European Research Studies Journal
Volume XXVIII, Issue 4, 2025

pp. 1000-1020

Digital Competencies in Polish Logistics Companies – Digital Security Profiles and Management in the Light of the DigComp 2.2 Model

Submitted 19/09/25, 1st revision 14/10/25, 2nd revision 26/10/25, accepted 20/11/25

Renata Piętowska-Laska[1], Adam Laska[2]

Abstract:

Purpose: *The aim of this article is to assess the level of digital competencies among employees of small and medium-sized logistics enterprises in Poland and to identify areas requiring support in the context of the sector's digital transformation. The article also aims to analyze the structure of relationships between individual digital competency domains according to the DigComp 2.2 framework and to define employee competency profiles that can serve as a basis for developing training strategies, development programs, and digital security management.*
Design/Methodology/Approach: *The survey was conducted among 367 employees employed in 207 small and medium-sized Polish logistics enterprises (SMEs) in Section H of the Polish Classification of Activities (PKD) in the first two quarters of 2024. A self-assessment questionnaire based on the DigComp 2.2 model was used, expanded to include elements addressing new digital challenges such as artificial intelligence, digital ecology, and disinformation. Data were analyzed using descriptive statistics, correlation matrices, and K-Means clustering analysis, which allowed for the identification of three coherent competency profiles of respondents.*
Findings: *The study revealed that the average level of digital competencies among employees was 2.99, corresponding to level B1 on the DigComp scale – a functional level, but insufficient in the context of advanced digitization of logistics processes. The most developed areas were "Communication and Collaboration" and "New Digital Challenges," while the weakest were "Problem Solving" and "Security." Correlation analysis revealed strong interdependencies between digital content creation, communication, and problem solving, confirming their complementarity in professional practice. Areas related to information and security showed weaker relationships with the others, indicating the need for better integration in work processes. Clustering revealed three competency profiles: entry-level users, digital leaders, and future specialists, suggesting the need for individualized training programs.*
Practical implications: *The research findings have implications for both management and security theory and managerial practice in logistics companies. They point to the need to implement diverse and modular training programs tailored to employee competency profiles. Companies should foster a culture of digital knowledge sharing, implement mentoring, and continuously monitor progress based on the DigComp framework. It is also necessary to incorporate digital competency assessment into HR systems, periodic assessments, and*

[1]*Ph.D., Eng., Rzeszow University of Technology, Poland, ORCID: 0000-0001-5665-0377, e-mail: rlaska@prz.edu.pl;*
[2]*Ph.D., Rzeszow University of Technology, Poland, ORCID: 0000-0002-9777-3557, e-mail: alaska@prz.edu.pl;*

professional development plans. A key development direction is strengthening digital security through regular training, testing, and preventative cyber hygiene measures.
Originality/Value: *This article provides both cognitive and practical value through a comprehensive assessment of digital competencies in the logistics sector, utilizing the latest DigComp 2.2 framework. It highlights the need to move away from uniform training models in favor of a personalized and data-driven approach. The presented research findings provide a foundation for developing human capital development strategies in logistics companies that support digital transformation and increase the industry's competitiveness. The findings can be used by both practitioners and theoreticians in the area of digital competencies of logistics company employees.*

Keywords: *Digital transformation, knowledge management, competency development, digital security, information security policy, logistics.*

JEL codes: *K24, L19, M10.*

Paper type: *Research article.*

1. Introduction

Digital literacy is a concept whose scope and interpretation seem to be evolving with technological advances and growing societal expectations for citizens in the so-called knowledge society. Research suggests that it encompasses both purely technical skills, such as operating hardware and software, and more complex abilities, such as critically evaluating technology or participating in digital culture (Ilomäki *et al.,* 2011).

The literature highlights the difficulty of establishing a single, universally accepted definition, which means that educational policies and training practices often employ different interpretative models (Ilomäki *et al.,* 2016; Perez-Escoda *et al.,* 2016; van Laar *et al.,* 2018).

Some researchers emphasize that developing digital literacy should not mean abandoning traditional forms of literacy, such as reading, writing, or math. However, the understanding of these fundamental skills must be adapted to the realities of a digital society. Thus, the evolution progresses from simple computer skills through ICT skills to full digital competences, which encompass strategies for adapting to constantly changing communication and information technologies (Ilomäki *et al.,* 2011; Eshet, 2004).

Technological advances related to artificial intelligence, machine learning, and the Internet of Things are accelerating the transformation of work environments. In this

context, pressure is growing on middle-skilled workers to develop new sets of digital competencies, often through continuous learning.

This phenomenon requires companies to adopt a flexible approach to personnel management and implement solutions that support employee adaptation to new tools and methods. At the same time, challenges arise due to the aging workforce; baby boomers may require additional training to compensate for technological gaps.

Demographic changes are concurrent with changes in the structure of competencies sought in the labor market. Since the beginning of the 21st century, there has been a noticeable shift in emphasis from technical, operational, and analytical competencies to creativity, logical reasoning, and socio-emotional intelligence, also in the context of corporate social responsibility (Laska and Piętowska-Laska, 2014; Khin and Ho, 2020).

Employers must therefore simultaneously develop employees' proficiency in digital tools and the soft skills necessary for effective functioning in hybrid teams. Implementing training programs is an attempt to address these challenges. For example, companies integrating human resources management systems with IoT solutions are investing in educating their staff on data analysis and working with real-time monitoring systems.

The results of such efforts can be measurable – there have been reports of increased proficiency among the vast majority of training program participants. However, this process can be hindered by resistance to organizational change or fear of job loss (Khang, 2024).

The development of the concept of digital competencies also applies to educational perspectives outside the corporate environment. This may include, for example, the ability to effectively search for job advertisements using mobile apps or the organization of topic-specific information within group projects in formal education (Punie, 2022).

Such examples demonstrate that digital literacy only becomes meaningful in specific practical contexts, regardless of whether it's professional life or academic learning. From the perspective of economic strategies, the issue of cross-sectoral collaboration in developing digital competencies across entire industries also arises.

Individual companies have limited capacity to independently adapt their workforces to the pace of technological change in the fourth industrial revolution – Industry 4.0. For this reason, partnerships are increasingly being formed, encompassing businesses of various sizes and sectors, educational institutions, and non-profit organizations. The goal of such initiatives is to consolidate resources and share knowledge to optimize staff development activities (Boyatzis, 2008; Hughes *et al.,* 2019).

A conceptual gap can be observed: although digital literacy has become a key concept in public policies regarding education and employment, its operationalization in research remains inconsistent (Ilomäki *et al.,* 2011; Cahen and Borini, 2020).

This raises questions about how to measure technological proficiency, taking into account different levels of user experience and the specific nature of their activities (e.g., differences between recreational and professional users). It is also possible to consider the influence of motivation to participate in digital culture as an element as important as the ability to use tools (Ilomäki *et al.,* 2011; Moorhead and Griffin, 2020).

This definitional ambiguity may stem from both the overall pace of technological innovation and the varying needs of individual stakeholder groups: from high school students to manufacturing workers to large-scale data analytics specialists. Future education models will therefore need to reconcile these diverse requirements by developing flexible qualification frameworks that allow for responsiveness to changing market conditions without the need for fundamentally overhauling training programs every few years (Khang, 2024).

2. Literature Review

Digital competences are defined in many ways by various institutions and researchers, including:

- European Commission Definition. In its Communication on Key Competences for Lifelong Learning, the European Commission defines digital competence as: "the confident and critical use of information society technologies (IST) for work, leisure, and communication. It is based on basic ICT skills: using computers to search, evaluate, store, create, present, and exchange information, and to communicate and participate in collaborative networks via the Internet" (Ferrari *et al.,* 2012). Digital competence is one of eight key competences, and its definition emphasizes that it is a combination of knowledge, skills, and attitudes appropriate to a given context (Rizza, 2013).

- Ferrari, Punie, and Redecker Definition. Based on an analysis of fifteen digital literacy frameworks, the authors proposed a collective definition: "Digital literacy is the set of knowledge, skills, attitudes, abilities, strategies, and awareness required when using ICT and digital media to perform tasks; solve problems; communicate; manage information; behave ethically and responsibly; collaborate; and create and share content and knowledge for work, leisure, participation, learning, socialization, empowerment, and consumerism" (Ferrari *et al.,* 2012).

- Definition by Ferrari *et al.* (2012). Another definition by the same authors, cited in the "Digital Competences Scale (DCS)," is: "the set of knowledge,

skills, attitudes, abilities, strategies, and awareness required when using ICT and digital media to perform tasks" (Schwarz *et al.,* 2024).

- Definition by the American Library Association (ALA). The ALA defines digital literacy as: "the ability to use information and communication technologies to find, understand, evaluate, create, and communicate digital information, an ability that requires both cognitive and technical skills" (Mbandje *et al.,* 2023). Multi-level definitions. Some researchers define digital literacy as a multi-level construct. Cerisier, Rizza, Devauchelle, and Nguyen (2008) distinguish three levels of digital literacy: instrumental (operational) competencies, transversal (functional) competencies, and meta-competencies (strategic) (Rizza, 2013). Ananiadou and Claro (2009), as part of the OECD/CERI project, also proposed a three-level typology: functional ICT competencies, ICT competencies for learning, and 21st century competencies (Rizza, 2013).

Anusca Ferrari, Yves Punie, and Christine Redecker analyzed 15 different digital literacy frameworks to understand how they are implemented (Ferrari *et al.,* 2012). They found that many frameworks focus on technical (tool-dependent) skills, such as ECDL, but an increasing number also incorporate critical thinking and cognitive skills (Ferrari *et al.,* 2012). They identified seven main areas of digital literacy, including: information management, communication, content creation, ethics, and responsibility (Ferrari *et al.,* 2012).

Dian A. de Vries, Jessica Taylor Piotrowski, and Claes de Vreese developed and validated the DigIQ measurement tool, which examines nine domains of digital literacy (e.g., strategic and critical information literacy, netiquette, digital content creation, security, and AI-related skills) (de Vries *et al.,* 2025). Studies with a sample of over 2,500 participants confirmed the scale's reliability and validity, although caution was indicated when comparing results across age groups (de Vries *et al.,* 2025).

Stephanie Schwarz et al. developed a short, 12-item digital competence self-assessment scale (DCS) based on the DigComp framework (Schwarz *et al.,* 2024). Validation studies with a sample of 1,109 participants demonstrated high internal consistency and satisfactory model fit, as well as significant correlations with related constructs such as the digital competence knowledge test and affinity for interacting with technology (Schwarz *et al.,* 2024).

Documents often emphasize that the term "digital competence" is part of a broader spectrum of concepts that are sometimes used interchangeably but are not synonymous. Competence, therefore, is a broader concept, encompassing "a combination of knowledge, skills, and attitudes appropriate to the context" (Almas *et al.,* 2021).

Digital skills are often viewed as practical, technical abilities that constitute a component of competence (Ilomäki *et al.,* 2011). Thus, digital competence builds on, but transcends, basic IT skills (Ferrari *et al.,* 2012).

Digital Literacy – this term is often used interchangeably with digital competence. It is defined as "the ability to understand and use information in multiple formats from a wide range of sources when presented using computers" (Schwarz *et al.,* 2024). Digital literacy is viewed as an extension of traditional literacy to include skills specific to the digital environment, including critical content evaluation and multimodality.

Digital literacy is closely related to other types of literacies, such as (Ferrari *et al.,* 2012):

- ICT literacy – the ability to use computers and related technologies effectively;
- Internet literacy – the proficient use of the internet, encompassing an understanding of how computers, information, media, and communication work;
- Media literacy – the ability to analyze, create, and critically evaluate media messages;
- Information literacy – the ability to recognize information needs and to locate, evaluate, and effectively use information.

Digital literacy is therefore more than the sum of its parts; it also encompasses new elements, such as the ability to navigate hypertexts and understand icon-based commands (Ferrari *et al.,* 2012).

3. Digital Competence Requirements in the Workplace

Digital competency requirements for specific professions are strongly dependent on the nature of the industry, the degree of process digitization, and the role of technology in carrying out daily tasks. Economic structures can distinguish between professions where information and communication technologies serve as a work-supporting tool and those where they are an integral foundation of operational activities.

Employees are expected not only to be proficient in using specific systems or applications but also to be able to adapt to new tools in step with technological changes (Khang, 2024; Andriushchenko *et al.,* 2020; Ellingrud *et al.,* 2020; van Laar *et al.,* 2019).

In professions involving data analysis, production process management, or online service provision, requirements include the ability to use advanced analytical algorithms and interpret results generated by artificial intelligence systems. Employees must be able to combine information management with the ability to identify patterns and anomalies based on large data sets. In sectors such as logistics

and manufacturing, the ability to integrate IoT devices with warehouse and production management systems is crucial, which means both configuration and diagnostic skills (Khang, 2024).

Such positions often also require knowledge of device communication protocols and the implementation of data transmission security procedures. In professions based on intensive project work – such as in the creative or IT industries – the ability to collaborate as a team in a distributed digital environment is crucial. This includes not only proficiency in using project management platforms but also soft skills that support group dynamics and synchronized activities.

According to HRD experts, the competency gap often occurs not at the level of tool use, but rather in its effective use to achieve team goals (Huhhes *et al.,* 2019) and in analyzing the relationship between e-skills and e-actions to achieve sustainable performance (Duica *et al.,* 2020).

Organizations must therefore invest in both technical training and modules that develop critical thinking, planning, and intercultural communication. A specific requirement for many professions is knowledge of privacy protection and compliance with legal regulations regarding the processing of personal data.

This is particularly true in the banking, medical, and education sectors, where the consequences of a breach of confidentiality can be serious. Employers expect employees to be familiar with multi-factor authentication mechanisms, information encryption, and system security monitoring skills (Punie, 2022).

With the increasing number of cyberthreat incidents, the need for ongoing updates on breach prevention methods also increases. Differences between industries are also evident in the level of detail required for digital skills. In the public services sector, proficiency in office suites and online document registration systems may be paramount. In software engineering, however, knowledge of programming languages and development environments is becoming standard. Integrating these skills with an analytical component is the foundation of a complete professional profile for a software engineer or data scientist (Farah *et al.,* 2023; Hughes *et al.,* 2019).

It's worth noting professions that require employees to work at the intersection of technical and social competencies. Digital marketing specialists who run online campaigns related to social causes (cause-related marketing) are an example. In addition to proficiency in creating multimedia content, this requires the ability to interpret campaign performance indicators and adapt strategies to audiences with diverse demographic profiles (Kozłowski *et al.,* 2025).

At the same time, demographic changes in the labor market mean that employers must consider generational differences when formulating competency requirements. Older employees may have greater industry experience but less familiarity with new formats

of process digitization; younger employees, on the other hand, adapt more quickly to ICT tools but often lack a strategic organizational perspective (Punie, 2022).

Effective teams are built by filling these gaps – which requires leaders to be aware of the complementary potential of different groups. Talent management focused on AI technologies increasingly includes analyzing employee profiles to assess their preparedness for the role of "digital leaders" of transformation within the organization.

Assessment models utilize data on employees' actual use of ICT tools, allowing them to precisely identify areas requiring development or mentoring support (Khang, 2024). This direction of action is particularly important for professions focused on product innovation and business process modeling. An interesting aspect is the gradual penetration of digital competencies into professions previously perceived as "analog."

For example, work in warehouse logistics or healthcare today requires the ability to operate mobile terminals connected to databases and use software that reports operational events in real time (Hughes *et al.,* 2019).

Formal education for these professions must include ICT modules as a permanent element of the job preparation program. The impact of automation is also changing the content of requirements. Some operational tasks taken over by AI systems reduce the need for manual data handling, while simultaneously increasing the importance of supervisory skills: analyzing the correctness of algorithm operation or predicting the effects of machine-made decisions is becoming part of a specialist's daily duties (Hughes *et al.,* 2019; Khin and Ho, 2020).

This increases the value of meta-skills that combine technical knowledge with a strategic perspective. Market analysis also shows the growing role of digital proficiency certification as a recruitment standard. Certificates compliant with the DigComp framework facilitate the comparability of candidates from different countries and economic sectors (Punie, 2022).

In many industries, these competencies are considered a prerequisite even for positions that do not require a high level of technical specialization, indicating a societal shift in standards regarding the minimum set of ICT competencies. A critical perspective highlights the risk of over-standardizing expectations for all professions without considering local technological realities or culturally specific ways of using digital tools (Sanchez-Canut *et al.,* 2023; Punie, 2022).

For example, security procedures developed for large corporations can be difficult for small businesses to implement due to limited human resources and infrastructure. Overall, technology-related competency requirements are increasingly multidimensional: they encompass a technical core (tool operation), an analytical

layer (data interpretation), a social component (team coordination), and an ethical and legal perspective (information protection).

4. Digital Transformation of Workplaces

Digital workplace transformation is a process that combines technological adaptation with the reorganization of organizational structures and practices. It is not limited to the introduction of new tools or the automation of selected work steps, but encompasses a range of changes in the way people and systems interact. In the professional context, this means both restructuring roles and responsibilities and redefining the competencies required for specific positions (Khang, 2024; Spencer and Spencer, 2008).

The integration of technologies such as the Internet of Things, artificial intelligence, and machine learning is leading to the emergence of work environments in which people make decisions based on data collected and analyzed in real time. Such conditions require employees to combine technical proficiency with critical thinking and interpretive skills.

One crucial element of this process is the automation of routine tasks. IoT-based systems can monitor production parameters, control equipment status, and generate alerts about potential failures (Khang, 2024).

Consequently, employee responsibilities are changing, and time previously devoted to manual tasks is being shifted to analytical and supervisory activities. This shift in emphasis requires developing skills related to data analysis, report interpretation, and process optimization.

Organizations that adopt such technologies often observe increased operational efficiency and a reduction in human-related errors. At the same time, there is a need for new training mechanisms tailored to the specifics of working in a highly digitalized environment. Digital transformation is also impacting communication within enterprises. Online collaboration platforms enable the synchronization of activities among geographically dispersed teams, but they also pose challenges related to real-time coordination and maintaining a consistent flow of information (Huhhes *et al.,* 2019).

This requires employees not only to be familiar with design applications but also to adhere to procedures for document versioning and communication etiquette in a digital environment.

Furthermore, the dynamics of interpersonal relationships are changing; interactions conducted via instant messaging or videoconferencing can limit nonverbal cues, requiring greater linguistic and cultural awareness. The issue of inclusiveness in workplace transformation becomes increasingly important where a competency gap

appears between different employee groups. Older generations may have less experience with cloud-based platforms or data management systems, while younger employees are quicker to adopt these technologies but often lack operational experience (Punie, 2022).

An effective transformation strategy incorporates knowledge transfer between these groups, for example, through reverse mentoring or joint project teams, where each party brings a unique set of competencies. Information security is an integral component of the digitalization of the workplace. As more processes are moved online, the scale of threats related to cyberattacks and data loss increases (Punie, 2022).

Companies are implementing multi-factor authentication systems, transmission encryption, and solutions based on behavioral analysis of user activity to detect anomalies. Employees must be aware of risks and have the knowledge to respond in accordance with security protocols, which requires training that is regularly updated as cybercriminal tactics evolve.

Digital transformation also applies to talent management models within organizations. HR analytics systems track employee interactions with ICT tools and identify potential leaders in technological change (Khang, 2024).

This data is then used to develop individual development paths and plan promotions for individuals with high adaptive potential. This approach allows for better alignment of human resources with the company's strategic directions. An interesting aspect of digitalization is the emergence of entirely new professions and hybrid roles combining competencies from multiple disciplines (Hughes *et al.,* 2019).

For example, a machine maintenance specialist can now act as an analyst of sensor data generated by industrial equipment; a graphic designer can manage a proprietary digital asset bank linked to an online licensing system; and a project manager can be responsible for configuring workflow tools that integrate the work of several departments across the globe. Work time structures are also being impacted by this transformation, with the growing popularity of asynchronous models and flexible scheduling, particularly in international teams operating across different time zones (Hughes *et al.,* 2019).

Such an organization increases the need for self-discipline and time management skills while ensuring availability for key synchronous interactions. The process of adapting to the new technological environment can be uneven, even within a single company.

Some departments are rapidly implementing innovative solutions – for example, integrating artificial intelligence modules for demand prediction – while others continue to rely on older methods of operation (Khang, 2024).

A lack of coordination between these areas can undermine the overall effectiveness of the transformation; Therefore, implementation strategies that encompass the entire organization and common standards for data exchange are crucial. It's worth noting the cultural aspect of this change: digital transformation is not neutral with respect to organizational identity.

Implementing new tools often involves a shift in a company's operating philosophy, a greater emphasis on process transparency through digital recording, and the promotion of a culture of knowledge sharing via internal platforms. For some employees, such changes are motivating; for others, they may mean a sense of loss of control over their professional autonomy.

One of the trends shaping the future of workplaces is the integration of immersive solutions, augmented reality (AR), and virtual reality (VR), used for both technical training and daily operational support (Hughes *et al.,* 2019).

VR simulations allow for the practice of complex procedures without the risk of disrupting the real production process; AR overlays can support the assembly of complex components by presenting instructions "in the user's field of view." From a global market perspective, digital transformation increases the mobility of human capital; specialists who can operate effectively in high-technology environments find employment abroad without the need for physical relocation (Hughes *et al.,* 2019).

On the one hand, this gives companies access to a broader talent pool; on the other, it intensifies competition for specialists with niche qualifications. Ultimately, digital workplace transformation is seen as a holistic process encompassing technologies, people, and organizational structures.

5. Methodology

The survey was conducted among 367 employees of 207 small and medium-sized logistics enterprises in Poland in the first two quarters of 2024. The research was conducted on a representative sample of companies from the SME sector, allowing for generalization of the results to the entire population of small and medium-sized logistics enterprises in the country.

According to the definition adopted by the European Commission and the Act on Entrepreneurs, small enterprises are those employing 10 to 49 employees and achieving an annual turnover or total annual balance sheet not exceeding €10 million, while medium-sized enterprises employ 50 to 249 employees and achieving an annual turnover not exceeding €50 million or a total annual balance sheet not exceeding €43 million.

The logistics companies included in the study operated in accordance with the Polish Classification of Activities (PKD) classification, Section H "Transport and

Warehousing," which covers sections 49 to 52: 49 – land and pipeline transport, 50 – water transport, 51 – air transport, and 52 – warehousing, storage, and support services for transport, including warehousing, forwarding, cargo handling, transhipment, freight transport, and logistics center operations.

A research tool was used to assess digital competences: a questionnaire based on DigComp 2.2 developed by the European Commission and expanded by the authors to include elements related to new digital challenges. The expanded DigComp 2.2 (Digital Competence Framework for Citizens) digital competence framework creates a model that distinguishes six competency areas:

- Information and Data – searching, filtering, evaluating, and managing information;
- Communication and Collaboration – communicating in a digital environment, collaborating using digital tools, netiquette, and digital identity management;
- Digital Content Creation – editing and creating content, including text, spreadsheets, images, and videos;
- Security – protecting devices, data, privacy, and digital well-being;
- Problem-Solving – identifying and solving technical issues, creatively using technology;
- New Digital Challenges – skills for the future, including: the foundations of artificial intelligence, sustainability, and countering disinformation.

Each area was assessed based on several questions (26 in total), and respondents rated their skills on a scale of 1 to 5. Based on this, average scores were calculated and competency levels were assigned according to the CEFR classification (A1–C2): A1 (lower basic), A2 (upper basic), B1 (lower intermediate), B2 (upper intermediate), C1 (advanced), C2 (proficient).

6. Research, Results and Discussion

During the research, the data was analyzed by individual competence areas, calculating average values and classifying the overall competence level, as presented in Table 1.

Table 1. *Average values in 6 thematic groups (scale 1–5)*

DigComp 2.2 Area	**Average**
Information and Data	2.98
Communication and Collaboration	3.03
Digital Content Creation	2.99
Security	2.97
Problem-Solving	2.93
New Digital Challenges (AI, ecology, etc.)	3.00

Source: *Own study.*

The mean levels are very similar, indicating that digital competencies are fairly evenly developed, but still moderate.

The dispersion of results (Standard Deviation, IQR) shows significant variation across individual levels, but most respondents are located around level 3.

In the "Problem Solving" and "Security" areas, there are individuals with very low and very high scores.

Table 2 presents basic descriptive statistics: minimum (Min), maximum (Max), mean (Mean), median (Median), standard deviation (Standard Deviation), and interquartile range (IQR) for each of the six competency areas.

Table 2. *Descriptive statistics – dispersion of results in groups*

Area	Min	Max	Mean	Median	Stand. Dev.	IQR
Information and Data	1.00	5.00	2.98	3.00	0.77	1.00
Communication and Collaboration	1.33	4.67	3.03	3.00	0.54	0.67
Digital Content Creation	1.00	4.75	2.99	3.00	0.73	1.00
Security	1.00	4.75	2.97	3.00	0.69	1.00
Problem-Solving	1.00	5.00	2.93	3.00	0.69	1.00
New Digital Challenges (AI, ecology, etc.)	1.20	4.60	3.00	3.00	0.64	0.80

Source: *Own study.*

As shown in Table 2, in the "Information and Data" area (mean: 2.98, median: 3.00, IQR: 1.00), most employees rate their skills in this area as moderate. However, the wide range of scores (Min: 1.00 – Max: 5.00) indicates significant variability in competencies related to searching, filtering, and evaluating information. This is also an area with high variability (Std. Dev: 0.77). In practice, this requires a differentiated approach to education – from basic to advanced training.

In the "Communication and Collaboration" area (the highest mean of all areas: 3.03 and the lowest variability of scores (Std. Dev: 0.54, IQR: 0.67), we observe a very uniform level of these competencies among employees. The results suggest that digital communication (e-mail, instant messaging, online teamwork) is well-developed and used in the logistics environment.

Another area characterized by significant skill variation is "Creating Digital Content" (mean: 2.99, median: 3.00). The range of scores: 1.00 to 4.75 indicates significant

variation in skills for creating documents, presentations, spreadsheets, etc., while the high standard deviation (0.73) and IQR (IQR) of 1.00 suggest the need for support for less advanced employees.

In the area of "Security" (mean: 2.97, median: 3.00, range: 1.00 to 4.75), significant variation also occurs, indicating an uneven understanding of digital security principles (passwords, data protection, privacy). Therefore, the area of cybersecurity requires the implementation of mandatory cybersecurity training.

In the fifth area, "Troubleshooting" (lowest mean: 2.93), employees experience the greatest difficulty in independently solving technical problems and using digital tools innovatively. The high variability (Std. Dev.: 0.69, IQR: 1.00) confirms the need for personalized training interventions.

In the final area, "New Digital Challenges" (Mean: 3.00, Median: 3.00, IQR: 0.80), which addresses future competencies such as understanding the fundamentals of AI, countering disinformation, and sustainability in a digital context, the balanced level of scores suggests that the topic of digital challenges has already been partially introduced in companies but still requires further development.

All averages therefore hover around 3.00, which corresponds to DigComp level B1 – functional competencies, but requiring further development.

The greatest development potential is in digital problem-solving, content creation, and security.

Communication and new digital challenges are relatively well developed, but do not yet reach advanced levels (B2–C1) (Table 3).

Table 3. *DigComp 2.2 Generic Competency Levels (A1–C2)*

Lp.	Level	Number of employees
1.	A2 (upper basic)	16
2.	B1 (lower intermediate)	300
3.	B2 (upper intermediate)	50
4.	C1 (advanced)	1

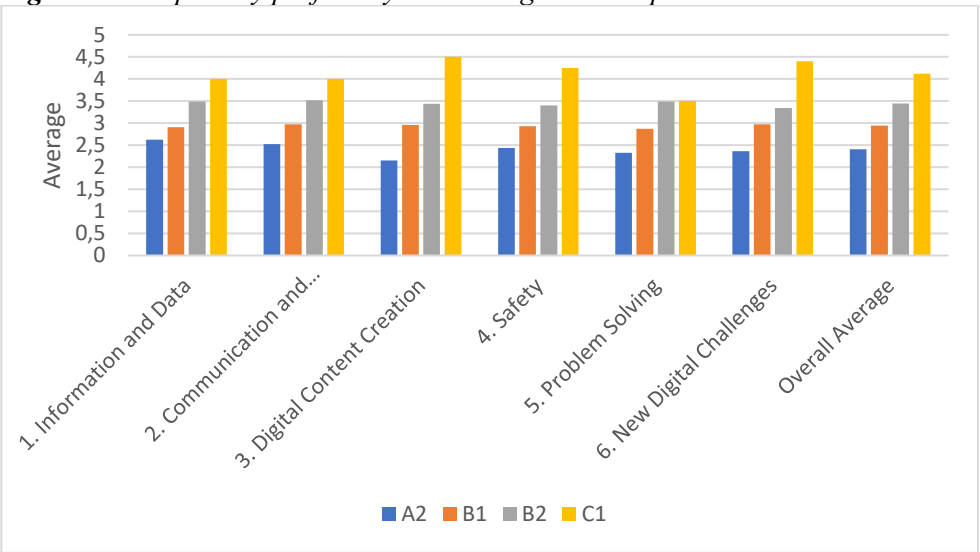
Source: *Own study.*

The profiles confirm a predictable increase in value with advancement. The largest differences typically occur in content creation and security – these areas have a higher threshold of difficulty, indicating the need for more advanced training interventions. Competency profiles of logistics employees are presented in Figure 1.

The lack of individuals at levels A1 and C2 indicates the effective elimination of the lowest competencies, but also the small number of digital experts (only one individual at level C1, none at C2). The overall mean digital competence score was 2.99, meaning

the average competency level falls within the B1–B2 range according to the CEFR scale. The minimum overall mean score was 2.27, and the maximum score was 4.12, indicating a wide range of levels within the study group.

Figure 1. *Competency profiles by level in logistics companies*



Source: *Own study.*

This study analyzed the interrelationships between the six main areas of digital competence according to the extended DigComp 2.2 framework. A correlation matrix allows us to understand how the development of one skill group can influence others. Based on this matrix, we can conclude that there are strong correlations between "Communication and Collaboration," "Digital Content Creation," and "Problem Solving."

The results indicate significant interdependencies between these three skill groups. This may mean that employees who are good at creating digital content (e.g., documents, presentations, spreadsheets) are also better at solving digital problems and collaborating more effectively in a digital environment. These three areas form a functional core of practical skills essential for everyday office and operational work in logistics (Figure 2).

Figure 2. *Interrelationships between the six main areas of digital competence according to the DigComp 2.2 framework.*

Specification	**1.Information and Data**	**2.Communication and Collaboration**	**3.Digital Content Creation**	**4.Security**	**5.Problem-Solving**	**6.New Digital Challenges**
1.Information and Data	1,000	0,042	0,031	0,006	0,091	0,054

Specification	1.Information and Data	2.Communication and Collaboration	3.Digital Content Creation	4.Security	5.Problem-Solving	6.New Digital Challenges
2.Communication and Collaboration	0,042	1,000	-0,061	0,029	0,162	0,027
3.Digital Content Creation	0,031	-0,061	1,000	-0,009	0,025	0,049
4.Security	0,006	0,029	-0,009	1,000	0,019	-0,001
5.Problem-Solving	0,091	0,162	0,025	0,019	1,000	-0,074
6.New Digital Challenges	0,054	0,027	0,049	-0,001	-0,074	1,000

Note: *Coloring shows the strength and direction of the correlation (−1 to +1).*
Source: *Own study.*

However, moderate correlations can also be found with "Digital Security." The area of security demonstrates moderate correlations with other competencies. This may indicate that security awareness and best practices are developing in parallel but are not yet integrated with other digital activities of employees. This may suggest the need for a separate educational approach to security – e.g., dedicated training or awareness campaigns.

The weakest correlations, however, are found with "Information and Data." Competencies related to searching, evaluating, and managing information demonstrate the weakest correlations with the other areas. This may be due to differences in the nature of these skills – they are more individual, analytical, and cognitive, and less operational and shared. This indicates the need to integrate information competencies with other digital activities, for example, through group projects or data processing exercises.

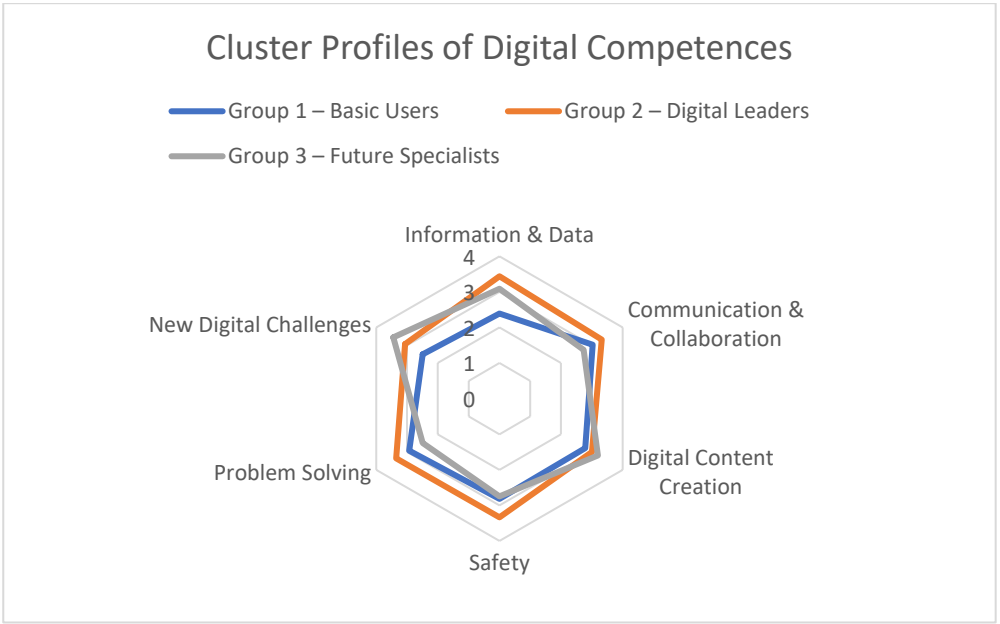
The K-Means clustering algorithm was also used to analyze the results. This method allows for the automatic detection of hidden structures in the data, the extraction of three coherent competency profiles, and grouping of employees not by company, age, or position – but by actual digital skills.

Using clustering (K-Means), respondents were grouped based on their characteristics. This allowed for the division of respondents into three groups: Group 1 – Basic Users, characterized by the lowest scores in all areas, particularly in "Information and Data" and "New Digital Challenges."

This group indicates the need for comprehensive support and training in digital fundamentals. Group 2 – Digital Leaders, possessing high and balanced competencies in each category and a dominant profile in the areas of "Security," "Problem Solving," and "Information and Data."

These are potential mentors or leaders of digital transformation. Group 3 – Future Specialists, possessing very high competencies in the area of "New Digital Challenges" (e.g., AI, disinformation). Although they are weaker in the traditional areas of "Communication and Collaboration" and "Problem Solving," these individuals can be classified as innovative individuals, but require better integration into teams and processes. The digital competency cluster profiles (K-Means) are presented in Figure 3.

Figure 3. *Cluster profiles of digital competences (K-Means)*



Source: *Own study.*

The groups demonstrate distinctly different competency profiles, suggesting the need for personalized development and training paths. The radar chart allows for quick identification of competency gaps and development potential within each group.

7. Conclusions, Proposals, Recommendations

Analysis of the study results indicates that the overall level of digital competence among the surveyed employees is functional, but not advanced: averages hover around 3.0 (B1), and the distribution of levels confirms the dominance of B1, with few B2 scores and a single C1, and no experts at the C2 level.

The largest gaps are revealed in the areas of problem-solving and security, which combine the lowest averages with high variability. These areas require mandatory, periodic training and just-in-time support, including mentoring and available technical assistance.

Although the averages across the six domains are similar, individual heterogeneity is significant, necessitating differentiated development paths. Competencies in communication and collaboration, as well as in the area of new digital challenges, remain relatively strong, but still below advanced levels. They can be leveraged to strengthen other domains, for example, by combining content creation training with teamwork and problem-solving practices.

The interdependencies between content creation, team communication, and problem-solving form a practical core of skills essential for everyday work, so development programs should integrate these modules rather than train them in isolation.

At the same time, information, data, and security require better integration with operational practice; the weaker connections between these domains and the others suggest the need for scenarios embedded in real-world processes, combining data acquisition and evaluation with decision-making and information protection requirements.

The identification of three competency profiles in the clustering analysis – entry-level users, digital leaders, and future specialists – indicates the value of personalized paths and roles: a foundational program for beginners, mentoring roles for leaders, and competency bridges for specialists strong in AI and future challenges but requiring strengthening in team and operational areas. This suggests that modularity and personalization are key to training effectiveness.

Therefore, it is concluded that practical implications and recommendations for the development of digital competencies in logistics companies should address the following areas:

- Correlation results suggest that development activities should not be conducted in isolation;
- Training in digital content creation can simultaneously strengthen communication and problem-solving competencies;
- Implementing interdisciplinary training programs can increase the effectiveness of competency development;
- For HR departments and managers, this means the need to plan development paths in a modular manner, with an emphasis on mutually supportive competency areas;
- Areas with the lowest scores (safety, competency development) should be strengthened through dedicated micro-training and mentoring;
- Develop a culture of digital knowledge sharing, which promotes the mutual transfer of competencies within organizations;
- Systematically monitor employee competency levels based on the DigComp model, using self-assessment tools and periodic tests;
- Include digital competencies in professional development plans and periodic assessments, especially for operational and managerial positions;

- Developing digital competencies should be part of a long-term development strategy for logistics companies, supporting their innovation, resilience to technological change, and market competitiveness.

Sustainable improvement therefore requires continuous measurement based on the DigComp 2.2 framework, with regular self-assessments and periodic tests that enable progress monitoring, comparability across teams, and rapid gap detection.

Demographic and cultural factors should be addressed through change management – particularly reverse mentoring, mixed-generational teams, and a culture of knowledge sharing – to reduce resistance to digitalization and accelerate skill diffusion.

Information security should become an everyday practice, which, in addition to training, requires simple operational standards such as multi-factor authentication, password policies, phishing simulations, and pre-implementation checklists, as well as cyber hygiene maturity measures.

Ultimately, strategically embedding digital competencies in HR policies and business goals – by linking DigComp results with periodic assessments, development plans, recruitment requirements and managerial support – determines the innovation, resilience to change and competitiveness of logistics companies.

References:

Almas, A.G., Andersen Bueie, A., Aagaard, T. 2021. From digital competence to Professional Digital Competence: Student teachers' experiences of and reflections on how teacher education prepares them for working life. Nordic Journal of Comparative and International Education (NJCIE), Vol. 5(4), 70-85. http://doi.org/10.7577/nicie.4233.

Andriushchenko, K., Rozhko, O., Tepliuk, M., Semenyshyna, I., Kartashov, E., Liezina, A. 2020. Digital literacy development trends in the professional environment. International Journal of Learning, Teaching and Educational Research, vol. 19, no. 7, 55-79.

Boyatzis, R.E. 2008. Competencies in the 21st century. Journal of Management Development, Vol. 27 Iss. 1, 5-12.

Cahen, F., Borini, F.M. 2020. International Digital Competence. Journal of International Management, 26(1).

de Vries, D, Piotrowski, J.T., de Vreese, C. 2025. Developing the DiglQ: A Measure of Digital Competence. PLoS One 20(5), e0322995. https://doi.org/10.1371/iournal.

Duica, M.C., Florea, N.V., Duica, A.O., Tanasescu, I.A. 2020. The role of e-skills in developing sustainable organizations and e-activities in the new digitized business world. Sustainability, Vol. 12, No. 8, 3400.

Ellingrud, K., Gupta, R., Salguero, J. 2020. Building the Vital Skills for the Future of Work in Operations. McKinsey & Company.

Eshet, Y. 2004. Digital literacy: A conceptual framework for survival skills in the digital era. Journal of Educational Multimedia and Hypermedia, 13(1), 93-106.

Farah, I., Dwi Suseno, B., Udin Suadma, U. 2023. The antecedents and consequences of digital competence: How to support the performance of organizations. Jurnal Ekonomi Modemisasi, 19(V), 41-57.

Ferrari, A., Punie, Y., Redecker, C. 2012. Understanding Digital Competence in the 21st Century: An Analysis of Current Frameworks. In: Ravenscroft. A., Lindstaedt, S., Kloos, C.D., Hernández-Leo, D. (eds) 21st Century Learning for 21st Century Skills. EC-TEL 2012. Lecture Notes in Computer Science, Vol. 7563. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-33263-0_7.

Hughes, C., Robert, L., Frady, K., Arroyos, A. 2019. Managing Technology and Middle and Low-Skilled Employees. Advances for Economic Regeneration. Emerald Publishing Limited.

Ilomäki, L., Kantosalo, A., Lakkala, M. 2011. What is digital competence? In Linked portal. Brussels: European Schoolnet.

Ilomäki, L., Paavola, S., Lakkala, M., Kantosalo, A. 2016. Digital competence - an emergent boundary concept for policy and educational research. Educ Inf Technol, 21, 655-679. DOI 10.1007/sl0639-014-9346-4.

Ingsih, K., Astuti, S.D., Riyanto, F. 2024. The role of digital competence in improving service quality and employee performance. SA Journal of Human Resource Management/SA Tydskrif vir Menslikehulpbronbestuur, 22(0). https://doi. org/10.4102/.

Khang, A. (ed.). 2024. Al-Oriented Competency Framework for Talent Management in the Digital Economy. Models, Technologies, Applications, and Implementation. CRC Press.

Khin, S., Ho, T.C.F. 2020. Digital technology, digital capability and organizational performance. International Journal of Innovation Science, 11(2).

Kozłowski, W., Figiel, Sz. 2025. Purchase Intentions for Food Products Under Different CRM. Campaign Settings: An Empirical Evidence from Poland. European Research Studies Journal, Vol. XXVIII, Issue 3, 73-93.

Laska, A., Piętowska-Laska, R. 2014. Społeczna odpowiedzialność biznesu firm logistycznych. Humanities and Social Sciences, t. XIX, z. 21(4/2014), 83-98.

Mbandje, D.C., Loureiro, M.J., Lucas, M. 2023. Digital competence and information literacy: clarifying concepts based on a literature review. Educational Media International, 60, 3-4, 306-316. DOI: 10.1080/09523987.2023.2324584.

Moorhead, G., Griffin, R.W. 2020. Organisational behavior: managing people and organisations. Cengage Learning.

Perez-Escoda, A., Fernandez-Villavicencio, N.G. 2016. Digital competence in use: from DigComp 1 to DigComp 2. in TEEM 16: Proceedings of the Fourth International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM'16), 619-624. New York.

Punie, Y. 2022. DigComp 2.2: The Digital Competence Framework for Citizens, October 19. https://doi.org/10.2760/115376.

Rizza, C. 2013. Digital Competences. A.C. Michalos (ed.), Encyclopedia of Quality of Life Research. DOI 10.1007/978-94-007-0753-5.

Sanchez-Canut, S., Usart-Rodriguez, M., Grimalt-Alvaro, C., Martinez-Requejo, S., Lores-Gomez, B. 2023. Professional Digital Competence: Definition, Frameworks, Measurement, and Gender Differences: A Systematic Literature Review. Human Behavior and Emerging Technologies, Vol. 2023, Article ID 8897227, 22 pages. https://doi.org/10.1155/2023/8897227.

Schwarz, S., Bieg, T., Svecnik, E., Schmolz, A., Geppert, C., Gerdenitsch, C. 2024. Digital Competence Scale (DCS). A Short Self-Assessment Instrument for Measuring Digital Competences. Nordic Journal of Digital Literacy, Vol. 19, No. 3, 126-143. DOI: https://doi.Org/10.18261/njdl.19.3.2.

Spencer, L.M., Spencer, P.S.M. 2008. Competence at Work models for superior performance. John Wiley & Sons.

van Laar, E., van Deursen, A.J.A.M.J., van Dijk. A.G.M, de Haan, J. 2018. 21st-century digital skills instrument aimed at working professionals: conceptual development and empirical validation. Telematics and Informatics, Vol. 35, No. 8, 2184-2200.

van Laar, E., van Deursen, A.J.A.M.J., van Dijk. A.G.M, de Haan, J. 2019. Twenty-first century digital skills for the creative industries workforce: perspectives from industry experts. First Monday, Vol. 24, No. 1.