The framework for assessing company's digital transformation readiness

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At present, the focus of discussions on digital transformation has shifted from issues of its necessity to problems of assessing a company's readiness for digital transformation. The specificity of digital transformation in Russia requires new criteria of readiness and prioritization of existing criteria. This study explores a combination of factors (prerequisites) that determine the readiness of Russian companies for digital transformation. Our hypothesis is that it is possible to systematize and formalize these prerequisites, which can be presented as a framework for assessing readiness. The purpose of the study is to design such a framework that takes into account not only the current state of the company, but also its previous development. The paper formulates the requirements for the readiness assessment system in the form of a framework. It also proposes a method of desing a framework with these requirements. The method combines analysis of practical cases and theoretical study of modern concepts and best management practices. As a result of applying the proposed method a framework for a company's readiness for digital transformation assessment (DTRA) is created. The DTRA framework includes criteria and characteristics of readiness grouped into domains. It is intended for a qualitative evaluation of readiness and for understanding obstacles to success of the digital transformation.

Keywords: digital transformation, the company's readiness, framework, criteria of readiness, readiness assessment.

Introduction

The digital transformation of the economy is connected with high expectations (new quality of services, increasing competitiveness and productivity, unique experiences, etc.) and concerns (new professions, job loses, threats to information security, high-cost risks) [Sebastian et al., 2017]. Digital transformation is a complex phenomenon that affects all areas in company organization and management and in the internal and external environment [Khan, 2016]. Misunderstanding the essence of this transformation, mistakes in determining initial projects, and too high expectations become severe obstacles to a company's success.

According to international cross-sectoral research on the impact of the digital transformation on company activity, conducted by analytical agency Arthur D. Little [Opitz et al., 2015], only 15 % of companies understand digital transformation strategies and allocate resources for analyses of the implementation of strategies and improvements.

Choosing a strategy for digital transformation has crucial importance for Russian companies. The Institute of Statistical Studies and the Knowledge Economy identified the digitalization index of Russian businesses as 28 points (Finladn is ranked highest, at 50) [Abdrakhmanova et al., 2019]. However, this indicator characterizes the level of technology used in business, rather than a transition to new business models. Moreover, as stated by A. Kudrin on August 19, 2019, the following problem has emerged: about 37 % of the national project's "Digital Economy" funds are blocked because they have not been requested [Minak, 2019].

According to the analytic report of the Digital Transformation in Russia [KMDA, 2018], only 25 % of companies are in the process of implementing digital transformation, and only 9 % have a strategy. These are mainly in the banking sector, IT companies, and telecommunications. 53.2% of the 700 respondents from different industries noted that the main obstacle to digital transformation is the lack of a clear strategy.

One of the reasons for this failure is the incomplete methodological base of company management in the digital economy, including in the field of digital transformation management. Existing models of IT management cannot be used as the basement for managing digital transformation, because they do not take into account features of the process, which involves changing all aspects, including company management, business models, and business processes, and not just information systems and technologies.

Recommendations about digital transformation management, offered by the scholarly community and by analytical and consulting companies, are usually general. They lack formal methods and models of solving many management problems, particularly the problem of choosing a digital transformation strategy. Successful practices of the digital transformation of Russian companies are still few and not consolidated to universal approaches.

Critical parameters for choosing a digital transformation strategy result from assessments of the current state of the company, or rather an assessment of the company's readiness for digital transformation. The analysis of published research in this area revealed a problem in choosing measurable readiness criteria. Most existing approaches for evaluating companies and digital transformations consider the level of digital maturity, and not readiness (in the sense of being prepared for implementing concrete activities). Another circumstance that exacerbates this problem is the insufficient consideration of the features of the digital transformation of Russian companies.

The results of numerous studies confirm the specificity of digital transformation in Russia. For example, according to the PWC survey, representatives of Russian companies identify "inflexible and slow processes" (70 % of respondents versus 42 % in other countries) and "lack of integration of new and existing technologies and data" (73 % versus 59 %) as the main obstacles to digital transformation [PWC, 2018]. These data confirm that for Russian companies, it is necessary to use specific prioritization of criteria for assessing readiness for digital transformation. This requires developing an integrated assessment system that includes interrelated indicators (metrics) of expectations and strategic goals of the company, the quality of business processes, competencies and motivation of employees, the maturity of technological environment of the company, manageability of information support, and a number of other characteristics.

For companies that are just starting this transformation, key questions are: how to start and what barriers are hindering the digital transformation. These questions relate to

the company's readiness for digital transformation. In this study, we consider the concept of readiness through the prism of the company's capabilities and internal barriers to digital transformation. The field covered by this study relates to a combination of factors (prerequisites) that determine the availability of Russian companies for digital transformation. The hypothesis of research can be formulated as follows: "There is the possibility to systematize and present in a formalized form (in the form of a framework) the prerequisites that determine the company's readiness for digital transformation". The purpose of the study is to design a framework that allows evaluating readiness and identifying barriers to digital transformation, taking into account not only the current state of the company but also the previous development.

Related work

Digital business transformation is widely discussed both in business and academic literature. The results of numerous studies represent that only the synergy of business and digital management strategies lead to success. For example, MIT Sloan Management and Capgemini Consulting conclude that digitally mature organizations are 26 % more profitable than their average industry competitors due to their ability to combine digital and transformational management intensity [Westerman et al., 2017]. The need for business and IT consistency is based on the idea that new technologies introduced into an organization should comply with its business strategy and goals [Nissen, Termer, 2015]. Moreover, some authors [Stucki, Wochner, 2019] consider the complementarity of technological and organizational capital as the key to the success of the digital transformation.

Typical barriers companies face in the transformation can be divided into two groups: leadership and institutional [Ismail, Khater, Zaki, 2017]. Among problems of leadership is the absence or uncertainty of a digital strategy, which turns out to be the most significant barrier, especially in the early stages of transformation [Kane et al., 2015]. Institutional barriers include insufficient organizational structure, lack of technical skills and investments, regulatory restrictions, the cultural gap between managers and employees, and even psychological aspects, such as indifference to the need for transformation and fear of change [EY, 2013; Von Leipzig et al., 2017]. These problems are not only in the scale of the novelty of digitalization, but rather in the company's inability to function outside of the familiar operating environment [Von Leipzig et al., 2017]. All these restrictions require the company to deeply analyze its internal relations and operations, to understand the company's readiness for digital transformation.

Leading consulting companies Forrester, BCG, IDC, PWC, and KPMG began developing methods and models that allow assessing a company's ability to implement digital projects in the first half of the current decade. As far back as 2008 Forrester [Gill, Van-Boskirk, 2017] proposed a methodology for evaluating e-business and digital marketing. The modern version of the Forrester model is a two-level model of digital maturity focused on assessing effectiveness of implementing digital technology for realizing competitive strategies. The readiness of companies for digital transformation as one indicator of digital maturity is assessed in the areas of Vision and strategy, Talent, Culture, Technology, and Structure (team organization). The model [BCG, 2016] allows one to evaluate a company's orientation to changes, and to a lesser extent its current state, using such measurements as digitally driven business strategies, creating new businesses and development

directions, digitalizing customer relations, implementing digital capabilities, and transforming technologies. The model [IDC, 2015] measures maturity by areas of Management (leadership), Omni practice, labor force, operational model, and information. This model allows companies to get a perception of the maturity level, to form a map of processes to be optimized, and to recommend technologies. A similar approach is used by the company [PWC, 2016] to determine the level of digital maturity along six dimensions, such as business model, processes, digital culture, compliance with laws and risks, IT architecture, and relations with customers. The company [KPMG, 2016] evaluates the ability to use new (digital) business, considering digital strategies, talents, flexible models of infrastructure, management, and digitalization of business processes. Notice, that all of the considered models do not contain a comrehensive assessment of the management system: they place emphasis on the automation/digitalization of business processes, but do not consider the level of their connectivity and regulaition, the company's digital culture is analyzed only from the point of view of competencies, etc.

Not only consulting companies, but also IT industry leaders (for example, IBM), IT communities (for example, the Open Group) and the academic community develop management and IT standarts. IT companies [Jan van Groningen, 2017] assess readiness for transformation through the prism of technological readiness as a determining factor in possible directions of changes (rethinking) of a business: developing competencies, using technologies in standard activities, introducing new working methods (new quality of customer service, flexible customization to customer needs, integration with customers based on open standards), and introducing new business models.

Using the methodology of enterprise architecture framework TOGAF, the Business Transformation Readiness Assessment framework [The Open Group, 2018] offers a list of readiness factors, which can be specified for any particular enterprise. A significant drawback of this framework is that it requires its inclusion in the general project of the company architecture development, which is not always possible at the start of transformation projects.

The academic community, including that in Russia, also conducts active research in assessing readiness for transformation and determining a company's digital maturity. Many authors emphasize the fact that existing standards provide recommendations for changes, and are not focused on the digital nature of transformation; reference models, including consulting models, are often generalized [Wulf, Mettler, Brenner, 2017].

Proposed by the academic community, evaluation models are usually oriented to specific sectors or activities and contain only partly overlapping areas of readiness assessment. However, their evaluation criteria are different. Thus, [Wulf, Mettler, Brenner, 2017] offers to evaluate digital readiness according to seventeen criteria clustered into seven groups (strategy, consumers, services/products, processes, management, information, technologies, and infrastructure). In turn, the DREAMY model (Digital Readiness Assessment Maturity model) [De Carolis et al., 2017] evaluates company processes grouped in five areas (Design and Engineering, Production Management, Quality Management, Maintenance Management, Logistic, Management). Another framework [Sánchez, Zuntini, 2018], unlike others, evaluates not only internal but also external factors that determine readiness for digital transformation: these include ecosystem collaboration, as determined by the level of partnerships with stakeholders; the power of consumers, the force of suppliers, digital products and services, industry boundaries that are changing due to new

digital capabilities, competitors (according Five Forces concept). Framework based on Industry 4.0 concept [Schumacher, Erol, Sihn, 2016] was designed to assess the maturity of an industrial company and contains nine dimensions: strategy, leadership, customers, products, operations, culture, people, governance, technology.

In any case, diagnosing the state of a company to identify internal and external [Sánchez, Zuntini, 2018] constraints, as well as possible risks, should be a key starting point for digital transformation. At the same time, as companies risk approaching transformation as an IT project, a concept is needed to integrate business and IT strategy. This risk could be overcome within the framework of the architectural approach [Dolganova, Deeva, 2019] to building the current and target architecture of the company, defining a transformation scenario, and ensuring smart management. Digital transformation is not recommended to be implemented as a single project [Issa et al., 2018], so as not to lead the company to a big failure, but to fulfill it gradually, based on capability maturity, that is, alignment and integration of business and technology.

As it is easy to see, the considered frameworks are oriented to a different level of generalization. They differ both in the object of evaluation — the effectiveness of digital technologies in the company, readiness to change, readiness to create a new business, etc., and measurement/evaluation domains. Moreover, there is no consistent terminology in the discussions on company readiness. Conducted analysis of existing solutions shows that there are several concepts concerning company readiness for digital transformation such as "readiness for digital transformation", "digital readiness", "digital maturity", "digital business aptitude", and others. At the same time, the methodologies of the framework development used by different authors have much in common.

The analysis and synthesis of methodologies for the development of models/frameworks made it possible to distinguish the following stages (steps).

1. *Setting objectives for the model/framework. Characteristics and limitations.* On this stage, consulting companies monitor successful projects [KPMG, 2016] to confirm the need to design a framework or develop previously existing evaluation models Forrester [Gill, VanBoskirk, 2017]. In the research of the academic community, the objective of developing a framework is formed based on a constant study of transformation problems [Schumacher, Erol, Sihn, 2016], identifying the need for a model by the business community [Dolganova, Deeva, 2019].

2. *The study of related materials.* Consulting companies rely, as a rule, on their own projects [PWC, 2016; KPMG, 2016; Gill, VanBoskirk, 2017], interviews of partners [BCG, 2016]. The academic researchers [Schumacher, Erol, Sihn, 2016; Dolganova, Deeva, 2019; Sánchez, Zuntini, 2018; Issa et al., 2018] provide analysis of articles, analytical reports of consulting companies and IT companies. Criteria for selecting sources corresponding to a given goal are defined, general concepts of a future model are marked.

3. *Generalization of desired concepts: levels of models/frameworks, measurements.* On this stage, through the used methodologies, the general framework of the model is determined [Schumacher, Erol, Sihn, 2016; Dolganova, Deeva, 2019; Bibby, Dehe, 2018; De Carolis et al., 2017].

4. *Consistency assessment.* This stage involves verification of the model with government programs, adopted methodologies, and standards: TOGAF [Dolganova, Deeva, 2019], CMMI, COBIT, CBOK [Isaev, Korovkina, Tabakova,

2016; Issa et al., 2018]; with scientific articles and analytical reports, official recommendations for the implementation of Industry 4.0 [Schumacher, Erol, Sihn, 2016; Bibby, Dehe, 2018]; scientific works and experience of briefing seminars [PWC, 2016; KPMG, 2016; BCG, 2016; IDC, 2015; Gill, VanBoskirk 2017].

5. *Testing (verification) on companies.* On this stage, a combination of methods is used to test the models, including analysis of cases of successful companies [Schumacher, Erol, Sihn, 2016; Sánchez, Zuntini, 2018; Dolganova, Deeva, 2019; Wulf, Mettler, Brenner, 2017], semi-structured interview [De Carolis et al., 2017; Bibby, Dehe, 2018; Gill, VanBoskirk 2017; BCG, 2016; IDC, 2015; Wulf, Mettler, Brenner, 2017], questionnaires [KPMG, 2016; PWC, 2016; Isaev, Korovkina, Tabakova, 2016], seminars and assessment of assumptions that are built into the logic of the case study, testing on real projects [Schumacher, Erol, Sihn, 2016; Wulf, Mettler, Brenner, 2017].

6. *Updating the model/framework and presenting results.* This stage is described in all studies of the academic community and reports of consulting agencies. Changes are presented and justified, evaluation algorithms are specified, recommendations for application are offered. In some cases, new versions of the Forrester models [Gill, VanBoskirk 2017] are formed.

The identified similarity of the approaches used to the development of frameworks does not ensure the generality of the obtained results, including the different purposes of the frameworks. On the whole set of proposed solutions for assessing the company's ability to implement digital transformation projects, in terms of the evaluation results, two approaches can be distinguished. The first approach (Approach A) allows defining the company's level of digital readiness/maturity; the second approach (Approach B) allows assessing specific aspects of the company's readiness for digital transformation.

As examples of Approach A we can note models/frameworks from Forrester [Gill, VanBoskirk, 2017], BCG [BCG, 2016], IDC [IDC, 2015], Maturity Model for Assessing Industry 4.0 Readiness [Schumacher, Erol, Sihn, 2016]. Forrester identified three levels of digital maturity: digital beginner, digital intermediate, digital advanced. The BCG framework describes four stages of digital transformation (levels of digital maturity): digital passive, digital literate, digital performer, digital leader. IDC identifies five stages of digital transformation: digital skeptic, digital experimenter, digital competitor, digital leader, and digital disruptor. Despite the usefulness of these models/frameworks (as well as others are implementing the same approach) for assessing the level of a company's digital readiness/maturity, they are not suitable for answering the questions:

- how to start, and does the company have the required capability to move to the next level of digital transformation;
- what are internal transition barriers?

Partially, this drawback is eliminated by the models implementing Approach B, for example, The Digital Business Aptitude mode [KPMG, 2016] etc., which helps companies to understand how prepared they are for adopting new digital technologies, as they propose the specific characteristics, which correspond to the key success factors of digital transformation.

The bottleneck of the models which implement approach B is the ambiguity of evaluation criteria, characteristics, and metrics. Some of the above-mentioned models, as well

as other models/frameworks for assessing readiness, contain several universal characteristics: the availability of company's strategy, support for changes by the company's management, digitalization of interaction with the client, the level of automation of the company's processes, the level of IT infrastructure, staff development, digital culture, etc. But the meaning of these characteristics varies in different models. Such characteristics as calibrated risk management [KPMG, 2016], risky, innovative solutions (tolerance of innovative risk) [Gill, VanBoskirk, 2017], etc. are presented only in particular frameworks/models. Moreover, in the mentioned above models/frameworks, there is no justification for choosing the characteristics of readiness and principle for grouping them.

The analysis confirms the relevance of developing a framework that includes criteria and characteristics of companies' readiness for digital transformation and allows to identify opportunities and obstacles based on which the choice of digital transformation strategy can be justified.

Analysis of applicability of existing solutions for readiness assessment by Russian companies

To understand whether the Russian specifics impose additional restrictions on the usage of existing frameworks for assessing readiness for digital transformation in domestic companies, a survey of representatives of Russian companies holding senior and middle-level managers was conducted. Approximately half of the respondents were IT managers and specialists with managerial authority. The purpose of the survey was to identify conformity between the respondents' assessment of the company's readiness for transformation in terms of various aspects (business processes, personnel, etc.), and evaluations of characteristics of these aspects, according to the same respondents. A questionnaire included questions that correlated with readiness criteria considered in the majority of existing frameworks. Questions were grouped into sections in accordance with the assessed aspect. In each section, there was added direct question about the respondent's assessment of the level of preparedness of the relevant aspect [Lezina et al., 2019]. As a result, exciting findings were obtained. For example, among those who rated the company's data management level as high, about 50 % noted the absence of data architecture in the company.

Moreover, within the survey, the task was to find out how the current level of use of digital technologies in companies is linked with digital transformation by company representatives. The survey results showed that among companies with a high demand for digital transformation and a high current level of digital technology usage, only 33.33 % consider the level of readiness for digital transformation as high, 50 % as a medium, and 11.11 % as low. 6 % of respondents could not answer the question.

The results of the survey allowed us to formulate the following conclusions.

The existing frameworks use many concepts and terms that are different and not always unambiguously interpreted by representatives of Russian companies. This significantly complicates the use of these frameworks and reduces the reliability of readiness estimates obtained with their help.

The least understandable criteria and readiness characteristics are in the area of enterprise architecture and data management. The main reason is the differences in the development of company management systems in Russia and the countries — digital leaders.

The indicated limitations of the frameworks for assessing digital readiness, along with previously mentioned factors, such as a large number of different criteria and characteristics of readiness, as well as the lack of justification of choosing these criteria and characteristics, determine the relevance of developing a new framework. The business requirements for such a framework are:

- taking into account the characteristics of Russian companies as objects of digital transformation;
- understandability and reasonableness of the criteria and characteristics of readiness;
- transparency of the framework structure.

Implementing these requirements will make the framework a convenient tool for independent (without the involvement of consultants) assessment of readiness for digital transformation by Russian companies.

General description of the framework

The basis of any assessment system is evaluation criteria. Moreover, for assessment to be reliable, criteria must satisfy the requirement of completeness, i. e., take into account all aspects of the object, process, or phenomenon under consideration. Moreover, the more complicated the concept, being the objects of assessment, the more difficult it is to ensure completeness of the criteria. This is the case for readiness assessment, since the concept of readiness is vague.

To simplify the task of ensuring criteria completeness, one should resort to grouping criteria according to some features (the basement of the grouping). The concept of a domain can be used to denote the idea of a group. In different areas of knowledge, the term Domain is considered an area, a set, group of objects, entities, characteristics, actions, similar in some sense. In frameworks and models, domains are used to define the structure, ordering characteristics, or variables to make the framework/model more comfortable for analysis. In a well-organized framework, the domain structure should be balanced in terms of the number of criteria for each Domain.

Another important requirement, in addition to the completeness of the criteria and the balance of their distribution across domains, is the relevance of criteria. In the case of a high rate of change of the object of assessment and external conditions, ensuring the relevance of criteria becomes the key requirement. Relevance can be maintained in various ways, the most obvious being the modification of the system by eliminating some criteria and adding new ones. The main disadvantage of this method is the difficulty of comparing evaluation results in a time perspective. A gentler option is to set criteria significance levels and modify them in accordance with changing conditions. The main disadvantage of this option is the difficulty of objectively assessing significance levels. An alternative is to use different readiness characteristics within each parameter. Changing the set of characteristics makes it possible to ensure the relevance of criteria system without changing the structure. The second method is preferable since, in the framework under development, it is planned to use readiness criteria evaluations as indicators of problems or barries.

To assess characteristics, we propose using so-called metrics — objective quantitative estimates. For example, for the characteristic "personnel qualifications", such metrics as
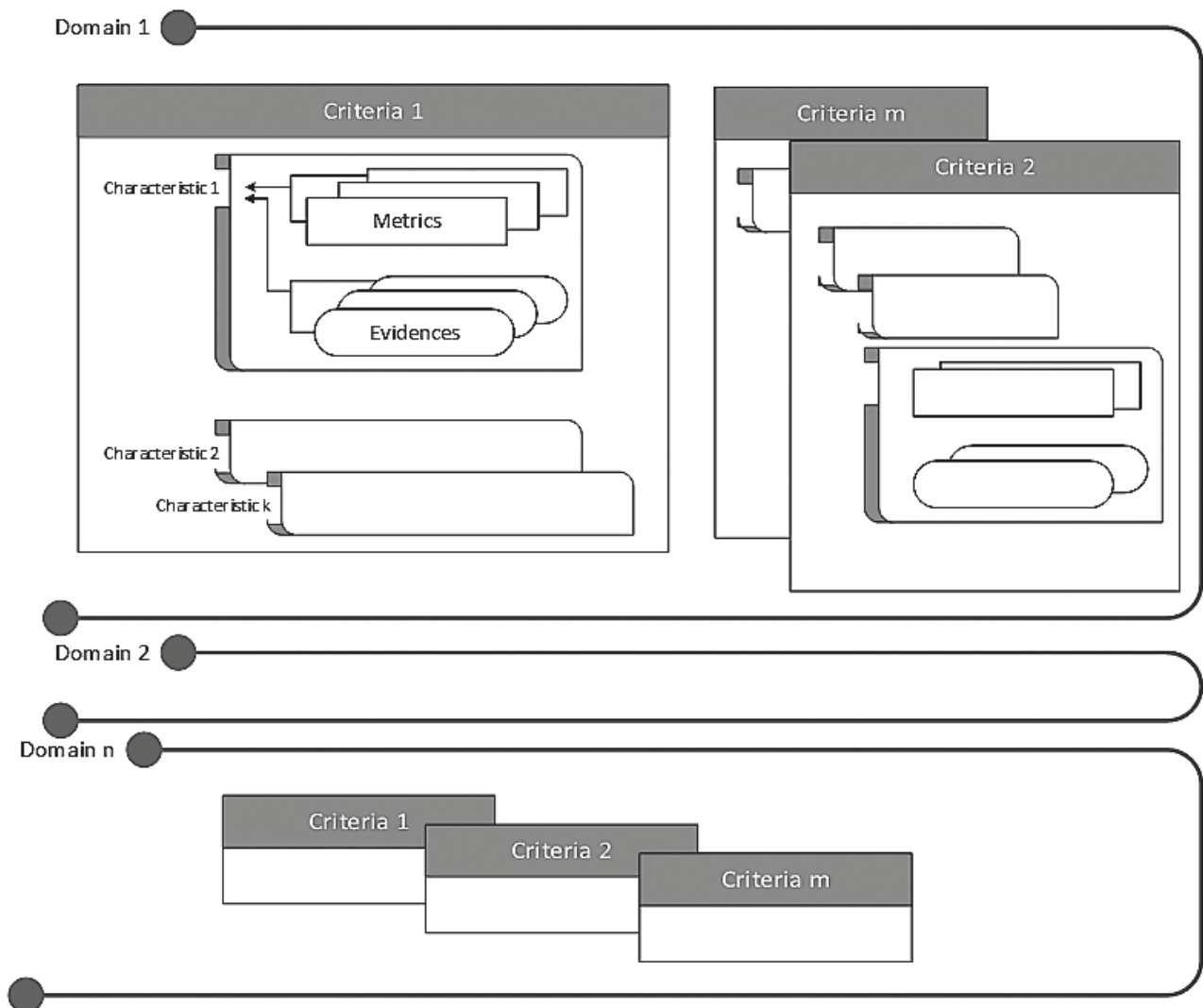
Fig 1. The structure of the DTRA framework

"average score based on certification results", "number of errors due to the fault of employees", etc. can be used. However, obtaining metrics for a number of characteristics is not always possible, due to the lack of initial data, poor data quality, etc. In such a situation, evidence can be used — facts confirming a particular value of a given characteristic. For example, for the same characteristic "personnel qualifications", evidence in favor of the values "high" or "above average" is the certificate "the presence of training and development programs for personnel in the company".

The alignment of evidence and metrics in accordance with the characteristics that underlie criteria grouped into domains determines the structure of the framework for assessing company's readiness for digital transformation (further, the Digital Transformation Readiness Assessment (DTRA) framework), which is shown in Figure 1.

It is important to emphasize that the structure of the framework does not imply a unified integral indicator of a company's readiness for digital transformation. Its purpose is a qualitative assessment of readiness according to the most significant universal criteria. Such evaluation aims to help managers understand what might prevent the success of that transformation.

The universality of the criterion is autonomy from the type and scope of the company, size, organizational form, and other factors.

Design of the study

The framework development methodology should provide compliance with the following system requirements discussed above:

requirement 1. Completeness of the criteria system;

requirement 2. A balanced distribution of criteria across domains;

requirement 3. The relevance of the criteria.

The requirement of relevance can be confirmed only by analysis of practical cases of companies that successfully implement digital transformation projects. Because there are not a large number of successful cases among Russian companies, the case research methodology does not guarantee the completeness of criteria. To confirm it, the study should also include a theoretical analysis of modern concepts and best management practices. Based on these prerequisites, the authors' research method was developed; those steps are described in Table 1.

Table 1. **Research stages**

Stage 1	Formulating hypotheses about framework domains
Research method	Case study
Goal	To identify general trends of changes in companies before implementing the digital transformation projects, and to formulate hypotheses about the domains of the framework for assessing companies' readiness for digital transformation
The subject of research	Changes of the previous periods in the companies which implement successful complex large-scale digital transformation projects
Information base	Official websites of companies, press releases, publications in professional journals and open reporting
Tasks	1. To analyze the activity in companies for the last 5–10 years. 2. To identify key areas of change for each company. 3. To identify common areas of change for all the companies and formulate hypotheses about the framework domains.
Stage 2	Clarification of framework domains
Research method	Analysis of management standards, bodies of knowledge, best practices
Goal	To clarify and create rationale of the domains of the DTRA framework
The subject of research	The content of management methodologies corresponding to each area of change distinguished on stage 1
Information base	Management standards, bodies of knowledge, etc.
Tasks	1. To analyze management methodologies corresponding to each area of change. 2. To match the changes with management tools, which can be used to guide them. 3. To create a final list of key domains of the framework for assessing companies' readiness for digital transformation.
Stage 3	Identification of criteria and characteristics of readiness
Research method	Systematic analysis of management standards and practices
Goal	To identify characteristics of the company's readiness for digital transformation corresponding to each domain
The subject of research	Features of transformation management discussed in the standards corresponding to each domain

Stage 3	Identification of criteria and characteristics of readiness
Information base	Management standards, bodies of knowledge, etc.
Tasks	1. To analyze management standards, bodies of knowledge to distinguish best management practices on the basis of domains 2. To create a list of typical features of transformation management by matching them with changes of previous periods in companies identified in stage 1 and to formulate hypotheses about characteristics of readiness
Stage 4	Verification of readiness criteria and characteristics
Research method	Case study
Goal	To verify characteristics obtained on the previous stage
The subject of research	Changes of previous periods in engineering companies implementing successful digital transformation projects (a set of companies differs from the set of companies used on stage 1)
Information base	Official company websites, press releases, publications in professional journals, and open reporting
Tasks	1. To match distinguished on previous stage characteristics of readiness with changes in the companies over the last 5–10 years. 2. To identify typical characteristics presented in most cases and create a verified list of readiness characteristics.

Stages 1 and 4 use case studies of successful companies that are implementing complex, large-scale projects of digital transformation. Companies embarking on similar projects have demonstrated their readiness for digital transformation and have gone through digital reinvention.

The study was conducted under the following limitations:

- digital leaders (banks) and IT companies were excluded from consideration, as their high readiness for digital transformation can be explained by the specifics of their activities;
- the research doesn't regard the aspect of readiness concerning the company's hardware and software assets, because the experience of Russian companies shows that this kind of gap is not a barrier to digital transformation.

Several examples explain the last limitation. In 2015, the company Russian Post had the following problems [Russian Post, 2019]: old technologies, a "patchwork" automation of business processes, absence of systems for planning and optimizing logistics flows, sales support systems, customer databases, etc. In 2017, Russian Post received the CNEW AWARDS in the digital transformation category. The company implemented the following projects of digital transformation: deploying a unified automated system of post offices, launching centralized accounting systems based on Data lake methodology, and implementing a computerized information system in more than 1050 regional sorting units. Several successful digital transformation projects in industries with intense technological weakness (e.g., mechanical engineering) confirm that the low quality of hardware and software assets is not a key barrier for digital transformation. It is important to note that the purchase of hardware and software does not guarantee digital transformation success: there are examples of failures of digital transformation, despite significant investments in technology.

Results

Results of stage 1. Formation of a hypothesis about the framework domains

Case study 1 was conducted to formulate a hypothesis about the DTRA framework domains. The objects of research in Case study 1 are industrial companies — digital leaders:

- NPO Energomash JSO (mechanical engineering);
- Cherkizovo Group PJSC (food industry);
- Gazpromneft PJSC (fuel and energy);
- Sportmaster LLC (textile&retail);
- Russian helicopters (mechanical engineering);
- FSUE Russian Post.

The companies belong to different industries, and some of them, such as Russian Post, had a strong technological backlog at the beginning of the digital transformation.

The subject of study is the changes in companies that preceded successful digital transformation projects.

The results of the analysis allow identifying common areas of changes, preceding the implementation of the digital transformation projects such as management system, business processes, human resources, and technologies. To illustrate the results, Table 2 provides a comparison of the presented cases. It contains the practices (projects) of digital transformation and key changes preceding the digital transformation in each company grouped according to the distinguished areas.

The distribution of changes by distinguished areas (as a percentage of the total number of changes), calculated on case-study data, is shown in Figure 2.
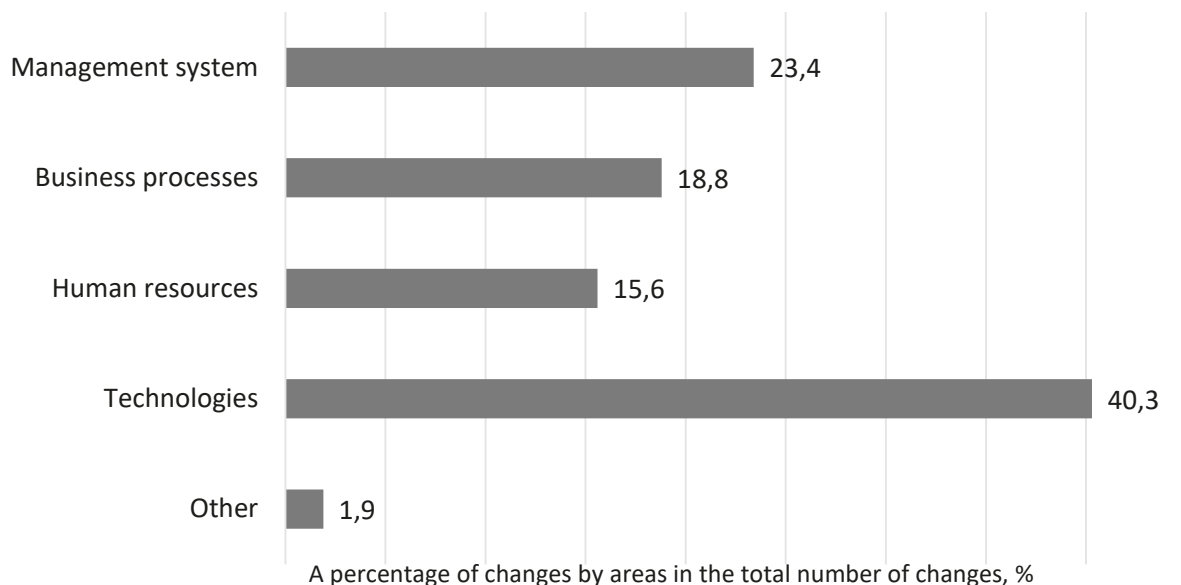

A percentage of changes by areas in the total number of changes, %

Fig. 2. Distribution of changes by areas

Note the asymmetry of the obtained structure, in which the technology field includes a significantly higher number of changes compared to all the others. This circumstance,

Table 2. **Key changes preceding digital transformation**

Management system	Business processes	Human resources	Technologies
NPO Energomash JSO [NPO Energomash JSO, 2019]. Project: "Ensuring digitalization of complex multi-stage production of the enterprise"			
— The research and technical council has been established; — a unified risk management policy has been introduced; — to coordinate production load, cooperation between the holding companies has been organized; — a quality assurance policy has been documented.	— Business processes have been organized according to common standards at all enterprises of the holding; — more than 700 business processes at one of the enterprises have been automated.	— Support programs for young professionals have been implemented; — "School Personnel reserve", the "Schoolmaster", etc., have been established; — the Centre of Dual Education started functioning.	— ERP for management integration is being implemented; — the system of navigation control of the equipment has been developed; — the corporate portal has been created; — digitization of design and technical documentation has begun; — PLM system modules have been implemented.
Cherkizovo Group PJSC [Cherkizovo Group PJSC, 2019]. Projects: robotic plant for producing smoked sausages, data processing center			
— A vertically integrated system of four business segments has been implemented; — the company follows the approach of cascading strategic (measurable) goals.	— Business processes in all companies of the group have been unified; — all lifecycle processes have been automated; — the sales network, supervisors and merchandisers have been automated.	— A study of employee engagement has been conducted; — the model of corporate management competencies has been created; — a social platform based on SFA exchange between employees of all levels has been launched.	— Unified corporate service helpdesk has been implemented; — a robotic plant for producing smoked sausage (Industry 4.0) has been launched; — a geographically distributed data storage system has been implemented.
Gazprom Neft PJSC [Gazprom Neft PJSC, 2019]. Projects: software and hardware complex "Digital substation", data management system			
— A vertically integrated company management system has been formed; — the Directorate for digital transformation has been created; — digital technology centers have been created.	— Process chain management system based on real-time data has been implemented; — business processes of branches have been automated; — coordination of business processes using cloud technologies has been implemented.	— "Corporate University" is functioning — competence centers have been created; — the system of training of students of leading universities is functioning; — a system of scholarships for students has been implemented.	— A data management system based on the Lake data methodology is being formed; — ERP system has been implemented; — digital tools for collective process development and data analysis are being implemented.

Sportmaster LLC [Sportmaster LLC, 2019]. Projects: "Cross-docking at entry points"; "Strategic Omni-channel Communications Planning"			
— The company's management system based on strategic goals has been implemented; — functional analysis and formation of electronic sales channel management system has been implemented.	— Optimization and automation of business processes of return logistics has been carried out; — business processes in the budgeting system has been optimized; — the system for complex automation and control of business processes' efficiency has been implemented.	— The company's "Distance Education" project was mentioned among the top 3 in the nomination of "Best e-learning project in the company"; — the transformation of the "Distance education" system into a knowledge management system; — an online tool for planning training has been implemented.	— The Oracle data backup complex (Zero data loss recovery appliance) has been implemented; — the project "Return logistics" on the automation of return logistics processes in the retail chains of the group was started; — the data center certified by international standards has been launched.
Russian helicopters [Russian helicopters, 2019]. Project: a unified information platform for all enterprises of the holding, a concept for the development of "digital production"			
— A policy to improve business efficiency has been developed; — the product life cycle management system has been implemented; — production planning and monitoring systems have been deployed.	— Automation of paperless production processes has been launched. — automation of design processes, technological preparation of production, manufacturing of products have been implemented.	— The corporate university began functioning; — the system of training of students of leading universities is functioning.	— The ERP system has been implemented; — end-to-end use of "digital" data in the entire process chain (from develop-ing a 3D model to controlling finished products) has been introduced.
Russian post [Russian Post, 2019]. Projects: unified automated system of post offices, centralized accounting systems, integrated data processing center			
— The centralization of accounting and management work took place; — a new organizational structure has been implemented; — a unified IT service management system has been created.	— Internal business processes have been transformed; — subscription online agency serving 1000 publishing houses without intermediaries has been launched.	— The human resource management system has been implemented; — professional skill competitions are held.	— Two projects for the integrated automa-tization of financial and business activi-ties have been imple-mented; — a unified corporate data transmission network has been created.

namely the violation of the systemic requirement of a balanced distribution of criteria by domains (requirement 2), indicates the need for additional research to clarify the possibil-ity of using these areas as domains of the readiness assessment framework.

Results of stage 2. Clarification of the framework domains

To characterize the areas of change and create rationale of the framework domains, analysis of management standards, bodies of knowledge, best practice, etc. (further, standards & practices), corresponding to each distinguished area of change, was carried out. The procedure of analysis included the following four steps.

1. Choosing standards & practices corresponding to areas of change.
2. Analysis of standards & practices and choice of recommendations to manage changes in each area.
3. Identification of standards & practices to be included in the analysis, in case there are groups of changes that do not correspond to any item from the set, created in the first step. Analysis of these standards & practices.
4. Creation of the list of domains by clarification, narrowing, splitting areas of changes based on the results of analysis of standards & practices.

The procedure and results of clarifying the framework domains are illustrated in Figure 3.
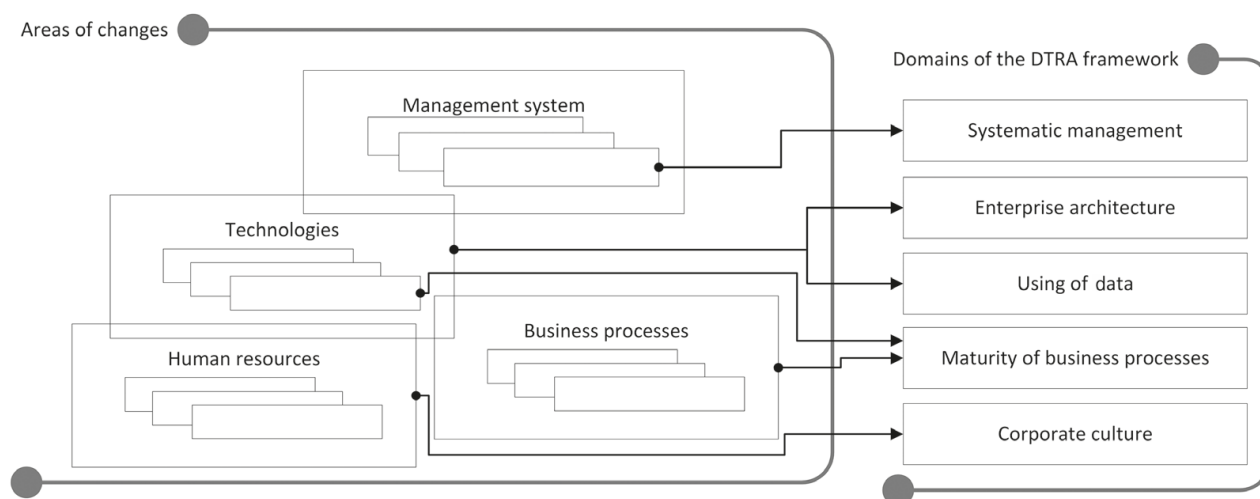

Fig. 3. Transition from the areas of changes to the domains of the DTRA framework

The area "Management System" was narrowed to the "Systematic management" domain, as the systematic factor was dominant in all the observed changes.

The changes in business processes that cover standardization, unification, and optimization were grouped into the "Business processes" area, while changes related to implementing complex automation progects associated with the field "Technologies" (see Table 2). Such allocation is ambiguous becouse these progects often aim to the optimization of businessprocesses through automation. In the readiness assessment framework, a domain " Maturity of business processes" is allocated to avoid such ambiguity. It includes, among others, the "automation of business processes" criteerion. This solution is proved by management standards & practices [BPM CBOK, 2013; SEI, 2010], which consider automation as one of the aspects of business processes maturity.

The area "Human Resources" was transformed into the "Corporate culture" domain, as the analysis of standards and best practices in the sphere of human resource management [TMI-ETMS, 2017; Deloitte, 2019] allowed classifying significant changes as elements of the corporate culture.
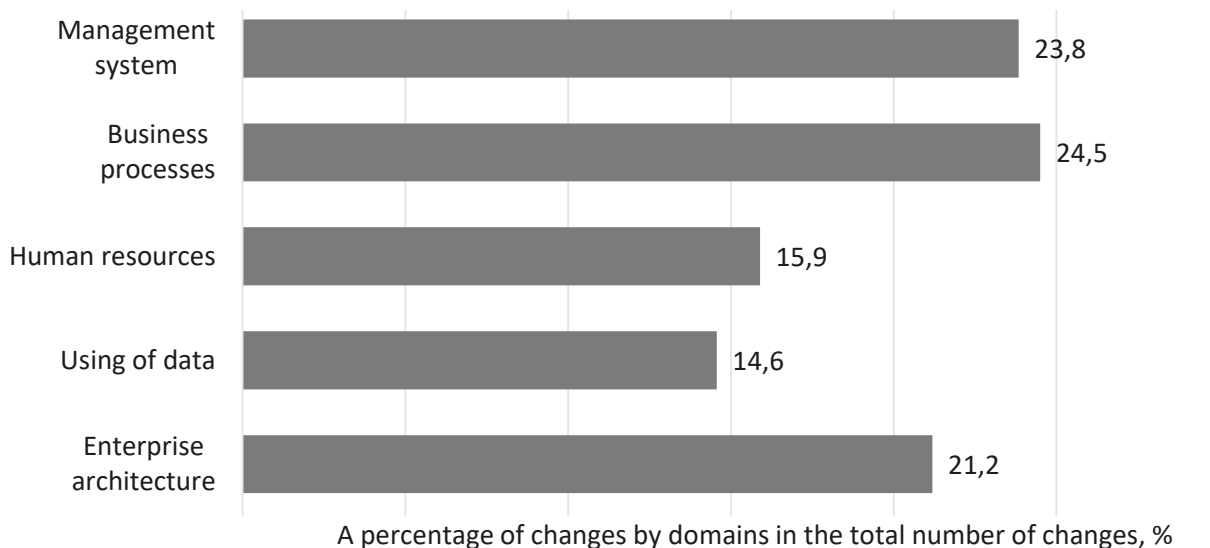
Fig.4. Distribution of changes by domains

The "Technologies" area turned out to be heterogeneous: it includes changes related to both purely technological innovations and IT management fields.

Analysis of management standards related to these fields (standards and bodies of knowledge of IT management [TSO, 2011; ISACA, 2012; The Open Group, 2016], enterprise architecture management [The Open Group, 2018], and data management [Earley, 2017; Gwen, 2006] allowed distinguishing the domains "Using of data" and "Enterprise architecture" from the "Technologies" area. The distribution of changes (analyzed in the case-study) by these domains is shown in Figure 4.

The results presented in Figure 4 allow to conclude that the proposed domain system ensures the fulfillment of requirement 2: a balanced distribution of criteria across domains.

Results of stage 3. Identification of criteria and characteristics of readiness

The goal of research on this stage is to identify the criteria and characteristics of the company's readiness for digital transformation related to each domain.

The study is based on the assumption that changes implemented in companies in the period preceding digital transformation are the prerequisites for the success of digital transformation, as they have led to improvements in the quality of management in different areas, so "characteristics of management quality in the context of each domain can be considered as characteristics of companies' readiness for digital transformation".

The results obtained on this stage are key criteria and characteristics of "high-quality management" through the prism of domains, and a list of criteria and characteristics narrowed by the generalized typical changes identified in the case study 1.

For example, an analysis of BPM, CBOK and ITIL as standards & practices related to the "Maturity of business processes" domain, in particular the subject of Business Process Efficiency Management, Process Design, Process Transformation, Building a Process-Oriented Organization, BPMS use, allows identifying the following key criteria and characteristics of "high quality management":

• BPMS is implemented; a significant part of the activity is carried out in the BPM operating environment using BPMS;

- inherited and acquired/leased information systems are integrated with BPMS;
- IT can create a flexible performance measurement system;
- process efficiency is measured: 1) close to real-time for operational management; and 2) for the needs of business intelligence;
- a system of metrics is described: what to measure, how to measure, whether it is normative and responsible;
- the coverage of measurement segments is defined: Operational efficiency, Finance, Legislation, Problem identification, and Consumer experience;
- the processes are decomposed into sub-processes and divided into actions and workflows concerning the company's divisions;
- organizational rules are established; processes are planned; process descriptions are approved;
- formal cross-functional process models are used;
- a system of indicators of cross-functional processes is built.

All listed aspects can be integrated into the following proposed readiness criteria:

- business processes standardization;
- business processes integration;
- automation of business processes;
- control of business processes.

The results of standards & practices analysis allow the DTRA framework to provide the requirement "The completeness of the criteria system" (requirement 1).

Results of stage 4. Verification of readiness criteria and characteristics

The objects of the research in case study 2 are engineering companies (C1–C9) that are currently implementing successful digital transformation projects. As it was mentioned above, mechanical engineering companies confirm the possibility of successful digital transformation in spite of strong technological gap.

C1. KAMAZ PJSC: one single production base incorporates the overall truck manufacturing cycle, beginning from design, manufacture, vehicle and component assembly, and ending up with the sales of finished products and service backup (https://kamaz.ru/).

C2. UEC-Saturn PJSC: engine-building company, specialized in research and development, production, marketing and sales, after-sale services of gas-turbine engines (and power plants/units) for aviation, power-generating and gas-pumping plants, ships, onshore, and off-shore industrial facilities (http://www.npo-saturn.ru).

C3. Novocherkassk Electric Locomotive Plant: the largest Russian manufacturer electric locomotives (https://www.nevz.com/).

C4. United shipbuilding Corporation: the largest shipbuilding company in Russia (https://www.aoosk.ru/).

C5. Moscow Machine-Building Plant "Vpered": production of tail rotor blades and rotor blades for helicopters of Mi series (http://mmz-vpered.ru/).

C6. Machine-Building Factory of Podolsk JSC: designs, engineers and fabricates steam and hot-water boilers of various types for thermal power plants (http://www.podolskmash.ru/).

C7. PSJC "Sukhoi Company": development, production, training of flight personnel, after-sales service for combat and civil aircrafts (https://www.sukhoi.org).

C8. Shvabe: development and serial production of optical and laser systems and complexes, modern optical materials and technologies, high technology medical equipment, aerospace monitoring and remote sensing systems of the Earth, scientific research instruments, energy-saving lighting equipment, nanomechanics (http://shvabe.com).

C9. KEMP JSC: production of machines and equipment for civil application: multifunctional frontal loaders, trailed and truck-mounted lifters, hydrostatic transmissions, and hydraulic platforms (http://www.kemz.org/).

The subject of research is the changes implemented in companies in the period preceding digital transformation. The aim of the analysis is to determine whether these changes confirm the selected at the previous stage criteria and characteristics.

The final list of criteria of a company's digital transformation readiness as the result of the verification and aggregation of initial list of readiness criteria obtained on the stage 3 (for each domain) is presented in Table 3. Example of characteristic of Systematic management domain is shown in Table 4.

Table 3. **Criteria of the company's readiness for digital transformation**

Domain	Criteria
Systematic management	Management coherence High quality feedback in management system Change management effectiveness
Enterprise architecture	Involvement of CIOs, CDOs in strategic management Efficiency of IT within the company
Using of data	Understanding the value of data Implementation of the data management system
Maturity of business processes	Business processes standardization Business processes integration Automation of business processes Control of business processes
Corporate culture	Personnel motivation for changes Support for initiatives and development of employees Employees' ability to learn

Table 4. **Characteristics of the company's readiness for digital transformation**

Criteria	Characteristic
Management coherence	— Vertical consistency of goals, objectives, plans, and actions (from strategic to operational level) — Horizontal consistency of goals, objectives, plans, and actions (between functional areas, departments)
High-quality feedback in the management system	— Quality of feedback within the company — Quality of feedback with partners and customers
Change management effectiveness	— Speed of implementation of various (not only digital) changes in the company — Completeness of changes
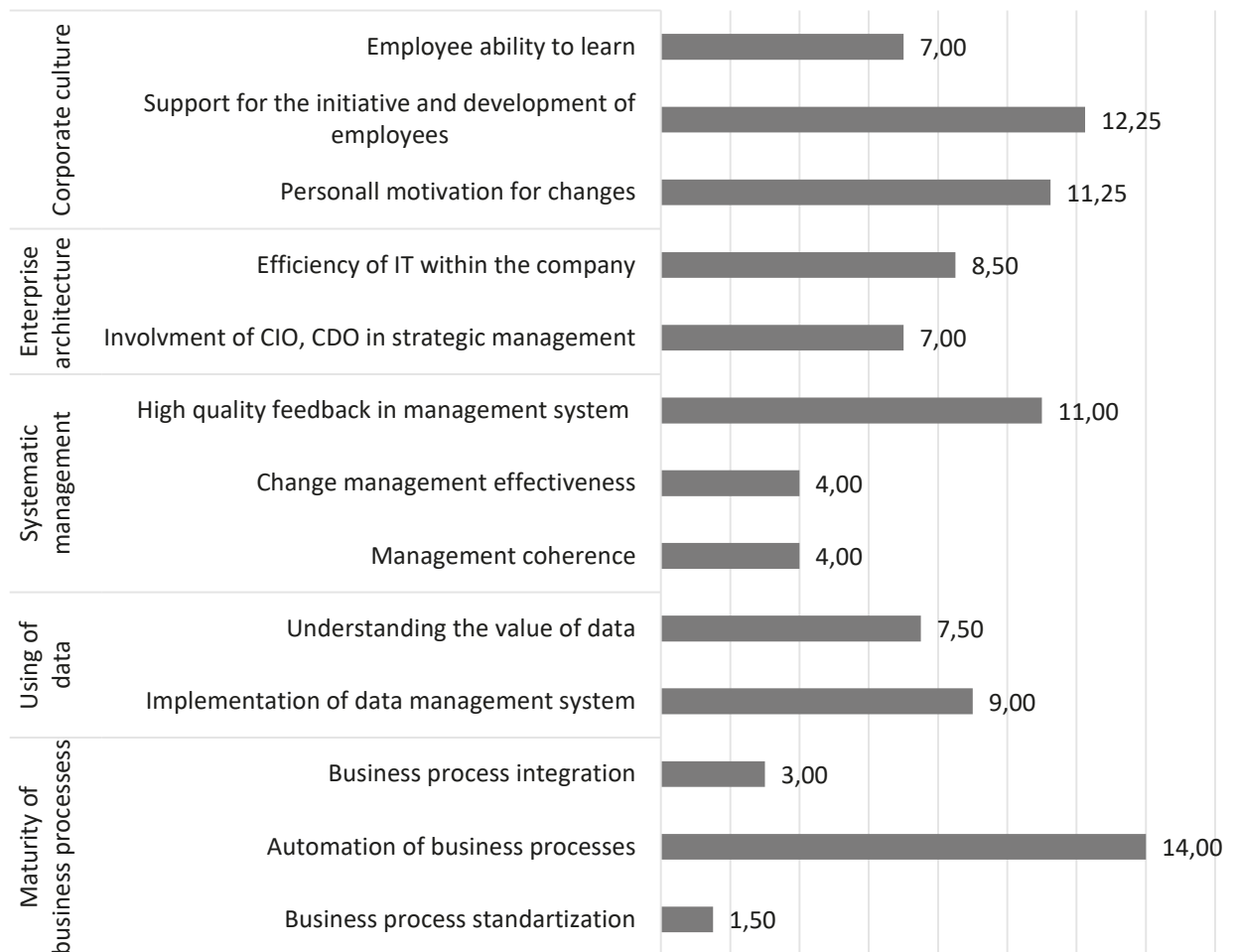
Fig. 5. The distribution of evidence by criterion

Figure 5 presents the distribution of pieces of evidence from the cases C1–C9 examined for all proposed readiness criteria. These results confirm the relevance of the selected criteria for assessing readiness. In all the cases examined, there is evidence of the proposed criteria. Therefore, the framework satisfies the system requirement "The relevance of the criteria" (requirement 3).

It should be noted that changes implemented in the company can lead to improving the characteristics related to different domains. This significantly complicates the structure of the framework for assessing companies' digital transformation readiness.

Conclusion

The key questions for companies that have only started transformations are how to start and what barriers prevent digital transformation. These questions concern the company's readiness for digital transformation, focusing on its capabilities and internal barriers.

The analysis of existing solutions for assessing readiness for digital transformation, proposed by consulting companies and the academic community, revealed an absence of consensus on criteria and characteristics of readiness, as well as justifications for proposed criteria and characteristics in most reviewed works. The lack of clarity creates a problem

in choosing a readiness assessment tool that most closely matches needs. As a result, this slows down or prevents the formation of a digital transformation strategy. Moreover, as demonstrated by the survey, some considered criteria in existing frameworks are not always definitely interpreted by representatives of Russian companies. This complicates the use of these frameworks and reduces confidence in the results of an assessment.

These reasons have resulted in the development of a new readiness assessment framework that meets the following business requirements:

- taking into account characteristics of Russian companies as objects of digital transformation;
- understandability and validity of criteria and characteristics of readiness;
- transparency of the framework structure.

Implementation of these requirements permits positioning the framework as a convenient and understandable tool for digital transformation readiness self-assessment by Russian companies.

In addition to business requirements during the research process, the following system requirements were formulated for the framework as a tool that ensures the reliability of the obtained estimates:

- completeness of criteria;
- a balanced distribution of criteria by domains;
- the relevance of the criteria.

In support of compliance with these requirements, an author's method of designing a framework was proposed. The method combines the analysis of practical cases of companies that successfully implement digital transformation projects and theoretical study of modern concepts and best management practices.

As a result of this method, the DTRA framework for assessing company readiness for digital transformation was developed, which includes criteria and characteristics grouped into the domains "Systematic management", "Enterprise architecture", "Using data", "Maturity of business processes", and "Corporate culture". The criteria are universal, they do not depend on the type and scope of the company, its size, etc. However, industry peculiarities can be taken into account. For each enterprise, there are critical resources and success factors, which relate to specific domains. Such domains need to be investigated more deeply, by specifying, and decomposing characteristics.

The framework is intended for a qualitative assessment of readiness and the development of the company's management understanding of what may hinder the success of the digital transformation.

To enhance the validity of the findings, further research could include a broader case sample. To improve the applicability and practical contributions of this study, new research will focus on selecting metrics for readiness characteristics and developing evaluation algorithms. Another question that requires additional research is whether the proposed framework can be applied to companies in advanced economies — the leaders of digital transformation.

This paper is an initial step towards creating a sophisticated model for assessing a company's digital transformation readiness, which includes criteria, characteristics, metrics, and evaluating algorithms.

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Фреймворк для оценки готовности компании к цифровой трансформации

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В настоящее время акцент в дискуссиях о цифровой трансформации сместился с обсуждения ее необходимости на проблемы оценки готовности компаний к цифровым преобразованиям. Для российских компаний, ввиду специфики цифровой трансформации в России, необходима разработка новых и приоритезация существующих критериев готовности. Это требует создания комплексной системы оценивания, включающей множество взаимосвязанных показателей, характеризующих ожидания и стратегические цели компании, качество бизнес-процессов, компетенции и мотивацию сотрудников, зрелость технологической среды компании, управление информационным обеспечением и др. Область, охватываемая данным исследованием, касается совокупности факторов (предпосылок), определяющих готовность российских компаний к цифровой трансформации. Согласно гипотезе исследования, эти предпосылки могут быть систематизированы в виде фреймворка для оценки готовности компании к цифровой трансформации. Цель исследования — спроектировать фреймворк, позволяющий оценить готовность компании, учитывая не только текущее состояние компании, но и ее предыдущее развитие. В работе сформулированы требования к системе оценке готовности, представленной в виде фреймворка, и предложен авторский метод его проектирования в соответствии с требованиями, сочетающий анализ практических кейсов компаний и теоретический анализ современных концепций и лучших практик менеджмента. В результате применения предложенного метода создан фреймворк Digital Transformation Readiness Assessment для оценки готовности компании к цифровой трансформации. Он включает критерии и характеристики готовности, сгруппированные в домены. Фреймворк предназначен для качественной оценки готовности и формирования у менеджмента компании понимания того, что может препятствовать успеху цифровой трансформации.

Ключевые слова: цифровая трансформация, готовность компании, фреймворк, критерии готовности, оценка готовности.

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