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Review

An analysis of the blockchain and COVID-19 research landscape using a bibliometric study

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ABSTRACT

The scientific community has become concerned about the impact of blockchain technology as a motivational tool in the COVID-19 era. Since the beginning of the pandemic, the number of scientific articles published in this field has been increasing, making it highly desirable to carry out a bibliometric study to identify research efforts.

Therefore, the aim of this work was to conduct a literature review of blockchain and COVID-19 technology in the field of Business Management to identify recent lines of research. To do so, we used a text mining technique on a corpus composed of 37 articles in the Web of Science database.

The results obtained clearly show 3 distinct clusters. The first represents the blockchain technology framework in organizations and stakeholders in which the research methodology in artificial intelligence is very important. The second shows the need to take into account business sustainability caused by COVID-19. The third indicates the impact of the pandemic on the supply chain industry.

Introduction

In a pandemic environment, the scientific community has put much of its research effort into the analysis of economic recovery through the optimisation of productive resources based on technology and entrepreneurship. The globalised economy has been an active principle of economic contraction which has paralysed international trade, through a crisis initiated on the supply and production chain side and immediately fed into the demand side on the consumption and investment side. On the other hand, this globalisation has become instrumental in increasing the adoption of digital technologies (Skare & Soriano, 2021).

After periods of financial crisis come phases of economic recovery and growth. According to the OECD economic report of September 2021 (OECD, 2021), the current global GDP is higher than the level before the pandemic. However, output in mid-2021 was still 3.5% lower than expected before the spread of COVID-19, resulting in job and income losses. Most tellingly, as shown in Fig. 1, inequality across countries, sectors and demographic groups explains an asymmetric recovery, with GDP increases to pre-pandemic levels not matched by the same increase in employment (US), or employment increases but without an increase in output and hours worked to pre-COVID levels (EU) (OECD, 2021).

In this phase of recovery and return to the path of global growth, new technologies are playing an ever more relevant role, closely related to the digital economy, the circular economy, the reactivation of industry, renewable energies and energy transition together with an increase in public spending not only at a national level but also at a supranational level: NextGenerationEU (European Union recovery funds of 750,000 million Euros and the Trump-Biden Stimulus Plans with 5 billion dollars between 2019 and 2021) based on R&D investment plans.

One of the problems generated in this post-pandemic period is related to the rising cost of raw materials: oil, gasoline, natural gas, ethanol, palm oil, heating oil, CO_2 emissions allowances (Dmytröw et al., 2021). The analysis of demand and supply factors driving disaggregated price developments and the implications for general inflation has been studied by different authors (Meyer et al.,

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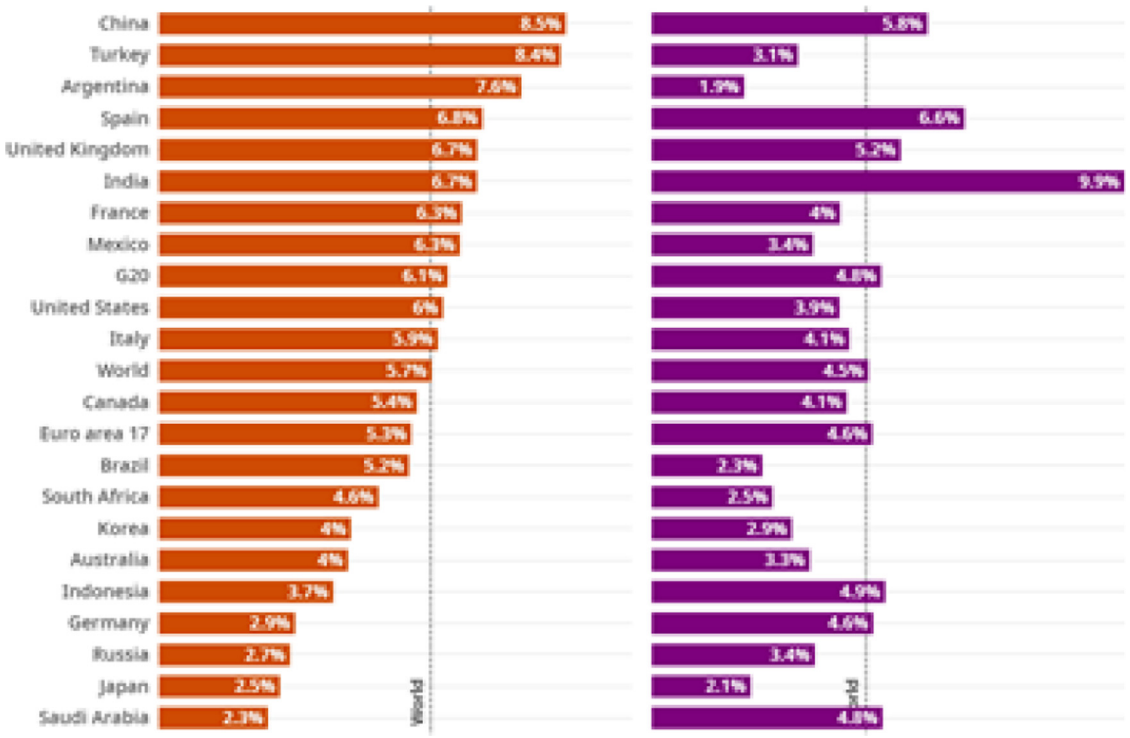

Fig. 1. Real GDP growth projections for 2021 and 2022.

2021). The rise in commodity prices translates into an overall increase in prices (Apergis & Apergis, 2021) and also an immediate and unprecedented increase in individual inflation uncertainty (Armantier et al., 2021).

In this environment of recovery and under the global threat of rising inflation and shortages of raw materials and intermediate products in strategic sectors, the concern of the scientific community in the application of new technologies in production processes has resulted in a multitude of scientific studies that have manifested themselves through numerous articles published in high-impact scientific journals. One of the most relevant technologies is blockchain, a technology that can help transform sectors that are hampered by inefficiency, as well as facilitating the emergence of new business models based on distributed markets and technology (Porras et al., 2019).

Blockchain's inherent features such as real-time exchange, cybersecurity, reliability and visibility, as well as transparency and traceability, make it the catapult for supply chain performance (Aslam et al., 2021). Its efficiency gains have been demonstrated in supply chain redesign (Nandi et al., 2021; Kouhizadeh et al., 2021), circular economy (Upadhyay, 2021), the healthcare sector (Idrees et al., 2021; Antal et al., 2021), the tourism sector (Rashideh, 2020), the agri-food sector (Feng et al., 2021), the energy sector (Wang & Su, 2020), the construction sector (Perera et al., 2021), mobile contact location applications (Kassab & Destefanis, 2021), Smart-cities applications (Esposito et al., 2021), and the digital economy sector (Idrees et al., 2021; Hasan et al., 2021).

The scientific community has begun to intensively and plausibly investigate the impact of blockchain technology as a motivational tool in this COVID-19 era. The study of this innovative technology has led to an increasingly relevant increase in the number of publications. The motivation of this work is based on discerning the status quo at the level of scientific literature that demonstrates an increasingly intensive role of research works related to an increase in blockchain technology in the field of Business Management. The authors have focused on the Web of Science (WoS) database as a scientific body and concentrated their study on the areas of Business Economics and Operations Research Management.

This study is organised as follows: Section 2 presents the database (WoS) or corpus constructed from the selected articles, and explains the text summarisation technique used to identify the most frequent terms, followed by the text clustering method used to determine the current lines of research on blockchain and COVID-19. Section 3 presents the main results of the research. Finally, Section 4 presents the most relevant conclusions of the study along with its limitations and future lines of research.

Corpus and methodology

This section describes the steps followed to obtain the dataset of articles in the field of Business and Management. The data is sourced from the Web of Science (WoS) database. We chose this database as it contains more than 21,100 journals which date back to 1990, most of them written in English and with a high impact factor published worldwide (Reuters, 2019; Carracedo et al., 2021).

The search criterion was to select in the title, abstract or topic the words blockchain and covid which resulted in 255 initial references. In the second step, we selected scientific articles as the document type, obtaining a total of 210 articles. Then, the research areas chosen were Business Economics and Operations Research Management in order to focus the study on research fields related to economics and economic management. Applying these filters, 39 articles were obtained, not considering those papers that were presented at scientific congresses. Finally, the papers written in English were selected. A total of thirty-seven research articles were included in the database. Note that this query was performed on 20th September 2021 and the papers included in the database were composed of titles and abstracts. The review procedure comprised four steps, which are summarized in Fig. 2.

Next, based on the retrieved database, we wanted to detect those lines of research on blockchain and COVID-19 that had a more consolidated character in the field of Business Economics and Operations Research Management. To do so, we used the software VOSviewer (OECD, 2021; Perera et al., 2020) (www.vosviewer.com) to group terms and to analyze the resulting clusters based on a corpus of

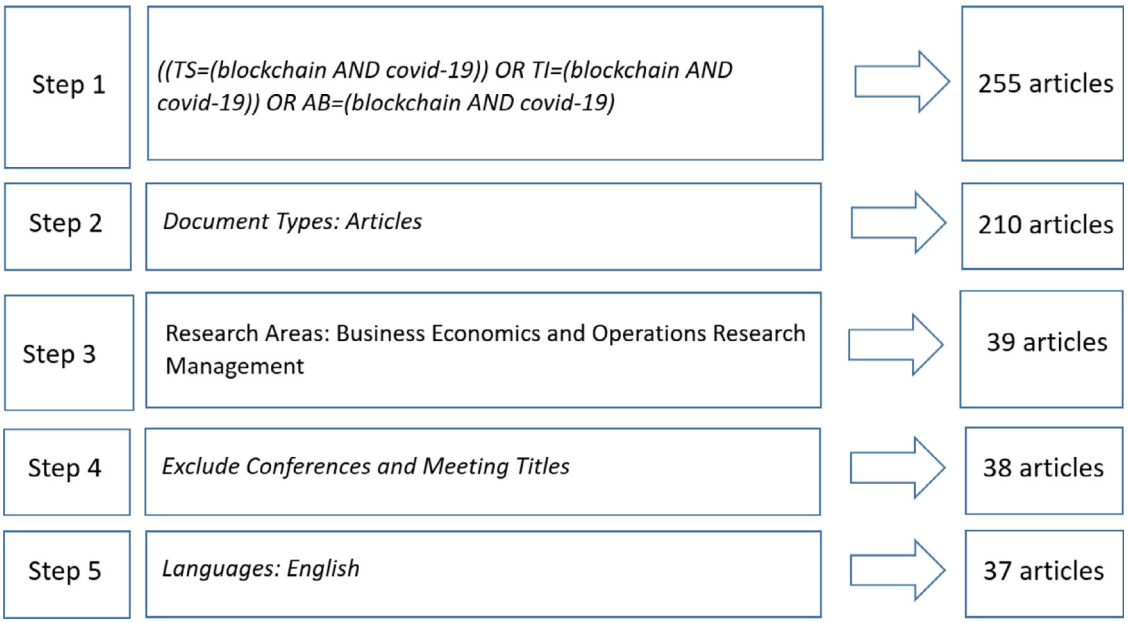

Fig. 2. Summary of the systematic review process.

documents. VOSviewer uses two standardised variables: the number of links for each term and the total link strength, and permits graphic visualisation of the network of relationships for each term. It then displays the relevance and strength of each link with the rest of the terms based on the letter size of each term and the number of interconnecting lines, as well as their thickness. VOSviewer has been implemented in a multitude of works showing the robustness of its methodology (Donthu et al., 2020; Guleria & Kaur, 2021).

A term map is a two-dimensional map where the distance between two terms is interpreted as the relationship between them. In general, the smaller the distance between two terms, the more related they are to each other. The relatedness of terms is determined based on co-occurrences in documents. For more information about how VOSviewer creates a term see Van Eck and Waltman (2011).

Results

This section presents a descriptive analysis of the retrieved data from the WoS database: evolution over time and year distribution, journals, research areas, research by countries and, finally, a term map or cluster analysis.

Evolution over time

Fig. 3 shows the number of articles published on blockchain and COVID-19 in relation to the time frame. As this is a recent topic, we have only 2 years of study available. Taking into account that the extraction of the database was carried out in September 2021, it can be seen that the first 9 articles were published in 2020 while in the following year the figure tripled to 28 articles.

Journals

Our final sample consisted of 37 scientific papers published in 28 different business and management journals which are available in the WoS database. In order to study the relevance of journals, the Impact Factor (IF) of each journal was analysed. IF is a key performance metric for ranking and comparison between journals (see Table 1 for details) (Torchia et al., 2015). In Table 2 we can observe that the journals IEEE Access and Transportation Research Part E-Logistics and Transportation Review published the largest number of articles, with 4 and 3 papers respectively. Considering the IF, the journals with the highest factor were Trends In Food Science & Technology followed by

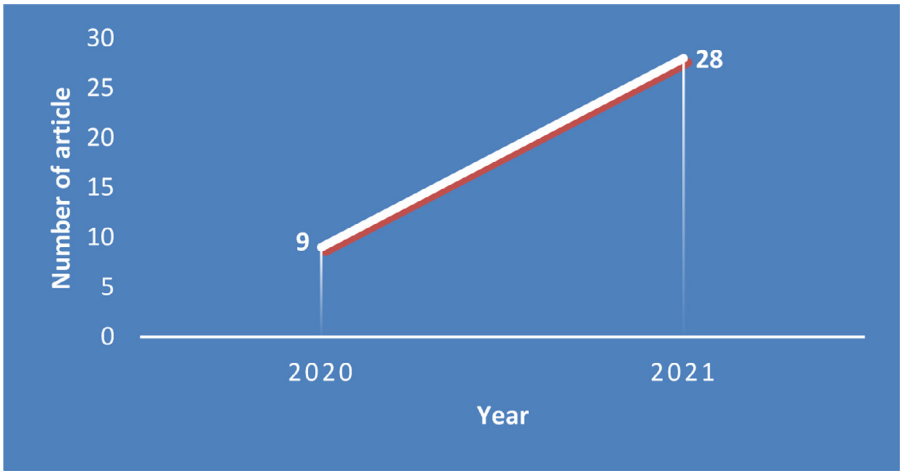

Fig. 3. Evolution over time.

Table 1
Summary of articles and Impact Factor by actuarial journals in the WoS database.

Journal	Frequency	Category Quartile	Impact Factor
Trends In Food Science & Technology	1	Q1	12.563
Journal of Cleaner Production	1	Q1	9.297
Supply Chain Management-An International Journal	1	Q1	9.012
Technological Forecasting And Social Change	2	Q1	8.593
International Journal Of Production Research	2	Q1	8.568
International Journal Of Production Economics	1	Q1	7.885
Global Food Security-Agriculture Policy Economics And Environment	1	Q1	7.772
Transportation Research Part E-Logistics And Transportation Review	3	Q1	6.875
International Journal Of Operations & Production Management	1	Q1	6.629
Electronic Commerce Research And Applications	1	Q1	6.014
International Journal Of Logistics Management	1	Q2	5.661
Annals Of Operations Research	1	Q1	4.854
Tourism Economics	1	Q1	4.438
Foods	1	Q2	4.350
Industrial Management & Data Systems	1	Q2	4.224
International Journal Of Logistics-Research And Applications	1	Q3	3.821
IEEE Access	4	Q2	3.367
Operations Management Research	1	Q3	2.706
Buildings	1	Q2	2.648
International Journal Of Accounting And Information Management	1		
International Journal Of Financial Studies	1		
International Journal Of Innovation And Technology Management	2		
International Journal Of Organizational Analysis	1		
International Review On Public And Nonprofit Marketing	1		
Journal Of Health Management	1		
Journal Of Humanitarian Logistics And Supply Chain Management	1		
Journal Of Industrial Integration And Management-Innovation And Entrepreneurship	1		
Review Of Business	2		
Total	37		

Table 2
Summary of co-authorship between authors.

Author	Documents	Citations	Cluster
Jayaraman, Raja	2	5	1
Omar, Mohammed	2	5	1
Salah, Khaled	2	5	1
Yaqoob. Ibrar	2	5	1
Nandi, Santosh	2	8	2
Sarkis, Joseph	2	8	2
Luthra, Sunil	2	0	3

Journal of Cleaner Production and Supply Chain Management - An International Journal with only one published article.

Our analysis shows 28 journals with 37 publications, of which 19 are indexed in the Web of Science with their corresponding impact factor. As can be seen in Table 1, the number of articles per journal is not directly related to their impact factor. This is evident in the case of the journal IEEE Access with four publications, but with the third worst impact factor, and the journal Transportation Research Part E-Logistics and Transportation Review with three publications and the eighth worst impact factor.

Research areas

A paper can belong to several research fields. Although we selected two research areas: Business Economics and Operations Research Management, our database of 37 articles also included several areas, with Engineering and Computer Science standing out. This is understandable when the topic analysed is blockchain since blockchain technology itself remains in constant evolution and has been studied since its origins (Kaur & Gupta, 2021) and as shown in Fig. 4.

The selection of these two areas is based on two factors: the first is that both areas are directly related to catch-up economic growth in the post-pandemic phase, with clear effects on employment, output, productivity and supply. The second is that it is a study that has not been carried out so far.

Scientific effort by countries

Countries and regions vary in their level of scientific effort as measured by publication and citation activity. Country counts are based on the institutional affiliations given in published papers[1].

With regard to the research line about blockchain and COVID-19, the country doing the most research is China. This is not surprising as in December 2019 COVID-19 was first reported to affect human life in Wuhan City in the Hubei province of China. Chang and Park (2020) argue that the blockchain can help people in the event of an infectious disease such as COVID-19, both in controlling information and optimising research processes. This is followed by papers published by authors from the USA, India and England, with 6 publications each. Fig. 5 provides an overview of the 15 main results. It should be noted that the 3 papers from China are included in the 10 (Peoples R China) and the 2 from the United Arab Emirates are also included in the 3 (U Arab Emirates).

In Europe, Italy stands out with 4 papers, Austria with 3, Denmark and Finland, both with 2, and Belgium with one, making a total of 12 papers for European countries. In the Middle East, the United Arab Emirates appears with 3 papers, and the African continent provides 1 paper from South Africa. In Latin America, only Chile appears with one paper.

Term map

A term map is a map with two dimensions where the terms of the obtained corpus are placed. When two terms are close to each other there is a relationship between them. This map is represented in Fig. 6. For the sake of brevity, the minimum number of occurrences of a term was 5, providing a total of 40 terms. The colours of the terms

[1] http://help.incites.clarivate.com/incitesLiveESI/ESIGroup/indicatorsGroup/citationThresholds/thresholdsESI/countriesTerritoriesESI.html

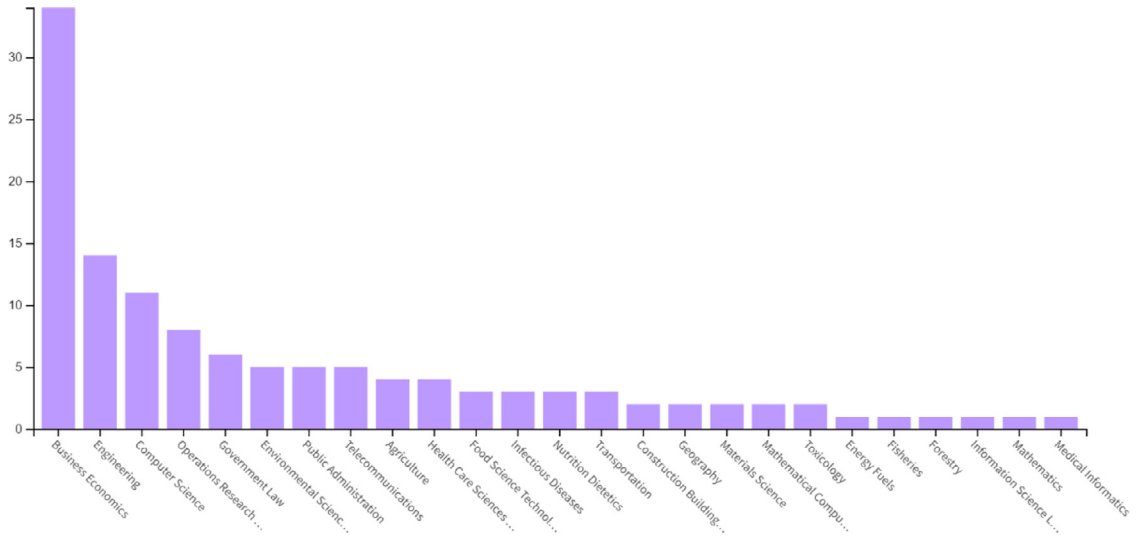

Fig. 4. Number of papers by field of research.

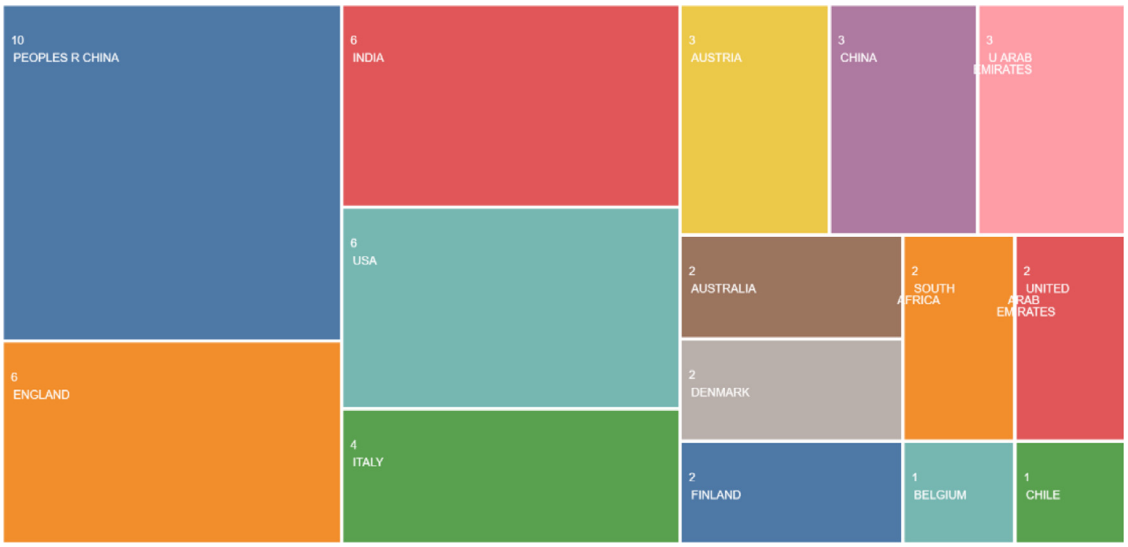

Fig. 5. Number of papers by country of analysis.

indicate clusters of related terms identified by VOSviewer. The clusters turn out to correspond reasonably well to three lines of research. The related terms in the 3 clusters obtained do not form closed groups of words, but as can be seen in the map, the terms belonging to one cluster are in turn related to the terms of the other two clusters, but a lower number of times than those of their own cluster and also at a greater distance in the 37 clusters analysed.

The blue cluster (top centre) is composed of 11 terms: *approach, artificial intelligence, blockchain technology, framework, importance, opportunity, organization, practitioner, research, resilience and stakeholder*. This cluster represents the blockchain technology framework in organizations and stakeholders, the research methodology in artificial intelligence is very important in this context. Many studies support the relationship between Industry 4.0, where Artificial Intelligence together with the Internet of Things (IoT) and Big Data result in several research articles (Javaid et al., 2021) demonstrating a natural convergence between blockchain technologies and Artificial Intelligence (Zhang et al., 2021; Kiruthika & Ponnuswamy, 2021).

The green cluster (lower left) is composed of 13 terms: *analysis, article, business, covid, data, internet, iot, need, role, sustainability, system, thing and world*. This group shows the need to take into account business sustainability caused by COVID-19. This highlights interest in the role of analyzing data and the article system provided by the internet of things worldwide. Many IoT technologies (Blockchain, Big Data analysis, cloud computing) applied in sustainable systems in supply chains (Yadav et al., 2021), in the energy efficiency of smart cities have been studied under the influence of the COVID-19 environment, and even for the effect of IoT to achieve the United Nations Sustainable Development Goals (López-Vargas et al., 2021).

The red cluster (lower right) is formed by 16 terms: *addition, author, challenge, design methodology approach, effect, impact, industry, insight, literature, originality value, outbreak, pandemic, paper, risk, study and supply chain*. This cluster represents the impact of the pandemic on the supply chain industry. One focus of the methodology used within the articles in the scientific literature highlights the value of originality in mitigating the risks and effect of the supply-chain disruptions brought on by the impact of the pandemic. Many articles support the relevance of studies on supply chain adaptation in the pandemic (Singh et al., 2021; Frederico, 2021; Schleper et al., 2021; Spieske & Birkel, 2021).

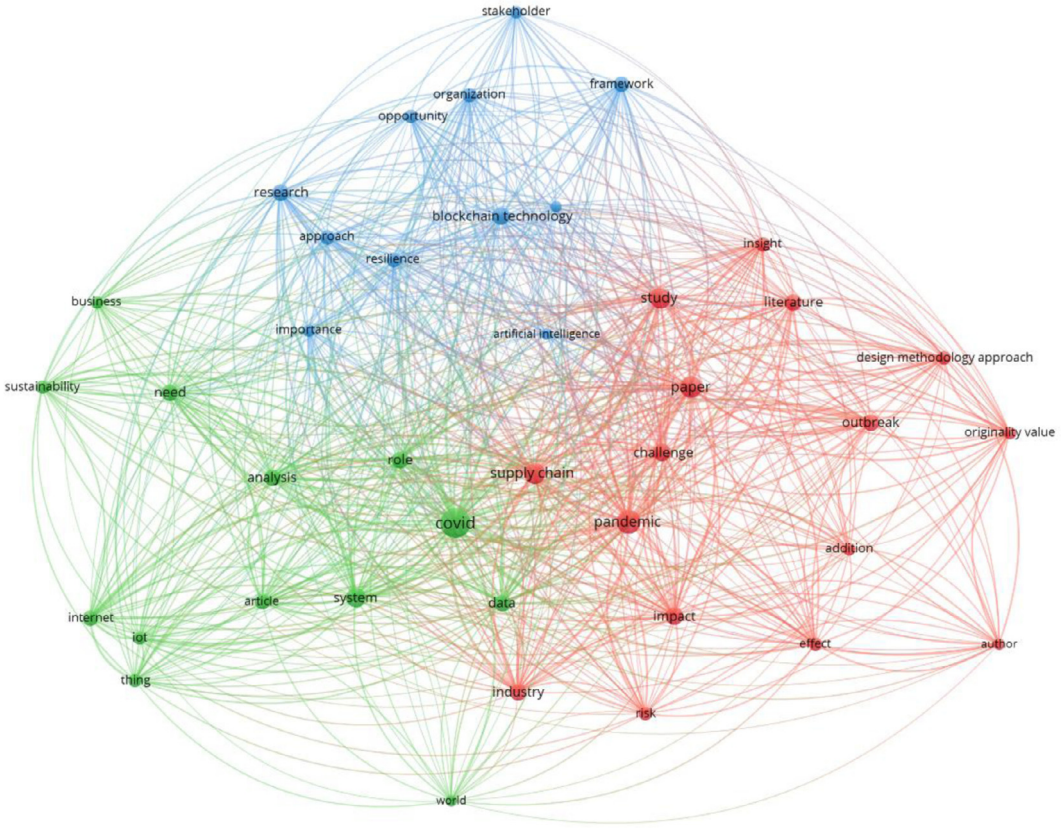

Fig. 6. Term map of the database formed by 37 documents.

Visualisation of co-authorship between authors

Table 2 shows the visualisation of co-authorship between authors. In the VOSviewer software we selected 2 as the minimum number of publications an author must have to be included in the co-authorship analysis. VOSviewer provided 3 clusters of authors indicating that those who are in a group are relatively related to each other and therefore, the co-authorship relationship between them is greater.

Conclusions

This paper presents a bibliometric analysis describing the recent state of the literature on blockchain and COVID-19 showing the journals with the most publications and the main lines of research in the fields of Business Economics and Operations Research Management. One of the most relevant findings of this study was that until now, no systematic review of the scientific literature on blockchain and COVID within the fields of Business and Management research had been carried out.

The WoS database was examined obtaining a database of 37 articles in the period 2020-2021. The number of articles does not seem to be relevant, although we must stress that this is a very current topic (COVID-19 and technologies) where we must also consider the delay between the preparation of a study by the researchers and the definitive publication in the journals that form part of the Web of Science. The results show that the journals with most publications were the IEEE Access and Transportation Research Part E-Logistics and Transportation Review, closely related to supply chain optimisation topics. In contrast, the journals with the highest impact factor only published one article each. These journals were Trends In Food Science & Technology followed by the Journal of Cleaner Production and Supply Chain Management - An International Journal. The fields with most publications in the area were those related to Business Economics, Operations Research Management, Engineering and Computer Science. The results also show a growing interest in this area where China is making the most scientific effort followed by England, India and the USA.

The analysis of the terms analysed through the clusters clearly detects three groupings of terms. Each cluster shows which were the most relevant topics related to COVID-19 and sustainable technology that motivated researchers to carry out research work. This methodology highlights above all research focused on blockchain and artificial intelligence, as well as the Internet of Things. Another relevant facet of this research was manifested through the constant analysis of supply chains and the search for more efficient processes by integrating technologies related to Industry 4.0.

The classification into three clusters (blue, red and green) showed the importance of each of the terms within each cluster (Intra cluster) as well as their relationship to other terms from other clusters (Inter cluster). This analysis shows a growing interest in the study of the scientific research community in one of the digital technologies that has been booming in recent years - blockchain - which is becoming one of the most widely used tools by companies when undertaking a technological transformation in this post-pandemic period, aimed at returning to paths of worldwide economic growth. Blockchain technology itself is also related to Artificial Intelligence, as well as to the sustainability of the new business models generated, which is clearly reflected in Industry 4.0 and specifically in the optimisation of production and supply chains, all of this in a crisis situation created by COVID-19. Finally, we found that 7 authors in the corpus published at least 2 papers. These make up 3 distinct clusters, indicating that the relationship of co-authorship between them is greater when the authors are in a group.

One of the limitations of this study lies in the research areas selected from the WoS Database, Business Economics and Operations Research Management, both of which were taken into account as

they are more related to economics and economic management. This fact shows that there are articles that were assigned to other research areas but that were not exclusive to those mentioned above, and that several research areas may overlap. This situation should be addressed in future research by carrying out a prior analysis of the most frequently cited words in this study in other research areas not previously included. Future works will deal with a larger corpus incorporating the Scopus database. In addition, the free R software (R Core Team, 2021) will be included to compare the results obtained.

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