less than 50% of the key business processes with external stakeholders use specialized ICTs	50% to 80% of the key business processes with external stakeholders use specialized ICTs	More than 80% of the key business processes with external stakeholders use specialized ICTs
Digitalization of the internal key business processes	More than 80% of business processes use specialized ICTs	COMPREHENSIVE DIGITALIZATION 9.5%*	SMART ORGANISATION 4.5%*	DIGITAL ECOSYSTEM 19%*
	30% to 80% of business processes use specialized ICTs	PARTIAL DIGITIZATION 45%*	-	-
	Less than 30% of business processes use specialized ICTs	LOCAL DIGITIZATION 21%*	-	-

* the share of respondents, percent of the total respondents' number (n=126)

Table 4. Distribution of Respondents (the Small and Medium Enterprises) by the Level of Digital Maturity

		Digitalization of the key business processes with external stakeholders		
		Less 50% of the key business processes with external stakeholders use specialized ICTs	50% to 80% of the key business processes with external stakeholders use specialized ICTs	More than 80% of the key business processes with external stakeholders use specialized ICTs
Digitalization of the internal key business processes	More than 80% of business processes use specialized ICTs	COMPREHENSIVE DIGITALIZATION 5.5%*	SMART ORGANISATION 2.8%*	DIGITAL ECOSYSTEM 16.7%*
	30% to 80% of business processes use specialized ICTs	PARTIAL DIGITIZATION 52.8%*	-	-
	Less than 30% of business processes use specialized ICTs	LOCAL DIGITIZATION 22.2%*	-	-

* the share of respondents, percent of the small and medium enterprises (n=108 units)

Table 5. Distribution of Respondents (the Big Businesses) by the Level of Digital Maturity

		Digitalization of the key business processes with external stakeholders		
		Less 50% of the key business processes with external stakeholders use specialized ICTs	50% to 80% of the key business processes with external stakeholders use specialized ICTs	More than 80% of the key business processes with external stakeholders use specialized ICTs
Digitalization of the internal key business processes	More than 80% of business processes use specialized ICTs	COMPREHENSIVE DIGITALIZATION 33.3%*	SMART ORGANISATION 33.3%*	DIGITAL ECOSYSTEM 16.7%*
	30% to 80% of business processes use specialized ICTs	PARTIAL DIGITIZATION -	-	-
	Less than 30% of business processes use specialized ICTs	LOCAL DIGITIZATION 16.7%*	-	-

* the share of respondents, percent of the big businesses (n=18 units)

We also have analyzed the digitalization respondents' level of the separate groups of business processes (table 6).

Table 6. Distribution of Respondents by the Digitalization Level of the Separate Groups of Business Processes

Percent of digitalization / The group of business processes	**0%**	**1-30%**	**31-80%**	**81-100%**
Human Resources	36 (28%)	24 (19%)	21 (17%)	45 (36%)
Product and Service Provision	40 (32%)	4 (3%)	21 (17%)	61 (48%)
Marketing	60 (48%)	15 (12%)	0 (0%)	51 (40%)
Logistics	33 (26%)	18 (14,5%)	18 (14,5%)	57 (45%)
Finance and Accounting	15 (12%)	0 (0%)	39 (31%)	72 (57%)
Other Support	18 (14%)	15 (12%)	54 (43%)	39 (31%)
Totally for the internal business processes	3 (2.4%)	36 (28.6%)	45 (35.7%)	42 (33.3%)
Totally for the business processes of interactions with external stakeholders	30 (24%)	27 (22%)	36 (28%)	33 (26%)

Thus, we note some findings.

1. 31% of respondents have a low or average digital maturity level of internal business processes (i.e. 2.4% and 28.6% totally). Despite it, the same organizations have a high level of digitalization of interaction with the external environment. For example, figure 4 shows a fragment of the distribution between the first forty investigated companies.

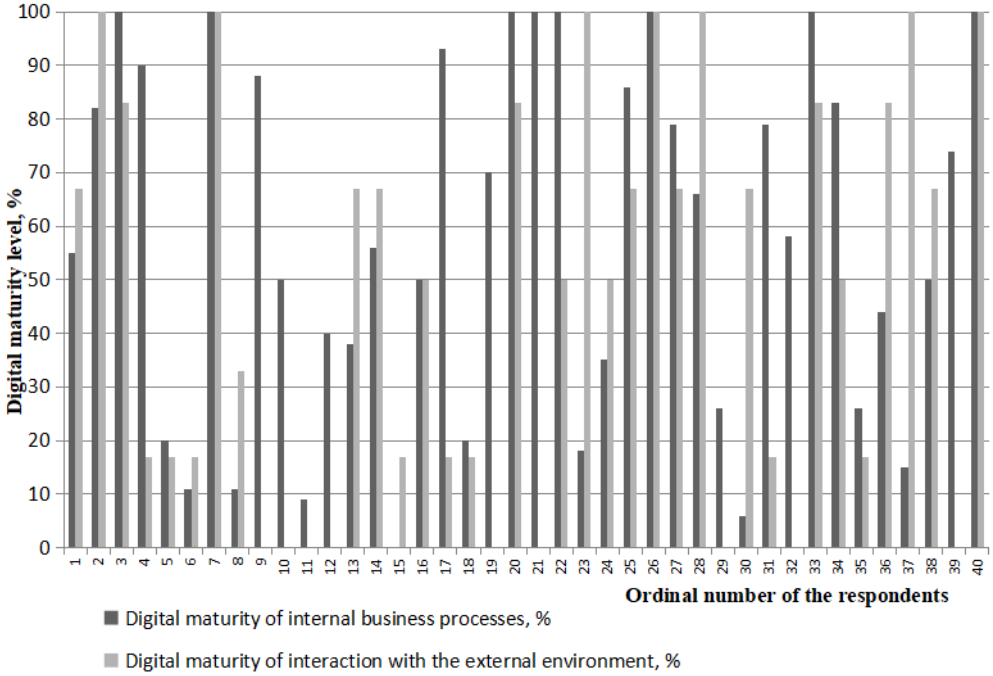

Figure 4. The Distribution of the Respondents by Internal and External Digital Maturity Level

2. Specialized ICT is most often used in the group of business processes such as (1) finance and accounting and (2) product and service provision.

3. The following groups of business processes have the largest capacity for further digital transformation: "Human Resources" (47.3% of the respondents have a low or zero digital maturity level) and "Marketing" (48% of the surveyed organizations do not use specialized ICT in the business processes).

3. We have identified some names of the frequently used (by more than ten respondents) specialized ICTs (table 7).

Table 7. The Most Frequently Used Specialized ICTs

The group of business processes	Name of the specialized ICTs
Human Resources	E-Staff, Web Tutor, Olympox*, Oracle E-Business Suite (OEBS), Dropbox, BOSS Personnel Manager*, 1C: Payroll and HR Management*
Product and Service Provision	Autocad Civil 3D, 1C:MES, 1C:Production management*
Marketing	Oracle E-Business Suite (OEBS), CRM, Bitrix24, amoCRM
Logistics	ISA-2010*, OEBS, SAR Ariba, ClientBase, 4logist, 1C: Transport Logistics*
Finance and Accounting	1C: Accounting*, OEBS, Oracle Hyperion Planning, Oracle Business Intelligence, 1C:ERP, Bitrix24
Other Support	Kaspersky Endpoint Security, Ideco UTM, Trassir, Intellect*, Max Patrol 8; FortiCate Security Fabrrie, Directum, 1C: Document Management*

* - a literal translation of the Russian software

5. Discussion and Recommendation

The testing of the DMM showed the following advantages:

- High simplicity of its implementation: (1) the structured interview allows getting the necessary information in an average of about one hour and (2) the specially structured xls-forms help to reduce the time for aggregating results.

- Top-management of the organizations can use the DMM for self-assessment. In this sense, the results can further be the basis for developing the digital transformation guidelines of the organization.

- The model can be applied to businesses of different forms of ownership, sizes, and types of economic activity.

- If we significantly increase the number of surveyed organizations (i.e. ensure representativeness), the DMM can provide the opportunity to create digital maturity rankings of industries, regions, and

countries. And that is the main direction of our future research.

- The DMM is rather flexible, i.e. if we expand and detail the number of business processes, the model will be able to reflect more detailed results.

Compared with some reviewed models, the DMM assesses only the current level of digital maturity and does not take into account the potential (readiness) of the organization for further digital transformation. On the one hand, this fact can be regarded as a disadvantage, on the other hand, it increases the level of objectivity of the study. For instance, some DMMs take into account the organization's strategic plans. So, the respondents' declaration of their plans does not always mean that these plans will be fulfilled. That is, it is important to understand that the presence of a certain "fashion for digitalization", may provoke respondents to embellish the situation.

In addition to this, in the case of repeated studies (e.g., annually), shifting in digitalization levels will indirectly confirm readiness for further changes.

The dimensions and recent criteria of most of the reviewed DMMs (DESI, 2021; UK Consumer Digital Index, 2021; Grebe et al., 2021; Dell Technologies, 2018; Berghaus, 2016; Friedrich et al., 2011; Westerman, 2012; Berger, 2015; Gill and VanBoskirk, 2016; Valdez-de-Leon, 2016; Salviotti et al., 2019; Ifenthaler and Egloffstein, 2019) can logically repeat each other. It increases the likelihood that the results of the study may be distorted (the same criteria are counted in several dimensions). For instance, installing and starting to use specialized software means the following: (1) appropriate investments have been made and (2) this is done under the strategy of the organization, (3) employees have been trained and know how to work with this software, etc. Our DMM operates only with facts answering the question: does each existing business process use any specialized ICTs or not?

We note that the question of what software to consider in the proposed model is debatable. As noted earlier, we proceeded from the fact that the use of text and table editors, and e-mail is the basic (zero) level of digitalization. That is why it is not considered in our DMM. In this regard, the next question arises. What ICTs and from what time should we exclude from the DMM. For instance, currently, the model considers cloud storage services as a specialized ICT. But the speed of dissemination of such services is quite high. Thus, perhaps soon, this ICT will be perceived as a certain basic level of digitalization.

We note that the developed DMM could be used to upgrade some other DMMs as a part of them. For instance, the Digital Economy and Society Index (DESI) can use our approach to calculate the subindex Digital Intensity Index (it shows the level of ICT used by businesses).

For our future studies we are planning to increase significantly the number of respondents. It will allow us to make rankings of the sectors and regions of our country based on the presented DMM.

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