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The Rise of Digital Skills Research in the Fourth Industrial Revolution: A Bibliometric Analysis (2015–2025)

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ABSTRACT

This study presents a bibliometric analysis of digital skills research based on 450 Scopus-indexed articles published between 2015 and 2025 in Business, Management, and Accounting. Biblioshiny and VOSviewer were used to identify influential authors, leading journals, institutions, and emerging themes. The analysis reveals an annual publication growth rate of 58.01%, underscoring the increasing importance of digital competencies in workforce development, educational innovation, and economic resilience within the context of the Fourth Industrial Revolution. Keyword co-occurrence highlights clusters related to digital transformation, technology adoption, digitisation, e-learning, and the digital divide, reflecting how organisations and societies incorporate digital capabilities. Bibliometric coupling identifies the intellectual influence of scholars such as Perez-Amaral, Lopez, and Garin-Munoz, while journals including Technological Forecasting and Social Change and Technology in Society emerge as central platforms for disseminating this research. Geographical analysis highlights significant contributions from Spain, Italy, and Indonesia, illustrating both global engagement and regional priorities. The COVID-19 pandemic further accelerated digital transformation, intensifying the urgency of digital upskilling. This review synthesises the evolution, structure, and gaps of digital skills research and provides guidance for scholars, educators, policymakers, and practitioners seeking to strengthen digital literacy and advance inclusive digital economies.

Keywords: Digital Skills, Digital Transformation, e-learning, Technology Adoption, Bibliometric analysis, VOSviewer
JEL Classifications: O33, M15, J24

1. INTRODUCTION

The rapid advancement of digital technologies has transformed economies, societies, and education systems worldwide. Within the Fourth Industrial Revolution, characterised by automation, artificial intelligence (AI), big data, and the Internet of Things (IoT), digital skills have become indispensable for success in technology-driven environments. These competencies strengthen workforce resilience, foster societal adaptability, and enhance global competitiveness. The urgency of developing digital literacy was further underscored during the COVID-19 pandemic, which exposed significant skills gaps and prevented many organisations, particularly small and medium-sized enterprises (SMEs), from transitioning effectively to digital systems during a period when technological adaptation was critical (Donthu and Gustafsson, 2020; Lathabhavan and Kuppusamy, 2024).

Digital competencies enable SMEs to adopt, operate, and optimise tools that improve efficiency, streamline operations, support data-driven decision-making, strengthen customer engagement, and accelerate innovation. Consequently, they contribute directly to productivity, competitiveness, and long-term growth. Yet, a persistent shortage of digital skills continues to delay digital initiatives worldwide. Reports indicate that 67% of digital transformation projects are postponed due to insufficient expertise (Aisyah et al., 2024; Ewim et al., 2021; Law, 2022; Lia, 2023; Setiyaningrum et al., 2021; Suartana et al., 2024; White, 2025). According to the World Economic Forum (2023), technological

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advances are expected to disrupt 35% of job skills within the next 5 years, with the disruption rate already reaching 44% by 2023. These statistics highlight the urgent need for upskilling and reskilling initiatives to prepare the global workforce for digital transformation.

SMEs are particularly vulnerable. Many lack the resources and expertise required to implement digital technologies effectively, which constrains innovation, reduces competitiveness, and hampers growth (Bikse et al., 2021; Ghobakhloo, 2020; Ochuba et al., 2024; Ollerenshaw et al., 2021; Ramadhan et al., 2024; Roman and Rusu, 2022; Shaikh et al., 2021; SME Corporation Malaysia, 2024; Uwagaba et al., 2023; Widiyanti et al., 2024; World Bank Group, 2022; Yang and Ming, 2024). Empirical evidence illustrates the severity of this shortage. SME Corporation Malaysia (2024) reported that more than 40% of SMEs lack employees with adequate digital competence. Other studies highlight difficulties in attracting and retaining digitally skilled professionals, with demand consistently outpacing supply (Arie and Fikry, 2021; Restrepo-Morales et al., 2024; Rupeika-Apoga and Petrovska, 2022).

Although digital skills are widely recognised as critical, findings on their impact on SME performance remain inconsistent. Some studies demonstrate a strong positive relationship (Joensuu-Salo and Matalamäki, 2023; Surahman et al., 2023), others show moderate associations (Mahmudah and Muhtarom, 2024; Mai et al., 2023; Wulandari et al., 2025; Zhe and Hamid, 2021), while a few report weak correlations (Khin and Ho, 2019; Prakasa and Jumani, 2024; Teng et al., 2022; Wahyuningtyas et al., 2023; Yasa et al., 2019). These variations may partly result from methodological limitations, as many studies rely on non-probability sampling techniques such as purposive and convenience sampling, which restrict generalisability (Rosyidah et al., 2024; Teoh et al., 2022; Ullah et al., 2025; Yasa et al., 2019).

To interpret these dynamics, scholars have applied theoretical perspectives such as the Resource-Based View (RBV), which emphasises the strategic value of firm-specific resources, including digital competencies, in sustaining competitive advantage (Khin and Ho, 2019; Mai et al., 2023; Ullah et al., 2025; Wahyuningtyas et al., 2023; Yang and Ming, 2024). Complementing this, Dynamic Capabilities Theory explains how firms adapt, integrate, and reconfigure internal resources to respond effectively to digital change (Ellström et al., 2022; Gyamerah et al., 2025; Khin and Ho, 2019; Prakasa and Jumani, 2024; Ullah et al., 2025; Yang and Ming, 2024; Yeow et al., 2018). Research further shows that employee digital competence is central to organisational readiness and transformation outcomes (Eller et al., 2020), while deficits in digital literacy remain a persistent barrier that increase transformation risks (Bousdekis and Kardaras, 2020; Law, 2022).

Despite growing policy attention, particularly in Malaysia, no scalable solution has been established to address skill shortages across industries (Dhakal et al., 2024; Rupeika-Apoga et al., 2022; Tabrizi et al., 2019; Trenerry et al., 2021). Moreover, much research on digital transformation has overlooked the central role of digital skills as a driver of organisational change. Scholars increasingly call for comparative, cross-country studies and for investigations into how socio-economic factors influence the development and application of digital competencies (Bouwmans et al., 2024; Nadkarni and Prügl, 2021; Rêgo et al., 2024; Schlegel and Kraus, 2023). These gaps underscore the need for a comprehensive synthesis of digital skills research to clarify trends, identify influential contributions, and highlight opportunities for future inquiry.

In response, this study conducts a bibliometric analysis of 450 Scopus-indexed articles published between 2015 and 2025 in Business, Management, and Accounting. Using Biblioshiny and VOSviewer, it examines publication trends, leading scholars, core journals, dominant themes, and geographical patterns. The objective is to provide a systematic overview of digital skills research and to identify emerging directions for future investigation. By mapping the evolution of the field, this study offers evidence-based insights to support researchers, educators, policymakers, and practitioners in strengthening digital competencies, advancing workforce preparedness, and fostering inclusive digital economies in an era of rapid technological transformation.

2. MATERIALS AND METHODS

This bibliometric study adopted a structured and systematic approach to examine scholarly research on digital skills. The dataset was retrieved from the Scopus database, recognised as one of the most comprehensive and authoritative sources of peer-reviewed academic literature. Scopus was selected to ensure the inclusion of high-quality publications across a wide range of disciplines. The search targeted documents containing the phrase "digital skills" published between 2015 and 2025. This timeframe was chosen to capture recent developments associated with technological progress and the growing importance of digital competencies in education and employment.

To ensure relevance, specific inclusion criteria were applied. Only peer-reviewed journal articles written in English were considered, and the analysis was confined to the fields of Business, Management, and Accounting. These subject areas were selected because they align closely with the study's objective of examining the relationship between digital skills, organisational performance, innovation, and workforce transformation. Publications that did not explicitly address digital skills or that fell outside the designated subject areas were excluded to maintain thematic coherence. Table 1 presents the inclusion criteria applied in this study.

The analysis was conducted using two specialised bibliometric tools, Biblioshiny and VOSviewer. Biblioshiny, built on the Bibliometrix R package (Aria and Cuccurullo, 2017), was

Table 1: Inclusion criteria

Inclusions	Inclusion criteria
Research issue	Digital skill
Source type	Peer-reviewed journal article
Subject area	Business, Management, and Accounting
Year of publication	2015–2025 (as of 4 July 2025)
Language	English

employed to perform keyword co-occurrence analysis and to examine author and journal coupling. These techniques facilitated the identification of dominant research themes, leading contributors, and core publication outlets. VOSviewer was used to construct and visualise citation networks, enabling the mapping of relationships among influential authors, highly cited works, and major journals. The visual outputs generated by these tools provided a detailed representation of the intellectual structure of the field.

Several bibliometric indicators were examined to track the evolution and structure of digital skills research. Citation analysis was applied to evaluate the academic impact of specific articles and authors. Co-authorship analysis provided insights into collaboration networks and interdisciplinary linkages. Keyword frequency and co-occurrence mapping enabled the identification of thematic clusters and emerging research directions. Bibliometric coupling further revealed patterns of association among authors, journals, and countries, helping to identify influential research hubs and collaborative efforts.

In addition, a geographic analysis was performed to identify the most active regions contributing to digital skills research and to highlight global trends and national priorities in digital competence development. Temporal analysis was also undertaken to assess the evolution of publication activity over time, with particular attention to the acceleration of digital transformation during the COVID-19 pandemic. By integrating these methods, the study established a replicable and transparent framework for evaluating the landscape of digital skills research. This approach systematically synthesises current trends, highlights knowledge gaps, and identifies opportunities for future investigation.

3. RESULTS

3.1. Descriptive Analysis

This bibliometric study analysed 450 peer-reviewed articles retrieved from the Scopus database and published between 2015 and 2025 in the fields of Business, Management, and Accounting. These publications provide a quantitative overview of research on digital skills, highlighting trends, patterns, and scholarly characteristics over the past decade. The analysis revealed a marked and accelerating growth in interest, with an annual publication rate increasing by 58.01%. This expansion reflects the rising significance of digital competencies in response to technological advancement and the digital transformation of organisations and institutions. The growth in publications underscores the role of digital skills as a critical driver of workforce development, educational innovation, and organisational adaptability.

The 450 documents were published across 260 distinct sources, including journals, books, and conference proceedings, which demonstrates the breadth of the field. Research on digital skills intersects with multiple domains, such as business strategy, educational technology, human resource development, and information systems. The wide distribution of publication outlets indicates that the topic attracts interest from a variety of academic perspectives. The average age of the articles was 2.22 years, suggesting that most contributions are recent and closely aligned with current developments. This is particularly important in light of rapid technological change and external disruptions such as the COVID-19 pandemic, which have heightened the demand for digital upskilling and adaptive learning environments.

The dataset collectively received 26,267 citations, averaging 17.09 citations per article. These figures confirm the strong academic influence of digital skills research and its contribution to scholarly discourse and policy debates. Of the 450 documents, 49 were single-authored, while the average number of co-authors per article was 3.13, reflecting the collaborative and interdisciplinary character of the field. Such collaboration is essential for addressing complex issues related to digital literacy, technology adoption, and workforce readiness.

Overall, the descriptive analysis provides essential context for understanding the development, scope, and academic impact of digital skills research. It also establishes a foundation for the subsequent sections, which explore thematic patterns and intellectual linkages that shape this growing field. The main descriptive information of the dataset is presented in Table 2.

3.1.1. Years of publication

Figure 1 presents the annual publication trend of scholarly articles on digital skills in Business, Management, and Accounting from 2015 to 2025. The data shows a steady upward trajectory, reflecting increasing academic attention to digital competencies over the past decade. Between 2015 and 2018, growth was modest, but from 2019 onward publication output rose sharply, marking a turning point in scholarly interest.

The year 2020 recorded a significant increase in publications, coinciding with the onset of the COVID-19 pandemic. The disruption caused by the pandemic compelled educational institutions, businesses, and governments to accelerate the adoption of digital platforms. This shift to remote operations and virtual learning underscored the importance of digital skills, exposing gaps in digital literacy and creating urgent demand for widespread upskilling. In response, researchers intensified their focus on technology adoption, digital competencies, and organisational adaptability.

The upward trend persisted after 2020, with publication output peaking in 2024 before a slight decline in 2025. This sustained growth indicates that digital skills have become firmly established as a central research theme, particularly in relation to workforce

Table 2: Descriptive information

Main information about the data	Outcomes
Timespan	2015–2025 (as of July 4, 2025)
Sources (Journals)	260
Documents	450
Annual growth rate (%)	58.01
Document average age	2.22
Average citations per doc	17.09
References	26,267
Single-authored docs	49
Co-authors per doc	3.13

resilience, institutional innovation, and socio-economic development.

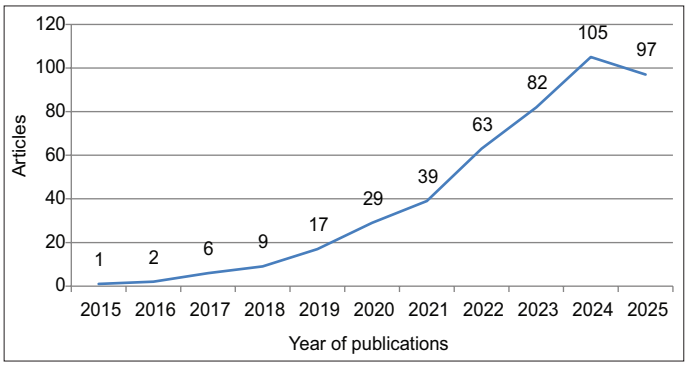
In summary, the trajectory illustrated in Figure 1 highlights the evolving significance of digital skills research within the academic community. The steady rise in publications demonstrates the momentum of the field and reinforces the value of bibliometric studies such as this one, which synthesise these developments and provide structured insights into the advancement of digital skills scholarship.

3.2. Co-word Analysis

Figure 2 presents the keyword co-occurrence network generated using VOSviewer, which visualises the thematic structure of digital skills research. Each node represents a keyword, while the connecting lines indicate the strength of their co-occurrence. The size of the nodes reflects their prominence in the literature, and their spatial arrangement shows the degree of relatedness among terms.

At the centre of the network is "digital skills," the principal hub from which several clusters radiate. The most frequently associated themes include digital transformation, technology adoption, e-learning, digitisation, and the digital divide, demonstrating that digital skills research spans organisational, educational, and technological contexts. One prominent cluster is centred on digital transformation, closely linked with terms such as technology adoption, digitisation, and automation. These associations indicate a strong research focus on how organisations design and implement digital strategies, adapt to technological change, and build agility through digital competencies.

Figure 1: Annual publication trend in digital skills research, 2015–2025



Another significant cluster revolves around e-learning. Keywords such as students, higher education, online learning, and digital devices frequently co-occur, reflecting the field's emphasis on educational contexts. The growth of these terms is closely linked to the COVID-19 pandemic, which accelerated the adoption of remote learning and highlighted the importance of digital skills among educators and learners. The digital divide also emerges as a core theme, associated with concepts such as accessibility, inequality, and educational disparity. This cluster underscores concerns about digital equity and the necessity of ensuring inclusive access to digital tools and training. These findings emphasise that digital transformation must be accompanied by efforts to reduce socio-economic barriers and bridge disparities in digital participation.

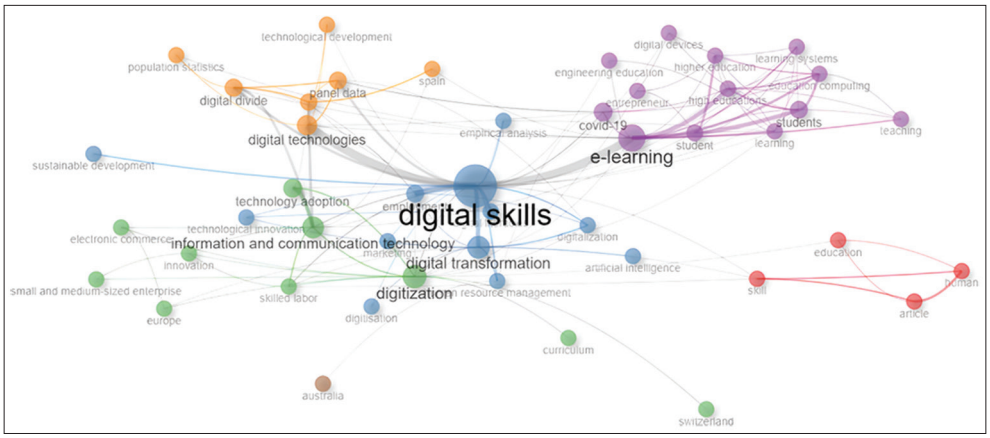
Overall, the co-occurrence network illustrates the growing thematic complexity of digital skills research. The interconnections between clusters highlight how digital skills are embedded in wider societal and organisational challenges, ranging from strategic technology adoption to inclusive education reforms. These insights provide a foundation for identifying new research priorities and encouraging interdisciplinary collaboration in future studies.

3.2.1. Most frequent words

Table 3 presents the ten most frequently occurring keywords identified in the bibliometric analysis of digital skills research. These terms provide insights into the main thematic trends, conceptual emphases, and methodological approaches shaping the discipline. Their prevalence reflects both established areas of inquiry and the growing prominence of emerging subjects in Business, Management, and Accounting.

The keyword digital skills, appearing 34 times, dominates the dataset and affirms its centrality to the field. Its prominence reflects sustained academic interest in how digital competencies drive workforce development, educational reform, and economic

Figure 2: Co-occurrence network of digital skills



Source: VOSviewer

adaptation in increasingly digitised environments. Closely following are digital transformation and technology adoption, each cited 14 times, signalling a strong emphasis on how digital skills facilitate technological integration, strategic innovation, and organisational agility.

Digitisation and e-learning, both appearing 13 times, further illustrate this dual focus on organisational processes and educational contexts. The visibility of e-learning is particularly associated with the COVID-19 pandemic, which accelerated the adoption of virtual education and highlighted the need for digital literacy among both students and educators.

The keyword digital divide, cited 11 times, introduces socio-economic concerns into the discourse. Its prominence underscores scholarly interest in digital inclusion and in addressing barriers that prevent marginalised communities from fully participating in the digital economy. Similarly, information and communication technology, also with 11 occurrences, reflects the importance of infrastructure and policy frameworks in enabling digital competence.

Table 3: Top ten most frequent keywords in digital skills

Ranking	Most frequent words	Occurrences
1	Digital skills	34
2	Digital transformation	14
3	Technology adoption	14
4	Digitisation	13
5	E-learning	13
6	Digital technologies	12
7	Digital divide	11
8	Information and communication technology	11
9	COVID-19	10
10	Panel data	10

The inclusion of COVID-19 confirms the pandemic's transformative role in accelerating digitalisation across education, workplaces, and society. Finally, the presence of panel data among the top terms signals a methodological shift towards empirical, data-driven approaches that investigate the relationship between digital skills and a range of performance outcomes.

Taken together, these frequently used keywords provide a snapshot of the intellectual structure of digital skills research. They reveal how the field engages simultaneously with technological innovation, educational practice, equity considerations, and methodological rigour. This analysis also points to future directions, particularly in integrating digital skills with emerging technologies while ensuring inclusive access and robust empirical foundations.

3.2.2. Word cloud

Figure 3 presents a word cloud generated from the bibliometric analysis, offering a visual summary of the most frequently used terms in the digital skills literature. The size of each word is proportional to its frequency of occurrence across the 450 Scopus-indexed articles, providing an intuitive overview of dominant and emerging themes. This visualisation highlights the conceptual breadth of digital skills research within Business, Management, and Accounting.

At the centre of the word cloud, digital skills appears as the most prominent term, reaffirming its position as the core concept in the field. Its dominance reflects sustained scholarly attention to equipping individuals and organisations with the competencies necessary to participate effectively in technology-driven environments. Closely related are digital transformation and technology adoption, both of which demonstrate research interest in how digital capabilities drive innovation, enable strategic change, and support organisational efficiency.

Figure 3: Cloud mapping

Source: Biblioshiny

Educational themes are also highly visible, particularly through the prominence of e-learning and digital education. These terms reflect the growing reliance on online platforms and virtual learning methods, especially during the COVID-19 pandemic, which accelerated the shift to remote education and increased the demand for scalable digital learning solutions.

Another recurring theme is the digital divide, which highlights persistent concerns about unequal access to digital technologies. Its association with terms such as accessibility and inequality underscores the need for inclusive strategies to close gaps in digital literacy across socio-economic and geographic boundaries.

Beyond these established areas, several emerging keywords point to the evolving scope of the field. Terms such as artificial intelligence, big data, Internet of Things, and electronic commerce reveal a growing emphasis on preparing the workforce for roles in data-driven and automated environments. These keywords signal the integration of digital skills research with frontier technologies, expanding its relevance across disciplines.

In summary, the word cloud provides a compelling visualisation of both established and emerging themes in digital skills research. It demonstrates how the field has evolved to encompass technological, educational, equity-related, and economic dimensions. This representation underscores the richness and diversity of the literature while pointing to areas that warrant deeper exploration in future studies.

3.3. Citation Analysis

Citation analysis provides a quantitative means of assessing scholarly influence and identifying intellectual linkages among documents, authors, journals, and institutions (Aria and Cuccurullo, 2017). Within bibliometric research, two common approaches are co-citation analysis and bibliographic coupling. While co-citation analysis is particularly effective for tracing historical intellectual foundations, this study employed bibliographic coupling, which more accurately captures emerging research trends and highlights collaborative linkages among authors (Gao and Guan, 2009; Zhao and Strotmann, 2008).

Bibliographic coupling establishes connections among publications that share references, thereby uncovering thematic similarities among more recent works that may not yet have accumulated extensive citations. This makes it especially valuable for mapping the evolving structure and developmental trajectory of digital skills research. For this study, VOSviewer was used to conduct bibliometric coupling at multiple levels of aggregation, including authors, documents, journals (sources), organisations, and countries. This multi-dimensional perspective provides a comprehensive understanding of the intellectual landscape, enabling the identification of both enduring foundations and emerging contours of the field.

The following subsections present three focal analyses: author bibliometric coupling analysis (ABCA), journal bibliometric coupling analysis (JBCA), and country/region bibliometric coupling analysis (CRBCA). Together, these analyses identify leading contributors, core publication venues, and geographic centres of scholarship, offering insights into the disciplinary foundations and global distribution of digital skills research.

3.3.1. Author bibliometric coupling analysis (ABCA)

Table 4 presents the results of the Author Bibliometric Coupling Analysis (ABCA), which identifies the most influential scholars in digital skills research. This method examines how frequently authors are cited together, thereby revealing intellectual connections and thematic alignments across the literature. A higher degree of coupling indicates shared research interests and convergence in scholarly objectives.

Table 4 presents the results of the Author Bibliometric Coupling Analysis (ABCA), which identifies the most influential scholars in digital skills research. This method examines how frequently authors are cited together, thereby revealing intellectual connections and thematic alignments across the literature. A higher degree of coupling indicates shared research interests and convergence in scholarly objectives.

Garin-Munoz ranks third and is recognised for research on digital equity, addressing disparities in access to infrastructure and promoting inclusive approaches to digital transformation. Authors such as Bokek-Cohen, Carlisle, and Lissitsa also demonstrate considerable influence. Carlisle and Lissitsa, despite producing only three publications each, have achieved exceptionally high citation counts of 128 and 127, respectively. Their work lies at the intersection of digital transformation and workforce preparedness, with a particular emphasis on upskilling strategies to meet evolving labour market demands.

Emerging scholars, including Mazurchenko and Navickas, are gaining recognition. Mazurchenko's research focuses on digital education and innovation, while Navickas contributes regional perspectives on how digital skills vary across socio-economic and geographic contexts. These contributions highlight the expanding geographical and thematic diversity of the field.

The prevalence of multi-authored publications, with an average of 3.13 co-authors per document, underscores the collaborative and interdisciplinary nature of digital skills research. Contributions increasingly draw on expertise from education, information technology, management, and public policy, reflecting the complex and multifaceted character of the domain.

Table 4: Author bibliometric coupling analysis

Ranking	Author	Documents	Citations
1	Perez-Amaral, T.	6	80
2	Lopez, R.	5	65
3	Garin-Munoz, T.	4	77
4	Bokek-Cohen, Y.	3	61
5	Carlisle, S.	3	128
6	Lissitsa, S.	3	127
7	Mazurchenko, A.	3	70
8	Navickas, V.	3	22
9	Valarezo, A.	3	48
10	Abaddi, S.	2	28

Table 5: Journal bibliometric coupling analysis

Ranking	Journal	Documents	Citations	Cite score
1	Technological Forecasting and Social Change	16	723	26.3
2	Telecommunications Policy	12	230	11.9
3	Technology in Society	11	618	21.9
4	Humanities and Social Sciences Communications	7	33	4.2
5	Industry and Higher Education	7	72	5.9
6	Problems and Perspectives in Management	7	23	3.3
7	Contemporary Educational Technology	6	54	9.3
8	TEM Journal	6	23	2.2
9	IEEE Transactions on Engineering Management	5	177	9.7
10	International Journal of Management Education	5	16	13.7

In conclusion, the ABCA results confirm that a core group of established scholars, together with an emerging generation of researchers, are shaping the intellectual structure of digital skills research. Their work has informed conceptual frameworks, methodological approaches, and practical strategies for embedding digital literacy in organisational and educational contexts. Collectively, these authors have played a pivotal role in advancing global scholarship on digital competencies.

3.3.2. Journal bibliometric coupling analysis (JBCA)

The Journal Bibliometric Coupling Analysis (JBCA) identifies the publication outlets that have made the most significant contributions to digital skills research. The analysis considers three indicators: number of documents published, total citations received, and journal CiteScore. Together, these metrics provide a clear perspective on the platforms that shape scholarly discourse and advance knowledge in this domain. As shown in Table 5, Technological Forecasting and Social Change emerges as the most influential journal, with 16 publications, 723 citations, and a CiteScore of 26.3. Its emphasis on technological innovation and societal implications makes it a central venue for scholarship on the development and application of digital competencies across business, education, and public policy.

In addition to Technological Forecasting and Social Change, two other journals demonstrate strong influence. Telecommunications Policy and Technology in Society, with 12 and 11 articles respectively, address regulatory frameworks, digital governance, and the societal consequences of technology adoption. Their CiteScores of 11.9 and 21.9 underscore their academic relevance, particularly in policy-oriented and equity-focused research.

Other journals, including Humanities and Social Sciences Communications and Industry and Higher Education, each contributed seven publications. Although their CiteScores are lower (4.2 and 5.9), these outlets play an important role in research on curriculum reform, competency-based education, and workforce readiness.

Specialised venues such as Problems and Perspectives in Management, Contemporary Educational Technology, and TEM Journal further demonstrate the interdisciplinary nature of digital skills research. While their citation counts are modest, these journals provide niche perspectives on management education, digital pedagogy, and technology-enabled learning.

Table 6: Country/region bibliometric coupling analysis

Ranking	Country/Region	Documents	Citations
1	Spain	148	876
2	Italy	85	1000
3	Indonesia	78	144
4	United Kingdom	62	399
5	India	61	506
6	Ukraine	57	27
7	Romania	51	108
8	United States of America	47	208
9	Slovakia	46	61
10	China	43	74

Finally, IEEE Transactions on Engineering Management and the International Journal of Management Education, despite publishing fewer articles, have considerable impact. Their high CiteScores and citation levels confirm their importance in advancing research on digital leadership, technological innovation, and competency frameworks in both engineering and managerial education.

Overall, the variation in publication volume, citations, and CiteScores reflects the diverse and multidimensional character of digital skills research. High-impact journals disseminate foundational studies on digital transformation and policy, while specialised outlets contribute targeted insights into education, pedagogy, and professional readiness. Together, these publication platforms demonstrate the interdisciplinary scope and applied significance of the field.

3.3.3. Country/Region bibliometric coupling analysis (CRBCA)

The Country/Region Bibliometric Coupling Analysis (CRBCA) evaluates national and regional contributions to digital skills research by examining publication volume and citation impact. This approach highlights the global distribution of scholarly activity and reveals intellectual connections between countries based on citation patterns. As shown in Table 6 and illustrated in Figure 4, Spain leads in both productivity and influence, followed by Italy and Indonesia, with the United Kingdom, India, Ukraine, Romania, the United States, Slovakia, and China also emerging as important contributors.

Spain demonstrates the highest research productivity, with 148 publications and 876 citations, reflecting strong contributions in areas such as digital transformation, organisational change, and education. Italy, ranking second, produced 85 publications with 1,000 citations, indicating high academic impact and leadership in digital education and workforce readiness. Indonesia ranks third with 78 documents and 144 citations, highlighting its growing role

in digital inclusion and the integration of digital competencies into education, particularly within emerging market contexts.

The United Kingdom and India also feature prominently, producing 62 and 61 documents, respectively. Their research commonly addresses technology adoption, digital readiness, and e-learning infrastructures, providing valuable insights into how digital skills support innovation and workforce resilience.

Several Central and Eastern European countries, including Ukraine, Romania, and Slovakia, are emerging contributors. Although citation counts from these regions remain modest, their growing output reflects increasing attention to educational technology, workplace digitisation, and regional upskilling initiatives.

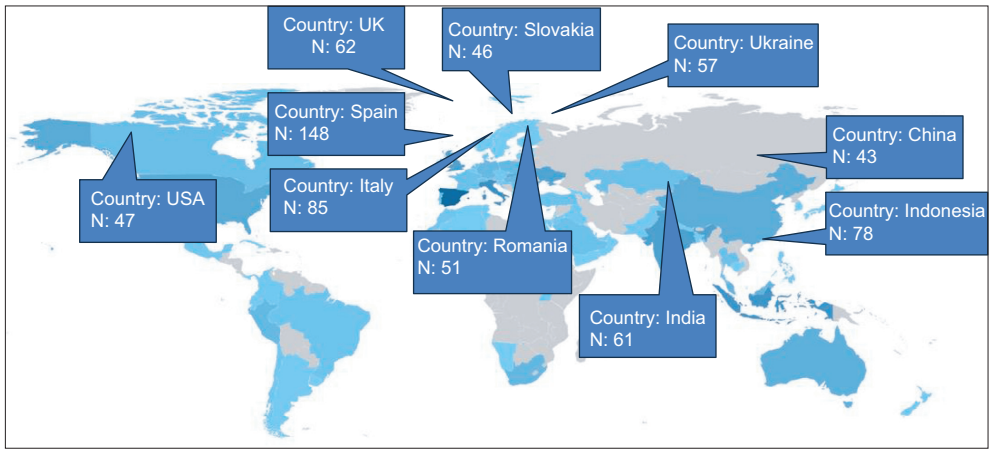
Meanwhile, the United States and China, despite global leadership in digital technologies, show comparatively lower representation in this dataset with 47 and 43 documents, respectively. Their contributions, however, are often published in high-impact journals and emphasise advanced technologies such as artificial intelligence, big data, and the Internet of Things, reflecting a more specialised research focus.

Overall, the CRBCA underscores both the international scope and the regional diversity of digital skills research. Established contributors such as Spain and Italy provide foundational insights into digital transformation and skills development, while emerging economies including Indonesia and India add perspectives on digital inclusion and workforce access. This global distribution highlights the importance of international collaboration in building inclusive frameworks for digital competence and ensuring that digital transformation benefits diverse contexts.

3.4. Research Trends

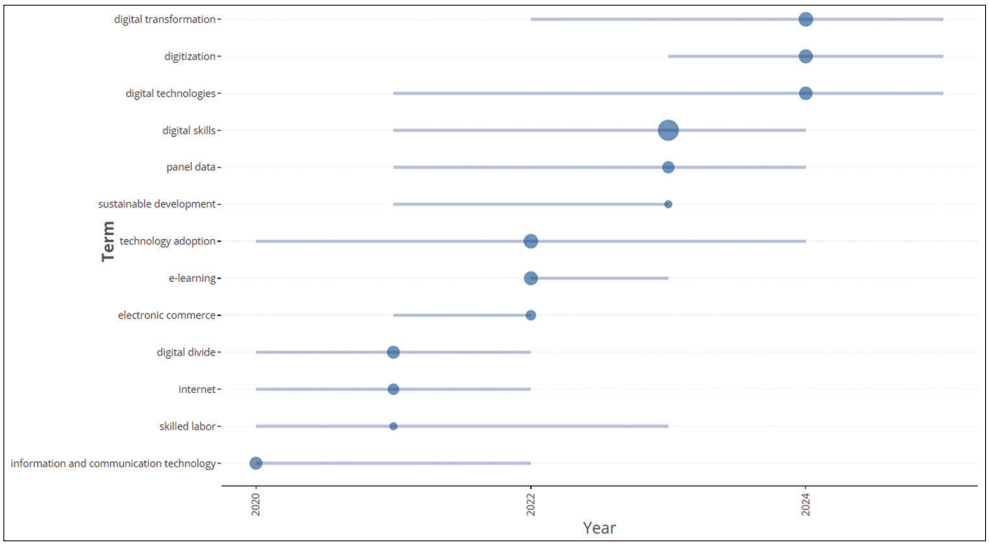
This section examines the evolving thematic landscape of digital skills research from 2015 to 2025 through bibliometric analysis of keyword co-occurrences and citation patterns. By analysing the frequency, timing, and interconnections of key terms, the study highlights dominant areas of inquiry as well as emerging priorities. Figure 5 illustrates the evolution of major keywords across the study period, reflecting both continuity and change in scholarly attention.

Figure 4: Countries' scientific production



Source: Biblioshiny

Figure 5: Evolution of terms (authors' keywords) from 2015 to 2025



Source: Biblioshiny

A major development in recent years is the growing emphasis on digital transformation. Terms such as digital skills, technology adoption, and digital technologies appear consistently in recent publications, indicating a shared academic interest in how individuals and organisations adapt to rapid technological change. This pattern reflects a strong orientation toward application-focused research, examining how digital competencies drive workforce preparedness, enterprise modernisation, and organisational resilience.

Educational themes also feature prominently. Keywords such as e-learning, digital literacy, and online education gained visibility during the COVID-19 pandemic, when remote and hybrid learning models expanded rapidly. Scholars increasingly explore how digital platforms support professional development, skills training, and academic teaching, establishing digital learning as a central mechanism for strengthening digital competencies in both educational and workplace environments.

Another area of growing attention concerns digital equity. The frequent use of terms such as digital divide, accessibility, and inclusion signals a strong interest in addressing disparities in access to digital resources and training. This research examines socio-economic, geographic, and demographic barriers to participation in the digital economy, highlighting the importance of inclusive strategies to ensure equitable opportunities for digital skills development.

The integration of Fourth Industrial Revolution technologies into the digital skills discourse is also evident. Increasing references to artificial intelligence (AI), big data, and the Internet of Things (IoT) demonstrate a shift from foundational digital literacy to advanced technical capabilities. These terms highlight an emerging research agenda focused on analytical, adaptive, and specialised competencies required in modern, data-driven work environments.

The bibliometric patterns also reveal an increase in interdisciplinary and collaborative research. Highly cited studies are frequently co-authored by teams spanning business, education, information systems, and engineering, illustrating the multidimensional nature of digital skills. Rising contributions from countries such as India, Indonesia, and Ukraine further emphasise the global scope of the field and the growing importance of diverse regional perspectives.

In sum, the analysis shows that digital skills research has evolved into a rapidly expanding and increasingly complex domain. While established themes such as digital transformation, e-learning, and digital equity remain central, growing interest in frontier technologies and international collaboration points to future directions. These trends confirm that continued research on digital skills is essential for advancing innovation, addressing global challenges, and preparing societies for a future shaped by digital transformation.

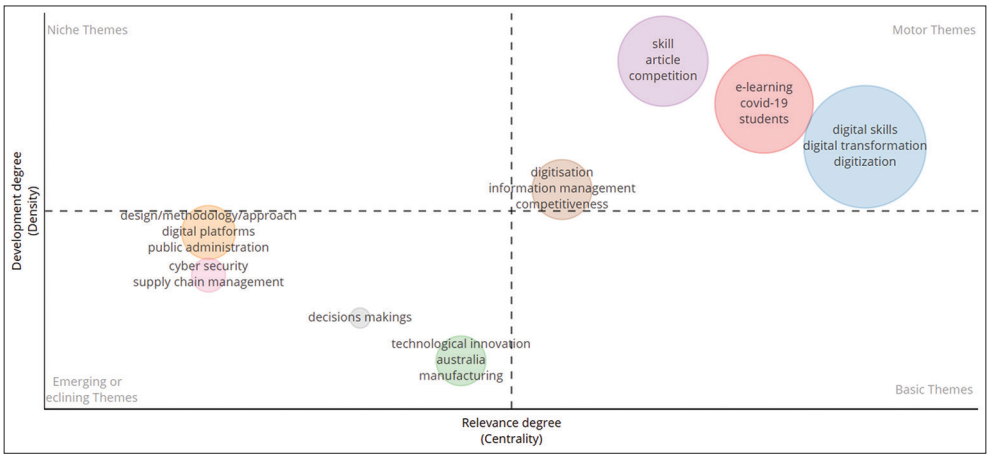
3.5. Thematic Map

To deepen understanding of the conceptual structure of digital skills research, a thematic map was generated using co-word network analysis. Figure 6 presents the map, which organises themes along two principal axes: centrality (horizontal) and density (vertical). Centrality reflects the degree of interaction between a theme and others in the field, indicating its strategic significance, while density represents the internal development of a theme, reflecting its conceptual maturity and empirical depth. The map is divided into four quadrants, each corresponding to a specific thematic category.

The upper-right quadrant, representing motor themes, contains topics that are both highly developed and highly relevant. These intellectual drivers include e-learning, COVID-19, students, skills, and competition, which underscore the central role of digital education and adaptation during global disruptions. Core concepts such as digital transformation, digitisation, and digital skills also appear here, reaffirming their pivotal position in discussions of technological literacy and institutional change.

The lower-right quadrant includes basic and transversal themes, characterised by high centrality but relatively low density. These themes connect broadly across subfields and form foundational pillars of the discipline, although they require further conceptual refinement. The repeated presence of digital transformation, digitisation, and digital skills in this quadrant signifies their dual status as central and evolving areas of inquiry.

Figure 6: Thematic map of digital skills research



Source: Biblioshiny

The lower-left quadrant reflects emerging or declining themes. Topics such as cyber security, supply chain management, public administration, and digital platforms display low centrality and density, suggesting limited influence at present. However, these areas may represent early-stage research streams with strong potential for growth, particularly as global attention to digital resilience and infrastructure expands.

The upper-left quadrant, associated with niche themes, contains topics that are internally well-developed but weakly connected to the broader research landscape. The relative sparsity of this quadrant indicates that digital skills research is largely cohesive and integrated, with few isolated or overly specialised strands.

In summary, the thematic map provides a structured overview of the conceptual organisation of digital skills research. It highlights the dominance of digital transformation, e-learning, and digital skills as core research drivers, while also pointing to emerging or underdeveloped themes that warrant further exploration. This framework enables researchers to focus on high-impact areas while contributing to the development of less-established, but potentially transformative, domains of inquiry.

4. DISCUSSION

This bibliometric analysis provides a comprehensive overview of the evolving digital skills research landscape, offering insights into dominant themes, scholarly trajectories, and global engagement between 2015 and 2025. The annual publication growth rate of 58.01% underscores a substantial rise in academic attention, reflecting the expanding role of digital competencies in shaping modern economies, workplaces, and education systems. This finding is consistent with earlier evidence that 67% of digital transformation projects are delayed due to skills shortages (Aisyah et al., 2024; Law, 2022; Setiyaningrum et al., 2021). It highlights the urgency of addressing workforce readiness gaps that have become particularly evident during the Fourth Industrial Revolution, where automation, artificial intelligence (AI), big data, and the Internet of Things (IoT) are redefining labour markets.

A central finding of this study is the pivotal role of digital transformation as a recurring theme. The repeated intersection of technology adoption, digitisation, and digital skills reflects sustained scholarly interest in how organisations adapt to rapid technological change. This aligns with the Resource-Based View (RBV), which positions firm-specific resources such as digital competencies as a basis for competitive advantage, and with Dynamic Capabilities Theory, which emphasises the ability to reconfigure resources in response to evolving digital environments (Gyamerah et al., 2025; Khin and Ho, 2019).

E-learning has also emerged as a dominant theme, particularly in response to the global transition to digital education during the COVID-19 pandemic. As classrooms and workplaces shifted online, virtual learning became indispensable for skills acquisition, professional development, and organisational adaptability. Research confirms that scalable and accessible e-learning platforms have repositioned digital literacy as an essential competency for sustaining academic and professional participation (Donthu and Gustafsson, 2020; Lathabhavan and Kuppusamy, 2024).

The growing prominence of digital equity further underscores the field's multidimensional character. Keywords such as digital divide, accessibility, and inclusion reflect increasing recognition of unequal access to digital technologies and expertise. This trend reinforces earlier findings that many small and medium-sized enterprises (SMEs) lack adequate digital capabilities (SME Corporation Malaysia, 2024). Studies focusing on underserved populations and transitional economies stress that digital transformation must be accompanied by strategies to reduce systemic inequalities and ensure inclusive participation in the digital economy.

The integration of frontier technologies, including AI, big data, and IoT, is expanding the digital skills agenda. Scholarship is increasingly concerned with the competencies required to interact with these systems, marking a shift from foundational literacy toward advanced analytical and technical skills such as data analytics, machine learning, and systems interoperability. This progression underscores that digital competence is dynamic rather than static, requiring continual adaptation to technological advances.

The Country/Region Bibliometric Coupling Analysis (CRBCA) demonstrates the global reach of digital skills research. Spain and Italy dominate in both volume and citation impact, reflecting strong academic and policy engagement with digital transformation. At the same time, countries such as Indonesia, India, and Ukraine contribute region-specific insights into inclusion, education, and workforce readiness. Their growing visibility in the literature highlights international recognition of digital skills as prerequisites for socio-economic development and emphasises the value of cross-country collaboration.

Despite its contributions, this study acknowledges certain limitations. Bibliometric methods rely on citation-based indicators, which may underrepresent recent or specialised studies that have not yet accumulated significant visibility. Bibliometric coupling is valuable for identifying intellectual linkages but cannot fully capture contextual dimensions such as practical relevance or alignment with policy initiatives.

Several directions for future research emerge from these findings. First, further work should examine how digital skills development can be integrated with emerging technologies such as blockchain, AI, and IoT, while also considering the socio-economic factors that shape access to digital opportunities. Second, greater attention should be devoted to how education and vocational training systems embed digital competencies to prepare learners for rapidly evolving labour markets. Third, bridging regional and socio-economic disparities remains critical, as reducing digital divides will be essential to achieving equitable participation in digital economies.

A particularly promising area for future investigation lies in the development of standardised frameworks for assessing digital skills. Such models could provide benchmarks across

sectors, cultures, and education systems, supporting evidence-based approaches to workforce planning and national digital transformation strategies. By enabling comparability and policy evaluation, these frameworks have the potential to strengthen inclusive and adaptive digital ecosystems.

In conclusion, this discussion highlights the increasing sophistication and multidimensionality of digital skills research. It calls for integrative, equity-focused, and forward-looking studies that address both technological and human aspects of digital transformation. The findings reaffirm the central role of digital competencies in navigating global change and emphasise the importance of sustained international collaboration in developing inclusive and effective strategies for digital development.

5. CONCLUSION

This study provides a comprehensive bibliometric analysis of the rapidly expanding field of digital skills research, offering insights into thematic developments, influential contributors, and international participation patterns. As digital transformation continues to reshape industries, economies, and education systems, the demand for strong digital competencies has become increasingly urgent. The findings confirm the central role of digital skills in enhancing workforce adaptability, supporting educational reform, and enabling inclusive participation in the digital economy.

A key result is the remarkable increase in scholarly output, with publication volume rising by 58.01% annually between 2015 and 2025. This growth reflects a global consensus on the importance of digital literacy for navigating the challenges of a technology-driven world. The prominence of keywords such as digital skills, technology adoption, and e-learning highlights the integration of digital competencies into education, professional development, and organisational strategies. The surge in e-learning research during the COVID-19 pandemic further demonstrates the essential role of digital platforms in sustaining educational continuity and fostering lifelong learning.

The analysis also underscores the growing emphasis on digital equity. Frequent use of terms such as digital divide, accessibility, and inclusion points to a sustained research focus on addressing inequalities in access to resources and training opportunities. This emphasis reinforces that digital transformation is not only a technological process but also a social imperative, requiring policies and practices that reduce systemic barriers and promote inclusive participation.

Geographic analysis confirms the global dimension of digital skills research. Spain and Italy have emerged as leading contributors in both productivity and citation impact, while countries such as Indonesia, India, and Ukraine provide valuable perspectives on digital inclusion and educational access. These findings highlight the need for international collaboration that incorporates region-specific challenges into globally relevant strategies.

Despite its contributions, this study acknowledges several limitations. Bibliometric methods rely on citation and publication indicators, which may not fully capture the qualitative depth, societal impact, or policy relevance of research contributions. Coupling analysis identifies intellectual linkages but does not reveal practical outcomes. Future studies would benefit from integrating qualitative approaches to complement bibliometric evidence and provide richer insights into the effectiveness of digital skills initiatives.

Several promising avenues for future research emerge. Further investigation is required into how digital skills intersect with advanced technologies such as artificial intelligence, blockchain, and the Internet of Things, as these innovations demand specialised competencies that should be embedded into curricula and training frameworks. The development of standardised models for assessing digital skills across contexts also remains a pressing need, as such frameworks would enable benchmarking and guide educators, policymakers, and employers in designing evidence-based strategies for workforce development. In addition, expanding access to digital training in underserved regions will be crucial for ensuring that the benefits of digital transformation are equitably shared.

In conclusion, this study contributes to the growing literature on digital skills by offering a structured analysis of the field's growth, priorities, and global impact. The findings reaffirm that digital competencies are fundamental for navigating the Fourth Industrial Revolution and adapting to rapid technological change. Looking ahead, research that is data-driven, interdisciplinary, and equity-focused will be essential for building resilient, inclusive, and future-ready digital societies.

REFERENCES

Aisyah, N.N.A., Hendrati, I.M., Wardaya, W. (2024), Adaptasi digital marketing dalam rangka mewujudkan ekonomi kreatif UMKM di Kelurahan Penjaringansari. Kacanegara Jurnal Pengabdian Pada Masyarakat, 7(1), 45.

Aria, M., Cuccurullo, C. (2017), Bibliometrix: An R-tool for comprehensive science mapping analysis. Journal of Informetrics, 11(4), 959-975.

Arie, A.H., Fikry, M.A. (2021), Development of synergistic between digitalization MSMEs and digital society in Indonesia. Ho Chi Minh City Open University Journal of Science - Economics and Business Administration, 11(2), 18-30.

Bikse, V., Lusena-Ezera, I., Rivza, P., Rivza, B. (2021), The development of digital transformation and relevant competencies for employees in the context of the impact of the COVID-19 pandemic in Latvia. Sustainability, 13(16), 9233.

Bousdekis, A., Kardaras, D. (2020), Digital Transformation of Local Government: A Case Study from Greece. In: Proceedings - 2020 IEEE 22nd Conference on Business Informatics, CBI 2020, 2. p131-140.

Bouwmans, M., Lub, X., Orlowski, M., Nguyen, T.V. (2024), Developing the digital transformation skills framework: A systematic literature review approach. PLoS One, 19(7), e0304127.

Dhakal, S.P., Nankervis, A., Burgess, J. (2024), The future of work in the Asia Pacific: Addressing critical skills shortages for sustainable development. In: The Future of Work in the Asia Pacific: Addressing Critical Skills Shortages for Sustainable Development. United Kingdom: Taylor and Francis.

Donthu, N., Gustafsson, A. (2020), Effects of COVID-19 on business and research. Journal of Business Research, 117, 284-289.

Ellström, D., Holtström, J., Berg, E., Josefsson, C. (2022), Dynamic capabilities for digital transformation. Journal of Strategy and Management, 15(2), 272-286.

Ewim, C.P.M., Omokhoa, H.E., Ogundeji, I.A., Ibeh, A.I. (2021), Future of work in banking: Adapting workforce skills to digital transformation challenges. International Journal of Multidisciplinary Research and Growth Evaluation, 2(1), 663-676.

Gao, X., Guan, J. (2009), Networks of scientific journals: An exploration of Chinese patent data. Scientometrics, 80(1), 283-302.

Ghobakhloo, M. (2020), Determinants of information and digital technology implementation for smart manufacturing. International Journal of Production Research, 58(8), 2384-2405.

Gyamerah, S., Afshari, L., Asante, D. (2025), Digital transformation in the SME context: The nexus between leadership, digital capabilities and digital strategy. International Small Business Journal: Researching Entrepreneurship, 43(3), 303-328.

Joensuu-Salo, S., Matalamäki, M. (2023), The impact of digital capability on firm performance and growth in incumbent SMEs. Journal of Enterprising Culture, 31(02), 211-232.

Khin, S., Ho, T.C. (2019), Digital technology, digital capability and organizational performance: A mediating role of digital innovation. International Journal of Innovation Science, 11(2), 177-195.

Lathabhavan, R., Kuppusamy, T. (2024), Examining the role of digital leadership and organisational resilience on the performance of SMEs during the COVID-19 pandemic. International Journal of Productivity and Performance Management, 73(8), 2365-2384.

Law, M. (2022), Lack of Digital Skills Jeopardising Digital Transformations. Technology Magazine. Available from: https://technologymagazine.com/articles/lack-of-digital-skills-jeopardising-digital-transformations

Lia, P. (2023), AdWords dan AdSense sebagai teknologi periklanan digital. Jurnal Ilmu Komunikasi, 21(1), 24.

Mahmudah, H., Muhtarom, A. (2024), Effect of business digitalization and social media on MSME performance with digital competence as a mediating variable. Scientific Journal of Informatics, 11(3), 645-660.

Mai, B.T., Nguyen, P.V., Ton, U.N.H., Ahmed, Z.U. (2023), Government policy, IT capabilities, digital transformation, and innovativeness in Post-Covid context: Case of Vietnamese SMEs. International Journal of Organizational Analysis, 32(2), 333-356.

Nadkarni, S., Prügl, R. (2021), Digital transformation: A review, synthesis and opportunities for future research. Management Review Quarterly, 71(2), 233-341.

Ochuba, N.A., Amoo, O.O., Okafor, E.S., Akinrinola, O., Usman, F.O. (2024), Strategies for leveraging big data and analytics for business development: A comprehensive review across sectors. Computer Science and IT Research Journal, 5(3), 562-575.

Ollerenshaw, A., Corbett, J., Thompson, H. (2021), Increasing the digital literacy skills of regional SMEs through high-speed broadband access. Small Enterprise Research, 28(2), 115-133.

Prakasa, Y., Jumani, Z.A. (2024), Linking digital capability to small business performance: The mediating role of digital business transformation. Cogent Business and Management, 11(1), 2342486.

Ramadhan, T.S., Wahyuningtiyas, N., Arsyianto, M.T. (2024), Mengangkat potensi UMKM: Strategi digital marketing untuk sukses pemasaran. Jurnal Abdi Insani, 11(2), 1263-1273.

Rêgo, B.S., Lourenço, D., Moreira, F., Pereira, C.S. (2024), Digital transformation, skills and education: A systematic literature review. Industry and Higher Education, 38(4), 336-349.

Restrepo-Morales, J.A., Ararat-Herrera, J.A., López-Cadavid, D.A., Camacho-Vargas, A. (2024), Breaking the digitalization barrier for SMEs: A fuzzy logic approach to overcoming challenges in business transformation. Journal of Innovation and Entrepreneurship, 13, 84.

Roman, A., Rusu, V.D. (2022), Digital technologies and the performance of small and medium enterprises. Studies in Business and Economics, 17(3), 190-203.

Rosyidah, U., Djatmika, E.T., Wardoyo, C., Restuningdiah, N., Soetjipto, B.E. (2024), Unleashing innovation potential: The role of human capital and digital capability to increase firm performance for sustainable development goals (SDGS) in Lombok island. Journal of Lifestyle and SDG'S Review, 5(2), e02670.

Rupeika-Apoga, R., Petrovska, K. (2022), Barriers to sustainable digital transformation in micro-, small-, and medium-sized enterprises. Sustainability, 14(20), 13558.

Rupeika-Apoga, R., Petrovska, K., Bule, L. (2022), The effect of digital orientation and digital capability on digital transformation of smes during the COVID-19 pandemic. Journal of Theoretical and Applied Electronic Commerce Research, 17(2), 669-685.

Schlegel, D., Kraus, P. (2023), Skills and competencies for digital transformation – a critical analysis in the context of robotic process automation. International Journal of Organizational Analysis, 31(3), 804-822.

Setiyaningrum, I.F., Walyoto, S., Suryati, S., Rizqiana, Z.D. (2021), Sosialisasi digital marketing bagi pelaku UMKM produk pertanian di desa Purworejo, Sragen. Transformatif : Jurnal Pengabdian Masyarakat, 2(2), 215-224.

Shaikh, A.A., Kumar, A., Syed, A.A., Shaikh, M.Z. (2021), A two-decade literature review on challenges faced by SMEs in technology adoption. Academy of Marketing Studies Journal, 25(3), 1-3.

SME Corporation Malaysia. (2024), Economic Performance and Outlook 2023/24. National Entrepreneur and SME Development Council (NESDC). Available from: https://smecorp.gov.my/images/publication/msme_insights/2023_24/economic_report/full_version.pdf

Suartana, I.M., Putra, R.E., Alit, R. (2024), Penguatan kompetensi literasi digital bagi guru sekolah dasar. Jurnal Abadimas Adi Buana, 7(02), 237-246.

Surahman, Shee, H., Fitrian, Z., Sasmoko Adi, A., Yudaruddin, R. (2023), The effect of digital transformation and innovation on SMEs' performance in times of COVID-19. Problems and Perspectives in Management, 21(4), 84-100.

Tabrizi, B., Lam, E., Girard, K., Irvin, V. (2019), Digital transformation is not about technology. Harvard Business Review. Available from: https://hbr.org/2019/03/digital-transformation-is-not-about-technology

Teng, X., Wu, Z., Yang, F. (2022), Research on the relationship between digital transformation and performance of SMEs. Sustainability, 14(10), 6012.

Teoh, M.F., Ahmad, N.H., Abdul-Halim, H., Huat, O.C. (2022), Digital business model innovation and SMEs' competitiveness: Insight from Malaysian SMEs. Global Business and Management Research: An International Journal, 14(3s), 412-433.

Trenerry, B., Chng, S., Wang, Y., Suhaila, Z.S., Lim, S.S., Lu, H.Y., Oh, P.H. (2021), Preparing workplaces for digital transformation: An integrative review and framework of multi-level factors. Frontiers in Psychology, 12, 620766.

Ullah, M.S., Umair, M., Qureshi, A.A., Baloch, F.M., Ahmed, S. (2025), The role of digital technology and digital innovation towards firm performance in a digital economy: In Pakistan. Bulletin of Management Review, 2(2), 56-77.

Uwagaba, J., Daniel Omotosho, T., Otundo George, G., Lecturer, A., Warsaw, M. (2023), Exploring the barriers to artificial intelligence adoption in Sub-Saharan Africa's small and medium enterprises and the potential for increased productivity. World Wide Journal of Multidisciplinary Research and Development, 9(6), 4-10.

Wahyuningtyas, R., Disastra, G., Rismayani, R. (2023), Toward cooperative competitiveness for community development in Economic Society 5.0. Journal of Enterprising Communities: People and Places in the Global Economy, 17(3), 594-620.

White, S.K. (2025), 67% of Digital Transformations Delayed Due to Skill Shortages. CIO. Available from: https://www.cio.com/article/3805174/67-of-digital-transformations-delayed-due-to-skill-shortages.html

Widiyanti, E., Cahyadin, M., Santoso, A.I., Santoso, R.E., Widyamurti, N., Ertimi, B. (2024), Synergy of digital literacy and e-commerce in boosting SME performance. EcceS (Economics Social and Development Studies), 11(1), 49-72.

World Bank Group. (2022), Deep-Dive on Malaysia's Digital Services Trade. The Malaysia Development Experience Series. Available from: https://documents1.worldbank.org/curated/en/099030105172211734/pdf/P174668089457d0060b87c026cd2d227771.pdf

World Economic Forum. (2023), Future of Jobs Report 2023. In World Economic Forum. Available from: https://www3.weforum.org/docs/wef_future_of_jobs_2023.pdf

Wulandari, S.S., Diah, M.L.B.M., Asari, A. (2025), Digital proficiency and entrepreneurial mindset for SME success through market savvy and tech literacy. APTISI Transactions on Technopreneurship, 7(1), 26-36.

Yang, L.C., Ming, C.W. (2024), Digital transformation and its effects on the financial performance of Malaysian SMEs. Journal of Digitainability, Realism and Mastery (DREAM), 3(8), 21-32.

Yasa, N.N.K., Ekawati, N.W., Rahmayanti, P.L.D. (2019), The role of digital innovation in mediating digital capability on business performance. European Journal of Management and Marketing Studies, 4(2), 111-128.

Yeow, A., Soh, C., Hansen, R. (2018), Aligning with new digital strategy: A dynamic capabilities approach. The Journal of Strategic Information Systems, 27(1), 43-58.

Zhao, D., Strotmann, A. (2008), Evolution of research activities and intellectual influences in information science 1996–2005: Introducing author bibliographic-coupling analysis. Journal of the American Society for Information Science and Technology, 59(13), 2070-2086.

Zhe, B.O.M., Hamid, N.A. (2021), The impact of digital technology, digital capability and digital innovation on small business performance. Research in Management of Technology and Business, 2(1), 499-509.