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MODERN APPROACHES TO THE FORMATION OF SYSTEMS FOR EVALUATING THE LEVEL OF ENTERPRISES DIGITIZATION

Kateryna Molchanova. "Modern approaches to the formation of systems for evaluating the level of enterprises digitization". *The article examines the essence of the concept of digital transformation of enterprises, which includes the introduction of digital technologies into the enterprise's business processes, management processes, and communication processes. The available approaches to assessing the level of digital transformation of enterprises, which is a necessary tool for further development strategy, were analyzed. It was determined that existing studies and scientific publications on the formation of systems for evaluating the level of digital development need some refinement, taking into account the specifics of the enterprises to which they are applied.*

A unique approach to forming an assessment of the level of digital transformation of aviation enterprises was proposed, according to which it is proposed to apply an integral assessment that takes into account indices of digital activity, maturity and interaction. The advantage of this approach is taking into account the specific processes inherent in aviation industry enterprises and forming a tool that allows you to assess the possibility of functioning of various aviation market subjects in a single information field.

Special attention was paid to the method of calculating indicators that are part of the indices of digital activity, maturity and interaction.

Thus, the assessment of the level of digital transformation of aviation enterprises will allow in the future to develop a joint strategy for the formation of a digital space in which the subjects of the aviation market will function.

Keywords*:* digital transformation, methods of digital transformation evaluation, digitalization, platformization, digital economy, digital readiness

Катерина Молчанова. «Сучасні підходи до формування систем оцінювання рівня цифровізації підприємств». *У статті розглянуто сутність поняття цифрової трансформації підприємств, що включає впровадження цифрових технологій в бізнес-процеси підприємства, в управлінські процеси, в процеси комунікації. Було проаналізовано наявні підходи до оцінки рівня цифрової трансформації підприємств, яка є необхідним інструментом для подальшої стратегії розвитку. Було визначено, що наявні дослідження та наукові публікації щодо формування систем оцінювання рівня цифрового розвитку потребують певного доопрацювання з урахуванням специфіки підприємств, до яких вони застосовуються.*

Був запропонований власний підхід до формування оцінки рівня цифрової трансформації авіаційних підприємств, згідно з яким пропонується застосовувати інтегральну оцінку, яка враховує індекси цифрової активності, зрілості та взаємодії. Перевагою такого підходу є врахування специфічних процесів притаманних підприємствам авіаційної галузі та формування інструменту, який дозволяє оцінити можливість функціонування різних суб'єктів авіаційного ринку в єдиному інформаційному полі.

Особлива увага була приділена методиці розрахунку показників, що входять до складу індексів цифрової активності, зрілості та взаємодії.

Таким чином оцінка рівня цифрової трансформації авіаційних підприємств дозволить в майбутньому розробити спільну стратегію формування цифрового простору в якому будуть функціонувати суб'єкти авіаційного ринку.

Ключові слова: слова: цифрова трансформація, методи оцінки цифрової трансформації, цифровізація, платформізація, цифрова економіка, цифрова готовність

Introduction. Digital technologies play one of the most important roles in today's society. Various gadgets have become a person's constant companions, and access to the Internet is currently defined as one of the necessities of life. The rapidly growing role of digital technologies in our lives is evidenced by the growing number of Internet users. So, in 2005, their number was 1.023 million people, while in 2023, this value is already 5.400 million people, that is, it has increased more than 5 times. Today, almost two-thirds of the planet's population is connected to the global web [1].

Rapid digitization leads to changes in communication processes, document flow, business processes of the enterprise, and the use of digital technologies becomes one of the most important factors of the company's competitiveness. In tough market conditions, the management needs to understand the level of digital transformation of the enterprise at the moment, what latest technologies are appearing on the market and whether there is a need for their implementation, what are the potential advantages and risks.

Different approaches can be used to assess the level of digital transformation, taking into account the specifics of the activities of enterprises and what the management is focusing on in order to improve efficiency. There are already established methods, but the rapid development of the latest technologies leads to the need to constantly revise approaches to the formation of evaluation systems.

Problem statement (formulation of research purposes). In today's conditions, in order to maintain competitiveness, enterprises must seriously approach the issue of choosing a method for evaluating digital changes in the company. The development of the further strategy of the enterprise will depend on the quality and completeness of the assessment of the state of digital transformation [2].

The list of indicators by which the state of digitization is measured directly depends on the level at which the assessment is made. It can be at the state, regional, industry level and directly at the enterprise. The research aims to analyze approaches to the formation of methods and indicator systems for assessing the state of digital transformation and is a continuation of a number of works [3, 4].

Approaches to the formation of methods for evaluating the digital transformation of aviation enterprises must take into account various specific factors. The aviation industry has always been high-tech, and the formation of a system of indicators for evaluating digital changes must take this fact into account. In our opinion, the existing indicator systems do not meet the specifics of the aviation industry

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and require adaptation to the operating conditions of aviation enterprises.

The main material and results of the research. The development of digital technologies gives airlines and airports the opportunity to increase the efficiency of their activities, the quality of the services provided, as well as to improve information interaction. However, it should be understood that the digital level of enterprises can be different due to different management systems, strategies, capabilities, approaches to the introduction of new technologies, etc. The different level of digitization of enterprises also affects the information interaction between them, it can be long, inefficient and contain errors.

The system of indicators of the level of airlines digital development can become a necessary tool for identifying factors that affect the level of information interaction between them [5].

Many methods have been developed (Table 1) that allow assessing the level of digitization of enterprises. The difference in the methods lies in the set of groups of indicators, the formation of the assessment, the methods of conducting the assessment (self-assessment, expert assessment, comparative assessment, etc.).

The analysis of various approaches to assessing the digital economy [6] allowed us to conclude that one of the most common methods is the index method, which is actively used by international and national organizations at the macroeconomic and micro level [3].

Table 1. Comparative characteristics of methods for assessing the level of digitization of enterprises

The name of the method	Developer	Indicators by which the assessment is carried out
1	2	3
1. Assessment of Digital Transformation	MIT Center for Digital Business and Capgemini Consulting	Evaluation in three key areas of digital transformation: customer experience, operational processes and business models. The total number of indicators is 9.
2. Digital Maturity Model	Deloitte	Assessing digital capabilities along 5 key dimensions: customers, strategy, technology, production, organization structure and culture. The total number of indicators is 179.
3. Digital Transformation Index	Arthur D. Little analytical agency	Conducting assessments in 7 key areas: strategy and leadership, products and services, customer management, operations and supply chains, corporate services and controls, information technology, workplace and culture.
4. Digitization piano	Global Center for Digital Business Transformation (created on the initiative of IMD and CISCO)	The digitization piano defines 7 distinct categories, any of which could be transformed digitally: the business model, the structure, the people, the processes, the IT capability, the offerings and the engagement model
5. Digital Transformation Assessment	Ionology	5 blocks of digital transformation are distinguished: strategy and culture, personnel and customers, processes and innovations, technologies, data and analytics.
6. Industrie 4.0 Maturity Index	Acatech National Academy of Science and Engineering	Assessment in 4 key areas of digital transformation: resources, information systems, culture and organizational structure.
7. A model for assessing digital aptitudes	KPMG	Assessment on 5 key dimensions: Vision and Strategy, digital talent, key digital processes, agile sourcing and technology, leadership.

Source: compiled by the author based on [7-13]

The most famous macro-indices are the following: Networked Readiness Index – NRI [14], E-commerce Index B2C – UNCTAD B2C ECI [15], ICT Development Index – IDI [16], E-Government Development Index – EGDI [17], Digital Economy and Society Index – DESI [18] and Global Digital Readiness Index – GDRI [19]. According to approximately all of

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the mentioned indices, Ukraine occupies an average place among the countries of the world.

However, the vast majority of the listed macro-indices do not reflect the economic and social consequences of digital transformations and do not take into account the peculiarities of the countries' development, which ultimately leads to a kind of adjustment of their indicators to the calculation requirements of the relevant international indices.

Most of the named indices are used to compare national economies and for a kind of benchmarking. Currently, there are attempts to develop digital indices for certain sectors of the economy.

Since there are significant difficulties in obtaining reliable statistical information regarding the use of digital technologies in the activities of aviation companies, the author proposed to use an index approach, namely to evaluate the level of digitization of the industrial and commercial activities of enterprises according to 3 indices [20].

1. The Digital Activity Index. This is a dynamic indicator that allows tracking the company's evolution in the use of digital technologies to optimize internal business processes in order to ensure business flexibility and reflects the level of adoption of digital technologies by the aviation enreprise. The digital activity index of the aviation enreprise is calculated according to the formula:

$$I_{DA} = \sum_{k=1}^{n} x_{1k} \cdot a_{1k} \quad , \tag{2.1}$$

where $x_{1к}$ – an indicator characterizing the digital activity of the enterprise,
$a_{1к}$ – indicator weight,
n – the number of digital activity indicators.

2. The Index of Digital Maturity. This index reflects the processes of creating value for the personnel, customers and stakeholders of the aviation company, that is, it is determined by the set of digital tools used by stakeholders for communications within the company and with the external environment. The digital maturity index is calculated according to the formula:

$$I_{DM} = \sum_{z=1}^{m} x_{2z} \cdot a_{2z} \quad , \tag{2.2}$$

where x_{2z} – an indicator characterizing the digital maturity of the enterprise,
a_{2z} – indicator weight,
m – the number of digital maturity indicators.

3. The Index of Digital Interaction. This index reflects the degree of use of digital services (digital platforms) to ensure interaction and partnership in passenger and cargo customer service chains. The index of digital interaction is determined by the formula:

$$I_{DI} = \sum_{p=1}^{h} x_{3p} \cdot a_{3p} \quad , \tag{2.3}$$

where x_{3p} – an indicator characterizing the degree of digital interaction,
a_{3p} – indicator weight,
h – the number of digital interaction indicators.

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The next stage after the determination of the three indices is the calculation of the integral index of the digital transformation of aviation enterprise according to the formula:

$$I_{ig} = {I_{DA}}^{\alpha} \times {I_{DM}}^{\beta} \times {I_{DI}}^{\gamma}. \quad (2.4)$$

where α, β, γ – dynamic weighting coefficients.

Quantitative assessment of any indicator can be carried out directly based on the results of its measurement, or, if such assessment cannot be established, then through expert assessment. The general method of determining indicators of digital activity, maturity and interaction is presented in Table 2.

Table 2. Methodology for calculating indicators of digital activity, maturity and interaction

Indicator	Symbol	Calculation methodology
1	2	3
1. The Digital Activity Index		
The level of information systems integration of the enterprise	x_{11}	(Number of integrated information systems) / (the total number of information systems of the enterprise)
The level of business processes automation	x_{12}	(Number of automated business processes) / (the total number of business processes that can be automated)
Quality level of connection	x_{13}	(Number of workplaces with broadband Internet access) / (total number of computerized workplaces)
The level of the corporate strategy development of digital transformation of the enterprise	x_{14}	Assessment of the level of development and implementation of the digital development corporate strategy of the enterprise (from 0 to 1)
Employees' understanding of the goals, importance and ways of digital development of the enterprise	x_{15}	(The number of employees who understand the company's digital development strategy) / (total number of employees)
Improvement of employees' skills in working with modern digital technologies	x_{16}	(The number of employees who attended professional development courses, trainings and seminars on the use of modern digital technologies over the past year) / (the number of employees whose job duties are directly related to digital technologies)
2. The Index of Digital Maturity		
The level of compliance of the aviation company website with the requirements of consumers	x_{21}	Assessment of quality and availability of information on the website and user-friendliness of the interface (from 0 to 1)
The digitization level of services for passengers	x_{22}	(Number of digital services) / (total number of services)
The level of digital services for cargo customers	x_{23}	(Number of digital services) / (total number of services)
The digitization level of service sales channels	x_{24}	(Number of digital sales channels) / (total number of sales channels)
The level of digital activity of customers	x_{25}	(Number of customers using digital sales channels) / (total number of customers)
The digitization level of communication channels with clients	x_{26}	(Number of digital communication channels) / (total number of communication channels)

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End of table 2

1	2	3
3. The Index of Digital Interaction		
The level of use of digital financial flow	x_{31}	(The number of transactions made using digital services for the specified period) / (the total number of financial transactions for the specified period)
The automation level of information exchange (electronic document flow)	x_{32}	(Number of documents transferred/received in electronic format for the specified period) / (the total number of documents transferred/received from the external environment for the specified period)
The level of use of integrated information solutions for coordination with other subjects of the air transport market	x_{33}	Assessment of the degree of use of integrated information solutions for coordination with other subjects of the air transport market (from 0 to 1)

Source: developed by the author

To determine the weight of the indicators, it is proposed to apply the method of expert evaluation, i.e. evaluation of the problem based on the opinions of specialists (experts) for the purpose of further decision making (choice). Expert evaluation is carried out in three stages - selection of experts, conducting a survey and processing its results. Methods based on the use of expert assessments are divided into two groups: individual (personal) expert assessments and group (collective) expert assessments. Individual expert evaluations are provided by each expert separately, independently of each other, and expert interviews can be conducted according to different procedures. Group expert evaluations are formed by a group (collective) of experts who agree on their opinion in an open discussion.

Gradation of airlines according to the integral index of digital transformation is carried out according to the scale shown in the Table 3.

Table 3. The scale of the digital transformation level of aviation enterprise

Integral index interval	Characteristics of the level
More than 0,90	High level of digital technologies development: most processes are digitized, high level of digital maturity and digital partnership
0,71-0,90	Sufficient level. Most business processes are digitized, the level of digital maturity is high
0,41-0,70	Middle level. The company works with digital technologies, but it needs to be expanded, it is necessary to acquire new digital competences or attract relevant specialists
Less than 0,40	Low level. Unstable development, changes in business processes and implementation of digital technologies are required

Source: developed by the author

Basically, the low level of digitalization of aviation enterprises is caused by the lack of a clear digital development strategy, insufficient involvement of company personnel in the processes of digital changes, and the low level of competence of employees in the processes of implementing digital technologies. The level of digital transformation and the insufficient integration of digital technologies into business processes also have a significant impact.

Conclusions. Today, aviation enterprises represent complex organizational structures in which each business process is characterized by the use of a certain

information system. In addition, the interaction of aviation enterprises with the external environment is characterized by a tendency to automate information exchanges. This, in turn, leads to the need for coordinated information interaction between the information systems of all participants in the transportation process. Considering how diverse the information systems used by airlines and airports are, as well as the fact that even within enterprises, information exchange between systems is not always established, the formation of a unified information environment is seen as a necessary means to improve the quality standards of consumer service.

An important step in the development of a unified information environment is the identification of factors that affect the level of information interaction between them. A necessary tool for this is a system of indicators of the level of digital development of aviation enterprises.

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