Assessment of Digital Maturity of Enterprises

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Abstract. The paper covers the issue of enterprise digital maturity assessment. This issue is relevant for modern enterprises being in the process of digital transformation. The tendency of the information community towards a qualitative change in organization management determines the development of the economy, increasing labor efficiency and improving the quality of life. Enterprises need to understand how to conduct business in changing conditions, what strategies and management methods to use in order to further maintain their competitiveness. Knowledge of the enterprise digital maturity level allows implementing and improving existing processes in order to become more attractive from the digital point of view. The paper represents a detailed analysis of enterprise maturity assessment methodologies as well as their key points, main advantages and limitations. Describing the basics of the project management approach, a rationale for the transition from process maturity assessment to digital assessment was proposed. The main purpose of the paper is to analyze existing approaches to assessing the digital maturity of an enterprise, determine their applicability and limitations, and identify further research.

Keywords: Digital maturity · Digital transformation · Digital technologies · Enterprise development · Enterprise assessment models · Company culture and strategy · Business models development · Business process development

1 Introduction

In the 21st century, it has become technologically possible to make a quantum leap in the development of many industries. But digital transformation requires an adequate level of enterprise reengineering. Therefore, it is important to understand its readiness to implement some technological projects. In turn, the degree of readiness is largely determined by the maturity of the business - the plan for the transition of the enterprise to digital models of implementing activities will depend on this. This paper represents an analysis of approaches to determining the maturity and digital maturity of an enterprise, to determine the limitations of existing approaches, to identify key factors that (in accordance with these approaches) determine the readiness of an enterprise for digital transformation processes.

Fast-growing companies and world leaders are forced to resort to digitalization, the integration of modern technological products and services, the transformation of all

processes and operational activities, cooperation, as well as improving the quality of customer service in order to maintain their competitiveness [1]. It includes the introduction of modern technologies and approaches into the company's business processes. This means not only a change of equipment to a new high-tech, but also a purposeful change in management approaches, company culture and partnership, and gaining customer focus. The analysis of activities, the compilation of work algorithms makes it possible to increase the speed of work, to optimize existing business processes and create new ones, thereby securing the company's reputation as modern and progressive in the global market.

As each company refers to its own development stage and has a specific business processes system, there is no single algorithm for the digital transformation. It is necessary to conduct a comprehensive analysis of the use of information technology in the activities of the company, considering both internal processes and interaction with the environment, customers, competitors and partners.

2   Materials and Methods

The paper is based on the analysis of existing approaches to the assessment of maturity and digital maturity and summarizes the data obtained from various sources. This section will briefly describe the methods that companies use in project management and strategy development.

2.1   Digital Maturity Definition

The concept of "digital maturity" helps to understand what processes and models are in need for transformation, as well as at what stage of development the company is currently located. In this paper there are several descriptions of this term:

Digital maturity is about adapting the organization to compete effectively in an increasingly digital environment. It is about implementing new technologies by aligning the company's strategy, workforce, culture, technology, and structure to meet the digital expectations of customers, employees, and partners. Digital maturity is, therefore, a continuous and ongoing process of adaptation to a changing digital landscape [2].

Digital maturity is a combination of two separate but related dimensions. The first, digital intensity is investment in technology-enabled initiatives to change how the company operates – its customer engagements, internal operations, and even business models [3]. Firms maturing in the second dimension, transformation management intensity, are creating the leadership capabilities necessary to drive digital transformation in the organization. Transformation intensity consists of the vision to shape a new future, governance and engagement to steer the course, and IT/business relationships to implement technology based change [4].

Digital maturity represents a systematic way for an organization to transform digitally [5]. Hence the term specifically reflects the status of a company's digital transformation. It describes what a company has already achieved in terms of performing transformation efforts and how a company systematically prepares to adapt to an increasingly digital

environment in order to stay competitive. Digital maturity goes beyond a merely technological interpretation simply reflecting the extent to which a company performs tasks and handles information flows by IT, but also reflects a managerial interpretation describing what a company has already achieved in terms of performing digital transformation efforts including changes in products, services, processes, skills, culture and abilities regarding the mastery of change processes [6].

There is no general approach to assessing digital maturity. But in the described terms there are similar statements that define the "digital maturity" term.

To sum up, digital maturity determines the ability of company's processes to adapt to environment of new digital technologies implementation.

2.2 Maturity Models

The digital maturity of a company directly depends on the overall maturity of the company, and the digital models are based on the maturity process models of the companies. By defining a company's maturity model, it becomes possible to analyze the process's readiness for changing not only in the management of processes, but also in a digital environment.

Evaluation of maturity model levels helps to understand better how digital maturity levels can depend on enterprise maturity. The maturity of the company can be represented in the form of stages, which also have some variability, but have common features.

In Russia various maturity models are used to assess enterprise maturity level:

- SW SMM;
- integrated CMMI model;
- standard ISO 15504;
- Maturity Model COBIT 4.1 (COBIT Process Assessment Model, PAM);
- ORMZ model (PMI community);
- model SPICE (Software Process Improvement and Capability determination) etc.

For compiling a general picture of existing methodologies let us consider in more detail some of them for determining the maturity of companies.

CMM and CMMI Models. The most popular model is the CMM (Capability Maturity Model for Software), which describes the maturity of software development processes in enterprises, developed by the Software Engineering Institute (USA). The success of the idea lies in the simplicity of understanding, the practicality of applying the model, and effective promotion from one level to another with significant changes in the quality of products. This model is focused on optimizing price-quality compliance.

In the process of development, the model was finalized and received the name CMMI (Capability Maturity Model Integration), which differs in some details, but retains the basic principles of CMM, discreteness of gradations of maturity, focus on the project business (see Table 1) [7].

Table 1. The differences of levels of CMM and CMMI models.

№	SW CMM	CMMI
1	Initial	Initial
2	Repeatable	Repeatable
3	Defined	Defined
4	Managed	Quantitatively managed
5	Optimizing	Optimizing

The integration of models resulted in a five-level methodology for determining the maturity of enterprises.

- Level 1 - Initial.
- Level 2 - Managed.
- Level 3 - Defined. Process engineering.
- Level 4 - Quantitatively Managed.
- Level 5 - Optimized (Optimizing).

Having determined the maturity level of the company in the field of digital transformation, it is already possible at the first stage to form a list of changes in the organization to adapt it in a changing world both in the external and internal environment. Achieving the desired level is possible only with a clear description of the further strategy for achieving the required state.

Disadvantages:

- The need to "align" all the processes of organizations to the requirements of the SMM, even though the processes of the organization did not require the fulfillment of certain requirements.
- The standard began to be used as a selection criterion for participation in tenders for software development or in outsourcing projects. The demand for certified organizations has created a proposal for "quick and painless certification".

Advantages

- A quality model specifically related to the software development process;
- CMM is a large, multi-stage quality standard covering the entire software development cycle: from design to implementation. It is suitable for optimizing and improving the quality of released software.

Maturity Model COBIT 4.1. International Standard ISO/IEC 15504. Initially, in practice, it turned out to be difficult to implement and did not give a definite understanding of the state of the company. So, processes could have signs of different levels, not even going in a row, which happened with attributes, making it difficult to assess the level at which the company is located. This led to the loss of the holistic look of its digital maturity [8].

The model was improved and began to be based on the international standard ISO/IEC 15504 "Information technology - process assessment". International Standard defines process evaluation as a complete process optimization program or as part of process capabilities.

Process optimization means a continuous increase in productivity and the application of rational methods in an organization.

Determining the capabilities of processes according to the standard is the correct representation of potential opportunities from ongoing processes.

This standard also involves five levels of digital maturity of the company, which directly depends on the maturity of the processes taking place inside.

Level 0. Incomplete process. When processes are underway, but have not yet reached it. There is no single base for systematic approaches to standard processes.

Level 1. Implemented process. Achieving processes at the final stage of their appointment without the use of special management methods.

Level 2. Managed process. The processes to be carried out are planned in advance, then subsequently regulated. Process monitoring is carried out, the compliance of the developed product or service with the intended goals is checked.

Level 3. Installed process. A base of basic processes is being formed, which are standardized and have common control algorithms. The described processes are used at all stages of the project, but are individually finalized during the execution for the purpose of the developed product.

Level 4. Predictable process. The results of the processes at this stage are predicted and known in advance. Achieving certain results is easily managed and controlled.

Level 5. The optimizing process. Predictable processes are constantly improving to achieve business goals.

The levels are arranged in such a way that it is impossible to skip or skip one of them, the transition through the levels is carried out in order. If the company decides to skip several levels, then the simultaneous implementation of several optimization tools can lead to unpredictable consequences, jeopardizing the entire project activity of the company. Each maturity level forms the basis for the rational and efficient implementation of processes at the following levels. Nevertheless, organizations can use and receive benefits from the implementation of processes characteristic of higher maturity levels in comparison with the achieved ones. All changes associated with maturity need not be consistent.

At every level implementation process, implementation management, work product management, definition, deployment, measurement, control, innovation, optimization processes are at different levels of achievement.

Levels are determined by the achievement of process attributes.
N - Not achieved - 0%–15% achievement.
H - Partially achieved - 15%–50% achievement.
B - Mostly achieved - 50%–85% achievement.
P - Fully achieved - 85%–100% achievement.

COBIT focused on the audit of IT processes than on the audit of specific functions or applications.

Disadvantages:

– An excess of poorly defined terms, unnecessary "formal" reasoning used to explain obvious things, and superficiality of presentation;
– The hierarchy of management goals plays a decorative role: no specific tasks associated with this hierarchy are posed and no special teaching methods are used;
– No holistic view of company maturity.

Advantages:

– Flexible and convenient assessment tool, compatible with the international standard ISO 15504;
– Ability to supply processes with attributes of ISO 15504;
– Certification Requirements (including Audit);
– Requirements for the Appraiser and His Experience.

The maturity methodologies of process approaches are constantly changing and new models are emerging such as SGMM, Model OPM3 (Project Management Institute, PMI), BPMM, etc. All approaches have their own characteristics and various criteria but most of them have 5 determined levels of maturity. By this way, digital maturity models have the same specification [9].

3 Results

3.1 Digital Maturity Models

There is a close connection between the transition from the process level of maturity to a digital one. The company's readiness for technological transformation is determined by assessing the level of compliance with fundamental processes and their management, methods of using the accumulated information. By determining the maturity level of the management system, it can characterize the stage of the company's readiness for digital transformation, identify the company's potential for development, and choose the direction of modernization and growth.

The company which is operating effectively achieves a stable state in the global market and has a high index of readiness for digital transformation [10]. Moreover, leadership of such companies is able to identify weaknesses that need improvement and innovation through IT technology, organize monitoring of changes in the environment, increase satisfaction of the needs and expectations of stakeholders, and structure goals.

An analysis of existing and popular maturity models is the basis for creating a digital maturity model. This article discusses one of the proposed models (Table 2).

This model as well as the maturity model of the company describes levels of digital maturity of companies, provides a description of the state of processes, technologies, also the level of organization of employees in the company. Thus, it allows to accurately determine the stage at which the company is currently located and whether it was preparing for digital changes.

Table 2. Digital maturity model.

Maturity level	Processes	Technology	Employees
Level 5	Development of processes for autonomous decision-making by systems; Development of processes for regular forecasting and planning of future production	Integration with external data of suppliers and customers; The use of artificial intelligence systems	Development of a culture of continuous improvement and innovation; Implementation of responsible persons for the corresponding direction of predictive analytics and adaptability
Level 4	Development of audit processes of historical and current data and the use of the obtained information for optimization; Introducing procedures for regular optimization initiatives	Real-time implementation of systems for analyzing activities that automatically perform analytics, generate warnings and recommendations; The introduction of digital counterparts for testing prototyping and optimization	Organization of cross-functional sessions and data exchange sessions to work on current problems and optimization methods based on new data; Attracting additional data analysts
Level 3	Formalization of data flow control processes Creation of processes for the active exchange of knowledge and data between all project participants; Creation of a cross-functional data exchange network	Improving data accuracy, reducing the amount of useless information; Implementation of data mining systems; Integration of data exchange systems	Training employees to work with system data, various devices and interfaces; Development of "Digital" skills; Developing a Knowledge Management Culture
Level 2	Formalization of the implementation processes of the "digital plant" Outsourcing processes for connectivity	Study of the directions of integration of existing systems and technologies with future elements of the "digital factory" Formation of a single information space and data flows, connection of systems	Involvement of employees in the development of the target vision; Separation of roles and areas of responsibility, attraction of employees with competencies in business, IT and production
Level 1	Elimination of paper forms and media, execution of processes through system interfaces Data Automation	Implementation of basic production and enterprise management systems; System Integration for Automatic Data Transfer	Trained employees and their areas of responsibility
Level 0	No direct impact on processes	Creating infrastructure for subsequent implementations of industrial Wi-Fi, local area networks	No additional digital competencies required for employees

Based on the previously described methodologies, a model of digital maturity of companies, by analogy with the process, includes 5 levels [11]:

- Level 0. Basic infrastructure. Technologies that do not produce business effects in themselves, but are necessary for the introduction of advanced technologies.
- Level 1. Computerization. The process is automated by some IT system. Data entry into the system is carried out manually.
- Level 2. Connectivity. The operational data of the process enters the system automatically, without human intervention. Integrated related systems. The control action is carried out remotely.

- Level 3. Transparency. Key process indicators are visualized and tracked in real time.
- Level 4. Predictability. Predictive systems have been introduced to predict the future state.
- Level 5. Adaptability. Systems have been introduced that have a corrective effect on equipment independently or as part of a corporate system to maximize efficiency.

To achieve the highest level or transition from one to another, two approaches have been singled out.

3.2   Replication of Existing Tools

It is assumed that the company uses basic digital tools that give positive results, or there are developments for future implementation with a high level of versatility that can be applied to most standardized enterprise processes.

Stage 0. Preparation. At this stage, there is an analysis of all the digital tools that are already used in the company or can be offered for implementation, a description of their potential effect, analysis and distribution by maturity levels, the formation of technical conditions.

Stage 1. Determination of the current maturity level by units, digital technologies used in production. During the stage, a list of tools used at the enterprise, their effectiveness, as well as the definition of new ones in accordance with maturity levels is determined, parameters for evaluating the success of their implementation are highlighted. The distribution of technologies by maturity levels can be represented as follows:

- Level 1. Computerization
- Level 2. Connectivity
- Level 3. Transparency
- Level 4. Predictability
- Level 5. Adaptability

The result is an understanding of the level of digital maturity, determining the degree of success of planned implementations and existing tools.

Stage 2. Formation of the target level of maturity of the unit and the mapping of the transition to it.

Based on the previously compiled register of instruments, a basis is formed for moving to a new level and is framed in the form of a roadmap for implementation (usually for 3–5 years). The quantitative results of achieving the target level for each of the departments of the company are outlined.

This approach requires the transformation of processes in individual production sections of the enterprise. It should be remembered that they can simultaneously have different levels of maturity.

Thus, a transformation takes place based on the replication of digital tools that have been introduced and need to be further developed, or have been considered by management as planned implementations with a definite result for the enterprise.

3.3 The Process Approach to Creating a Digital Transformation Program

A second approach is proposed for the improvement and implementation of IT technologies in enterprises, which is based on a detailed analysis of processes up to operational activities. New modern technologies are taken as the basis of optimization.

At levels 1–3, groups of processes are defined, from which sequences of business chains with input and output data are formed, a deep decomposition of all business processes occurs. This allows you to determine the boundaries of the enterprise's business, the relationship of processes and functional features.

To write the technical specifications for the implementation of the software, compile a user manual, and formulate standard operating procedures at levels 4–5, a detailed analysis of the steps of each process and the actions of the user group contained in the business model takes place [12].

Stage 0. Identification of the main processes for digital transformation. Includes analysis of end-to-end business processes, IT infrastructure of the company, discussion of the company's activities and its goals with senior management. The implementation of the stage gives a detailed description of the existing processes and the level of use of IT technologies in them, identifying potentially problematic places.

Stage 1. Advancing optimization measures. Evaluation of the current labor costs of processes and their efficiency, comparing the data obtained with world market leaders, identifying priority areas for development and optimization hypotheses [13]. As a result, the company receives a detailed report on the course of business processes, a comparative assessment of process activities with international practices, and quantitative indicators of the cost of optimization processes.

Stage 2. Evaluation and detailed study of the proposed optimization solutions.

It contains the development of top-level business processes to-be models, the definition of functional requirements for IT systems. Also, at this stage, a ranked list of initiatives to improve the company's activities is being formed taking into account the assessment of the effect of their implementation.

Stage 3. Formation of the optimization program. A to-be model of business processes is compiled in accordance with the selected modeling methodology, an optimization program and a pool of recommendations for automating specific processes are formed, all functional and non-functional requirements for the implemented IT systems are written, and a quantitative business case for each project is developed and calculated [14].

Thus, the output is a detailed program for digital transformation of the main processes to increase the efficiency of the enterprise.

4 Discussion

It is possible to present the advantages and disadvantages of each of the approaches in the form of a Table 3:

It should be noted that both approaches are practically applicable and are chosen by the company depending on its transformation tasks and the level of digital maturity. One more feature can be noted - this is the application of the described approaches to digital transformation at the same time, analyzing both the instrumental basis of the company and internal business processes.

Table 3. The advantages and disadvantages of the approaches.

Advantages	Disadvantages
Replication of existing tools	
+ Quick start of digital asset transformation; + Intensive use and development of existing digital tools; + Transparency and comprehensibility of the expected effects due to the lower degree of unknown	— Potential loss of benefits associated with insufficient diving; — High requirements for the quality of existing tools and implementation team; — Amount of problems may not be resolved
The process approach to creating a digital transformation program	
+ Detailed study of a wide range of processes; + Orientation to real problems; + Potentially high effects if significant labor-intensive processes are detected that could potentially be automated; + Revision and updating of the process model; + Third-party effects expressed in detecting organizational problems	— High complexity of the stages, especially the stage of the diagnostic examination; — High qualification requirements of the methodologists conducting the research and the methods used; — Significant distraction of employees at the stages of diagnosis; — Delaying the start of digital transformation until the end of the diagnosis

5   Conclusion

To achieve enterprise strategic goals and results, to determine an effective strategy, it is necessary to understand the state of maturity of the company. There are special methodologies that provide an assessment and description of models of digital maturity, divided into appropriate levels.

This paper examined several models having 5 maturity levels. It can also be noted that CMM (CMMI) is based on three basic principles that also apply to the ISO 15504 standard.

The maturity of an enterprise is determined by five levels, which depend on the specific criteria applied to both the developing and implementing systems of the company.

The objective of each organization is to move from a lower level to a higher one in order to maintain competitiveness, increase productivity and improve the quality of developed products or services.

An analogy of the process model of the enterprise maturity level with the digital one was carried out in this paper. Five levels of digital maturity are defined, and digital transformation campaigns are also considered. A number of differences between them were noted in the paper.

The replication approach of the tools and developments used is considering the formation of a digital transformation program "from top to bottom", as well ad considering existing technologies and adapting them to some specific tasks. In this case, the effect is

obtained in any case, so technologies that have positive results are used. However, problematic points may be missed with such principles, the elimination of which requires development completely from scratch, which leads to significant costs.

The process approach is defined in the opposite way to the "bottom – up" approach as a more fundamental. It identifies problems that need to be addressed. To do this, we have to do a detailed analysis of the enterprise's business process model and diagnose the levels at which they are located.

Thus, knowledge about the level of digital maturity, assessment of readiness for digital transformation, application of certain approaches to optimize activities help management in making managerial decisions for successful business development.

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