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DIGITAL TRANSFORMATION OF ECONOMIES THROUGH TECHNOLOGY, EDUCATION AND COMPETENCES

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Abstract

Digital transformation has profoundly impacted social and economic life by enhancing workforce competences, fostering innovation, and creating competitive advantages. Given that the driving force of digital transformation is technology, this study aimed to determine whether education and workforce competences are perceived as essential factors in the digital transformation narrative across diverse fields of socioeconomic development at both macro and micro levels. To achieve this, 528 abstracts from various scientific fields focused on digital transformation were analyzed using both manifest and latent content analyses, the latter ensuring a more objective interpretation of the outcomes derived from manifest content analysis. Frequency, word linkage, and concordance analyses of key concepts were used. The results indicated that education and workforce competences are viewed as vital for the digitalization of various sectors of the economy at both macro- and micro-level development. The findings suggest that technology drives digital transformation by delivering different types of value, including innovation and sustainability, while relying on education and technology-related competences. The results also revealed concerns about barriers to technology implementation, which could be overcome through education and competences. The originality of this research lies in its application of both manifest and latent analyses to identify the roles of education and technology in driving economic digital transformation.

Keywords: *digital transformation, education, workforce competences technology, macro-level development, micro-level development*

Introduction

The pervasive influence of digitalization and AI has been transforming personal, social, and economic spheres. This integration of technology has led to shifts in labor markets, the emergence of new business models, and new patterns of social interaction, reshaping value creation at personal, organizational, and societal levels. As the adoption of technology is a gradual process, both social and economic aspects of life are undergoing digital transformation (Uzule et al., 2021), including education, competencies (Misnevs et al., 2021), and ultimately economic systems (Uzule & Verina, 2023). By expanding opportunities, fostering innovation, and offering competitive advantages, such as reducing financial barriers (Peng et al., 2023), digitalization continues to drive organizational and national economic growth. The level of organizational and national economic development in the context of technological progress is closely linked to the concept of the digitalization of economies, underscoring its importance in shaping future economic landscapes.

The concept of digitalization of economies pertains to the creation of a context in which individuals and businesses are connected through data, digital technologies, and digital spaces (Javaid et al., 2024). Digital economies are driven by big data, artificial intelligence, blockchain, the Internet of Things (Javaid et al., 2024), the Internet of Services, and other technological tools and contexts (Misnevs et al., 2021). But digital transition and transformation can bring not

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only expansions of businesses (Sadigov, 2022) but also can cause disruption at various levels of organizational structure and induce technostress (Ye & Chen, 2024), which are created by digitalization barriers (Uzule & Verina, 2023).

Transition to digital economies proceeds through overcoming various digitalization barriers, such as the lack of digitalization strategy, insufficient resources, unsuitable governance, as well as poor digital competences of the workforce. Transition to digital economies at the organizational level rests on relevant technological/digital competences (Kulju et al., 2024), proper critical information analysis skills (Ye & Chen, 2024), flexible learning styles, good stress management skills, high motivation, good communication skills, and personality traits of conscientiousness and openness to experience at least at the medium level. The development of such skills is subject to various constraints, including financial, technological, and training (Uzule & Verina, 2023), which together with skill expectations create a network of requirements for continuous acquisition, retainment, and enhancement of competences. The diversity of such competences and the need for continuous upskilling creates a network of challenges for employees, which might be problematic to overcome without continuous organizational and institutional support. Therefore, organizations should be able to develop a system of factors enabling individual assessment of digital needs to ensure organizational transition to digital operations (Kulju et al., 2024), which could bolster organizational resilience in the face of digital disruption and foster a culture of adaptability and innovation essential for long-term success in digital economies.

Digital Economies and Workforce Competencies

The rapid development of technology and electronic communications has accelerated the digitization of the global economy, which stimulated the emergence of a new form of economy (Zou & Deng, 2022) - a digital economy, based on information and communication technologies (ICT) (Meng et al., 2023). This economy has become an important part of the global economy and a key driver of development, influencing and transforming various business sectors such as e-commerce, digital marketing, software development, computer games and digital financial services, facilitating the interaction of online and digital business (Xia et al., 2024). Digital economy is significantly different from traditional economy with its high connectivity and automation, facilitating not only faster communication, simpler access to information and more efficient transactions, but also greater reliance on data, which accordingly enables data-based decisions to be made. This shift to digital technologies and data usage not only improves productivity and reduces costs, but when integrated with the traditional economy, the digital economy improves corporate social responsibility, as well as promotes green innovation, contributing to sustainable development and supporting global efforts to mitigate climate change.

The development of digital economy has a significant impact on labor demand, changing work tasks, professions and roles in organizations. Digitalization in organization leads to higher demand for highly skilled workers (Balsmeier & Woerter, 2019; Jin & Lyu, 2024; Wu & Yang, 2022). A report by the World Economic Forum predicts that by 2025, the labor market will undergo significant changes, creating 69 million new jobs, while 83 million will disappear, resulting in a net loss of 14 million jobs; and by 2027, 42% of business tasks will be automated, emphasizing the need for reskilling (World Economic Forum, 2023). Digital literacy reduces the risk of falling into poverty (Zhou et al., 2024). Digital literacy in tandem with agile thinking significantly contribute to the development of design thinking skills and management control competencies among young accountants (Imjai et al., 2024).

In case of Europe, more than 90% of professions in Europe require at least basic digital knowledge (European Commission, 2023). Forty-two percent of Europeans, representing 37%

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of the total workforce, lack this skill, indicating a significant lack of digital skills in Europe (European Commission, 2023). Only 54% of Europeans aged 16-74 have basic digital skills, in 2021, 1 in 6 Europeans had no digital skills (European Commission, 2022a). In order for Europe to achieve the European Digital Decade goal of 80% of the European population having at least basic digital skills by 2030, additional efforts and investments in digital education are urgently needed to improve the digital skills of Europeans (European Commission, 2022a). To be able to follow the market demands, the European Center for the Development of Vocational Education and Training (CEDEFOP, 2024) created an online vacancy analysis tool called Skills-OVATE, which uses the ESCO classification of skills, competences and occupations (European Commission, 2024), to improve labor market transparency and facilitate policy making. This tool uses big data and provides detailed information on skills demand and vacancies (OJAs) based on real-time data from millions of job advertisements on thousands of private job portals, public employment job portals and recruitment agency portals (CEDEFOP, 2024). OJA's latest data indicates that digital skills are among those in the highest demand across all industries.

Consequently, digital competences of the workforce should be developed not only at educational institutions but also at the workplaces (Uzule & Kuzmina-Merlino, 2022). To synchronize training standards, various digital competence frameworks have been designed, including the DigComp framework of the Department of Education and the European Commission (Audrin et al., 2024; Vuorikari et al., 2022) due to the necessity to improve digital skills of all citizens by 2030 (European Commission, 2022b).

At the organizational level, successful digital transformations depend on the digital competencies of both the workforce and managers. Specifically, digital transformations require significant financial resources and organizational change (Geada et al., 2023), and it is up to managers to understand how to organize these processes. For these transformations to succeed, employees should fully trust and support the company's vision and adapt to new technologies and processes (Florek-Paszkowska et al., 2021). The level of trust depends on the workforce's understanding of the implemented processes. Change management literature highlights that about 70% of change initiatives fail due to common mistakes or overlooked factors such as employee resistance, undefined goals, and lack of management support (Bellantuono et al., 2021). Management plays a crucial role in facilitating change by actively supporting and promoting the use of digital tools and user engagement (Ewenstein et al., 2015). Although managers recognize the importance of digital transformation, they often struggle with its implementation. In this context, active participation from all stakeholders involved in the change process can reduce resistance and the risk of failure (Bellantuono et al., 2021).

Overall, the digital economy's rapid advancement necessitates a workforce proficient in digital skills across all sectors of socioeconomic development. As digital literacy directly impacts job security, entrepreneurship, and poverty alleviation, continuous education and reskilling become indispensable. National and organizational strategies must prioritize digital competence frameworks and practical assessment methods to ensure alignment with market demands. Moreover, successful digital transformation hinges on the collaborative efforts of skilled employees and adept managers who can navigate and implement technological changes effectively. Therefore, fostering digital competences is not just a technical requirement but a fundamental component for sustainable socioeconomic progress in the digital age.

Research Aim and Research Questions

The success of digital economies hinges on the availability, affordability, and accessibility of technological tools, digital spaces, organizational support as well as digital competences of employees. Gobniece and Titko (2024) verified these claims through a bibliometric analysis of research publications related to the digitalization of economies in which they established

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three pivotal categories of concepts driving digital transformation: employees, skills, and technologies. Building upon this foundation, this research aimed to determine if education and workforce competences are viewed as important factors within the digital transformation narrative across diverse fields of socioeconomic development at both macro- and micro-level development. To attain the aim, the following research questions were formulated:

- Research Question 1: *Are the concepts of technology, education, and workforce competences important in research on digital transformation across various fields of economy at both macro- and micro-levels of economic development?*
- Research Question 2: *Is technology viewed as a driving force of digital transformation fueled by education and workforce competences?*
- Research Question 3: *What are some factors contributing to the perception of technology as a driving force in digital transformation?*

In contrast to the approach taken by Gobniece and Titko (2024), this study focused on conducting frequency, word link and concordance analyses of the keyword concepts for both explicitly and implicitly encoded meaning, thus, offering a nuanced exploration of their importance in shaping the discourse about digitalization.

The originality of this research stems from its dual approach, utilizing both manifest and latent analyses to uncover the key factors driving digitalization and digital transformation. The applied methodology allowed for a more comprehensive examination of the roles of technology and education, as well as the identification of secondary factors driving digital impediments, which hinder digital transformation. These factors emerged organically from the combined analysis of explicit (manifest) and implicit (latent) meanings within the corpus, providing deeper insights into the challenges and opportunities associated with digital transformation.

Research Methodology

Methods

The applied research method included content analysis both at the explicitly (manifest content) and implicitly (latent content) encoded levels of content (Graneheim & Lundman, 2004) to ensure that the identified key concepts were interpreted in line with the abstract authors' intention rather than within the scope of subjective views of the authors of this paper. Such division into manifest and latent content analysis is justified by reality being subject to multiple interpretations, with comprehension being contingent upon individual rather than universal perspectives (Graneheim & Lundman, 2004). In general, the focus on content analysis was justified due to the fact that a vast amount of data is encoded as unstructured text (Marzouk & Enaba, 2019), and thus, the text analysis of diverse written materials yields an insight into the concepts that are considered essential in a specified context.

As for the specific methods of research, they included keyword frequency and link analyses as part of manifest content analysis, whereas concordance analyses allowed for a deeper review of the relationships of the concepts related to keywords, which is why it represented latent content analysis. Keyword frequency analysis was applied due to its bibliometric feature of identifying the most essential concepts within a specific research domain/text (Han et al., 2017; Vought et al., 2024). This analysis is deployed to tap into research hotspots and track evolving trends over time (Han et al., 2017). The keyword link analysis, which can be represented as a collocate network, was selected to identify relationships with a keyword. Both keyword frequency and link analyses were conducted within the framework of manifest content analysis to identify the most salient concepts in the corpus. Finally, the concordance analysis was run as a measure of latent content analysis to ensure the interpretation of results more consistent with the abstract authors' intentions.

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Corpus Creation

Abstracts of scientific papers provide an insight into key aspects of scientific investigation, which is why they contain the most important concepts of research. This was the primary reason for the analysis of abstracts. Titles, author information and keywords were removed from the abstracts at the time of analysis. The abstract selection was subject to the following criteria:

- Types of publications: Journal papers
- Source of publications: Scopus database
- Publication period: 2014-2023
- Paper title concepts: Digitalization, workforce, competences, training
- Research areas: Education, business, management, economics, digitalization, socioeconomic transformation, sustainability, social sciences, accounting, finance, decision sciences
- Geographical regions: Europe, Asia, North and South America, Africa, and Oceania
- Language of publication: English

Representativeness of the sample was ensured by a diverse range of research areas and geographical regions (74 countries, mostly Europe and Asia). In total, the corpus comprised 528, with a notable trend of increasing publications over time suggesting a growing interest in issues of digitalization of economies and workforce competences.

Keyword Identification

The keywords for this research were obtained from Gobniece and Titko (2024), who identified the following 3 groups of employee competencies essential for digital transformation: employees (11 items), skills (10 items), and technologies (10 items) (see Table 1)

Table 1
Keywords Of the Employee-Skill-Technology Triad

Employees	Skills	Technologies
Employee*	Competence*	Automation
Human (resource*)	Digital skill* (training)	Digital* (transformation)
Labor	Knowledge	Development
Personnel	Learning	Innovation
Staff	Qualification improving	Innovative work
Work/er*/force	(Up/re) skill*	Machine*
Team	Training	Technolog* (progress)
Professionals	Upgrading	Tech

Source: Gobniece & Titko, 2024, p. 31.

These very lexical items and related concepts (such as learning and human capital) were analyzed for frequency in this research.

Data Analysis

To analyze the created corpus, open access text analysis tools were used - *Voyant Tools (*Sinclair & Rockwell, 2024a) and *AntConc* (Anthony, 2024). In general, both tools are used for creating and analyzing corpora of text, extracting words and their frequencies and providing visualization of analysis. One of the greatest advantages of *Voyant Tools* is visualization (Na-

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hotko et al., 2023), identification of word frequency and their distribution in an unstructured format (Kasilingam et al., 2021), recognition of patterns (Chomintra, 2023) and identification of links between keywords based on their co-occurrence in a corpus rather than linear adjacency in the format of collocate graphs *Tools (*Sinclair & Rockwell, 2024b). As for *AntConc* software, Łuszczuk et al. (2020) viewed its strength in performing collocate, cluster and N-gram analyses, while Cordeiro (2019) in conducting concordance analyses. The authors of this research used both tools to verify the analysis obtained by application of one tool and to provide a better visualization outcome. Thus, the keyword frequency analysis (Figure 1) and collocates or link analysis of the highest frequency concept (Figure 2) were conducted in *Vaynt Tools,* whereas *AntConc* was used to perform the keyword phrase frequency analysis (Figure 3) and the concordance analyses of the top frequency concept (Figures 4-5).

Research Results

The created corpus contained 98,604 words. The first task was to verify if the created corpus was relevant to attaining the research aim (see *Research Aim and Research Questions*). To do so, the top frequency concepts of the entire corpus were analyzed concerning their relevance to the concepts of *technology, education, workforce competences* (see Table 1), *digitalization/digital transformation,* and *sectors of economy*. The top frequency word threshold was set at 0.2% of the corpus (200 words) to balance the comprehensiveness and specificity of the research while minimizing the linguistic noise that could result from overrepresenting less critical words, which might occur in case of 0.5% threshold. In other words, the 0.2% threshold is sufficiently substantial to capture a broad range of significant terms without diluting the importance of each word. The threshold was not reduced to 0.1% because the highest word frequency analysis aimed to identify not 1-2, but 5 key concepts. The top frequency analysis was run in the format of a word cloud (see Fig. 3). Grammar words were excluded, as the analysis focused on the conceptual lexical meaning of the corpus rather than syntactic relations.

The analysis of the highest-frequency concepts demonstrates that the created corpus is relevant to addressing the research aim due to the inclusion of concepts pertinent to the *technology-education-workforce competence* triad (see Table 1) and *digital transformation of various sectors of economies*. Specifically, concepts related to technologies included *technological, digital*, *innovation, and blockchain*. Concepts associated with the concept of education included *students, teaching, science, data, learning, and training*. Concepts relevant to workforce competence encompass groups, companies, humans, *work, and skills. Digitalization/digital transformation* was practically encoded through *digital,* while *various sectors of economies* through *economy*, industry.*

The next step in the analysis was to answer Research Question 1: *Are the concepts of technology, education, and workforce competences important in research on digital transformation across various fields of economy at both macro- and micro-levels of economic development?* To do so, first, the lexical items from the technology-education-workforce competence triad (see Table 1), referred to as keywords, were analyzed for frequencies across the entire corpus (Figure 1). The concepts related to the workplace, such as *employees, labor, human resource*, etc., relate them to the micro-level of economic development.

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Figure 1
Keyword Frequencies

Employee-related concepts	Education-related concepts	Technology-related concepts

Cirrus | Terms | Links

	Term	Count
1	human*	96
2	professional*	78
3	human	72
4	worker*	40
5	staff*	34
6	employee*	16
7	labour*	13
8	workforce*	10
9	team*	10
10	"human resource*"	9
11	personnel*	6
12	"human capital*"	1

Total count: 385

Cirrus | Terms | Links

	Term	Count
1	stud*	957
2	learn*	334
3	know*	141
4	skill*	122
5	train*	103
6	competenc*	47
7	upgrad*	6
8	qualificat*	4
9	upskill*	0
10	"knowledge impro...	0
11	"digital skill*"	0

Total count: 1714

Cirrus | Terms | Links

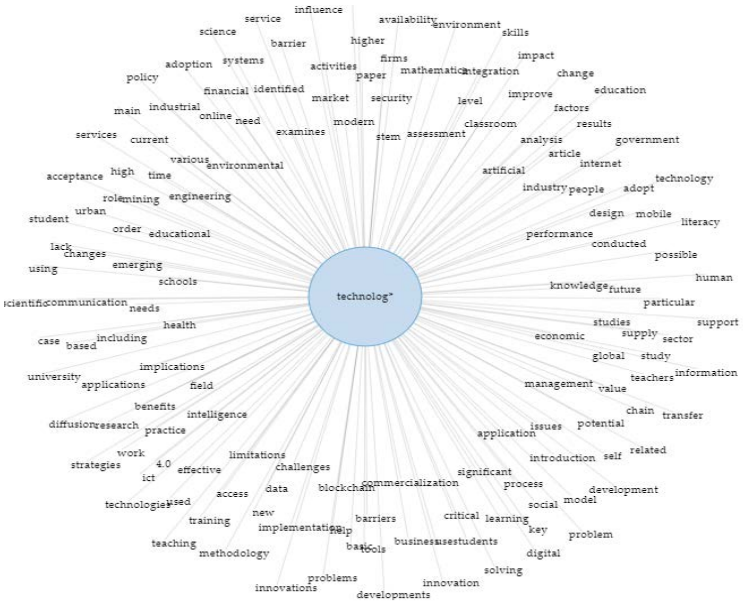
	Term	Count
1	technolog*	1570
2	digital*	488
3	develop*	476
4	innovat*	292
5	automation	49
6	machine*	19
7	tech	14
8	"technological pro...	1
9	"innovative work*"	0
10	"digital transforma...	0

Total count: 2909

The results reveal that the total raw frequency of the keywords amounted to 5,008 occurrences, constituting 0.5% of the entire corpus, thus pointing to the high importance of these concepts. A closer examination of the keyword frequencies shows a strong emphasis on competence-related concepts, positioning *education* above *employees* on the conceptual priority ladder. Yet, the area of highest priority pertained to *technology* concepts, with *technology* being the most frequent lexical concept in the entire corpus, appearing 1570 times (1.6% of the corpus).

Because the concepts relevant to *technology* were of the highest occurrence, they might be related to the concepts encoded in Research Question 1, such as digital transformation, various sectors of the economy, macro-level of economic development, micro-level of economic development, education and workplace. To verify it, a collocation analysis, which is based on the systematic co-occurrence of concepts, was run on the concept of technolog* (Figure 2).

Figure 2
Collocations of "Technolog"*



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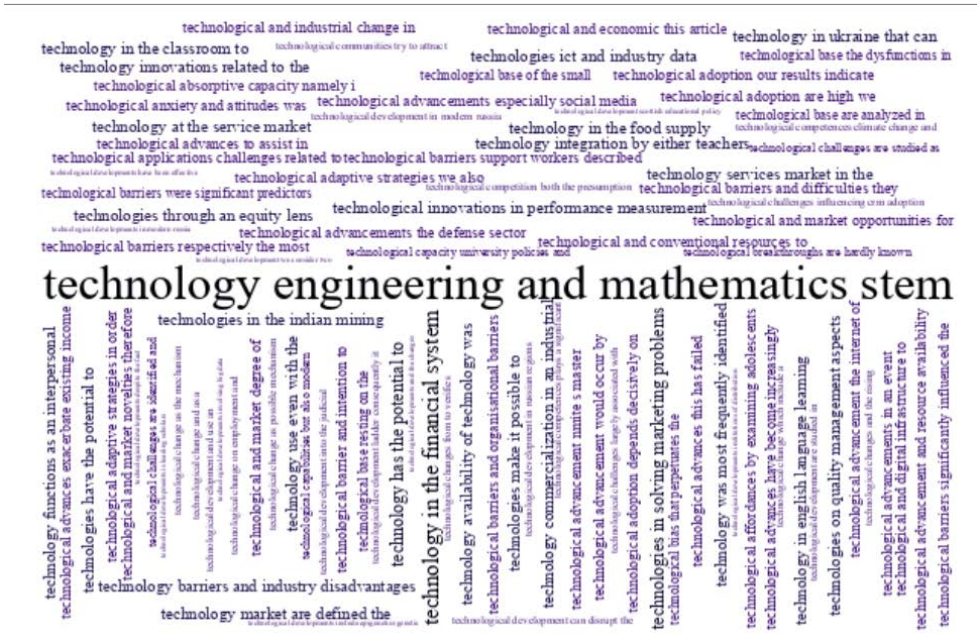
Indeed, the outcomes of the collocation analysis relate the findings to the:

- *macro-level of economic development* via the use of *government, global, sector, economic, industry;*
- *micro-level of economic development* via the use of *business, schools, university, supply & chain, performance;*
- *digitalization/digital transformation* via the use of *digital, transfer, technology; strategy, blockchain, data, artificial & intelligence, problem, barriers, limitations,*
- *various sectors of the economy* via the use of *sector, economy, industry, education, science, environmental, engineering, health, ICT;*
- *education* via the use of *schools, university, students, methodology, teaching, training, assess, educational;*
- *workforce competences* via the use of *skills, digital, business, performance.*

Thus, Research Question 1 was positively answered: *The concepts of technology, education, and workforce competences are important in research on digital transformation across various fields of economy at both macro- and micro-levels of economic development.*

The answer to Research Question 2, which asks *whether technology is viewed as a driving force of digital transformation fueled by education and workforce competencies*, was partially addressed in the process of answering Research Question 1. Specifically, the highest frequency of the concept of *technology* proves its dominant node position over other concepts of the corpus in the hierarchical node structure of the corpus concepts, including *digital transformation, education,* and *workforce competences*. However, to be able to establish its dominance over digital transformation, encoded along the lines of a driving force, and dependence on education and workforce competences, the keyword-in-context (KWIC) analysis was run on *technolog**, the summary of which is encoded in the format of the KWIC-cloud (Figure 3).

Figure 3
Word-Cloud: KWIC Analysis of "Technolog"*



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The KWIC analysis produced the following concepts pointing to the relationship between technology and digital transformation: *technological change; technological and industrial change; technologies, ICT and industrial data; technological advancement (in defense sector, assistance); technological innovation in performance management; technology in the food supply; technology integration; technological and market novelties; technologies in solving market problems; technological and organizational barriers; technological and digital infrastructure.* Given the node dominance of technology over the entire structure, then, it can be concluded that *technology* changes/relates/effects *market/organizational/market transformations.*

The KWIC analysis also revealed a connection of *technology* to *education* via the occurrence of the following concepts: *technology integration (…) by teachers; technology in the classroom; technological capacity (in) university policies; technology engineering and mathematics.* The KWIC analysis additionally indicated a connection of *technology* to the concepts associated with *workforce competences* via the following phrasal units: *technological and organizational barriers; technologies (in pertinence) to quality management; technology advancement and resource availability, technology barriers support workers….; technology at the service market.*

Thus, there are reasonable grounds to suggest that technology is viewed as a driving force of digital transformation, which takes place both in education and workplace, and therefore, more than likely to depend on education and workforce competences. To further verify the outcomes of this manifest content analysis, concordances of *technolog** were examined within the latent content analysis. This required the extension of the analysis to meaning units beyond the scope of condensation, or else, the phrasal scope, to include both phrasal and sentence scopes. This was made possible in the software *AntConc* by setting a meaning unit at 15 words, proceeding and following *technolog**. Some results are available in Figures 4-5.

Figure 4
KWIC by Frequency of Phrases from the Keyword to the Right

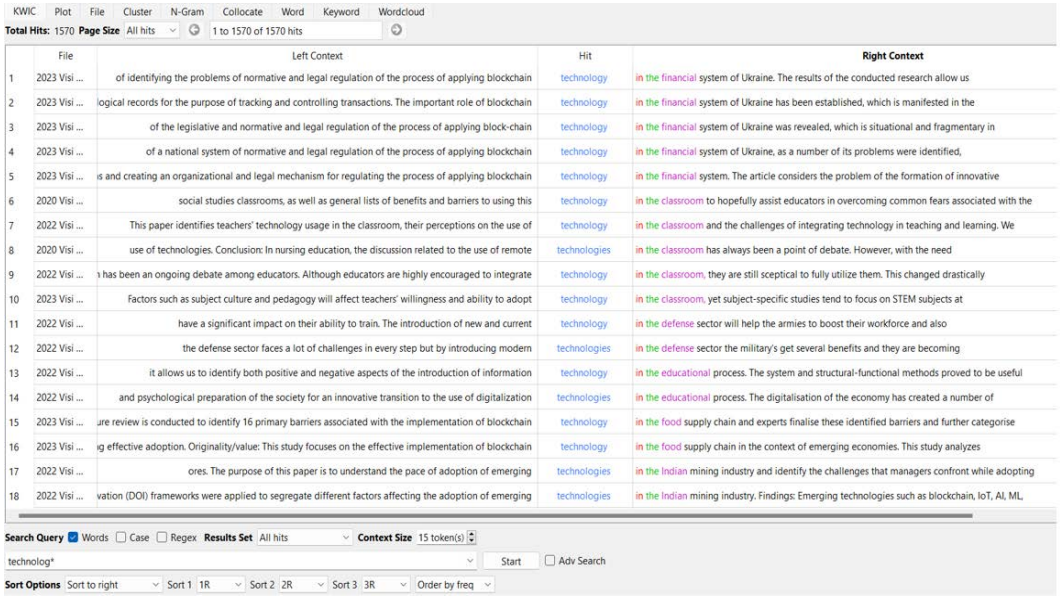

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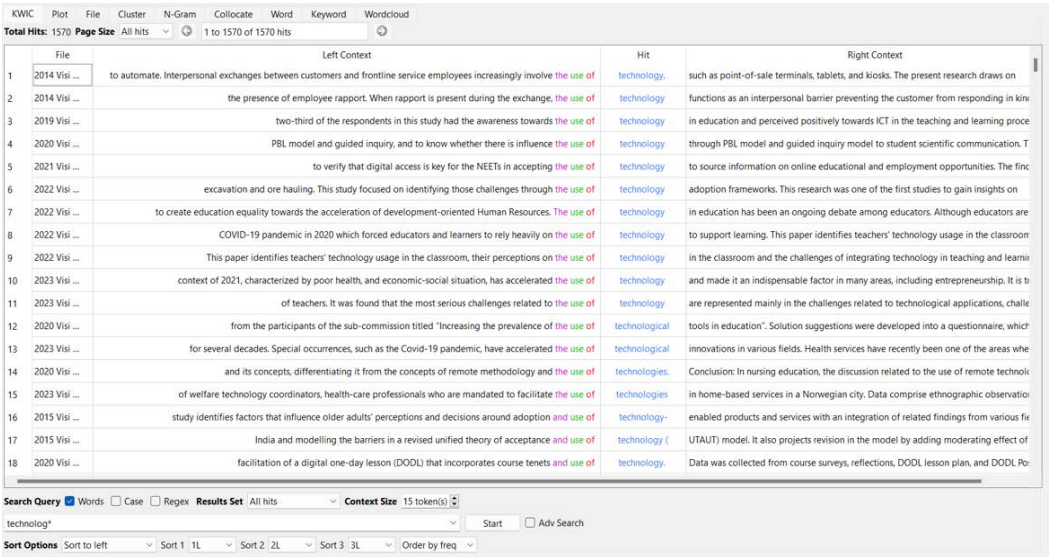
Figure 5
KWIC by Frequency of Phrases from the Keyword to the Left



Indeed, the concordances support the above interpretation. For example, the concordance of "*identifying the problems in the normative and legal regulation of the process of applying blockchain technology in the financial system of Ukraine"* (Figure 4) indicates that blockchain technology is an innovation in the financial system of Ukraine, and that there is a need to identify challenges in the application of normative and legal regulation. This certainly requires proper workforce competences. Another concordance, "*… interpersonal exchange between customers and frontline service employees increasingly involve the use of technology, such as point-of-sales terminals, ..."* (Figure 5) also proves the need of workforce to develop competences related to the use of technologies to serve customers. Another concordance, *"The introduction of new and current technology in the defense sector will help armies to boost their workforce…"* (Figure 4) suggests that technologies introduce novelty into the defense sector, and this helps workforce to perform their duties. Some other concordances related to workforce competences were as follows: *"... problem-solving skills and investigated the moderating effect of academic achievement on the effect of* ***technological skills*** *on developing* ***problem-solving skills****…", "An innovation* ***management*** *investigative framework (IMIF) is built, establishing links between the drivers of technological change, which include* ***[A] effectuation, [B] entrepreneurial orientation, [C] strategy and leadership****….", "... comprehensive literature review is conducted to identify 16 primary* ***barriers*** *associated with the* ***implementation of blockchain technology*** *in the food supply chain and experts finalize these identified barriers and further categorize…"*

The acquisition of relevant competences is contingent upon *education*. This conclusion is supported by concordances on education, such as this: "*….remote methodology and use of technologies [was discussed for] nursing education ", "awareness of use of education in technologies"* (Figure 5). Some other examples of education-related concordances are the following: *"... COVID-19 pandemic in 2020 which forced* ***educators*** *and* ***learners*** *to rely heavily on the use of technology to support* ***learning****. This paper identifies teachers' technology usage in the* ***classroom,*** *their perceptions", "... investigated digitalization as a way of creative choreographic communication, the role of synchronous and multimedia technologies in the system of* ***digital learning****, identified the main features of the multimedia environment, ….".*

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Examples of concordances related to *digital transformation* are the following: *"… and psychological preparation of the society for an innovative* ***transition*** *to the use of* ***digitalization technologies*** *in the educational process. The* ***digitalization of the economy*** *has created a number of …", "… **AI healthcare technology** innovations related to the life science industry. The socio-technical analytical framework Technological innovation systems (TIS) was used to assess the* ***structural and functional dynamics of AI", "****… changing society and business.* ***Digitalization*** *causes changes for companies due to the adoption of digital technologies in the organization or in the operation environment…."*

Examples of concordances related to *various sectors of the economy* are the following: *"The purpose of this study is to focus on identifying the challenges of technology adoption in* ***dairy farms*** *and constructing a hierarchical model using soft systems methodology", "… Financial Reporting Standards (IFRS) as the applicable accounting standard under* ***financial accounting****. The impact of technology on individual* ***economic sectors*** *has also reached the service industry…", "…. have a significant impact on their ability to train. The introduction of new and current technology in the* ***defense sector*** *will help the armies to boost their workforce and also…."*

Thus, the answer to Research Question 2 is also positive: *Technology is viewed as a driving force of digital transformation contingent on education and workforce competences.*

Research Question 3 aimed at identifying *some factors contributing to the perception of technology as a driving force of digital transformation.* Top word frequency analysis, *technology* collocations (Figure 1) and KWIC analyses (Figures 3-5) identified the following concepts in relation to the outcomes of *technolog**: *innovation, value, benefits, development,* and *solving problems.* Among the examples of other concordances were the following: *"… importance of technology as a pillar for the implementation of the* ***Sustainable Development Goals (SDGs)****",* ***"****Technology innovation promises benefits especially for the implementation of* ***SDG2*** *to end hunger, achieve food ….", "… of i****nnovation*** *itself. In this paper, the attention is focused on the impact of new technologies in order to increase SME's* ***competitiveness and productivity*** *among the firms…", "… **New products** depend on the technological and market* ***novelties*** *….".*

Overall, the section focused on the exploration of the relatedness of concepts related to the digitalization of various sectors of the economy at both macro- and micro-levels of development and the role of technologies, education and workforce competences in supporting digital transformation. The research results point to the pivotal role of technology in driving economic digital transformation via education and workforce competences. The research results also pointed out that the outcomes of technological transformation include innovation, value creation, and sustainability.

Discussion

Digital transformation, implemented with technologies, is an indispensable component of business development (Clemente-Almendros et al., 2024) across various sectors of the economy (Schiavi et al., 2024). To promote digital transformation, it is important to determine factors supporting it. The research aimed to determine whether education and workforce competences are perceived as critical elements in driving digital transformation across various sectors of socioeconomic development, at both macro and micro levels. The analysis revealed that education and competences are indeed viewed as pivotal in facilitating the digitalization of economies through the application of technologies. These findings align with earlier research that underscores the value of technology and workforce competences in driving digital transformation and, ultimately, in creating digital economies.

In this study, various forms of the concept of technology emerged as the most frequently used lexical items. Given that the research corpus was constructed based on key concepts such

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as digitalization, workforce, competences, and training, first, the keyword collocation and concordance analyses pointed to a close relationship between technologies, digitalization, and digital transformation. Both were further linked to education and workforce competences. These results indicate that technologies drive the digitalization and transformation of socioeconomic activities through the workforce competences that are developed via education and training. Earlier research supports this interpretation of the findings.

Technologies are generally seen as essential tools for promoting digitalization (Liu et al., 2024) and for creating ecosystems that facilitate digital transformation (Oludapo et al., 2024). This perspective aligns with the concept of the 4th Industrial Revolution, also known as the Technological Revolution (Van Meeteren et al., 2022). Digital technologies have permeated operations in several industries, including construction (Rinchen et al., 2024) and agriculture (Zhao et al., 2024). Digital technologies have also been found to enhance organizational performance, even in small and medium-sized enterprises (Skare et al., 2023). This supports the conclusion that digitalization and the adoption of technologies occur at both macro and micro levels of economic development, as was also confirmed through the concordance analyses in this study.

At both the macro and micro levels, digital transformations collectively create digital economies. Digital economies have been promoted for their ability to foster sustainable development (Raihan, 2024) in both urban (Xu et al., 2024) and rural areas (Deng et al., 2024). These economies can reduce the negative environmental impact of human activities (Jin et al., 2024), promote green transformations, boost total factor productivity (Cheng et al., 2023; Li et al., 2024), and foster the creation of new business models and corporate strategies. Additionally, digital economies have been found to improve customer experiences (Skare et al., 2023) and reduce income inequalities (Tian & Xiang, 2024). Like traditional economies, digital economies evolve through different stages, with each transition requiring digital transformation. Given a wide range of objectives and contexts of digital transformation, they encompass a wide range of processes (Chen et al., 2024) driven by the need to improve organizational performance (Barba-Sanchez et al., 2024) through creating better value propositions (Ghafoori et al., 2024), fostering innovation (Fang & Liu, 2024), implementing change, increasing risk-taking behaviors, and improving financial outcomes (Wu & Lu, 2023). The process of digital transformation is influenced by a multitude of factors (Ran et al., 2023), which are not always under control of organizations, which may explain why many digital transformations fail (Oludapo et al., 2023). In fact, a secondary outcome of this research is the identification of digital barriers as an important factor in digital transformation. Therefore, to succeed in digital transformation and contribute to the growth of digital economies, individuals and organizations should possess relevant digital and technological skills to navigate associated risks and opportunities. Education plays a critical role in equipping the workforce with these competencies. In this study, education and workforce competences were among the most frequently mentioned concepts, reinforcing their significance in the context of technology and digital transformation. These findings echo earlier research highlighting the importance of education in preparing the workforce for participation in digital economies. For instance, Clemente-Almendros et al. (2024), Mirza et al. (2024) proved that the education of managers supports workplace digital transformation, while Wang et al. (2023) asserted that both technology and education drive the growth of modern economies.

Overall, this study demonstrated that technologies drive digital transformation via education and workforce competences across multiple socioeconomic sectors. Therefore, education should focus on the development of skills relevant to the use of technologies and digital transformations.

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Conclusions and Implications

This research underscores the pivotal role of education and workforce competencies in driving digital transformation across various sectors and socioeconomic development levels. While technology serves as the primary catalyst for digitalization, its successful implementation hinges on a digitally skilled and well-educated workforce. The study reaffirms the symbiotic relationship between technology, education, and workforce development in fostering digital economies. These economies not only stimulate economic growth but also advance sustainability, innovation, and social equity.

To fully capitalize on the potential of digitalization, future initiatives should prioritize educational programs that equip individuals with the necessary skills to navigate the rapidly evolving digital landscape. By doing so, economies can promote the success of digitalization rather than its failure.

One important finding of this research is the emergence of digital barriers as factors hindering digitalization and digital transformation. This suggests that the success of digitalization and transformation depends on the simultaneous interplay of factors both promoting and hindering digital activities. Consequently, promoting digital transformation requires addressing the development and implementation of technologies while simultaneously overcoming digital barriers.

The implications of this research extend to educators. Education systems should prioritize digital literacy and competency-building programs to prepare the workforce for a digitally driven economy. This involves aligning curricula with the evolving demands of contemporary and emerging technologies. For organizations, especially those in industries undergoing rapid digitalization, investing in workforce training is essential. Continuous upskilling and reskilling initiatives will be key to ensuring that employees remain adaptable to technological changes, thereby enabling organizations to maintain competitiveness and innovation.

Declaration of Interest

The authors declare no competing interest.

References

Anthony, L. (2024). *AntConc software* (Version 4.3.1) [Computer software]. https://www.laurenceanthony.net/software/antconc/

Audrin, B., Audrin, C., & Salamin, X. (2024). Digital skills at work – Conceptual development and empirical validation of a measurement scale. *Technological Forecasting and Social Change, 202,* Article 123279. https://doi.org/10.1016/j.techfore.2024.123279

Balsmeier, B., & Woerter, M. (2019). Is this time different? How digitalization influences job creation and destruction. *Research Policy, 48*(8). https://doi.org/10.1016/j.respol.2019.03.010

Barba-Sancez, V., Meseguer-Martínez, A., Gouveia-Rodrigues, R., & Raposo, M. L. (2024). Effects of digital transformation on firm performance: The role of IT capabilities and digital orientation. *Helioyn,10,* Article e22725. https://doi.org/10.1016/j.heliyon.2024.e27725

Bellantuono, N., Nuzzi, A., Pontrandolfo, P., & Scozzi, B. (2021). Digital transformation models for the I4.0 transition: Lessons from the change management literature. *Sustainability, 13*(23). Article 12941. https://doi.org/10.3390/su132312941

CEDEFOP (2024). *Skills-OVATE*. https://www.cedefop.europa.eu/en/tools/skills-online-vacancies

Cheng, Y., Zhou, X., & Li, Y. (2023). The effect of digital transformation on real economy enterprises' total factor productivity. *International Review of Economics and Finance, 85,* 488-501. https://doi.org/10.1016/j.iref.2023.02.007

Chen, A., Li, L., & Shahid, W. (2024). Digital transformation as the driving force for sustainable business performance: A moderated mediation model of market-driven business model innovation and digital leadership capabilities. *Heliyon, 10,* Article e29509. https://doi.org/10.1016/j.heliyon.2024.e29509

Chomintra, M. (2023). Assessing the use of critical literacies in mis/disinformation literacy instruction. *The Journal of Academic Librarianship, 49,* Article 102762. https://doi.org/10.1016/j.acalib.2023.102762

Clemente-Almendros, J. A., Nicoara-Popescu, D., & Pastor-Sanz, I. (2024). Digital transformation in SMEs: Understanding its determinants and size heterogeneity. *Technology in Society, 77,* Article 102483. https://doi.org/10.1016/j.techsoc.2024.102483

Cordeiro, C. M. (2019). A corpus-based approach to understanding market access in fisheries and aquaculture international business research: A systematic literature review. *Aquaculture and Fisheries, 4,* 219-230. https://doi.org/10.1016/j.aaf.2019.06.001

Deng, X., Huang, M., & Peng, R. (2024). The impact of digital economy on rural revitalization: Evidence from Guangdong, China. *Heliyon, 10,* Article e28216. https://doi.org/10.1016/j.heliyon.2024.e28216

European Commission (2024). *Digital skills*. https://digital-strategy.ec.europa.eu/lv/policies/digital-skills

European Commission (2024). *The ESCO classification*. https://esco.ec.europa.eu/en/classification/skill_main

European Commission (2022a). *The digital economy and society index (DESI).* https://digital-strategy.ec.europa.eu/en/policies/desi

European Commission (2022b). *Digital competences framework (DigComp 2.2).* https://ec.europa.eu/social/main.jsp?langId=en&catId=89&newsId=10193&furtherNews=yes

Ewenstein, B., Smith, W., & Sologar, A. (2015). *Changing change management*. McKinsey, Co. https://www.mckinsey.com/featured-insights/leadership/changing-change-management

Fang, X., & Liu,M. (2024). How does the digital transformation drive digital technology innovation of enterprises? Evidence from enterprise's digital patents. *Technological Forecasting & Social Change, 204,* Article 123428. https://doi.org/10.1016/j.techfore.2024.123428

Florek-Paszkowska, A., Ujwary-Gil, A., & Godlewska-Dzioboń, B. (2021). Business innovation and critical success factors in the era of digital transformation and turbulent times. *Journal of Entrepreneurship, Management and Innovation, 17*(4), 7–28. https://doi.org/10.7341/20211741

Geada, N., Alturas, B., & Anunciacao, P. (2023). Digital change management in healthcare organizations : Insights from performance context. *Proceedings of the 18th Iberian Conference on Information Systems and Technologies (CISTI)*. https://doi.org/10.23919/CISTI58278.2023.10211720

Ghafoori, A., Gupta, M., Merhi, M. I., Gupta, S., & Shore, A. P. (2024). Toward the role of organizational culture in data-driven digital transformation. *International Journal of Production Economics, 271,* Article 109205. https://doi.org/10.1016/j.ijpe.2024.109205

Gobniece, Z., & Titko, J. (2024). Staff competencies for digital transformation: Results of bibliometric analysis. *Virtual Economics, 7*(1), 25-46. https://doi.org/10.34021/ve.2024.7.01(2)

Graneheim, U. H., & Lundman, B. (2004). Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse Education Today, 24,* 105-112. https://doi.org/10.1016/j.nedt.2003.10.001

Han, S.-F., Zhu, R.-F., & Zhao, J. (2017). A study of clinical psychological nursing research hotspots in China and variation trends based on word frequency analysis and visualization analysis. *Chinese Nursing Research, 4,* 186-191. http://dx.doi.org/10.1016/j.cnre.2017.06.005

Imjai, N., Promma, W., Usman, B., & Aujirapongpan, S. (2024). The intertwined effects of digital literacy, agile mindset on design thinking skill and management control competency: Insights from Thai young accountants. *International Journal of Information Management Data Insights, 4*(2). https://doi.org/10.1016/j.jjimei.2024.100244

Javaid, M., Haleem, A., Singh, R. P., & Sinha, A .K. (2024). Digital economy to improve the culture of industry 4.0: A study on features, implementation and challenges. *Green Technologies and Sustainability, 2,* Article 100083. https://doi.org/10.1016/j.grets.2024.100083

Jin, X., & Lyu, K. (2024). The impact of digital economy on emerging employment trends: Insights from the China Family Panel Survey (CFPS). *Finance Research Letters*, *64*. https://doi.org/10.1016/j.frl.2024.105418

Jin, M., Feng, Y., Wang, S., Chen, N., & Cao, F. (2024). Can the development of the rural digital economy reduce agricultural carbon emissions? A spatiotemporal empirical study based on China's provinces. *Science of the Total Environment, 939*, Article 173437. https://doi.org/10.1016/j.scitotenv.2024.173437

Li, H., Zhang, Y., & Li, Y. (2024). The impact of the digital economy on the total factor productivity of manufacturing firms: Empirical evidence from China. *Technological Forecasting & Social Change, 207,* Article 123604. https://doi.org/10.1016/j.techfore.2024.123604

Liu, Y., Zeng, N., Papadonikolaki, E., Maritshane, K., & Chan, P. W. (2024). The future of digitalized project practices through data-savvy talent: A digital competence formation perspective. *Project Leadership and Society, 5,* Article 100120. https://doi.org/10.1016/j.plas.2024.100120

Łuszczuk, M., Padrtova, B., & Szczerbowicz, W. (2020). Political dimension of Arctic research. *Oceanologia, 62,* 608-621. https://doi.org/10.1016/j.oceano.2020.03.008

Kasilingam, S., Keepers, M., & Wuest, T. (2021). A bibliometric analysis of physics-based and data-driven hybrid modeling. *Procedia CIRP, 103,* 49-54. https://doi.org/10.1016/j.procir.2021.10.007

Kulju, E., Jarva, E., Oikarinen, A., Hammaren, M., Kanste, O., & Mikkonen, K. (2024). Educational interventions and their effects on healthcare professionals' digital competence development: A systematic review. *International Journal of Medical Informatics, 185,* Article 105396. https://doi.org/10.1016/j.ijmedinf.2024.105396

Marzouk, M., & Enaba, M. (2019). Text analytics to analyze and monitor construction project contract and correspondence. *Automation in Construction, 98,* 265-274. https://doi.org/10.1016/j.autcon.2018.11.018

Meng, X.-N., Xu, S.-C., & Hao, M.-G. (2023). Can digital-real integration promote industrial green transformation: Fresh evidence from China's industrial sector. *Journal of Cleaner Production,* Article 426. https://doi.org/10.1016/j.jclepro.2023.139116

Mirza, S.S., Miao, Y., Corbet, S., Scrimgeour, F., & Goodell, J. W. (2024). Benefits of Top Management Team Education for Corporate Digital Transformation: *A Critical Mass Perspective from China. Finance Research Letters, 61,* Article 104976. https://doi.org/10.1016/j.frl.2024.104976

Misnevs, B., Kabashkin, I., & Uzule, K. (2021). A model describing the required digital and green competences of VET educators for practical use. *Proceedings to the 6th South-East Europe Design Automation, Computer Engineering, Computer Networks & Social Media Conference of IEEE Computational Intelligence Society.* https://doi.org/10.1109/SEEDA-CECNSM53056.2021.9565883

Nahotko, M., Zych, M., Januszko-Szakiel, A., & Jaskowska, M. (2023). Big data-driven investigation into the maturity of library research data services (RDS). *The Journal of Academic Librarianship, 49,* Article 102646. https://doi.org/10.1016/j.acalib.2022.102646

Oludapo, S., Carroll, N., & Helfert, M. (2024). Why do so many digital transformations fail? A bibliometric analysis and future research agenda. *Journal of Business Research, 174,* Article 114528. https://doi.org/wo.1016/j.busres.2024.114528

Peng, S., Jiang, X., & Li, Y. (2023). The impact of the digital economy on Chinese enterprise innovation based on intermediation models with financing constraints. *Heliyon, 9,* Article e13961. https://doi.org/10.1016/j.heliyon.2023.e13961

Raihan, A. (2024). A review of the potential opportunities and challenges of the digital economy for sustainability. *Innovation and Green Development, 3,* Article 100174. https://doi.org/10.1016/j.igd.2024.100174

Ran, Q., Yang, X., Yan, H., Xu, Y., & Cao, J. (2023). Natural resource consumption and industrial green transformation: Does the digital economy matter? *Resources Policy, 81,* Article 103396. https://doi.org/10.1016/j.resourpol.2023.103396

Rinchen, S., Banihashemi, S., & Alkilani, S. (2024). Driving digital transformation in construction: Strategic insights into building information modelling adoption in developing countries. *Project Leadership and Society, 5,* Article 100138. https://doi.org/10.1016/j.plas.2024.100138

Sadigov, R. (2022). Impact of digitalization on entrepreneurship development in the context of business innovation management. *Marketing and Management of Innovations, 1,* 167-175. https://doi.org/10.21272/mmi.2022.1-12

Schiavi, G. S., Behr, A., & Marcolin, C. B. (2024). Institutional theory in accounting information systems research: Shedding light on digital transformation and institutional change. *International Journal of Accounting Information Systems, 52,* Article 100662. https://doi.org/10.1016/j.accinf.2023.100662

Sinclair, S., & Rockwell, G. (2024a). *Voyant Tools* (Version v.2.6.14) [Web-based reading and analysis environment for digital texts]. https://voyant-tools.org/

Sinclair, S., & Rockwell, G. (2024b). *Voyant Tools Help*. https://voyant-tools.org/docs/#!/guide/collocatesgraph

Skare, M., de las Mercedes de Obesso, M., & Ribeiro-Navarrete, S. (2023). Digital transformation and European small and medium enterprises (SMEs): A comparative study using digital economy and society index data. Intern*ational Journal of Information Management, 68,* Article 102594. https://doi.org/10.1016/j.ijinfomgt.2022.102594

Tian, L., & Xiang, Y. (2024). Does the digital economy promote or inhibit income inequality? *Heliyon, 10,* Article e33533. https://doi.org/10.1016/j.heliyon.2024.e33533

Uzule, K, Kuzmina-Merlino, I., & Merlino, M. (2021). Modern managers in GIG economies: competencies, personality and their effect on manager education in the digital era. In I. Kabashkin, I. Yatskiv, & O. Prentkovskis, O. *(Eds.) Reliability and statistics in transprotation & communication. RelStat 2020. Lecture Notes in Networks & Systems, 195* (pp. 613-622). Springer. https://doi.org/10.1007/978-3-030-68476-1_57

Uzule, K., & Kuzmina-Merlino, I. (2022). Framework of digital competences for business and management programs in higher education. In I. Kabashkin, I. Yatskiv, & O. Prentkovskis, O. *(Eds.) Reliability and statistics in transprotation & communication. RelStat 2021. Lecture Notes in Networks & Systems, 410* (pp. 435-447). Springer. https://doi.org/10.1007/978-3-030-96196-1_40

Uzule, K., & Verina, N. (2023). Digital barriers in digital transition and digital transformation: literature review. *Economics and Culture, 20*(1), 125-143. https://doi.org/10.2478/jec-2023-0003

Van Meeteren, M., Trincado-Munoz, F., Rubin, T. H., & Vorley, T. (2022). Rethinking the digital transformation in knowledge-intense services: A technology space analysis. *Technological Forecasting & Social Change, 179,* Article 121631. https://doi.org/10.1016/j.techfore.2022.121631

Vought, V., Vought, R., Lee, A. S., Zhou, I., Garneni, M., & Greenstein, S. A. (2024). Application of sentiment and word frequency analysis of physician review sites to evaluate refractive surgery care. *Advances in Ophthalmology Practice and Research, 4,* 78-83. https://doi.org/10.1016/j.aopr.2024.03.002

Wang, Y., Hong, D., & Huang, J. (2023). A diffusion of innovation perspective for digital transformation on education. *Procedia Computer Science, 225,* 2439-2448. https://doi.org/10.1016/j.procs.2023.10.235

World Economic Forum (2023). *The future of jobs report 2023*. https://www.weforum.org/publications/the-future-of-jobs-report-2023/

World Economic Forum (2023). *Why we need to ramp up tech diplomacy to harness opportunities of the digital economy*. https://www.weforum.org/agenda/2023/12/tech-diplomacy-harness-digital-economy/

Wu, K., & Lu, Y. (2023). Corporate digital transformation and financialization: Evidence from Chinese listed firms. *Finance Research Letters, 57,* Article 104229. https://doi.org/10.1016/j.frl.2023.104229

Xia, L., Baghaie, S., & Mohammad Sajadi, S. (2024). The digital economy: Challenges and opportunities in the new era of technology and electronic communications. *Ain Shams Engineering Journal, 15*(2). https://doi.org/10.1016/j.asej.2023.102411

Xu, Q., Zhong, M., & Dong, Y. (2024). Digital economy and risk response: How the digital economy affects urban resilience. *Cities, 155,* Article 105397. https://doi.org/10.1016/j.cities.2024.105397

Ye, Y., & Chen, K.-H. (2024). Hospitality employees and digital transformation: The mediating roles of alienation and motivation. *International Journal of Hospitality Management, 119,* Article 103731. https://doi.org/10.1016/j.ijhm.2024.103731

Zhao, L., Chen, H., Wen, C., & Y, J. (2024). Digital transformation of the agricultural industry: Behavioral decision-making, influencing factors, and simulation practices in the Yunnan highlands. *Journal of Environmental Management, 358,* Article 120881. https://doi.org/10.1016/j.jenvman.2024.120881

Zhou, D., Zha, F., Qiu, W., & Zhang, X. (2024). Does digital literacy reduce the risk of returning to poverty? Evidence from China. *Telecommunications Policy.* https://doi.org/10.1016/j.telpol.2024.102768

Zou, J., & Deng, X. (2022). To inhibit or to promote: How does the digital economy affect urban migrant integration in China? *Technological Forecasting and Social Change*, *179*. https://doi.org/10.1016/j.techfore.2022.121647

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