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Technology, Business, Innovation, and Entrepreneurship in Industry 4.0

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Preface

This book presents a selection of chapters accepted for publication in the book *Technology, Business, Innovation, and Entrepreneurship in Industry 4.0*, which is part of EAI/Springer Innovations in Communication and Computing series that discusses recent innovations, trends, challenges, results, experiences, and concerns in the several perspectives of technologies, business, innovation, and entrepreneurship. Due to its broad impact in many fields, it has rapidly gained global attention from academia, government, industry, cities, and citizenship, providing the reader with an insight overview of the technologies, business, innovation, and entrepreneurship, in particular the new trends and challenges in Industry 4.0.

The program committee of was composed of a multidisciplinary group of more than 75 experts from 21 countries, with the responsibility for evaluating, in a "double-blind review" process, the chapters.

We received 52 contributions from 18 countries around the world. The acceptance rate was 38%.

The accepted chapters are published through EAI/Springer Innovations in Communication and Computing series, and will be submitted for indexing in Scopus, Ei Compendex, and zbMATH.

We acknowledge all of those who contributed to *Business, Innovation, and Entrepreneurship in Industry 4.0*: authors, reviewers, and editors. We deeply appreciate their involvement and support that were crucial for the success of this book.

Santa Elena, Ecuador — Teresa Guarda
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July 2022

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Chapter 17
Two Decades (2000–2020) of Scientific Production About Digital Economy: A Bibliometric Analysis

Maria I. B. Ribeiro, António J. G. Fernandes, Isabel M. Lopes, and Teresa Guarda

1 Introduction

The digitization of the economy is considered a key factor in developing sustainable competitive advantages for the economy at large [1]. The digital economy is experiencing a significant growth, especially in developing countries [2]. The rapid transition to a digital economy resulted from a converging set of technological innovations, both in terms of hardware and software.

Important advances that, when combined, gave rise to new applications of information and communication technologies (ICT) [3] open new opportunities for the global economy [4]. The widespread adoption of ICT is currently one of the most important conditions for the development of national economies in all countries simultaneously with the positive effects of the digital economy, new challenges arise [5]. Currently, the search for new sources of competitiveness is concentrated not only in the field of the company's scientific, technological, and innovation policies but also in the Internet space, which configures new digital formats for

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intra- and inter-process interaction [7]. The only way for most companies to maintain their competitive edge is to adapt to ongoing digital transformation, meet new pressures, keep up with the competition, and take advantage of new technologies [8].

This research proposes to carry out a bibliometric analysis using the binary counting method, using the technique of co-occurrence of terms, with the objective of grouping the existing literature into clusters, to know in a broader and deeper way the themes developed, in the literature, within the scope of the digital economy and identify the main lines of research about this field.

This book chapter is organized into five sections. In the first section, the introduction is stated, the theme is justified, the objectives are presented, a brief reference is made to the methodology used, and the chapter structure is presented. The second section organizes the literature review on the digital economy. The third section describes the methodology used in this research, that is, materials and methods. The fourth section describes the results. Finally, the fifth and last section presents the conclusions and limitations of this research and suggests guidelines for future researches.

2 Literature Review

The digital economy, characterized by the wide adoption of digital technologies, cyber physical systems, intelligent solutions, and network technologies, among others [6], is a system of economic and social relations based on the use of ICT facilitated by the use of the Internet, cloud computing, mobile social networks, and remote control sensors. The basic elements of a digital company are: (1) infrastructure, namely, Internet access and software; (2) e-business, which consists of conducting business through computer networks; and (3) e-commerce, which comprises the distribution of goods over the Internet [7]. Innovations associated with digital technologies have opened up new opportunities for the global economy and started the era of electronic commerce [4]. It is true that the digital economy is advancing at various speeds. While most developed countries register moderate levels of digitization, in terms of business and public services, the countries with the lowest gross domestic product focus their policies on building the digital infrastructure and training qualified personnel [9].

Globalization and technological developments have brought fundamental changes to the current business landscape [10]. The spread of information technologies and the Internet served as an important turning point for consolidating the growth of the digital economy and for building the competitiveness of national economies around the world [11]. Based on ICT, the digital economy grows faster, surpassing the traditional industrial economy [12]. The introduction of digital technologies and the Internet affects most socioeconomic processes and activities in the economy, from agriculture to public services [9]. The digital economy accelerates the exchange of information flows, which, in turn, have an impact on the creation of new forms of business and socioeconomic interactions [8]. While the growth of a

digital economy can increase efficiency and benefit global and regional economies, it is also an indispensable tool for the challenges of sustainability in social terms and environmental well-being [13]. In addition, the digital economy is more sustainable as it requires fewer energy sources, contributing to the formation of the green economy and greater acceptance of renewable energies [8, 13]. These characteristics constitute in themselves a competitive advantage that needs to be further supported and fostered [8, 13]. Likewise, the digital economy positively affects social reforms [13], provides higher-quality interactions between governments and their citizens [14], greater social inclusion, and more opportunities for shared communication [13]. And, although some disadvantages associated with the digital economy, namely, cybercrime, interruption of work, absence from companies, and social isolation of individuals, among others [15], the benefits exceed the costs.

3 Materials and Methods

This is a quantitative study that involved the development of a bibliometric analysis based on a search carried out in March 2021, which focused on publications available in the "Scopus" and "WoS" databases, since these multidisciplinary databases allow the analysis of citations and bibliometric data.

In the search carried out, only publications that contained, in the title, abstract or keywords, the words "Digital Economy," "E-commerce," "Internet," "Technology," and "Business" were selected (Scopus = 64; WoS = 39). Subsequently, a chronological filter was used, limiting the search period from 2000 to 2020, having counted 86 publications (Scopus = 60; WoS =26). Finally, only documents of the "article" and "review" type, subject to blind peer review, were considered, making a total of 28 articles (Scopus = 20; WoS = 8). Of these, one article was removed because it was duplicate in the two databases (Fig. 17.1).

Initially, a descriptive analysis involving the calculation of absolute and relative frequencies and growth rates was developed for the following variables: (1) articles by year, (2) publishing sources, (3) authors' affiliation (institutions), (4) nationality of authors (countries), (5) subject field, and (6) publications by funding sponsor.

Later, a bibliometric study was conducted using the VOSviewer software, version 1.6.16, and the binary counting method that selected only the documents where the words "Digital Economy," "E-commerce," "Internet," "Technology," and "Business" appeared. In the case of binary counting, the occurrence attribute indicates the number of documents in which a term occurs at least once [16]. Subsequently, the minimum number of occurrences was set at five. These procedures aimed to build a map that displayed the relations between the various words and their association in clusters of thematic areas. This methodology analyzes the distance between various words selected. The shorter the distance between two words, the stronger the relation between them [17]. On the map, the colors represent the various clusters of thematic areas, and words with the same color are part of the same cluster and therefore are more strongly related to each other compared to words with a different color.

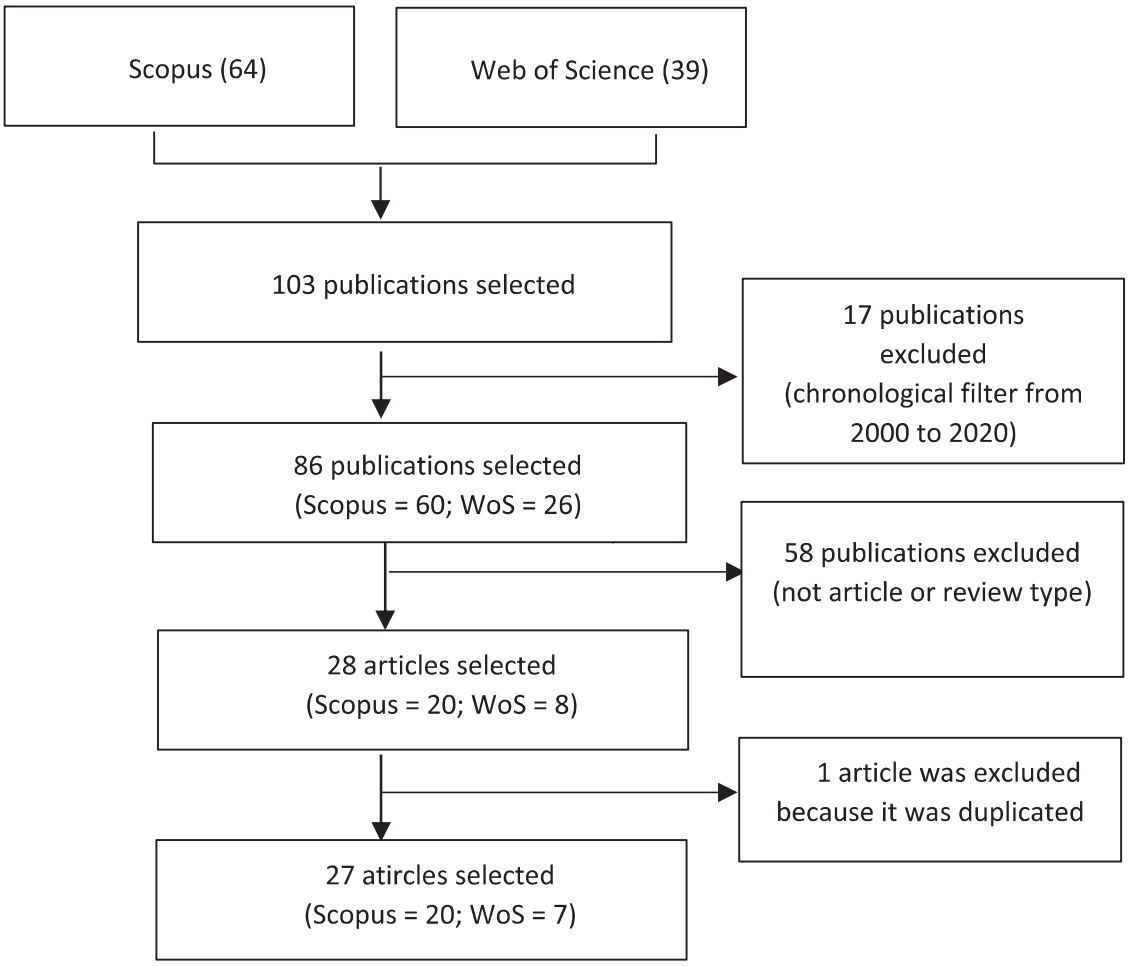

Fig. 17.1 Selection of the publications

4 Results

The results are presented in two subsections. Initially, the results of the descriptive analysis are presented, such as the evolution of the articles published between 2000 and May 2020, the publishing sources with the most publications, the publishing institutions with the most publications, countries with most published articles, articles published by scientific area, funding agencies of published articles, and index h of the literature on digital economy, e-commerce, internet, technology, and business. Subsequently, the co-occurrence map of words for publications on digital economy, e-commerce, internet, technology, and business is presented.

4.1 Descriptive Analysis

As already mentioned, 27 publications were selected, 20 in the Scopus database, and 7 in the WoS database. It can be seen, through Fig. 17.2, that in the period under analysis, there was an average annual growth of articles published of 4.7%. This

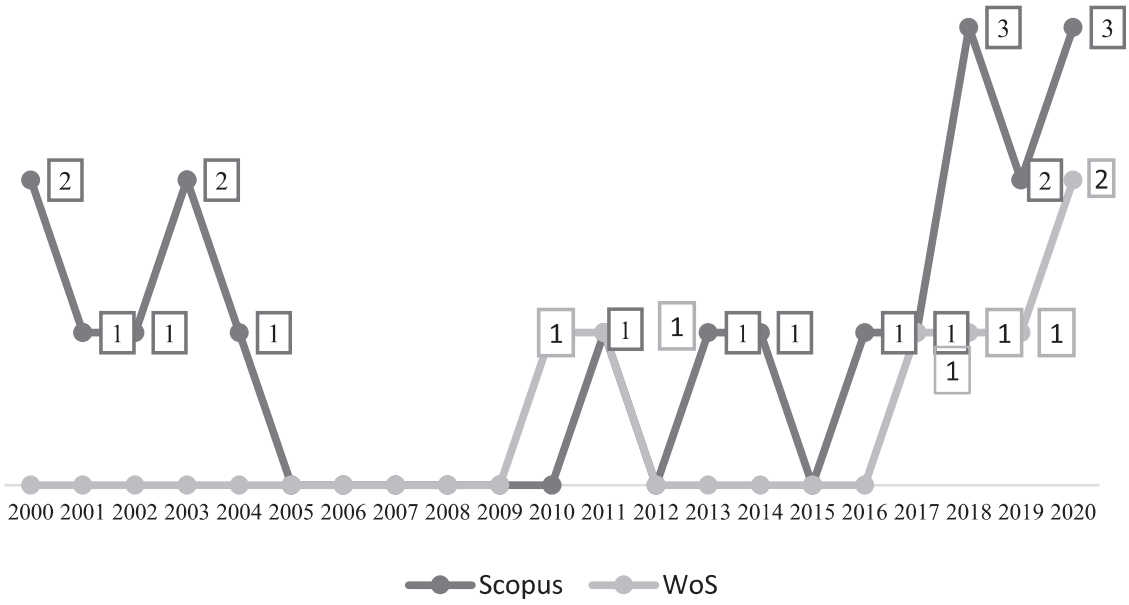

Fig. 17.2 Evolution of the number of articles published per year from 2000 to 2020

growth is mainly due to publications in the Scopus database since, in the periods from 2000 to 2009 and from 2012 to 2016, no article was published in the WoS database. The same situation occurred in the 2010 in relation to the Scopus database.

Figure 17.2 shows that, in the WoS database, the first publication is from 2010. Taking the two databases together, 2020 was the year in which the highest number of publications were registered (WoS = 2; Scopus = 3).

The literature focuses on journals in the fields of Engineering, Technology, Computing, Economics, Management, Environment, and Agricultural Sciences (Fig. 17.3).

As shown in Fig. 17.3, there is one publishing source that is simultaneously part of the Scopus and the WoS databases, namely, the IEEE Consumer Electronics Magazine.

At the institutional level (authors' affiliations), the articles are very dispersed, with Kazan Federal University being the institution that occupies the first position with three publications (Scopus = 2; WoS = 1) out 41 institutions (Fig. 17.4).

The articles were authored by authors of 16 nationalities. As shown in Fig. 17.5, the Russian Federation had the highest number of publications (50.0%), followed by the United States (37.5%) and China (18.8%). In the Scopus database, for 12.5% of the authors, the nationality was not identified.

Regarding the scientific areas of the articles published, 17 subject fields were identified. The five areas with the highest representation in terms of publications were Business, Economics, Management and Accounting (70.6%); Engineering (47.1%); Computer Science (41.2%); Social Science (41.2%); and Economics, Econometrics, and Finance (23.5%), as shown in Fig. 17.6.

Eight funding agencies of the published articles were identified. Funding comes from programs and/or institutions located in descending order: three agencies in China, namely, Changzhou Science and Technology Program, Fundamental

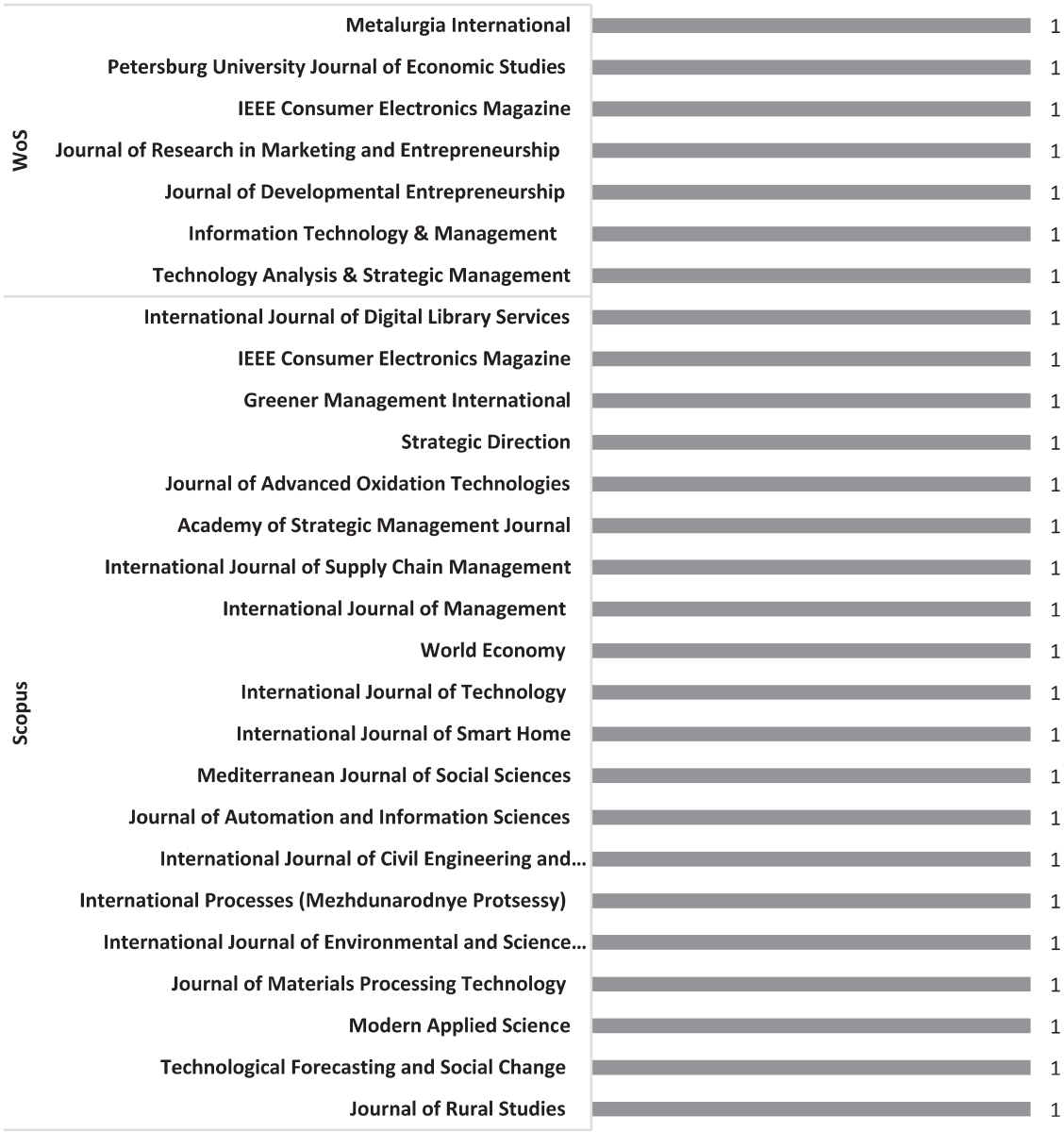

Fig. 17.3 Publishing sources by database (n = 26)

Research Funds for the Central Universities, and National Natural Science Foundation of China NSFC); an equal number of agencies in Russia, namely, Kazan Federal University, Russian Foundation for Basic Research and Russian Economy University; an agency in Korea, the Global Infrastructure Program through the National Research Foundation of the Korean NRF Ministry of Science and ICT; and an agency in the United States, the National Science Foundation, as shown in Fig. 17.7.

Tables 17.1 and 17.2 show the studies included in the h-index, that is, the number of articles by a given author with at least the same number of citations [18]. The h-indexes totaled six publications in the Scopus database (Table 17.1) and three publications in the WoS database (Table 17.2).

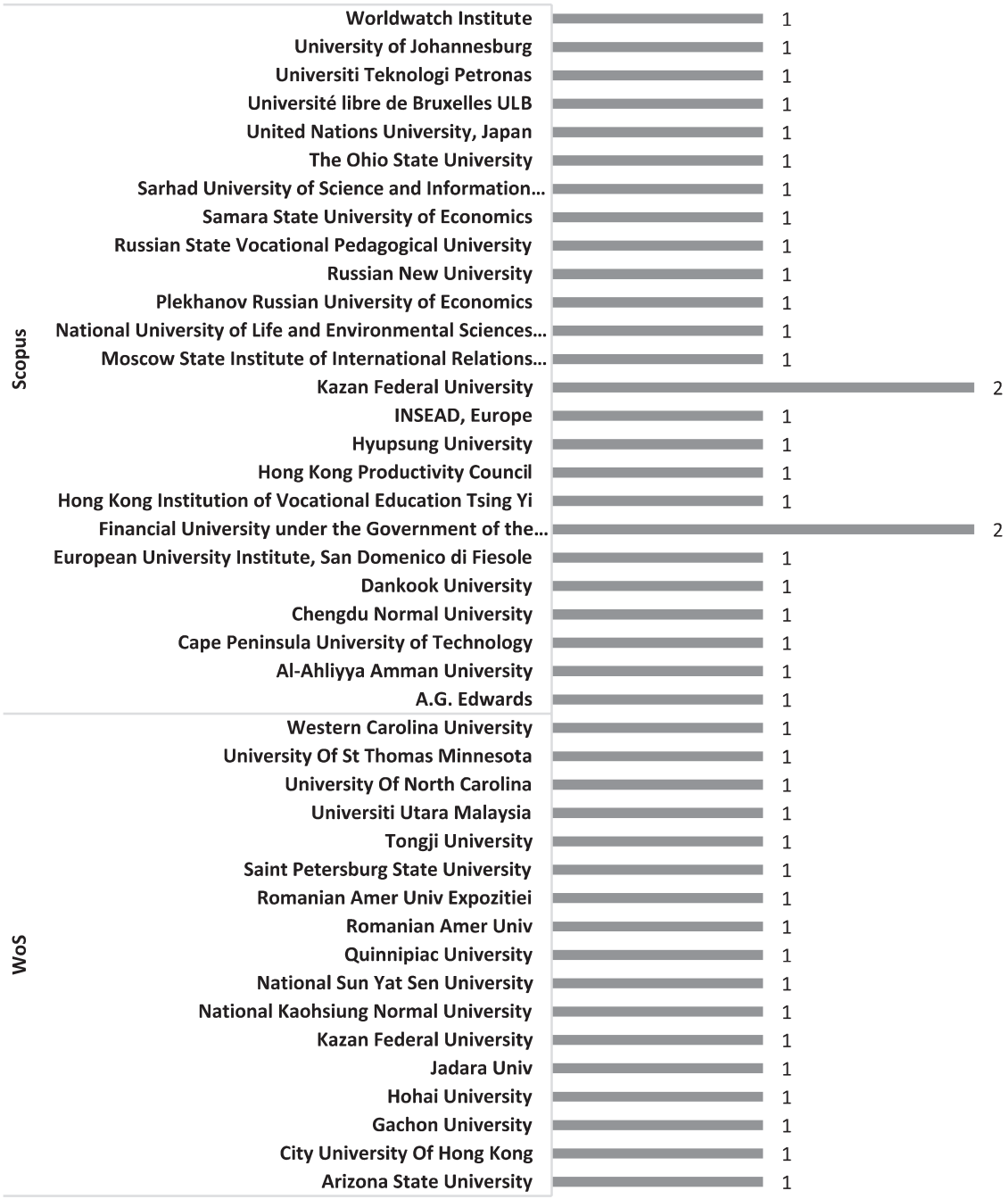

Fig. 17.4 Authors' affiliation (institutions) by database (n = 41)

As shown in Table 17.1, taking into account the methodology used in the h index publications, all articles published in the Scopus database are conceptual in nature. That is, in all articles, research is conducted by observing and analyzing information that already exists on a particular topic with no data collection.

The most cited article [19], with 187 citations, consisted of a conceptual study that addresses the potential of communication technologies in the development of rural areas in the United States. The results of this study suggest that there are major deficiencies in most rural communities. The shortage of human capital with digital

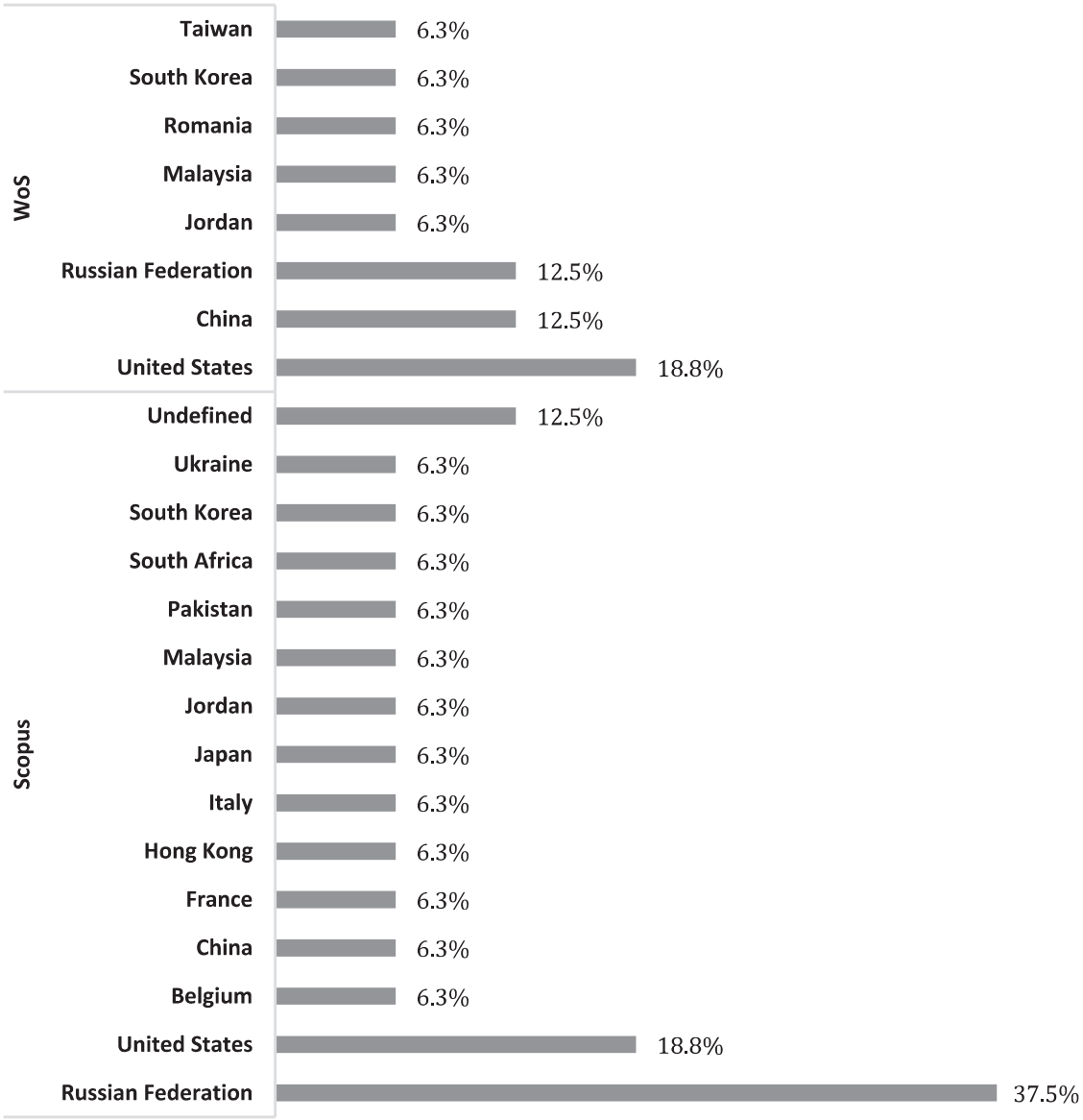

Fig. 17.5 Authors' countries of origin (nationalities) by database (n = 16)

skills seems to be one of the most serious problems. In the author's opinion, this problem can be solved in some rural areas with brain migration. The author concluded that, despite the use of ICT, not being a quick fix for rural development, and the desired improvements being limited to certain rural areas, the use of the Internet and e-commerce, by companies and users, can provide important benefits.

ICT and the Internet also play an important role in health economics. The use of ICT and the Internet has a positive and significant impact on the health sector, with a substantial reduction in costs and the minimization of unnecessary medical services, and on the patient's quality of life [21].

In an article developed in Hong Kong, the authors propose to develop an integrated strategy to plan the curriculum of training, which allows to equip young people with skills so that they are prepared and can play a vital role in ICT vision

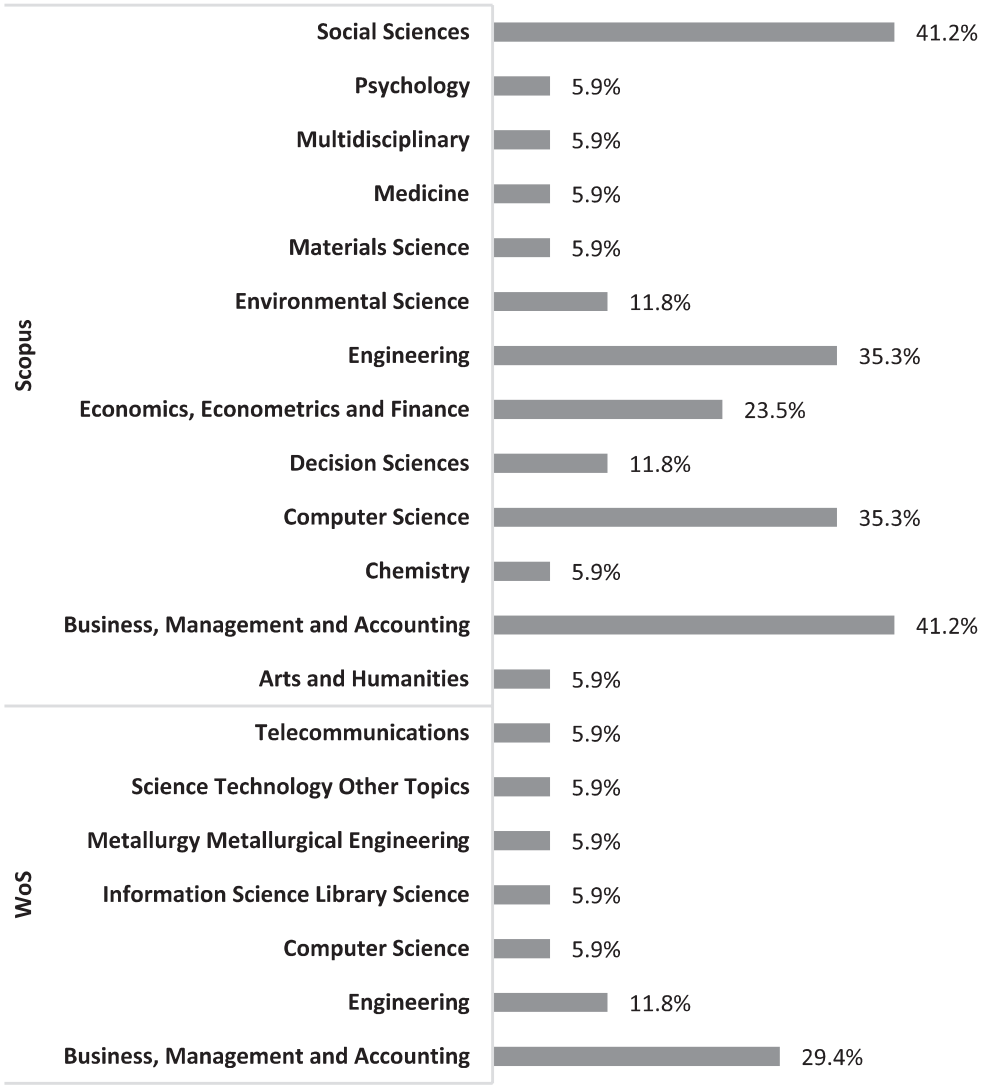

Fig. 17.6 Articles published by subject field and by database (n = 17)

and innovation [22]. These young people must be able to create agile business processes, adaptable to change to ensure business success. The authors argue that the ability to reduce cycle time, deliver high value-added services, and integrate businesses across many functions and geographic locations through e-commerce, information technology, and knowledge management will provide a competitive advantage for any company in the twenty-first century [22].

In a study aiming to show the potential growth of ICT and e-commerce development in Malaysia, the authors argue that the impact of Internet use, Internet dissemination, Internet experience, and ICT improvement have positive implications for information technology infrastructure and for the development of e-commerce in the country [20].

The most recent study aimed to significantly change and improve traditional management methods and tools, more specifically, marketing [23]. According to the authors, marketing associated with e-commerce is a new and little-known area that is developing in an intuitive, random, and unsystematic way. In this context, the

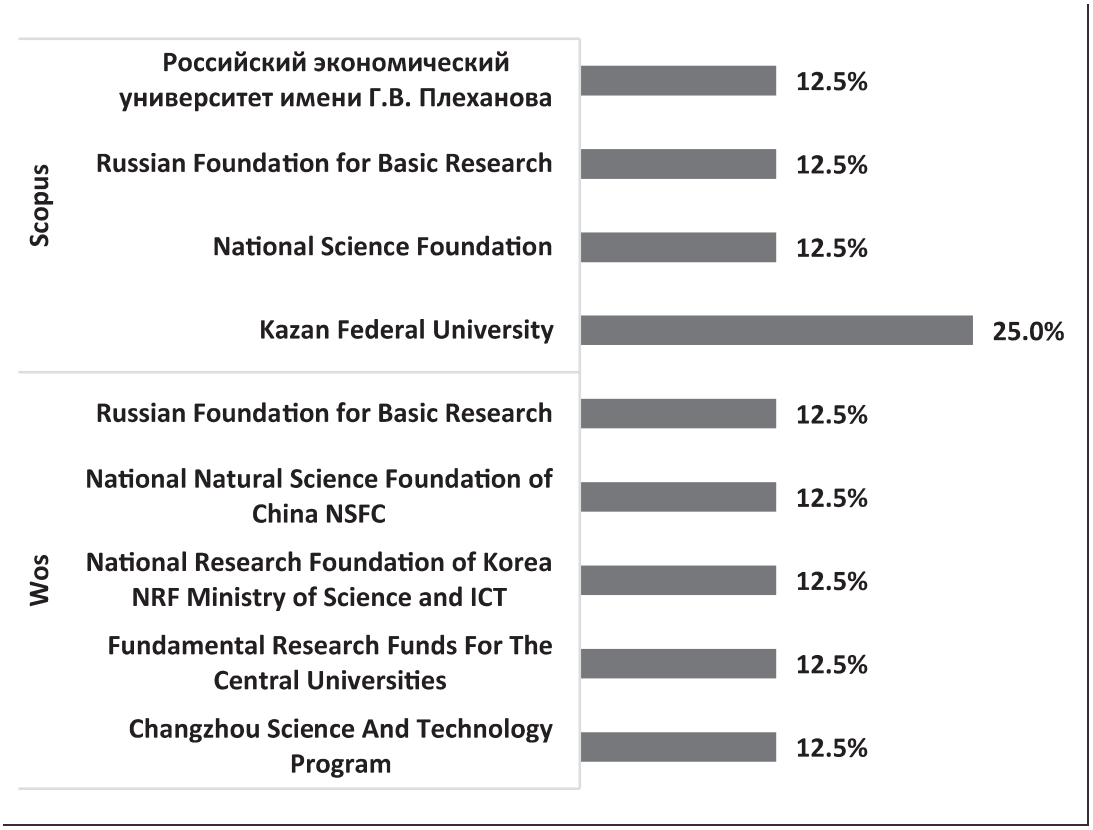

Fig. 17.7 Funding agencies of published articles by database (n = 8)

authors propose to identify changes in the elements of the marketing mix associated with e-commerce and that result from the evolutionary trend of e-business, technology, and the Internet. In this regard, other authors state that there is a new and different digital exclusion for small rural businesses that is related, not only to internet access but also to the way in which digital marketing is used. In this context, the authors consider that to promote rural economies, decision-makers and policy makers must address not only the existence of the Internet infrastructure but also the willingness and ability of small businesses to use them effectively, as they online marketing best practices are facilitated by the use of broadband [24]. Strengthen support for innovative small and medium enterprises by promoting technology adoption, as well as creating knowledge management platforms and knowledge bases throughout the technology transfer process is fundamental for the development of economies [6].

Table 17.2 shows the publications that make up the Hirsch index of the WoS database. Three publications are part of this index. Taking into account the methodology used in the articles in the WoS database's h-index, only one publication is qualitative in nature. The authors try to broadly examine and understand certain behaviors through the collection of narrative data, analyzing the individual preferences of one or a few elements that are the object of study, thus deepening the knowledge about it. The remaining two are quantitative longitudinal studies using panel data. This type of study uses quantitative methods and statistical inference with the aim of extrapolating the results of a sample to a population. In this context,

Table 17.1 H-index of literature on digital economy, e-commerce, internet, technology, and business (Scopus database)

Reference Author (date)	Methods	Contributions	Cit.
[19] Malecki (2003)	Conceptual	Examines US data on digital exclusion and rural residents and businesses' access to digital infrastructure. On the other hand, it focuses on two topics, supply and demand with an impact on digital development. Supply aspects include infrastructure and policy issues. Demand aspects include entrepreneurs among others, such as education and skills to take advantage of digital technologies	187
[3] Ayres and Williams (2004)	Conceptual	Highlights pertinent and current issues related to the ICT revolution. Is the industry entering a new phase of slow progress and/or technological growth? Will this be a natural stagnation due to over-optimism, so far, from investors and will the expansion continue as before? Should societies rethink how to facilitate innovation and the adoption of ICT? Given the extent to which many societies have benefited economically from ICT, there is an obvious interest in sustaining growth as much as possible	31
[20] Jehangir et al. (2011)	Conceptual	Bearing in mind that ICT is one of the most important determinants of the rapid growth of e-commerce, the authors seek to highlight the potential growth of ICT and the development of e-commerce in Malaysia	25
[21] Frank (2000)	Conceptual	Highlights the benefits of using ICT and the internet in medical care	25
[22] Lee and Lo (2003)	Conceptual	Formulates a strategy that integrates three widely used strategic business management tools and makes use of the 1999 Education criteria adopted by the Malcolm Baldrige National Quality Award (MBNQA) to develop education strategies	18
[23] Pogorelova et al. (2016)	Conceptual	Identifies changes in the elements of the marketing mix in the virtual e-commerce environment in line with the trend of e-business and internet technology	10

the quantitative study makes it possible to draw conclusions that can be extrapolated to a larger group than the one investigated. Furthermore, longitudinal studies make it possible to identify causal relationships as they use information from the same unit or from several units (companies) over time.

The most recent and also the most cited study, with eight citations in the period under analysis [25] aimed to develop a digital restriction index that would allow to analyze the role of the complex e-commerce system and the competitive pressure in the spread of B2B e-commerce, controlling the gross domestic product (GDP) per capita and the technology infrastructure of Information and Communication Technologies (ICT). The authors used data from 143 countries over a three-year period (2014–2016). Data were extracted from the Network Readiness Index Report and the Global Competitiveness Report. Based on the developed index and performing an econometric analysis, the authors showed that the greater complexity of trade

Table 17.2 H-index of literature on digital economy, e-commerce, Internet, technology, and business (WoS database)

Reference Author (date)	Methods	Contributions	Cit.
[25] Alsaad et al. (2018)	Quantitative Longitudinal	Provides evidence that the increased complexity of business relationships with the global economy and the high level of competitive pressure are the main forces for the use of B2B in all countries. Consequently, the authors suggest that having a strong business relationship with developed countries with mature B2B e-commerce practice is useful to sustain the use of B2B e-commerce across countries	9
[4] Ho et al. (2011)	Quantitative Longitudinal	The authors proved that the variables internet user penetration, capital invested in telecommunications (exogenous variables) and international openness (endogenous variable) led to a normalized level of B2C e-commerce revenues over time. On the other hand, the authors concluded that it is useful to incorporate a technology adoption function into the model for growth, since it is based on the adaptability of information technologies, made possible by the availability of venture capital. Finally, they found that B2C e-commerce revenue growth and venture capital also contribute to the adoption of internet-based sales technologies	7
[26] He (2019)	Qualitative Case study	Focused on China's rural poor population, the authors sought to understand, in the era of digital entrepreneurship and IT globalization, what would be the structural barriers, exclusion mechanisms and persistent immutable conditions that rural poverty faces. On the other hand, they sought to understand the potential of a digital ecosystem that would minimize the risk-return of rural entrepreneurs, change the terms of exchange of rural products with urban dwellers and increase marginal returns	5

relations with the global economy and the high level of competitive pressure are the main forces for the use of B2B in all countries. Consequently, the authors suggest that strong business relationships with developed countries with mature B2B e-commerce practice are useful to sustain the use of B2B e-commerce across countries [25].

In the H index, also known as the Hirsch index, publications are organized in ascending order according to the most cited publication and then calculated where the sequence number of publications meets the citations [27]. Taking the two databases together, the H index counted seven publications (H-7), as shown in Table 17.3.

4.2 Analysis of Thematic Areas

Taking into account the analysis of thematic areas and using the VOSviewer software, version 1.6.16, using the binary counting method that selects only the documents where the words appear [28], a total of one thousand and five words were

Table 17.3 H-index of literature on digital economy, e-commerce, internet, technology, and business

Ref.	Authors	Date	Title	Citations	Ranking
[19]	Malecki	2003	Digital development in rural areas: Potentials and pitfalls	187	1
[3]	Ayres and Williams	2004	The digital economy: Where do we stand?	31	2
[20]	Jehangir, Dominic, Naseebullah, and Khan	2011	Towards digital economy: The development of ICT and E-commerce in Malaysia	25	3
[21]	Frank	2000	Digital health care: The convergence of health care and the internet	25	4
[22]	Lee and Lo	2003	E-enterprise and management course development using strategy formulation framework for vocational education	18	5
[23]	Pogorelova, Yakhneeva, Agafonova, and Prokubovskaya	2016	Marketing mix for e-commerce	10	6
[25]	Alsaad, Mohamad, Taamneh, and Ismail	2018	What drives global B2B e-commerce usage: An analysis of the effect of the complexity of trading system and competition pressure	9	7

identified. Subsequently, the number of occurrences of a word in the total of analyzed documents (27 articles) was defined as five, obtaining a total of 32 words. Of these, the words with more than 60% relevance were selected, corresponding to 19 words and, finally, four irrelevant words were excluded, namely, article, research, paper, and study. In the end, a total of 15 words were obtained and distributed over three thematic clusters.

The first cluster consists of seven words (red color in Fig. 17.8), namely, business, change, company, consumer, digitalization, field, and information technology. This approach encompassed all the articles that reported the changes as a result of digitization, both in terms of companies and businesses and in terms of consumer behavior and attitudes. In a study that aimed to examine the role of information and communication technologies (ICT) in the dynamics of labor productivity in Russia [29], the authors concluded that the digitization of business processes and an increase in participation of organizations that use technologies and the Internet lead to an increase in labor productivity. Furthermore, some socioeconomic indicators also registered significant improvements, namely, the real wage bill and the percentage of people with higher education in the active population. From the authors' perspective, it is important that managers develop strategies, adopting technologies and the Internet, to increase labor productivity and production efficiency [29]. The implementation of modern information technologies contributes to reducing expenses, improving the quality and transparency of processes [30]. On the other hand, the digitization climate allows the adoption of business strategies that range from the use of new electronic marketing channels to the conquest of new markets, which was almost impractical in the traditional business sector [31, 32].

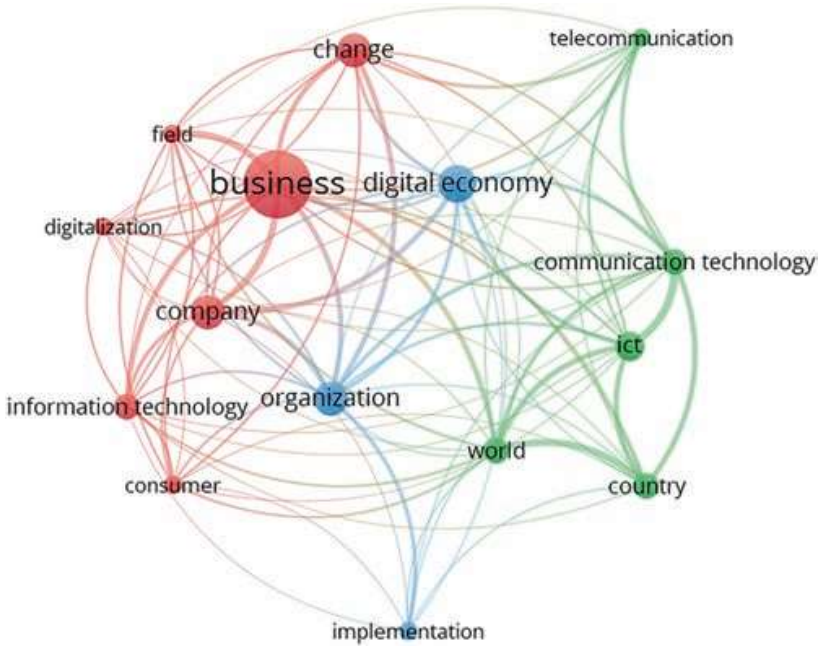

Fig. 17.8 Map of the relations between the different words grouped in thematic clusters

The second cluster includes five words (green color in Fig. 17.8), namely, communication technology, country, information and communication technologies (ICT), telecommunications, and world. In general, these publications described the improvements in the functioning and communication of countries as a result of the adoption of technologies and the Internet, including in less developed rural areas. With the development of digital information and the network, e-commerce emerges as a new form of business that has brought new changes to the world economy and people's lifestyles [4]. On the other hand, the use of the Internet, the World Wide Web, and applications has a substantial, positive, and measurable impact on the health sector, as they can be used to disseminate information, aid in informed decision-making, and promote health in the exchange of information with the community, in self-care, and in managing the demand for health services [21].

Finally, the third cluster includes three words, namely, digital economy, implementation, and organization (blue color in Fig. 17.8). This cluster related the digital economy with the implementation, in organizations, of software and instruments that allowed to stimulate electronic commerce, in a safer way, and to favor relations between economies. It portrays, in essence, the creation of easy, fast, and secure instruments and methodologies, which give leverage to e-commerce, ensuring data integrity. The emergence of electronic money has become an important issue in e-commerce and can be considered a monetary revolution that replaces traditional payment methods such as cash, check, and others [11]. Several studies indicate that the main barriers to online shopping are the lack of trust in payment systems and e-commerce sites, as well as concerns about security and privacy [33, 34]. In this context, a technology using encryption in an attempt to find an effective way to ensure the security of electronic payment was developed [35]. The authors concluded that digital signature technology is able to meet the confidentiality, integrity,

and non-repudiation requirements of the electronic payment process. Electronic money, in the near future, will consolidate its position as part of our daily lives and will be used to generate profit and a new business culture [11]. More recently and in response to the rapid development and application of information technologies, a method based on blockchain technology to ensure data security and establish trust between entities involved in transactions was developed [36]. According to the authors, this technology, in addition to reducing divergences and business costs, protects confidential data in circulation, promoting the integrity of the real economy and the digital economy [36].

5 Conclusion

The digital economy is a research area that, in the last 20 years, has seen a growing number of publications following the evolution of digital technologies and other intelligent systems, as these are the main structural components of the digital economy [6].

Bearing in mind that there is no study in recent literature on the most relevant thematic lines of research in the field of digital economy, with this research, it was proposed to carry out a bibliometric analysis of binary counting to group the literature into thematic clusters. In this context, three lines of research were found: (1) relation between "business," "change," "company," "consumer," "digitalization," "field," and "information technology;" (2) relation between "communication technology," "country," "information and communication technology," "telecommunication," and "world;" and (3) relation between "digital economy," "implementation," and "organization."

In the first thematic cluster, the literature that supports this line of research is particularly related to the consequences of the digital transformation, both at the level of companies and businesses and at the level of consumer behavior and attitudes. Technologies imply, for economic agents, structural and large-scale changes and provide unrealizable business opportunities in the traditional economy.

The second cluster comprises publications that reported and described improvements in the functioning and organization of societies and in communication between the various developed and underdeveloped countries, as a result of the adoption of digital and internet technologies, in all sectors of activity and even in the poorest regions.

Finally, the third cluster related the digital economy with the implementation, in organizations, of software and tools that allowed to stimulate electronic commerce, in a more secure way and favor international trade.

Taking into account the clusters found, the research area that relates the words "digital economy," "implementation," and "organization" stands out. Digital technology and devices connected to the Internet are part of our daily lives. According to the literature, there are many benefits and opportunities provided by its use. However, its use must be safe, and it must emphasize the preservation of privacy and

personal information. In this sense, guaranteeing the security and protection of data between people and institutions seems to be the challenge and the greatest concern of current and future societies. For these reasons, this will be a new line of research.

This research has some limitations. On the one hand, it is supported only by articles from the Scopus and WoS databases. Despite being considered the most comprehensive bibliometric databases in terms of peer-reviewed publications, there are other international databases that were excluded, namely, Scielo. On the other hand, a filter was used to limit the search period from 2000 to 2020 and to select only the documents of the "article" and "review" type. In fact, literature prior to 2000 could have been omitted, as well as other types of documents (books, book chapters, and conference papers). However, the rigorous and reproducible procedure makes us believe that the information contained in the excluded publications does not add or substantially alter the conclusions drawn in this research.

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