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SYSTEM OF KEY COMPETENCES IN THE LABOR MARKET OF THE DIGITAL ECONOMY

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Abstract. *Purpose.* The article addresses the problem of identifying and classifying workforce competencies in the context of the digital economy. The objective is to identify the core components of "digital economy competencies" and construct a competency model relevant to the digital labor market. It is hypothesized that defining these core competencies will facilitate the creation of a model aligned with external demands and societal expectations.
Design/methodology/approach. The research is based on a comprehensive analysis of academic literature and empirical data, employing the categorical methodology known as the "Finite Information Flow" method.
Findings. The study identified a set of essential competencies for the digital economy, structured them into a competency model, and demonstrated that the model reflects the evolutionary development of competencies within an organization's qualification system. The model includes four logical levels of development.
Originality. The proposed model captures the dynamic nature of digital competencies and offers broad applicability for further research into competency development mechanisms, structural relationships among competencies, and the enabling and limiting factors of digital labor market transformation.
Key words: categorical method "final information flow", key competencies, digital economy.

Introduction

The modern transformation of the labor market of the Republic of Kazakhstan is determined not only by technological progress, but also by strategic guidelines of the state policy aimed at developing the digital economy. The key documents are the State Program "Digital Kazakhstan" (2018), the Concept of Personnel Policy in Government Agencies until 2030, and the Strategy "Kazakhstan – 2050", which emphasize the need to develop human capital and build competencies that meet the challenges of the sixth technological order. The transition to the sixth technological order, in which intangible resources, including knowledge, skills and digital literacy, become dominant factors of production, requires the creation of an effective system for the formation and development of key competencies of employees. In the context of the rapid development of digital technologies and automation of business processes, there is a growing demand for specialists with not only technical knowledge, but also a set of interdisciplinary, cross-functional skills (Whiddett & Hollyforde, 2003; Hamel & Prahalad, 1994).

A significant part of international studies emphasizes that the key competencies of the digital economy are: digital literacy, cognitive flexibility, critical thinking, creativity, teamwork in a distributed environment, programming, design thinking and continuous self-learning skills (Ala-Mutka, 2011; OECD, 2019; Carretero et al., 2017; World Economic Forum, 2020).

As highlighted in the World Economic Forum's 2020 report, enhancing digital skills contributes to improved workforce efficiency and strengthens an organization's capacity to adjust to the uncertainties and rapid changes characteristic of a VUCA environment. In turn, the results of studies by Ala-Mutka (2011) and Carretero et al. (2017) indicate a correlation between the level of digital skills of workers and the competitiveness of the national economy. These findings actualize the issue of adapting international

competency models (such as DigComp 2.2) to the conditions of the Kazakhstani labor market, taking into account the specifics of the educational system and current demographic trends.

Today, Kazakhstan experiences a shortage of specialists with relevant digital and supra-professional competencies, which negatively affects the level of digitalization of enterprises, especially in the regions. This requires rethinking traditional approaches to professional training and the formation of a system for the constant updating of competencies focused on inter-industry mobility and flexibility of employees.

The study of the system of key competencies in the digital economy is becoming especially relevant in the context of Kazakhstan's reality. This approach enables the identification of key competencies across different sectors and the formulation of institutional strategies for their advancement, aligning with global best practices and the nation's long-term strategic goals. The purpose of the study is to analyze and systematize key competencies in demand in the labor market of the digital economy of the Republic of Kazakhstan, with the subsequent formation of a competency model based on a functional-professional approach and identifying patterns of their evolutionary development.

Literature review

Modern research in the field of competence development in the digital economy emphasizes the multidimensionality of approaches and the need for interdisciplinary analysis. There are two main areas of research in the scientific literature:

- the first is related to the theoretical substantiation of digital competence models and their classification;
- the second is related to the empirical verification of the effectiveness of educational programs and professional training.

S. Whiddett and S. Hollyforde (2003) proposed a competency model that considers functional and behavioral components that are adaptable to digital conditions. The research of G. Hamel and C.K. Prahalad (1994) became fundamental in understanding strategic competencies as the main resource of an organization in the era of digital transformation. D. Levy and R. Murnane (2004) in their works emphasize the shift in requirements for employee skills – from routine tasks to analytical, cognitive and digital abilities. According to the World Economic Forum (2020), the list of key competencies of the future includes analytical thinking, active learning, stress resistance, emotional intelligence, self-learning ability, as well as digital literacy and understanding of AI.

Frey and Osborne (2017) analyzed more than 700 professions in the context of automation and identified the need to develop trans-professional competencies. OECD (2019) in the "Skills Outlook" review emphasized the need for continuous updating of digital skills as a key component of employment sustainability. The works of Van Laar et al. (2017) systematize digital competencies into six categories: technical, information, communication, collaboration, critical thinking and creative skills.

Some authors, such as A. Ferrari (2013), proposed instrumental approaches to measuring digital literacy (DIGCOMP), which later formed the basis of EU strategic initiatives. The works of Martin & Grudziecki (2006) have become significant for the development of digital competence frameworks in education and the labor market.

It should be noted that in the available studies there is insufficient adaptation of international competency models to the specifics of regional labor markets, including Kazakhstan. There are no studies examining key competencies taking into account the specifics of the transition to the sixth technological order and the territorial segmentation of the economy of the Republic of Kazakhstan.

This gap is filled in this article, which substantiates the system of key competencies in the Kazakhstan labor market, develops a model that takes into account institutional features, and offers recommendations for the development of human resources in the context of digitalization.

Materials and methods

The study is aimed at identifying and systematizing key digital competencies in demand in the Kazakhstan labor market in the context of the digital economy. The research focuses on Kazakhstan's labor market as its object, while its subject concerns the framework of digital competencies shaped through professional practice and the advancement of digital infrastructure. The following questions were formulated during the study:

- What key digital competencies are most in demand in the context of digital transformation?
- How can digital competencies be classified depending on the level of complexity, professional qualifications and industry affiliation?

The hypothesis of the study is that digital competencies are formed evolutionarily and can be structured as a multi-level model reflecting the gradual

complication and specialization of knowledge and skills.

The stages of the study included: Gathering and analyzing statistical data related to Kazakhstan's digital economy and employment structure; Conducting a critical review of academic literature and legislative frameworks; Utilizing the categorical-systemic approach of the Functional-Informational Framework (FIF) to construct a digital competency model.

The primary research methods selected for this study include statistical data analysis, critical examination of academic literature (drawing from sources such as Scopus and Web of Science), and the Final Information Flow (FIF) method.

The FIF approach was employed to construct an evolutionary model of competencies, conceptualized as a dynamic system wherein each successive level represents an increased complexity of tasks undertaken by professionals. It made it possible to create a four-level model that includes nine components of digital competencies, ranging from basic digital literacy to strategic management of digital processes.

The research drew upon materials such as state programs of the Republic of Kazakhstan (including "Digital Kazakhstan" and the "National Development Plan until 2025"), data provided by the Bureau of National Statistics under the Agency for Strategic Planning and Reforms, as well as international benchmarks from organizations such as the OECD, ILO, and the World Bank.

Through the application of these methodologies, a structural model of digital competencies was developed. This model is organized by levels of complexity and importance, aligned with both the demands of Kazakhstan's digital economy and relevant international standards.

Results and discussion

In today's environment, information and communication technologies (ICT) are increasingly integrated across nearly all sectors of Kazakhstan's economy. However, the level of demand for digital competencies remains different across sectors. Figure 1 shows the distribution of sectors of the economy of Kazakhstan by the level of ICT application, the largest share of which is the information and communication sector, education, financial services and public administration.

The proportion of professionals utilizing digital technologies in their daily work is growing, even in fields not traditionally linked to ICT.This trend is supported by the analysis results shown in Table1.

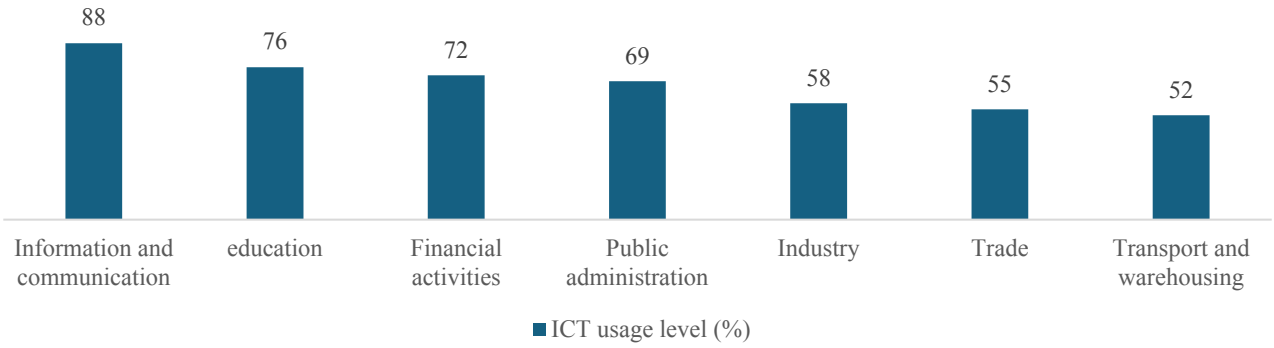

Figure 1 – Distribution of sectors of the economy of Kazakhstan by the level of ICT use (in %)
Source: Bureau of National statistics Agency for Strategic planning and reforms of the Republic of Kazakhstan, 2024

Table 1 – Share of workers using ICT by type of professional activity in the Republic of Kazakhstan, %

Professional group	Share of employees using ICT (%)
ICT specialists	100
Financial and accounting workers	93
Administrative positions	89
Medical personnel	77
Teachers and researchers	84

Continuation of the table

Professional group	Share of employees using ICT (%)
Industrial engineers	71
Working specialties	58
Source: analytical processing of data from hh.kz, Rabota.kz, 2024.	

The data obtained indicate that digital competencies are becoming a universal component of professional training of specialists, regardless of industry affiliation. This transformation reflects the growing demand for flexible, interdisciplinary skills, including digital literacy, analytical thinking, and the ability to communicate across industries.

An in-depth review of more than 100 job vacancies in the field of information technology and adjacent industries–gathered from platforms such as hh.kz, Rabota.kz, and superjob.ru–revealed several key trends that illustrate the changing competency landscape in Kazakhstan's labor market. Among the most prominent shifts is the growing focus on teamwork and the individual responsibility of employees for collective outcomes. Employers are increasingly broadening functional responsibilities, expecting professionals to be versatile, perform multiple tasks, and step into related roles when needed. Additionally, there is rising demand for metacompetencies such as emotional intelligence, positive thinking, and openness to innovation. Understanding broader business processes beyond one's immediate role has become a valuable asset, along with active involvement in shaping new directions and forming project teams.

These trends signal the rapid evolution and transformation of the competency system in the context of Kazakhstan's digital economy. This dynamic environment necessitates the development of a national competency model that not only accounts for industry-specific features and the country's strategic priorities but also aligns with global developments. As a response to the challenges of the sixth technological paradigm, this study introduces an evolutionary model of digital competencies structured into four logical levels of complexity. Unlike previous research, which often overlooked the interconnected and institutional nature of digital competencies within the national labor context, this study highlights their interdisciplinary essence and formal integration into Kazakhstan's workforce development framework. This research helps bridge theoretical and methodological gaps in evaluating essential competencies relevant to the digital economy within a national framework. Based on the conducted analysis, a comprehensive set of competencies was identified that is critical for all participants in modern labor relations amid ongoing digitalization. While some of these align with existing official competency lists, several newly recognized skills have also been included.

Projecting these results forward, it can be argued that the competencies outlined in Table 2 are both universally applicable and essential across various economic sectors. The growing demand for these skills shows consistent momentum. It is also important to stress that specific expertise, abilities, and prior work experience are integral to shaping an employee's professional competence, serving as the core for acquiring and advancing in any given profession.

Consequently, this study has established a competency profile that reflects the demands of the evolving external environment and supports workforce competitiveness in the digital economy.

At the next stage of the study, a scientific task was implemented to design a list of digital competencies based on the Final Information Flow (FIF) method, developed within the framework of the categorical-system methodology (Boush et al., 2020). The essence of the method lies in the description and modeling of systems that go through a stage of complication in the development process, by identifying logical levels (Ll), each of which records a qualitatively new level of system complexity.

The analysis demonstrated that the digital competencies essential for participation in the digital economy can be organized into four progressive levels, each representing a step up in the complexity of job responsibilities, the depth of professional expertise, and the degree of engagement in digital workflows. This allows us to create an information model that adequately reflects the dynamics of competence development.

The logical limit (LL) in the FIF model demonstrates the potential set of qualitative characteristics (competencies) within a specific level, while the transformability indicator (T) describes the system's ability to combine and complicate these characteristics. This is especially important for the digital economy, where the adaptability and variability of competencies are becoming a factor in sustainable development.

Table 2 – Competencies of the economically active population in the digital economy

Categories of Employed	Functions before digital economy	Functions in modern society	Competencies
Skilled Workers	Performance of work functions in accordance with instructions	Interaction via digital ICT technologies	Digital Literacy
		Work in a high uncertainty mode	Adaptability
Employees	Communications were limited to functionality	Communications involve the use of an ever-increasing arsenal of digital tools	Interaction and cooperation
	Not assumed	Understanding business processes	Critical Thinking
Specialists	Not assumed	Analysis and elimination of systemic problems in work	Systemic Thinking
	Ability to work in a team	Compensation and closing of team weaknesses	Emotional Intelligence
Managers	Control over the allocated area	Launching and developing startups, project management, personnel management	Resource Management
Formal control over compliance with environmental legislation		Active participation, support and generation of projects in the field of environmental protection, formation of eco-thinking in the company	Ecological Thinking
	Not provided	Participation and control in several types of activities simultaneously (personnel management, procurement, logistics)	Cross-functionality and interdisciplinary interaction

Note – compiled by the authors

Figure 2 shows a structural diagram of the digital competencies model built using the FIF method. The system of logical levels allows us to identify the principles of the emergence of new qualities in the competency system and provides the basis for developing labor potential management strategies. This approach is aimed at bridging the gap between the current requirements of the labor market and the current state of workforce preparedness in the context of the digital transformation of the economy.

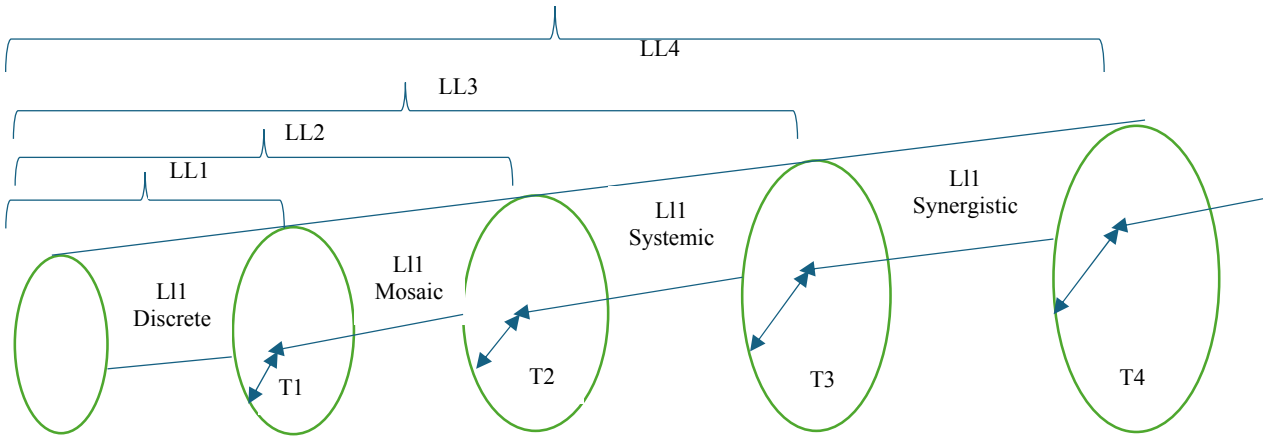

Figure 2 – Competency system presented using the "finite information flow" method

Logical level 1 – Discrete. Competencies: digital literacy, adaptability. Aimed at entry-level workers and qualified specialists whose activities do not require involvement in business processes. Competencies include basic ICT skills: working with office programs, electronic communication, file transfer, etc. (Oluwaseye, 2022).

Logical level 2 – Mosaic. Competencies: interaction and cooperation, critical thinking. At this stage, the elements of information processes begin to line

up into a single system. Competencies at this level allow you to see the relationships between business functions, offer non-standard solutions, and carry out role-based interaction with colleagues. Here, critical thinking is manifested as the ability to identify bottlenecks in the system and suggest optimization paths.

Logical level 3 – Systemic. Competencies: systemic thinking, emotional intelligence. This level is characterized by involvement in management processes, the ability to integrate knowledge within the framework of project and innovative solutions. Emotional intelligence allows you to establish productive relationships in a team, resolve conflicts, and understand the motivation of participants. The use of gamification elements in business processes contributes to employee engagement and productivity growth (Dacre et al., 2021; Zloteanu et al., 2018).

Logical level 4 – Synergetic. Competencies: environmental thinking, cross-functionality, interdisciplinary interaction, resource management. At this level, an employee is able not only to understand the long-term consequences of their actions, but also to strategically build a sustainable development model for the organization. Competencies are aimed at developing ecosystem thinking, minimizing costs, and increasing environmental and social responsibility. According to some scientists (Hermundsdottir et al., 2022), such qualities are especially valued today in the context of global instability and the need to transition to a green economy model. The competency of "cross-functionality and interdisciplinary collaboration" is regarded by numerous researchers as essential in the current stage of societal evolution. It is strongly tied to the ability of each team member to realize their individual potential, as it promotes the utilization of diverse connections and communication pathways for addressing key challenges. This approach minimizes bureaucratic delays and boosts employee engagement and efficiency by integrating everyone into the workflow.

Competencies at the synergetic level – such as ecological awareness, resource optimization, and interdisciplinary cooperation – demonstrate a person's capacity for long-term strategic vision, spanning 10 to 30 years. They also reflect efforts to cultivate eco-consciousness in others, encourage sustainable production and consumption practices, and foster employee development.

The structured implementation of competency-building models is intended to gradually enhance individual capabilities, overcome fragmented skill sets, and enable progressive advancement toward more integrated levels of development – from mosaic to systemic and finally to synergetic stages. As a result, the research led to the creation of an evolutionary framework for digital competencies, articulated through a hierarchy of logical development levels. The proposed model allows not only to diagnose personnel competencies, but also to predict the needs of the organization in the context of digitalization. The use of the FIF method makes strategic human resource management possible.

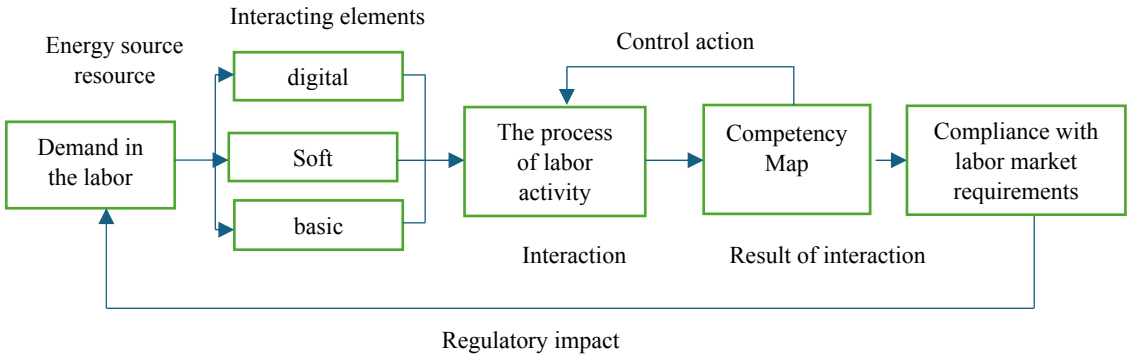

Figure 3 – Model of formation and development of competencies
Note – compiled by the authors

The competency framework proposed by the authors, comprising four logical tiers and eight core skills, serves as a universal foundation for designing models aimed at developing and enhancing competencies within the digital economy. This system can be expanded to a full-fledged model based on the categorical-systemic methodology, i.e. on the method of the "Universal Scheme of Interaction of Elements" (USIE), which allows reflecting the systemic connections between processes, resources, elements, inter-

action and result within a single cognitive structure. Figure 3 shows a model for the formation and development of competencies in the digital economy as a result of applying the "Universal Scheme of Interaction of Elements" method.

Consider the basic categories of this scheme:

1. Process. In the context of the proposed model, the process is the compliance of the formed competencies with the current and future requirements of the labor market. This is a dynamic mechanism for the evolution of competencies as a response to the challenges of the external environment.

2. Source of Activation. The driving force behind the system is the demand from the labor market for specific sets of knowledge, abilities, and competencies. This external requirement, shaped by evolving job functions and tasks, initiates the development of new skill sets within the competency framework.

3. Components. The model is structured around three interconnected clusters of competencies:

- Foundational digital skills (comprising 20 elements organized into general, typical, functional, and specialized categories);
- Soft skills, categorized into four progressive levels: discrete, mosaic, systemic, and synergetic;
- Sector-specific (professional) competencies, aligned with occupational standards and job profiles.

Each of these competencies undergoes a developmental progression, facilitating its integration into a cohesive system.

4. Interrelations. In this framework, the interaction element captures how labor potential is realized within the context of a digital economy. Interaction encompasses not only the reciprocal relationship between employee and employer, but also the dynamic adaptation of skills under digital working conditions.

5. Outcomes of Interaction. A central outcome is the ability to accurately evaluate the current competency level and construct a personalized development trajectory. By using a logical-semantic modeling approach, this system merges conceptual content with structural logic to create clear and adaptable pathways for competency growth.

Thus, the USIE method provides formalization and structuring of complex processes of competence development in the context of digitalization, allowing to identify the relationship between the elemental composition, the nature of interaction and the systemic effect for the subject himself, the organization and the environment.

Within the framework of the proposed model, it is necessary to jointly reflect the content of competencies and the logic of their evolutionary arrangement.

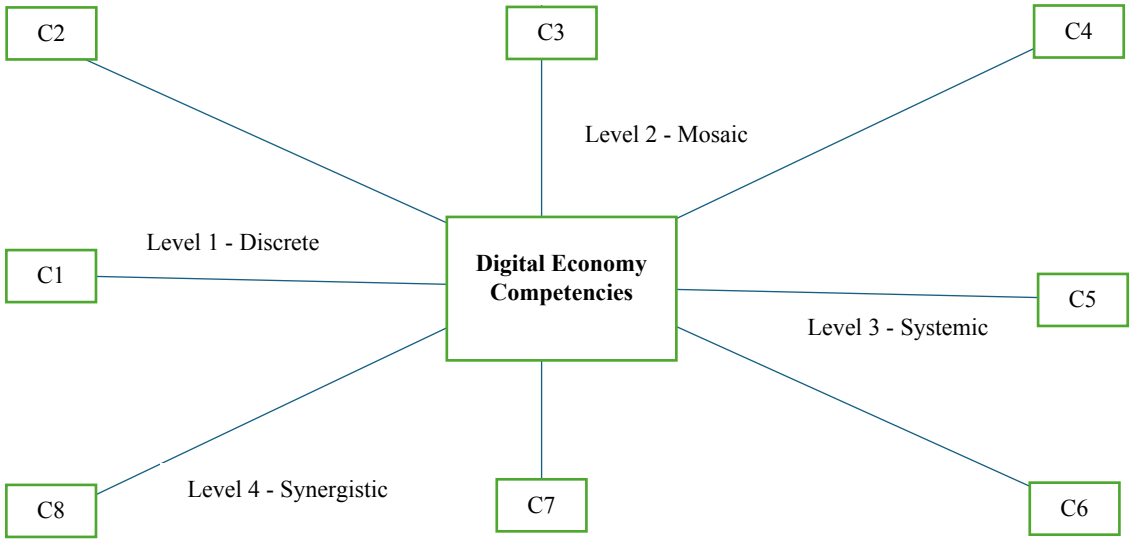

Figure 4 – Logic and content of the assessment system in the competency model
Note – compiled by the authors

Figure 4 presents a graphical representation of digital economy competencies, mapped along the coordinate axes of the proposed model. The progression through the logical levels follows a clockwise direction, beginning from the top-left quadrant.

The first quadrant (discrete level) encompasses core digital competencies (C1), which are subdivided into 20 components across four categories, along with the adaptability skill (C2). In the second quadrant (mosaic level, upper right), competencies such as collaboration and interaction (C3) and critical thinking (C4) are located. The third quadrant (lower right), which reflects the systemic level, incorporates systemic thinking (C5) and emotional intelligence (C6). The fourth quadrant (lower left), representing the synergetic level, features ecological awareness (C7) and resource management abilities (C8).

Competency development in the model is evaluated using a five-point scale. For instance, the cumulative score for K1-level is calculated by summing the points for all associated elements, ranging from 20 to 100 points (see Table 3).

It is important to note that competency formation can be nonlinear, with development occurring simultaneously across multiple logical levels. This reflects the adaptive and multi-dimensional demands of today's labor market, where different competencies may evolve concurrently at varied stages.

Table 3 – Competency assessment indicators

Competencies/ indicators		1	2	3	4	5
C1	Digital and computer literacy	20-35 points	36-51 points	52-67 points	68-83 points	84-100 points
C2	Adaptability	Adapts work methods to new requirements	Can quickly switch between tasks	Knows how to remain a holistic person	Effectively solves problems in changing conditions	Anticipates changes and reacts in advance
C3	Interaction and cooperation	Establishes working relationships	Uses an arsenal of digital tools in the communication process	Identifies the needs of others	Involves others in joint work	Builds a basic network of contacts, establishes connections
C4	Critical Thinking	Identifies gaps and sets tasks	Can analyze errors	Finishes unusual ideas personally or in a team	Understands key business processes	Makes the right decisions in specific situations
C5	Systems Thinking	Links team actions to goals	Understands the contribution to achieving strategic goals	Monitors industry development trends	Acts taking into account the future needs of the company	Eliminates systemic problems
C6	Emotional Intelligence	Recognizes own emotions, describes verbally	Recognizes the feelings of other people	Respects the opinions of others	Open to different cultures, rules	Compensates for the team's weaknesses
C7	Resource Management	Combines efforts to solve problems	Coordinates, delegates team actions	Forms goals, evaluates completed tasks	Responsible for the results of employees' work	Able to launch startups, projects
C8	Ecological Thinking	Shows interest in environmental issues	Participates in environmental protection projects	Participates in promoting eco-thinking in the company	Generates projects in the field of environmental protection	Forms policies within the framework of the lean manufacturing concept

Note – compiled by the authors

The formation of digital competencies is determined not only by their current level but also by how rapidly and intensively they evolve (Doronenko, 2021). Despite the analytical complexity posed by the non-linear nature of competency development, this very feature allows for more accurate data interpretation–an essential aspect of informed managerial decision-making within the proposed model. To facilitate such assessment, a classification system has been introduced to determine the degree of alignment

between employee competencies and labor market requirements. This system categorizes alignment into four levels: not aligned, minimally aligned, fundamentally aligned, and fully aligned. This tiered structure enables qualitative evaluation of an individual's existing competencies and supports the formulation of personalized development trajectories. In this framework, human resource management becomes a strategic function, involving targeted recruitment, internal mobility, and workforce optimization in response to changing labor market dynamics.

By applying the developed model, organizations can forecast the degree of competency alignment with market expectations. At the same time, it acknowledges that the development of human capital is a continuous process–one that evolves with time and has no finite end point.To ensure the clarity and systematicity of further work with competencies, a competency map has been developed (Figure 5), reflecting the levels of development for each element and their possible combinations. The map is based on the method of categorical-systemic methodology – "A series of information criteria" (SIC). This method involves the decomposition of competencies into information units reflecting the key qualities of an employee.

							8. Ecological thinking 7. Resource Management
						7. Resource Management 6. Emotional intelligence	8. Ecological thinking 6. Emotional intelligence
					6. Emotional intelligence 5. Systems thinking	7. Resource Management 5. Systems thinking	8. Ecological thinking 5. Systems thinking
				5. Systems thinking 4. Critical thinking	6. Emotional intelligence 4. Critical thinking	7. Resource Management 4. Critical thinking	8. Ecological thinking 4. Critical thinking
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1.Digital and computer literacy	2. Adaptability	3. Interaction and cooperation	4. Critical thinking	5. Systems thinking	6. Emotional intelligence	7. Resource Management	8. Ecological thinking

Figure 5 – Competency Map
Note - compiled by the authors

Each cell of the map is a combination of two competencies, allowing to identify individual features of the employee's professional profile. The model does not exclude the participation of all other competencies, since the development of any of them occurs in conjunction with elements of a lower or accompanying order.

Thus, the competency map performs several functions at once:

- Assessment of the degree of compliance of a specific employee's competencies with the organization's tasks;
- Identification of areas of personalized development;
- Formation of a HR strategy at the level of a department or the organization as a whole.

Conclusion

The proposed model enables a comprehensive assessment of the development of digital competencies, taking into account both their logical hierarchy and interrelations. By introducing different levels of compliance, the model allows for systematic diagnostics and the design of personalized development strategies for employees. A competency map based on the SIC (Structured Information Context) method serves as an effective tool for strategic human resource management in the digital economy. The practical significance of the model lies in its flexibility to be applied across different organizational levels and its predictive capacity to assess how well an employee's professional profile corresponds to current labor market demands. Moreover, the construction of both individual and group development pathways using the competency map supports the long-term sustainability of organizations, enhancing their resilience and adaptability in a rapidly changing external environment. While the model allows for forecasting the likelihood of achieving optimal competency alignment, it also underlines that this alignment is not a definitive outcome. Rather, the advancement of human potential is viewed as a dynamic and continuous journey.

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