

The Comparison of Digitalization Based on Innovation or Economic Development Through Bibliometric Analysis Between Asian Countries and European Countries

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Abstract: Countries worldwide are undergoing a rapid digitalization and innovation to create smarter and more sustainable urban environments. This study explores the progress made in this regard by comparing the efforts of Asian countries and Europe through bibliometric analysis. The analysis focuses on one main area: digitalization based on economic development or innovation, and three sub-areas: smart city, digitalization in accounting, green innovation, and green economic development. These sub-areas are chosen based on their impact on both economic and financial development.

Using a range of bibliometric indicators, including publication output, citation impact, and collaboration patterns, this study compares the performance of Asian countries and Europe in these areas. This study covers publications between 1997–2023 collected from the Web of Science and not restricted to only Asian and European countries.

The results reveal interesting insights into the progress of both regions. While Asian countries, such as China and South Korea, have made significant strides in innovation and digitalization, the United Kingdom, Sweden, and some countries from Europe have been at the forefront of smart city development. The study also highlights the challenges faced by both regions in creating smart cities.

Overall, this study concludes that bibliometric analysis provides a valuable tool for comparing the progress made by different regions and illustrates the significance of these areas in the past, present, and future. By identifying areas of strength and weakness, public and private sectors can better understand the challenges they face and develop more effective strategies.

Keywords: Bibliometric Analysis, Digitalization, Economic Development, Innovation, Smart City.

JEL: O00, O10, O32, C00, C88

1. Introduction

Digitalization plays a crucial role in driving economic growth and fostering innovation. By embracing digital technologies and leveraging their potential, businesses and economies can unlock new opportunities. The relationship between digitalization, innovation, and economic growth has surpassed mere interconnectedness, and their impact on each other has become profoundly significant. Innovation plays a vital role in shaping smart cities. This involves the development and application of new technologies, solutions, and business models to address urban challenges and improve urban services. The combined efforts of digitalization and innovation in smart cities have a direct impact on economic growth, augmenting productivity, attracting investments, and generating fresh economic prospects through the effective utilization of digital technologies and data-driven insights. By leveraging digital technologies and data-driven insights, cities can enhance productivity, attract investment, and create new economic opportunities.

Accounting is one of the main steps that plays an important role in digitalization. By embracing digital accounting systems and practices, businesses can streamline financial processes, automate data entry and reconciliation, and improve financial reporting accuracy.

The adaptation process of digitalization and related concepts, which are profoundly influenced by digitalization, varies significantly from country to country. Socioeconomic, cultural, and social factors contribute to these differences. Additionally, each country possesses its own unique technological infrastructure, economic conditions, and industrial structure.

We sought to undertake a comprehensive evaluation of scientific research conducted worldwide on these subjects, considering the universal recognition that these topics pertain to the past two to three decades and are subject to rapid and continuous change. In addition, we aimed to determine the regions of the world that have focused more intensively on these topics. Furthermore, we sought to examine the situation in countries, such as Singapore and Japan, which are often regarded as leaders in these areas when it comes to discussions related to these subjects.

The subsequent section of this study presents an in-depth examination of the conceptual framework encompassing innovation and its relationship to economic growth, with a specific emphasis on the phenomenon of digitalization. In

section 3, we describe the research methodology and identify a sample of papers for further analysis. Section 4 encompasses a comprehensive presentation of the obtained results and an extensive discussion thereof.

2. Innovation or Economic Development Concepts and Digitalization

Innovation plays a crucial role in driving economic development, as it leads to the creation of new products, services, and business models that can increase productivity, create jobs, and stimulate economic growth. Studies have demonstrated the link between innovation and economic development (Liu, Si and Li, 2023; Zhong and Chen, 2023) as World Intellectual Property Organization (WIPO) showed that countries that invest in innovation tend to have higher economic growth rates, higher levels of productivity, and greater competitiveness in the global marketplace (WIPO, 2018). The study found that innovation can contribute up to 80 percent of economic growth in some countries (WIPO, 2018). Another study by the Organization for Economic Co-operation and Development (OECD) found that innovation can lead to higher wages and greater income equality (OECD, 2010). The study also found that innovation is essential for addressing global challenges such as climate change, health, and food security (OECD, 2010). Furthermore, according to the McKinsey Global Institute (MGI) companies that prioritize innovation tend to have higher revenue growth, higher profit margins, and greater market share than companies that do not (MGI, 2018). For this reason, innovation is becoming increasingly important in Asian countries as they strive to achieve economic growth and development. The following Asian countries are the forerunners of economic development for the last decade (OECD, 2010):

South Korea: South Korea has become one of the most innovative countries in the world, with a strong focus on technology and research and development (R and D) (Dayton, 2020). This has helped South Korea to become a global leader in industries such as electronics, semiconductors, and automotive manufacturing (GII, 2021). According to the Global Innovation Index (GII) 2021 South Korea ranked 1st in R and D expenditures and 2nd in the innovation output sub-index (GII, 2021).

Singapore: Singapore has also made innovation a key part of its economic development strategy. The government has implemented policies and initiatives to support innovation, such as funding for R and D, tax incentives for innovative companies, and the creation of innovation hubs (GII, 2021; Tan and Phang, 2005). As

a result, Singapore has become a hub for startups and has attracted investments from global companies. According to the GII 2021, Singapore ranked 3rd overall and 1st in the innovation input sub-index (GII, 2021).

China: China has become a major player in innovation with a focus on developing advanced technologies, such as artificial intelligence (AI) and 5G. The Chinese government has made significant investments in R and D, and has created policies to encourage innovation, such as the Made in China 2025 initiative (GII, 2021). According to the GII 2021, China ranked 12th overall and 1st in the quality of scientific publications sub-index (GII, 2021). In various academic inquiries examining the case of China, it has been observed that AI significantly impacts green total factor productivity (Zhao, Gao and Sun, 2022; Qian, Liu, Shi, Forrest and Yang, 2023).

India: India has also been focusing on innovation as a key driver of economic growth. The government has implemented policies and initiatives to support innovation, such as the Startup India initiative and the Atal Innovation Mission. India has also been investing in R and D and has become a hub for IT services and software development (GII, 2021; Joshi, 2008). According to the GII 2021, India ranked 46th overall and 3rd in the quality of scientific publications sub-index (GII, 2021).

Digitalization also plays a critical role in economic development, as it can lead to increased productivity, improved efficiency, and new opportunities for innovation and growth (OECD, 2019b). By embracing digital technologies and leveraging their potential to innovate and grow, businesses and governments can create new opportunities for economic growth and development (Deloitte, 2020). Digitalization can also become a way of creating new job opportunities in areas such as software development, data analytics, and digital marketing (World Economic Forum, 2020). Digital tools, such as Enterprise Resource Planning (ERP) systems, customer relationship management systems, and data analytics software, can help businesses optimize their operations and improve their bottom line by automating routine tasks and providing real-time data and analytics for decision-making (OECD, 2019b). For example, digital platforms, such as e-commerce marketplaces and online payment systems, can help businesses to reach new customers and expand their operations globally, leading to new opportunities for growth (Deloitte, 2020). In addition, digitalization can improve efficiency by reducing the time and resources required to perform tasks, such as document management, inventory tracking, and financial reporting. This can

help businesses to operate more efficiently and reduce their costs (OECD, 2019b). Overall, digitalization can have a significant impact on economic development, both in developed and developing countries. While some jobs may be replaced by digitalization, new jobs will also be created in areas such as data analysis, cybersecurity, and digital marketing, leading to a potential net increase in employment opportunities (World Economic Forum, 2020).

Digitalization and innovation are closely interconnected as digital technologies can facilitate and drive innovation, and innovation can lead to new digital solutions and applications. For example, digital platforms can enable new business models and ways of delivering services, while data analytics can provide insights that drive innovation and improvements (Deloitte, 2019). Innovation can also lead to the creation of new digital solutions and applications. For example, innovative new products and services, such as mobile apps and cloud-based software, can leverage digital technologies to provide new capabilities and benefits to users (Gassmann, Frankenberger and Csik, 2017). Digitalization can also enable new forms of innovation, such as open innovation and crowdsourcing. These approaches involve leveraging the collective knowledge and expertise of a wider community of stakeholders to drive innovation and develop new solutions (OECD, 2019a). Overall, the relationship between digitalization and innovation is one of mutual reinforcement as each can drive and enable the other. By embracing digital technologies and leveraging innovative approaches, businesses and organizations can create new opportunities for growth and development.

Green innovation refers to the development and adoption of new technologies, products, and services that have positive environmental impacts, such as reducing greenhouse gas emissions, improving energy efficiency, and promoting sustainable practices (Meidute-Kavaliauskiene, Çiğdem, Vasiliauskas and Yıldız, 2021). Major contributions of green innovation to economic development can be summarized as follows:

Creating new markets and opportunities: Green innovation can create new markets and business opportunities in areas such as renewable energy, green building, and sustainable transportation. These new markets can drive economic growth and job creation, while also promoting sustainability (UNEP, 2016).

Enhancing competitiveness: Green innovation can also enhance the competitiveness of businesses and industries, by enabling them to develop new products and services that meet the growing demand for sustainable solutions (OECD, 2012).

In addition, green innovation can help businesses reduce costs and increase efficiency, by promoting resource efficiency and reducing waste.

Addressing global challenges: Green innovation can also play a critical role in addressing global challenges, such as climate change, air and water pollution, and resource depletion. By developing and adopting sustainable solutions, countries can reduce their environmental impact and contribute to a more sustainable future (World Bank, 2021).

Overall, green innovation can contribute to economic development by creating new markets and opportunities, enhancing competitiveness, and addressing global challenges. By promoting green innovation, governments and businesses can foster sustainable economic growth while also promoting environmental sustainability.

Green innovation and digitalization are closely related and can support each other in multiple ways. Digitalization can provide new tools and technologies that enable green innovation such as smart grids, renewable energy management systems, and digital simulations for designing and testing sustainable products and services (Hashem, Yaqoob, Anuar, Mokhtar, Gani and Khan, 2015). Additionally, the process of digitalization can contribute to the attainment of sustainability goals by fostering resource efficiency, mitigating waste generation, and advancing the principles of a circular economy (Maiurova, Kurniawan, Kustikova, Bykovskaia, Othman, Singh and Goh, 2022). Moreover, digitalization can enable new business models that support sustainability, such as platform-based sharing and circular economy models. These models can promote resource efficiency, reduce waste, and provide new opportunities for economic development (UNEP, 2019). In summary, digitalization can play a critical role in driving sustainable economic growth and reducing environmental impact by enabling and promoting green innovation and sustainability.

From an accounting perspective, digitalization can have significant implications for financial reporting, auditing, and taxation (AICPA and CPA Canada, 2019). One of the key benefits of digitalization for accounting is the potential for automation and standardization of financial processes. Digital tools, such as accounting software, robotic process automation, and blockchain, can streamline tasks such as data entry, reconciliation, and reporting reducing the risk of errors and improving the efficiency and accuracy of financial information (PwC, 2018). Moreover, digitalization can enable more timely and relevant financial reporting,

with real-time access to financial data and performance metrics. This can provide stakeholders with a more comprehensive and up-to-date picture of the company's financial position and performance which can support the decision-making process. However, digitalization can also present new challenges for accounting (Gulin, Hladika and Valenta, 2019). For example, the increasing use of cloud computing and digital storage of financial data raises concerns about data security and privacy (Richins, Stapleton, Stratopoulos and Wong, 2017). In summary, from an accounting perspective, digitalization can offer significant benefits in terms of efficiency, accuracy, and relevance of financial information. But it also presents new challenges that need to be addressed to ensure the integrity and security of financial data and to comply with evolving regulatory requirements.

3. Research Methodology

Publications in the field of the main areas, such as digitalization, innovation, and economic development, have gained increasing attention, along with the subareas, such as green innovation and green economic development, to create smarter and sustainable urban environments. We divided countries into two basic regions for detailed comparisons by using multiple bibliometric indexes. Region 1 includes Asian countries and Region 2 includes European countries. To provide a comprehensive assessment, numerous indicators were consolidated in the analysis of the study. Three main indicators including the number of publications, the most cited countries, and authors were initially selected for assessing the quantity and quality of the publications based on these areas. In addition, the relation of three elements, countries, authors, and keywords are identified based on these groups and the differences between the regions are examined. This study will offer assistance to distinguish the key concepts in this area of research and may uncover rising patterns and new directions for future studies.

To comprehend the deviation in innovation and economic growth to the side that deals with the importance of environmental facts, this study draws on bibliometric methodology. This methodology is a common and rigorous method for investigating and analyzing large amounts of scientific data. This type of analysis allows researchers to uncover the nuances of a particular field's evolution while shedding light on new areas in that field (Albort-Morant and Ribeiro-Soriano, 2016). In addition, a bibliometric analysis using keywords enables the analysis of specifics in the primary research topics within a domain and relationship at the micro level (Chen and Xiao, 2016). This type of analysis also generates useful

information for researchers evaluating scientific activity (Rey-Martí, Ribeiro-Soriano and Palacios-Marqués, 2016).

Bibliometric analysis has recently gained huge popularity in business research (Albort-Morant and Ribeiro-Soriano, 2016; Donthu, Kumar and Pattnaik, 2020a; Donthu, Kumar, Pattnaik and Lim, 2021; Khan, Pattnaik, Ashraf, Ali, Kumar and Donthu, 2021). The emergence of scientific databases, such as Scopus and Web of Science (WoS), has made it significantly easier to gather substantial amounts of bibliometric data. Additionally, the availability of bibliometric software like Gephi, Leximancer, and VOSviewer has facilitated the analysis of this data in a practical manner. This has led to a recent increase in scholarly interest in bibliometric analysis (Donthu et al., 2021, p. 286). In fact, the bibliometric methodology has been used in business research areas, such as business strategy (Kumar, Surekha, Lim, Mangla and Goyal, 2021; Villa, Ruiz, Valencia and Picón, 2018), electronic commerce (Bawack, Wamba, Carillo and Akter, 2022), finance (Ahmi, Tapa and Hamzah, 2020; Baker, Kumar and Pandey, 2021; Durisin and Puzone, 2009; Elie, Granier and Rigot, 2021; Linnenluecke, Chen, Ling, Smith and Zhu, 2017; Xu, Chen, Jia, Brown, Gong and Xu, 2018; Zhang, D., Zhang, Z. and Managi, 2019), human resources (Andersen, 2019; Bahuguna, Srivastava and Tiwari, 2023; Danvila-del-Valle, Estévez-Mendoza and Lara, 2019), management (Ellegaard and Wallin, 2015; Zupic and Čater, 2015), and marketing (Backhaus, Lügger and Koch, 2011; Donthu et al., 2020a; Donthu, Kumar and Pandey, 2020b; Donthu, Kumar, Pandey and Soni 2020c; Hu, Song and Guo, 2019; Samiee and Chabowski, 2012; Ye, Hudders, De Jans and De Veirman, 2021). The application of bibliometrics ranges from studying publications to analyzing collaboration trends to examining the intellectual hierarchy of the research field. Journals may also represent the research field in this instance. The bibliometric analysis has been used to provide retrospectives of journals, such as the *Journal of Business Research*, which typically happen in landmark years (Donthu et al., 2020a).

This study introduces bibliometric methods by Biblioshiny for a comprehensive review of innovation, digitalization, and economic development. The main aim of the study is to examine the growth and trend of the research in digitalization based on innovation or economic development with the subgroups defined as smart city, digitalization in accounting, green economic growth in case of sustainability, and to comprehend the distribution of the countries that contribute these research areas. With the help of this examination, we investigate the globally cited documents and themes depending on these research areas. In addition,

we can identify the direction of future thematic research based on the main group and the subgroups of the study.

3.1. Keywords Define and Data Collection

In order to examine bibliographic information, the studies were gathered from the online WoS database's Social Science Citation Index which includes thousands of scholarly articles and bibliographic data on authors, affiliations, and citations. Since the analysis focuses on the main areas, such as digitalization based on innovation or economic development, with three sub-areas, such as green economic growth or green innovation, digitalization in accounting, and smart city. The keywords for the data collection for each group are represented in Table 1.

Table 1. Groups of the Study

Group	Keywords
Group 1	Green Innovation AND Green Economic Growth AND (Digitalization OR Digital Transform OR Digitalisation)
Group 2	(Digitalization OR Digital Transform OR Digitalisation) AND (Innovation OR Economic Growth) AND <i>Accounting</i>
Group 3	(Digitalization OR Digital Transform OR Digitalisation) AND (Innovation OR Economic Growth) AND <i>Smart City</i>
Group 4 (Main Group)	(Digitalization OR Digital Transform OR Digitalisation) AND (Innovation OR Economic Growth)

In the study, the words such as “digital transformation” were not added as keywords because all studies that include digital transformation also encompass “digital transform”. For instance, the studies included in Group 1 should encompass the concepts of green innovation, green economic development, and digitalization simultaneously. In the second group, studies should consist of an examination of the concepts of accounting, digitalization, and innovation together, or an examination of the concepts of accounting digitalization and economic growth together.

In this study, although the aim is to compare Asian and European countries in the identified areas, it is also important to know in which countries outside these regions the research in this field has taken place. Therefore, studies that were not conducted in these two regions have not been excluded from the analysis, recognizing the significance of understanding the broader geographical distribution of research in the field.

3.2. Data Analysis

This study employs two analytical tools, Excel and the Biblioshiny application of the R package. Excel has been used to clean the dataset and generate descriptive statistics and basic graphs. Biblioshiny has been used to produce basic indicators of the study to produce collaboration networks. Its web-interface tool provides visualizations with high readability and understandability.

The time span of the collected data of Group 4, which is the main group of the study, ranges from 1997 to 2023. Table 2 illustrates the main information about the dataset of each group. The documents in Group 4 were published in 2237 sources with an average citation score of 7.54. The time span of the subgroup (Group 1), based on green innovation and green economic growth, ranges from 2019 to 2023, and they were published in 22 sources with an average citation score of 6.82.

Table 2. Distribution of Document Types of Each Group

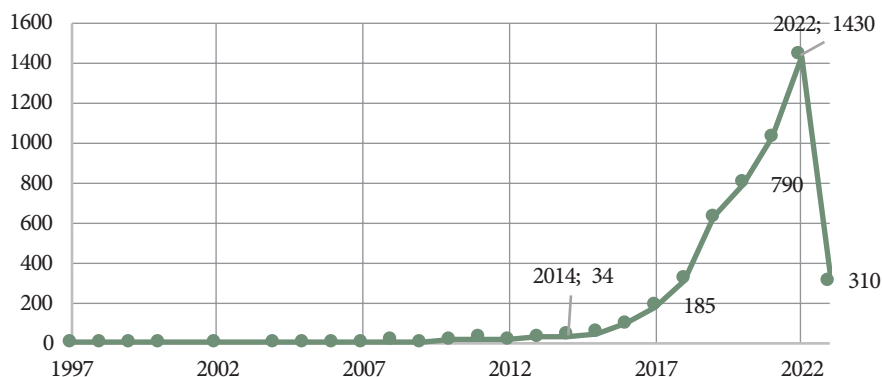
Main Information About Data	Group 4	Group 3	Group 2	Group 1
Timespan	1997–2023	2016–2023	2013–2023	2019–2023
Sources (Journals, Books, etc.)	2237	58	80	22
Documents	5216	67	98	34
Average years from publication	2.79	3.08	2.02	1.06
Average citations per documents	7.541	9.164	5.173	6.824
Average citations per year per doc	1,934	2.16	1.709	2.842
References	203539	3032	4998	2327
Article		32	60	32
Article, Early Access		3	9	2

Source: compiled by the authors based on Bibliometric Analysis.

As observed from Table 2, the time span of the subgroup (Group 2) focused on digitalization in accounting ranges from 2013 to 2023. These studies were published in 80 sources, with an average citation score of 5.17. Additionally, the time span of the subgroup (Group 3) focused on smart cities ranges from 2016 to 2023. These studies were published in 58 sources, with an average citation score of 9.16.

Figure 1 illustrates the number of papers published each year in Group 4. It should be noted that Figure 1 does not include early access documents and similar figures. From 2014 to 2022, there is an increasing trend in publications. The lower value in 2023 is due to the sampling inclusion of studies published in the first three months of the year.

Figure 1. Annual scientific production of Group 4: 1997–2023



Source: compiled by the authors based on Bibliometric Analysis.

The number of papers published each year for the remaining groups is depicted in Figure 2. In Group 2, the initial publication emerged in 2013, and this particular subarea remained largely unexplored until 2017. Subsequently, a noteworthy and significant surge in research activity is evident beyond 2017, indicating a bullish development in the field.

Figure 2. Annual scientific production of Group 1, 2 and 3: 2013–2023

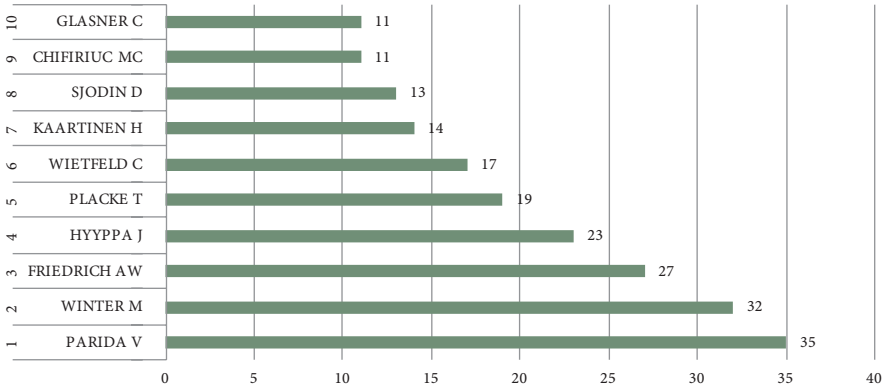


Source: authors' elaboration using Biblioshiny.

As depicted in Figure 2, within Group 1, the inaugural paper was published in 2019, signifying a relatively recent exploration of this specific subarea which remained largely unexplored until 2021. Furthermore, Figure 3 presents the top

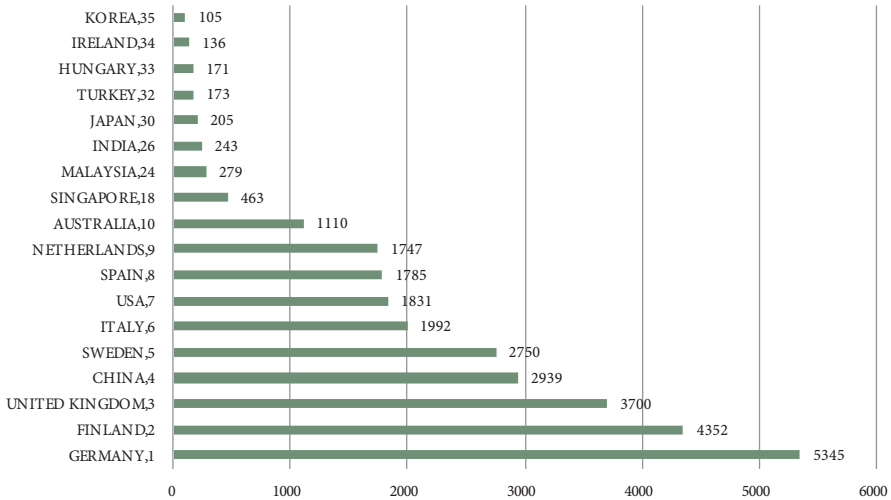
ten researchers who have contributed to the primary domain of the study. At the forefront is Parida Vinit, with a remarkable 35 publications. Following closely on the list is Winter Martin, with an impressive count of 32 publications.

Figure 3. Authors with higher production: Group 4



Source: compiled by the authors based on Bibliometric Analysis.

Figure 4. Total Citation of Group 4 with ranking information



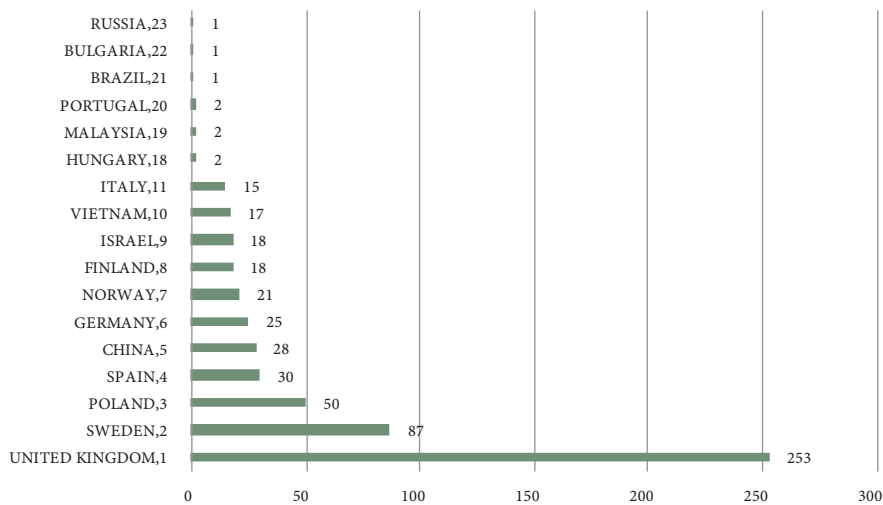
Source: compiled by the authors based on Bibliometric Analysis.

One of the essential factors in determining the impact of a publication is the number of citations. Figure 4 illustrates the top 10 highly cited publications' countries from all over the world with some other countries from Region 1 and Region 2. These countries are not the countries under study; rather, they represent the countries where the institutions/universities employing the researchers who conducted the study are located. Considering that China is the sole country from Region 1 to appear in the top 10 highly cited countries globally, the remaining countries from both Region 1 and Region 2 were included with rank information in a non-biased manner. This approach was adopted to facilitate the understanding and comparison between Region 1 and Region 2.

Despite the implementation of innovation-supportive policies and initiatives, such as R and D funding, by the Singaporean government, their current position of 18th in the overall citation ranking may be considered relatively modest when compared to the extent of their innovation-driven implementations.

Figure 5 displays the top ten countries with the highest number of citations for their publications, including some additional countries from Region 1 and Region 2. China and Vietnam are the countries from Region 1 that are in the top 10 list.

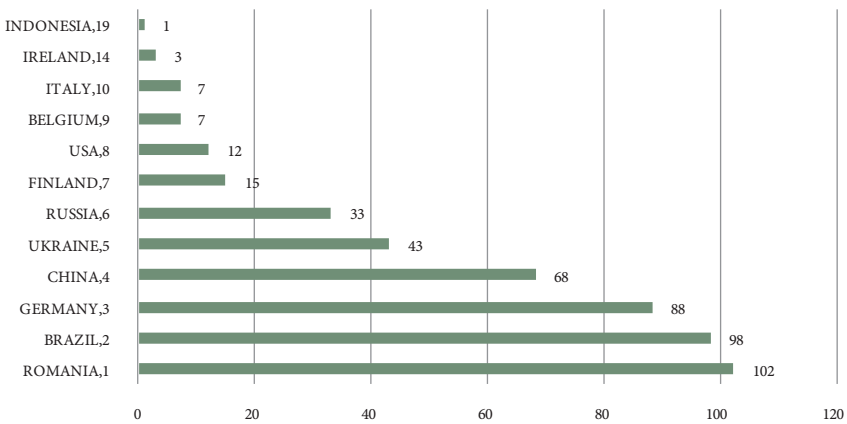
Figure 5. Total citation of Group 3 with ranking information



Source: compiled by the authors based on Bibliometric Analysis.

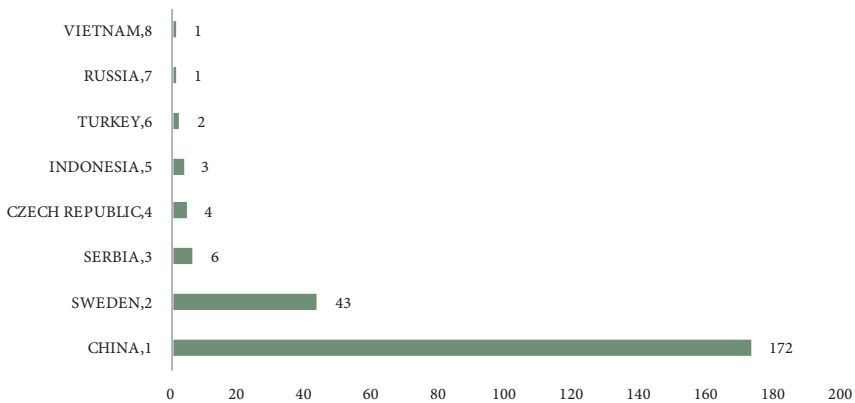
Figure 6 illustrates the ranking graph of the top ten cited countries that depend on digitalization in accounting with the ranking information of Ireland and Indonesia. Figure 6 provides valuable information about the research influence of Group 2, but it should be considered in the context of other bibliometric factors that may impact research quality. The high number of citations implies that Romania is making vital contributions to the field of digitalization in accounting, and the country is a key player in this quickly developing field of study and practice.

Figure 6. Total citation of Group 2 with ranking information



Source: compiled by the authors based on Bibliometric Analysis.

Figure 7. Total citation of Group 1 with ranking information

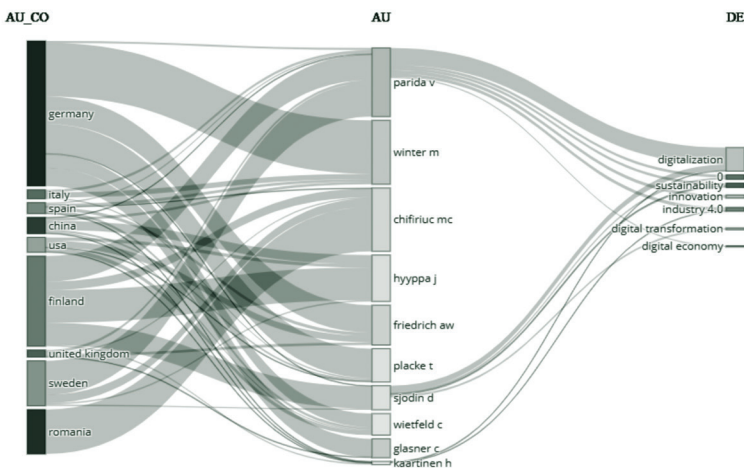


Source: compiled by the authors based on Bibliometric Analysis.

Figure 7 illustrates the ranking graph of the top ten cited countries that depend on the main area with the concept of environmental facts. The high number of citations implies that China is making vital contributions to this field. Countries from Region 2, such as Turkey, Indonesia, Vietnam, and Russia, have the highest number of publications and belong to the top 10 list.

The three fields plot shown in Figure 8 is an illustration of three crucial elements, consisting of a list of the top ten authors' countries, authors, and the studies' keywords. These three elements are plotted with gray linkages that show their relationship with each other. The size of each rectangle in each list indicates the number of papers associated with that element. Additionally, the countries associated with the authors represented in Figure 8 and similar figures also indicate the countries of the co-authors involved in the relevant author's works on that subject, apart from the country of the respective author. The information can be found under the 'countries' section on the relevant author's page in the Web of Science database¹ to find co-authors who have collaborated with the respective author, to verify its accuracy. However, the co-author information obtained from this link encompasses not only the WoS database, but also all the studies scanned on the internet.

Figure 8. Illustration of three elements, consisting of a list of countries, authors, and keywords: Group 4



Source: compiled by the authors based on Bibliometric Analysis.

¹ The database can be accessed at the following link: <https://app.dimensions.ai/discover/publication>

Apart from the topics that define the main group, the most commonly used keywords are sustainability and industry 4. As illustrated in Figure 8, Germany emerges as the country that places the greatest emphasis on research about these subjects. The country with the most scientific studies on these issues outside of Europe is China. In fact, no other Asian countries besides China ranks within the top ten countries with the most research on these issues. Similar figures were generated for each subarea to analyze the progress of the subareas that are associated with the main area. In addition, Figure 9 displays this illustration based on the smart city concept.

Figure 9. Illustration of three elements, consisting of a list of countries, authors, and keywords: Group 3

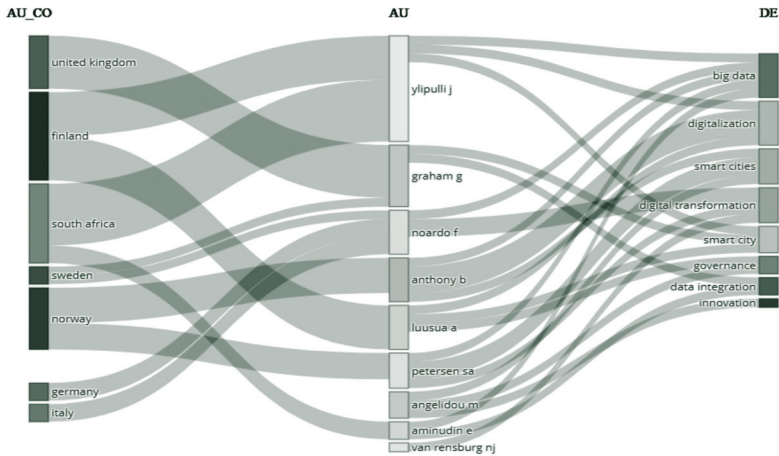
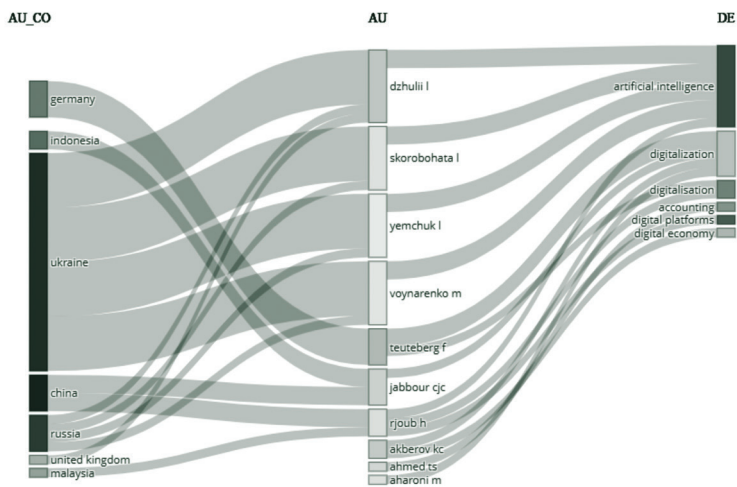
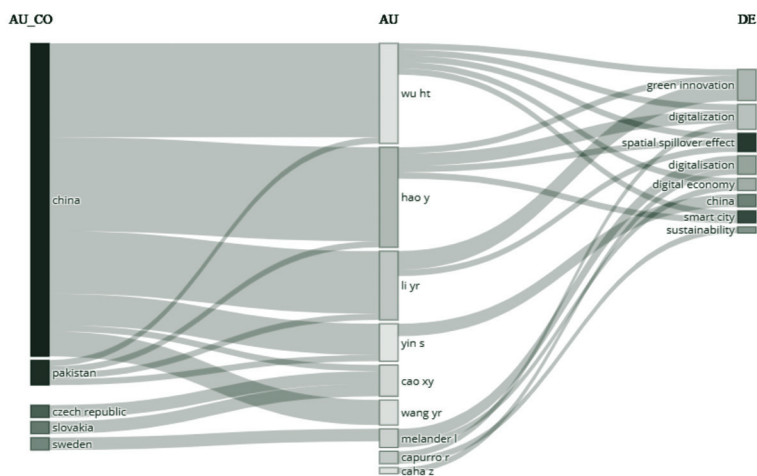


Figure 10. Illustration of three elements, consisting of a list of countries, authors, and keywords: Group 2



Source: compiled by the authors based on Bibliometric Analysis.

Figure 11. Illustration of three elements, consisting of a list of countries, authors, and keywords: Group 1



Ukraine is the country that gives the most importance to related studies based on digitalization in accounting. China, Malaysia, and Indonesia are the countries that rank within the top ten countries with the most research on digitalization in accounting. Apart from the topics that define Group 2, the most used keywords are sustainability, artificial intelligence, and digitalization of the economy. Figure 11 displays the illustration of three elements based on the sub-area green innovation and green economic growth.

China and Pakistan are the countries that belong to Region 2, and rank within the top ten countries with the most research on sub-area depending on the environmental facts. Apart from the topics that define Group 1, the most used keywords are sustainability, digital economy, digital green innovation, and spatial spillover effect.

4. Conclusion

This study provides a systematic review of the topics of digitalization and innovation, or digitalization and economic growth, encompassing pertinent sub-topics including accounting, smart cities, and environmental factors such as green economic growth and green innovation. While the main topic of the study has garnered a significant number of published papers, scholarly attention towards the sub-topics has emerged relatively recently within the past few years. This suggests a growing interest in these domains and implies a likely concentration of future studies in these areas. Additionally, the groups analyzed in the study have been defined as specific groups obtained through the confluence of specific and significant concepts. Although it is an important finding to examine the studies conducted in this field and observe their increase over time, it has emerged that the actual starting years of collaboration in these areas are relatively late.

The present study endeavors to conduct a regional comparison in order to ascertain the countries that prioritize these areas to a greater extent. The findings indicate that China, among the Asian countries, has demonstrated a noteworthy level of engagement and interest in these fields and their associated domains as in the GII. When considering country rankings, it is notable that among the groups other than Group 1, no country from the Asian region is present in the top three. Interestingly, in Group 2, Romania ranks first, which may be attributed to its implementation of accounting-related regulations. Additionally, this indicator serves as a promising sign of the increasing scholarly interest in the subject

over time. However, it is crucial to acknowledge that the study's focus on mostly English-language articles exclusively screened within the Web of Science (WoS) database may lead to the exclusion of certain countries from this ranking.

Based on the observations derived from Figure 8–11, it is evident that the prominent authors within the groups engage in research endeavors involving international collaborations. Notably, Figure 10 highlights that among the top 10 authors, there exists an individual who has a connection with the United Kingdom and China as well. This connection implies the occurrence of joint research initiatives between this author and universities in China, likely facilitated by their association with the university in the United Kingdom. It can be anticipated that these collaborative efforts will gain increasing significance over time, primarily due to the inherent relevance of the conceptual frameworks employed. Consequently, such collaborations are expected to stimulate a rise in the number of authors engaging in cooperative research activities within their respective nations.

It is crucial to acknowledge that, like any study, our research is subject to a set of limitations. The primary limitation stems from the fact that the analysis was restricted to articles included within the WoS database, thereby encompassing only a specific set of documents. Another limitation to consider is the reliance on keywords used to define the groups. Altering the definitions of these groups by broadening or narrowing down their scope in accordance with one's specific research interests may yield disparate outcomes.

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