The importance of circular economy in the supply-chain-bibliometric analysis

Kovačić, Matija; Mutavdžija, Maja; Milojica, Vedran

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Governance of Environmental Challenges in Post-Pandemic Era discusses major changes in governance caused by recent turmoil due to the pandemic. The pandemic crisis was turbulent with high levels of uncertainties making planning and coordination hard to perform. Since a turbulent environment continues to exist after the pandemic, countries have to deal with them in the coming period, which makes the collection of papers relevant and useful.

Prof. Aleksandar Jovović

The authors of the collection of papers used quantitative and qualitative research methods that resulted in firm conclusions. The issue of "new governance" in a turbulent environment characterized by uncertainty and high volatility will be even more relevant in the coming period, which is marked as an era of "policrisis". The publication would be useful to both scientists and policymakers since the topics explored are scientifically relevant and contemporary.

Prof. Željko Požega

The results of the scientific research presented in the publication can serve as a guide for policymakers in their efforts to improve the governance of sustainable development. The authors' recommendations provide a significant contribution to the design of regulations required for sustainable development. The publication is focused on topics that are scientifically based, innovative and internationally relevant.

Prof. Marija Topuzovska Latkovikj

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GOVERNANCE OF ENVIRONMENTAL CHALLENGES IN POST-PANDEMIC ERA

edited volumes

EDITORS: PREDRAG JOVANOVIĆ, NATAŠA DRVENKAR, BOJANA NAUMOVSKA

GOVERNANCE OF ENVIRONMENTAL CHALLENGES IN POST-PANDEMIC ERA

The collection of papers Governance of Environmental Challenges in Post-Pandemic Era deals with changes in governance caused by new conditions created in the pandemic era. Post-pandemic recovery period was marked by the emergence of new types of crises, such as the war in Ukraine and in the Middle East. To have successful environmental and more broadly sustainable development policies, countries need to adapt their governance models to the "new reality" marked by sudden pattern changes, high variability and unpredictability. The publication is divided into nine chapters. The authors of the papers analyze modern governance challenges and responses comprehensively, including both vertical and horizontal (sectorial) perspectives. In a constantly and rapidly changing environment where the only certainty is uncertainty, the publication provides a new and fresh perspective on governance in turbulent, post-pandemic conditions. It could be useful to scientists as a basis for further research of "polycrisis" circumstances as well as to policy-makers in designing new, more appropriate and more efficient governance models.

Predrag Jovanović
Nataša Drvenkar
Bojana Naumovska

GOVERNANCE OF ENVIRONMENTAL CHALLENGES
IN POST-PANDEMIC ERA

PUBLISHED BY

Institute of Social Sciences, Belgrade

Faculty of Economics, University "J. J. Strossmayer", Osijek

Institute for Sociological, Political and Juridical Research, University "Ss. Ciryl and Methodius", Skopje

PUBLISHER

Goran Bašić

REVIEWERS

Prof. Aleksandar Jovović

Prof. Željko Požega

Prof. Marija Topuzovska Latkovikj

SERIES

Edited Volumes

SERIES EDITOR

Veselin Mitrović

Belgrade 2023

ISBN 978-86-7093-272-2

edited volumes

GOVERNANCE OF ENVIRONMENTAL CHALLENGES

IN POST-PANDEMIC ERA

EDITORS
Predrag Jovanović
Nataša Drvenkar
Bojana Naumovska

INSTITUTE OF SOCIAL SCIENCES
Institute of national significance for the Republic of Serbia

EFOS Faculty of Economics in Osijek

ИНСТИТУТ ЗА СОЦИОЛОШКИ И ПОЛИТИЧКО ПРАВНИ ИСТРАЖУВАЊА

CIP – Каталогизација у публикацији
Народна библиотека Србије, Београд

351.862(082)
351.759.6(083)
338.1:502.131.1(082)

GOVERNANCE of environmental challenges in post-pandemic era / editors Predrag Jovanović, Nataša Drvenkar, Bojana Naumovska. – Belgrade : Institute of Social Sciences ; Osijek : Faculty of Economic ; Skopje : Institute for Sociological, Political and Juridical Research, 2023 (Beograd : RIC Grafičkog inženjerstva Tehnološko-metalurškog fakulteta). – 295 str. : graf. prikazi, tabele ; 22 cm

Tiraž 150. – Str. 7–13: Foreword / Predrag Jovanović, Nataša Drvenkar, Bojana Naumovska. – Napomene i bibliografske reference uz tekst. – Bibliografija uz svaki rad.

ISBN 978-86-7093-272-2 (ISS)

1. Jovanović, Predrag, ekonomista, 1961– [уредник] [аутор додатног текста]
а) Јавна безбедност – Зборници
б) Управљање ванредним ситуацијама – Зборници
в) Привредни развој – Одрживи развој – Зборници

COBISS.SR-ID 134277897

Language proofreading: M. Prevodi | **Graphic design and layout:** MITRACK | **Print:** 150 copies | **Printed by:** Faculty of Technology and Metallurgy, Research and Development Centre of Printing Technology

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The Importance of Circular Economy in the Supply-Chain-Bibliometric Analysis

Abstract

The circular economy's significance and importance are expanding along with the society's growing concern over wasteful resource consumption or pollution that results from the expansion of industry and other processes. If the supply chain and circular economy are linked, it will be possible to see how the two are interconnected, because the supply chain includes all activities that are typical of raw material and product producers and those that can use recycled resources in production, increasing the supply chain's sustainability. Additionally, the primary objective of this paper is to identify the present status of the literature and to provide an overview of the bibliometrics connected to the topic of sustainability and the supply chain, given the growing significance of the circular economy. The authors discovered through their research that there is a link between sustainability and the supply chain and that efforts to promote sustainability can significantly affect the supply chain in the context of enhancing sustainability.
Keywords: Circular economy, Supply chain, Sustainability

Introduction

The need to analyze the circular economy is becoming imperative due to the growing concerns about uncontrolled resource consumption, i.e., excessive use of available resources. Accordingly, the interest of scientists in researching the circular economy is growing, which has led to the emergence of new concepts that link the circular economy with sustainability and sustainable development (Geissdoerfer et al., 2017). Circular economy implies functioning of the economy so that already used resources are reused, i.e., it emphasizes the need to recycle and reuse once used resources (Rizos et al., 2017). The need to increase the efficiency of resource use arises through the goals of sustainable development emphasized by the UN (Biermann et al., 2017).

Furthermore, given the importance of the supply chain and its role in satisfying the requirements of stakeholders (Alkier et al., 2023), it is necessary to ensure that the resources used in the supply chain are environmentally friendly (Raian et al., 2022), i.e., sustainable, because otherwise a risk would occur of negative environmental impact and unsustainability. The sustainable effects of the efforts are reflected in shorter supply chains (no middlemen) and a smaller carbon footprint while stimulating the small local economy (Alkier et al., 2023a). Therefore, designing the supply chain according to the principles of circular economy is of particular importance and requires changing the culture and policies of stakeholders in the supply chain (Bastas & Liyanage, 2018), as well as developing strategies that will transform the traditional (linear) supply chain into a sustainable (circular) chain (De Angelis et al., 2018). The supply chain transformation strategy must be systematic because a different approach will result in only partial improvements in sustainability. Such strategies must develop policies and a culture that are based on sustainability and the sustainable use of resources (Iqbal et al., 2020).

Given the global distribution of supply chains, or the current paradigm that emphasizes the development of expanded supply chains due to lower costs and greater availability of resources needed for the normal functioning of the chains, the challenge of ensuring the sustainability of the supply chain is growing. The fundamental reason for this can be found in different legislations of different countries in which the organizations involved in the supply chain operate. In other words, the diversity of legislation in the context of waste management, resource use, and the like can determine the sustainability of the entire supply chain, as well as what can affect the disruption of the circular economy. But most importantly, the establishment of a circular economy is of particular importance as it can reduce the need for resources necessary for the conduct of production and other processes in the supply chain.

Green economy concept is recognized as a means to achieve sustainable development (Ostojić et al., 2022). If existing papers in the field of circular economy and supply chain are analyzed, it is identified that the authors primarily deal with the "green transition" of the supply chain, which means the use of environmentally friendly technologies in the supply chain, i.e., environmentally

friendly management and use of resources, and how the "green transition" can affect the creation of a circular economy (Ying & Li-jun, 2012), use and development of green packaging, i.e., sustainable packaging in the supply chain (Meherishi et al., 2019), the impact that the circular economy has on supply chain management in general (Del Giudice et al., 2020; Buntak et al., 2019), indicators that can be used to analyze the performance of the circular economy (Howard et al., 2019), as well as aspects of the supply chain types, aspects of their design and impact on the circular economy (Kiss et al., 2019). Furthermore, it is identified that the authors deal with the development of strategic frameworks, i.e., models by which they connect the circular economy and sustainability, i.e., sustainable development, which is of particular importance, since sustainable development can be based on circular economy settings and rationality in resource use (Pieroni et al., 2019). With this in mind, two research questions were defined in the paper:

> Can the supply chain be designed according to the principles of the circular economy?
>
> What does the circular economy mean in the context of the supply chain?

The paper is divided into five chapters. In the first chapter, an introduction to the topic is given, where the context and importance of the topic are clarified. In the second chapter, the used methodology is described, as well as the formulas used in calculating the parameters for the analysis. The third chapter describes the research results. The fourth chapter is a discussion chapter in which the obtained results are discussed, while the last fifth chapter is a concluding chapter in which recommendations for future researchers are defined, i.e., research limitations.

Theoretical Framework

Circular Economy

The significance and importance of the circular economy are growing with the increase in society's concern about excessive use of resources, i.e., pollution that occurs as a result of the

development of production and other processes (Velenturf & Purnell, 2021). Due to the scarcity of natural resources, enterprises must rely more on the circular economy and as the awareness of the importance of the circular economy and more intensive involvement in the green transition process grows, so will the need for greening the economy (Ostojić, 2023). However, the importance of the circular economy development is also significant due to the need to reuse, i.e., recycle the used resources. The fundamental reason for this is the lack of resources, in addition to the decreasing amount of available resources necessary for the normal development of business and social processes (Morseletto, 2020). The establishment and encouragement of the establishment of a circular economy lead to significant changes in existing production paradigms that require consideration of the processing of used products, as well as a reduction in the total amount of harmful gases released into the atmosphere (Zeng et al., 2022). The newly established paradigm must contain product design settings so that the products can, after their use, be reused, i.e., recycled. In other words, it means extending the life cycle of the product as well as the life cycle of the materials used in production (Neves & Marques, 2022).

The circular economy is one of society's responses to the problems of sustainability, primarily the ecological component thereof, which is of increasing importance in view of the global challenges related to climate change, such as rising air temperatures and the like (Rödl et al., 2022). This has been proven by the promotion and encouragement of the circular economy development by the countries that are global leaders in the context of the production of goods and services, such as China, the European Union, Japan, the United States of America, etc. (Korhonen et al., 2018). However, despite the circular economy being emphasized as a response to sustainability problems, it is necessary to highlight that the adoption of the principles of the circular economy, as well as the general paradigm shift from a linear economy to a circular one, also implies significant challenges, such as financial profitability, the need to change the design of products, i.e., production technology in general, structural changes in society, changes in customer attitudes, etc. (Ritzén & Sandström, 2017). In other words, the existing production procedures that are adapted to the linear

economy must be changed. That is, they should be adapted to the new characteristics of the recycled resources used in the production. Recycling of resources and their adaptation for reuse involve the need to use thermodynamic and chemical processes (Jubinville et al., 2020) which in turn implies a potential negative impact on the environment, i.e. the release of greenhouse gases (Ross, 2019). Therefore, promoting recycling and reuse of used resources can have a positive impact on the environment and sustainability on the one hand, but on the other, a risk of a potential negative impact may occur (Kalyani et al., 2021). Essentially, the circular economy is based on efficient and effective waste management, i.e., the waste management realized in such a way that waste can be reused as a resource in production in the future (Ranjbari et al., 2021). This brings with it the need to establish a different waste management system, based on the classification of waste at the place of its origin, i.e., the households where the largest share of the waste is produced in most cases (Tomić & Schneider, 2020). The introduction of a different waste management system also has the potential to increase costs for households, which may lead to resistance from the population itself (Di Foggia & Beccarello, 2020). However, in order to make waste management easier, i.e., to create a basis for encouraging recycling at the places where the waste is generated, the European Union through its directives, such as the EU Circular Economy Action Plan (COM/2020/98), has created a basis on which all member states can develop plans and foundations for the establishment of a circular economy (Calisto Friant et al., 2021). One of the fundamental reasons for the European Union emphasizing the need to establish a circular economy is the projection that indicates an increase in the amount of waste production of 70% by 2050. This increase brings with it a significant risk of a lack of space to accommodate this amount of waste, but also the risks of air and water pollution associated with a large increase in production and the amount of disposed waste.

So, in essence, the circular economy implies reuse of the previously used resources, which is especially significant when it comes to the resources such as water (Macedonio & Drioli, 2022), the lack of which can significantly threaten agricultural production, plastic, and especially microplastic, the presence of which can cause the

pollution of flora and fauna (Payne et al., 2019) i.e., generally, all types of hazardous waste the disposal and presence of which in the environment can cause major environmental disasters (Zhang et al., 2022). Although scientists are still debating the establishment and definition of the concept of circular economy (Prieto-Sandoval et al., 2018), there is no doubt that the fundamental principles advocated by the circular economy are aimed at increasing environmental sustainability, which is of particular importance given the growing concern (Roblek etl al., 2021) and the importance that sustainability has, and will preserve in the future due to the culture of consumerism (Coderoni & Perito, 2020). Likewise, it should be emphasized that the circular economy affects all branches of activity (Fukumoto & de Vasconcelos, 2022), and with the properly defined policies and laws, it will affect the increase in sustainability will in the future.

Supply Chain and Sustainability

The importance of a sustainable supply chain is growing as sustainability concerns grow. A green supply chain implies sustainable flow of materials, i.e., resources and information, including sustainable development of products (Zhu & He, 2017), a sustainable way of securing the necessary resources for production (Peng et al., 2022), sustainable way of production (Junaid et al., 2022), sustainable way of disposing of resources (Sarkar et al., 2022), i.e., their reuse (Mardani et al., 2020). Ensuring the sustainability of the supply chain, i.e., the transformation of the existing supply chain, often unsustainable by nature and design, into a sustainable chain, is a significant challenge due to the systematic approach (Samper et al., 2022). In other words, a sustainable supply chain must be based on the sustainability of all stakeholders involved in the chain, and cases of unsustainability of one of the stakeholders in the chain, division in the supply chain according to the life cycle of the product has been written about (Mardani et al., 2020). This can result in unsustainability of the entire supply chain. In this context, in order to achieve supply chain's sustainability, one of the mechanisms available to organizations is digital transformation (Samper et al., 2022; Seuring et al., 2022). With the development of

Internet technologies and the ability to communicate through the Internet, many technological innovations developed within Industry 4.0 use the Internet to transmit information (Kovačić et al., 2022a). Through digital transformation and application of the Industry 4.0 technologies, the efficiency of processes in the supply chain can be influenced (Núñez-Merino et al., 2022; Khan et al., 2021), implying less need for resources, better optimization of transport routes, greater safety of employees involved in processes within the supply chain, etc. (Junge & Straube, 2020). To use digital technologies and to have digital innovations, organizations must have supportive organizational culture (Kovačić et al., 2022b). However, it is necessary to emphasize again that for a complete digital transformation of a supply chain, it is necessary to carry out digital transformation of each of the stakeholders in the supply chain (Guandalini, 2022). Implementing digital transformation in the supply chain can require significant financial resources (Yang et al., 2021), i.e., financial investments, which is also the reason why organizations located in the countries with a worse economic situation and those lacking infrastructure and knowledge, may lag behind in terms of digital transformation compared to developed countries (Chen et al., 2021). A sustainable supply chain, i.e., a green supply chain, involves a fundamental challenge related to the impact on the ecological component of sustainability, while researchers (Hong et al., 2018) believe that a sustainable supply chain does not have a significant impact on the economic and social components. This is partly true, since solutions within a sustainable supply chain address parameters such as waste management during the production (De Angelis et al., 2018), release of harmful gases into the atmosphere (He et al., 2019), etc. All of the above may, of course, also affect the economic component of sustainability, which is confirmed (El Amrani et al., 2021) and adds that a sustainable supply chain has the least impact on the social component, which is also in line with the attitude (Hong et al., 2018) that is, in accordance with the recommendations it defines (Zhang et al., 2018).

There is no doubt that sustainable supply chains are in their infancy and that the importance that sustainable supply chains will have in the future is growing (Koberg & Longoni, 2019) due to the potential risks associated with the scarcity of resources such

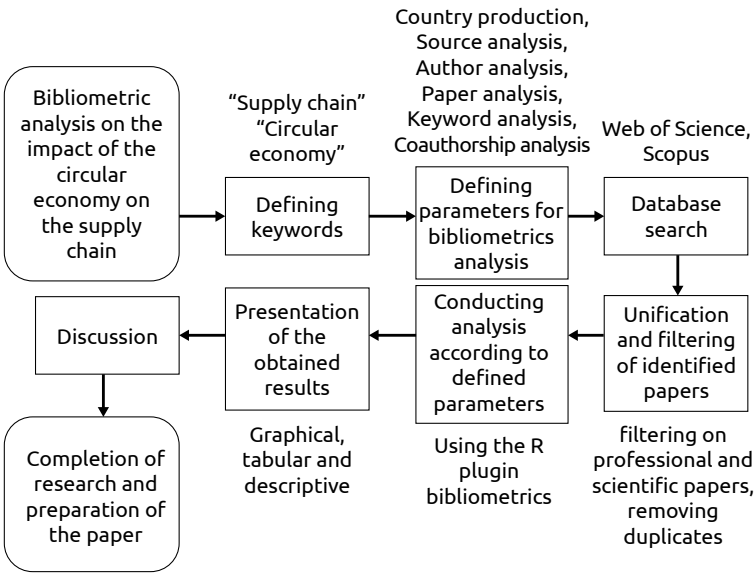
as water (García-Cáceres et al., 2019), as well as energy sources such as gas and electricity, due to an increase in demand caused by the transition from fossil fuels to the use of electricity (Makholm, 2022), i.e., before the complete transition to electricity, the lack of fossil fuels, primarily oil, (Ghorbanpour et al., 2022). In other words, in order to ensure a successful transition towards sustainable energy sources, it is necessary to ensure that the entire energy supply chain is sustainable (Safarzadeh et al., 2022), which means ensuring that all stakeholders in the supply chain are sustainable and do not use transformation and production mechanisms that are unsustainable, as may be the case with electricity production. Namely, with the increase in demand for electricity due to the imperative of the transition to electric vehicles, it is necessary to take care that the electricity produced comes from sustainable, i.e., clean, sources (Kovačić et al., 2022; Mutavdžija et al., 2022). Otherwise, a risk would occur of an insufficiently successful transformation since, in the case of using sources of electricity that are not sustainable, a similar amount of harmful gases will be released into the atmosphere as in using fossil fuel cars (Zeng et al., 2021). Considering the large number of stakeholders that belonging to global supply chains, it must be emphasized that it is necessary to ensure transparency (Montecchi et al., 2021) in the supply chain on the basis of which it is ensured that all interested parties have the possibility of insight into the origin and the way in which resources are provided, i.e., the way in which waste is disposed of and managed in the supply chain (Apeji & Sunmola, 2022). In the context of transparency, it should be emphasized that transparency can be linked to ensuring the equality of all stakeholders, since through transparency, a basis is created for identifying potential benefits to stakeholders in the supply chain. This also affects the social component of sustainability (Gardner et al., 2019), and it can be achieved based on the application of technologies developed in the context of Industry 4.0, such as blockchain (Kshetri, 2021; De Carvalho et al., 2022). The application of blockchain technology in the supply chain affects the security of transactions carried out in the supply chain, as well as the ability to ensure satisfactory quality of products and services, information security, etc. (Azzi et al., 2019). Therefore, the creation of a sustainable supply chain in the future is today's imperative,

and it will affect all industries with regard to sustainability requirements, the potential of applying Industry 4.0 to increase efficiency and effectiveness in the supply chain, thereby reducing costs (Birkel & Müller, 2021; Khan et al., 2022) that is, due to the imperative of establishing a circular economy, which can be established precisely through the creation, i.e., the design of a sustainable supply chain (Manavalan & Jayakrishna, 2019).

Materials and Methods

The research methodology is shown in Figure 1. Before the start of the research, the key words used in browsing scientific databases were defined, namely "supply chain" and "circular economy." After defining the keywords, the parameters for conducting the analysis were selected. All the selected parameters and the way in which the selected parameters were used are described in chapter 2.1. when it comes the analysis of the productivity of the

Figure 1. Phase of conducted research



Source: Authors presentation

states; 2.2. analysis of the relevance of sources; 2.3. authors' analysis; 2.4. paper analysis; and 2.5. keyword analysis. After the parameters were selected, the WoS and Scopus databases were searched for the defined keywords in the period from 2006 to 2022. During the search, a total of 1481 articles were identified, after which the articles were filtered according to the parameters of focusing exclusively on scientific and professional articles, i.e., removing duplicates and reading abstracts. From the total number of identified papers, 739 articles were taken into account, which has been the basis for conducting the research. Likewise, it should be emphasized that only articles in English were taken into account.

After filtering the articles, the obtained results have been presented graphically, tabularly, and descriptively, this also being the basis for the discussion chapter. It should be emphasized that the methodology used in the research is similar to the methodology used by (Kovačić et al., 2022; Mutavdžija et al., 2022) that is, the methodology used by (Sombultawee et al., 2022; Gonçalves et al., 2022; Marôco et al., 2022).

County Productivity Analysis

When analyzing countries, the variables that are considered are the number of papers coming from each country, the total number of citations, or the average number of citations per paper coming from the country being analyzed. The total number of countries considered in the analysis is 10. The results of the analysis of countries are presented in corresponding tables and descriptions. The average number of citations was calculated as the ratio of the total number of papers from each country and the total number of citations recorded for each paper coming from the observed country, which is shown in expression 1.

$$Average\ Article\ Citations = \frac{Total\ number\ of\ papers}{Total\ number\ of\ citations} \quad (1)$$

Source Analysis

The indicators h-index, m-index and g-index were used for the analysis of the source. In addition, the analysis considered the

number of papers published in each journal. The number of journals considered in the analysis is 10.

To calculate the h-index, the expression 2 was used:

$$h - index = \frac{Total\ number\ of\ produced\ papers}{Total\ number\ of\ cited\ papers} \quad (2)$$

m-index is used for analysis of h index per year since the first publication of the paper. To calculate the m-index, the expression 3 was used:

$$m - index = \frac{h-index}{Number\ of\ years\ since\ the\ publication\ of\ the\ first\ paper} \quad (3)$$

Analysis of the Authors

When analyzing authors, the parameters considered are the number of papers that the author produced in the period from 2006 to 2022, the country that the author comes from, the institution where the author is engaged, or works, the number of citations that each author has, or Articles Fractionalized. The expression 4 was used to calculate Articles Fractionalized:

$$Frac\ Freq\ (AU_j) = \sum_{h \in AU_j} \frac{1}{n\ of\ CoAuthors\ (h)} \quad (4)$$

Analysis of Papers

When analyzing the papers, the parameters considered are the total number of citations for each paper, the total number of citations that each paper has in a year and Normalized TC. The total of 10 papers with the highest number of citations were considered. Papers are presented in the table according to the total number of citations from the paper with the highest number of citations, down to the paper with the lowest number of citations. Each paper is accompanied by a reference.

When calculating the total number of citations in a year, the expression 5 was used:

$$TC\ per\ year = \frac{Total\ number\ of\ citations}{Number\ of\ years\ since\ the\ publication\ of\ the\ paper} \quad (5)$$

Furthermore, when calculating Normalized TC, the expression 6 was used:

$$NCL_i = \frac{\sum_f \sum_t \sum_f p_{ift} RCR_{ift}}{\sum_f \sum_t p_{ift}}$$

Keyword Analysis

When analyzing keywords, they are categorized into clusters. The clusters are divided according to the similarity of the keywords and their interconnectedness. Each keyword is associated with a circle the size of which is determined by the number of the keyword's appearance. The higher the keyword's incidence, the larger the circle size, and vice versa. Furthermore, all keywords are interrelated. The thickness of the line that connects the circles with the keywords denotes the association of the keywords, where greater thickness of the line implies the greater the association of the keywords and vice versa. When analyzing keywords, cluster names were formed based on keywords, and sub-themes were defined within each cluster.

Co-authorship Analysis

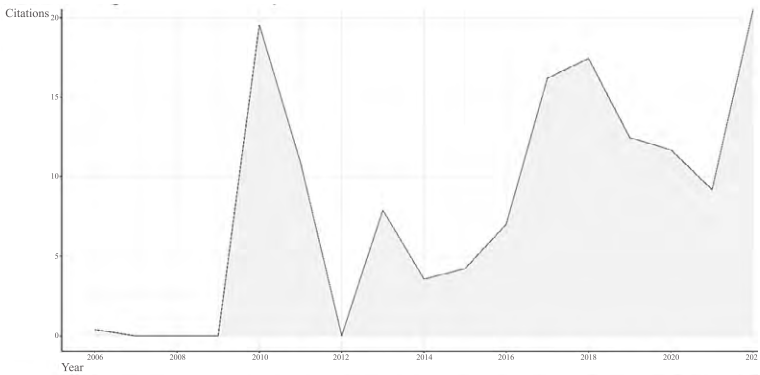
The analysis of co-authorship is based on the consideration of cooperation between authors. All authors, depending on the collaboration and the topics they deal with, are categorized into clusters. Each cluster has a different color, and within each cluster the author who has the greatest influence is defined. The influence of the author is shown by the size of the circle. The larger the circle, the greater the influence of the author, and vice versa. Furthermore, all authors within the cluster are interconnected. The larger and thicker the number and the lines connecting the clusters, i.e., the authors within the cluster, the more pronounced is the cooperation between the authors and vice versa.

Results

Figure 2 shows the analysis of the average number of citations of papers in the observed period from 2006 to 2022.

The average number of citations varies depending on the year. The highest number of average citations was recorded in 2010, after which there was a significant decline. However, after 2014, there was an increase in the number of average citations of papers.

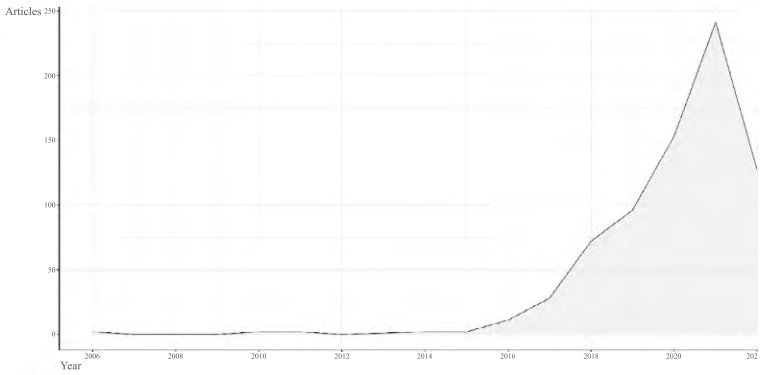
Figure 2. Average number of citations



Source: Authors' research

Figure 3 shows the total number of papers produced in the period from 2006 to 2022. It is evident that the number of papers is growing and that the number of papers has increased, especially since 2016 from which point the number of papers has been constantly increasing.

Figure 3. Total number of produced papers



Source: Authors' research

If we look at other information related to the papers, the results of the research showed that the average increase in the number of papers per year is 41%. Of the total number of analyzed papers, 37.08% were created based on international cooperation between authors. The average number of authors per paper is 3.94, and the total number of papers authored by a single person is 50. If we are talking about citations, the average citation per paper per year is 6.61 while the average citation per article is 24.62.

Country Analysis

Table 1 shows the analysis of the productivity of countries, i.e., the analysis of citations of papers from individual countries. As it can be seen from Table 1, the country with the highest number of citations is the United Kingdom with the total of 4164 recorded citations followed by Italy with 1750 citations and China with 1731 citations. If we talk about the average number of citations per paper, the largest average number per paper is in Sweden (56.38 citations) followed by France (51.83 citations) and Denmark (50.43 citations). On the other hand, if we talk about the number of papers by country, the largest number of papers comes from the United Kingdom (278 papers in total), followed by Italy (215 papers in total) and China (170 papers in total).

Table 1. Country productivity analysis

Country	Total Citations	Average Article Citations	Number of papers
United Kingdom	4,164	42.93	278
Italy	1,750	17.68	215
China	1,731	25.84	170
USA	1,128	34.18	142
France	933	51.83	77
India	908	25.94	123
Sweden	733	56.38	40
Netherlands	716	37.68	51
Denmark	706	50.43	37
Brazil	513	19.73	84

Source: Authors' research

Source Analysis

Table 2 shows the analysis of the source. The journal with the largest number of papers was the *Journal of Cleaner Production* (United Kingdom) with the total of 125 published papers and the h-index of 232. It is followed by *Sustainability* (Switzerland) with the h-index of 109 and the total of 78 published papers. The third in terms of the number of published papers is the journal *Resources Conservation and Recycling* (Netherlands) with the total of 52 published papers and the index of 150.

Table 2. Source analysis

Sources	Articles	H -index	G -index
Journal of Cleaner Production	125	232	66
Sustainability (Switzerland)	78	109	48
Resources Conservation and Recycling	52	150	25
Business Strategy and the Environment	24	115	23
International Journal of Production Research	23	153	23
Sustainable Production and Consumption	20	38	15
International Journal of Production Economics	18	197	12
Science of the Total Environment	14	275	12
Production Planning and Control	12	85	11
Journal of Industrial Ecology	10	112	10

Source: Authors' research

Analysis of the Authors

Table 3 shows the analysis of the authors. The author with the largest number of citations is Lauri Jäämaa (Finland, Aalto University School of Science, Industrial Engineering and Management) with the total of 115 citations followed by Riikka Kaipia (Finland, Aalto University School of Science, Industrial Engineering and Management) with also 115 citations in total. Hendrik Birkel (Germany, Friedrich-Alexander Universität Erlangen-Nuremberg) is the third concerning the number of citations with the total of 85 citations, followed by Maximilian Gebhardt (Germany, Friedrich-Alexander

Universität Erlangen-Nuremberg) with the total of 85 citations. It should be emphasized that authors with the same number of citations have the same significance.

Table 3. Author citation analysis

Author	Citations	Country	Institution
Lauri Jäämaa	115	Finland	Aalto University School of Science, Industrial Engineering and Management
Riikka Kaipia	115	Finland	Aalto University
Hendrik Birkel	85	Germany	Friedrich-Alexander Universität Erlangen-Nuremberg
Maximilian Gebhardt	85	Germany	Friedrich-Alexander Universität Erlangen-Nuremberg
Alexander Spieske	85	Germany	Friedrich-Alexander Universität Erlangen-Nuremberg
Mikael Skou Andersen	57	Denmark	Aarhus University
Maria Emilia Brassesco	56	Portugal	Universidade Católica Portuguesa
Ezequiel Coscueta	56	Portugal	Universidade Católica Portuguesa
Manuela Pintado	56	Portugal	Universidade Católica Portuguesa
Aman Kumar	55	Taiwan	National Taiwan University

Source: Authors' research

The analysis identified that the most cited authors come from same institutions and that only Mikael Skou Andersen (Denmark, Aarhus University), Riikka Kaipia (Finland, Alto University) and Aman Kumar (Taiwan, National Taiwan University) come from different institutions, since ten authors have been considered in total. Furthermore, it should be emphasized that if we look at the country from which the authors come, the authors with the largest number of citations come from the countries of the European Union and Europe.

In addition to the analysis of citations of authors, an analysis of the productivity of authors was also conducted. The results of the analysis are shown in Table 4. As can be seen from the table, the author with the largest number of papers is Yigit Kazancoglu (11 papers in total) from the Yaşar Üniversitesi and Articles Fractionalized in the amount of 2.74, followed by Aman Kumar from National Taiwan University (10 papers), Sachin Kumar Mangla from the OP Jindal Global University (10 papers in total) and Yingli Wang from the Cardiff University (10 papers in total). It should be emphasized that the authors who have the same number of articles have the same importance regardless of their position in the table.

Table 4. Authors' productivity analysis

Authors	Articles	Country	Institution	Articles Fractionalized
Yigit Kazancoglu	11	Tukey	Yaşar Üniversitesi	2.74
Aman Kumar	10	Taiwan	National Taiwan University	2.16
Sachin Kumar Mangla	10	India	OP Jindal Global University,	2.23
Yingli Wang	10	United Kingdom	Cardiff University	2.45
Liu Yang	9	United Kingdom	University of Birmingham	2.14

Source: Authors' research

Papers Analysis

Table 5 shows the analysis of the papers and contributions by the authors. It should be emphasized that the 10 most significant papers were excluded from the total number of articles included in the research. One also needs to bear in mind that the largest number of papers is directed towards the analysis of the existing research, with a few papers based on primary research, i.e., describing conceptual models.

Table 5. Contribution analysis of the most cited papers

Reference	Goal of the paper	Type of Paper /Method	Contribution of the Paper
Genovese et al. (2017)	Defining a hybrid methodology for life cycle assessment	Article	In the article, the authors describe the methodology that can be used for the analysis, that is, provide the assessment of the total emissions of harmful gases that can occur during the life cycle of a product. The methodology includes the analysis of direct emissions of harmful gases, indirect emissions of harmful gases, or total emissions of harmful gases in the supply chain. The authors come to the realization that the establishment of a green supply chain, that is, a circular economy, has a significant positive impact on the environment, but it can be economically questionable from the aspect of profitability.
Kalmykova et al. (2018)	An overview of the strategies and practices of establishing a circular economy	Literature review	The authors come to the realization that civil associations and consulting agencies have the greatest influence on the development of the circular economy. However, despite emphasizing the importance of establishing a circular economy, there are no solid foundations in the context of clear strategies for the development of a circular economy. In addition, the authors analyze the tools that are available for creating a circular economy and divide the obtained tools into categories of strategies for implementation tools. Furthermore, the authors emphasize the special importance of establishing a circular economy in the supply chain in order to influence the increase in sustainability.

Reference	Goal of the paper	Type of Paper /Method	Contribution of the Paper
Lopes de Sousa Jabbour et al. (2018)	Overview of the impact of Industry 4.0 on the circular economy	Literature review	In the paper, the authors provide an overview of the impact that the Industry 4.0 technologies have on the creation of a circular economy. The authors come to the realization that the establishment of a circular economy is more efficient and effective with the application of the Industry 4.0 technologies. In addition, the authors analyze the impact of ReSlove's business model on the establishment of a circular economy through the Industry 4.0 technologies, which represents a new approach and a new framework in the study of the circular economy.
Govindan & Hasanagic (2018)	Overview and analysis of the drivers of establishing a circular economy	Literature review	Through a systematic review of the literature, the authors analyze the relationship between interested parties and the circular economy. The paper identifies 13 drivers in total that influence and encourage the creation of a circular economy; 34 practices that indicate how the drivers influence the creation of a circular economy; and the total of 39 barriers. In addition, the paper describes a multi-perspective model of the interested parties that can be used to analyze the influence that the interested parties have on the establishment of a circular economy.
Geissdoerfer et al. (2018a)	Defining a framework for understanding how the circular economy affects the supply chain	Literature review/case study	In the research, the authors present four different case studies and describe how different models of establishing and managing the circular economy affect the performance of the established circular economy, that is, business

Reference	Goal of the paper	Type of Paper /Method	Contribution of the Paper
			in general. The authors have identified significant advantages to establishing a circular economy, but they also emphasize that there are a significant number of challenges associated with the transition from linear to circular economy.
Zhu et al. (2010)	Analysis of different supply chain management practices	Article	In the article, the authors analyze organizations located in the Chinese economy and their management practices in establishing a circular economy, or a green supply chain. The authors come to the realization that a particularly significant role in the establishment of a circular economy is played by management systems, i.e. management system policies such as the environmental management system. On the other hand, the authors come to the realization that the state government also has a special significance, since it can encourage organizations to establish a circular economy through laws and policies defined at the state level.
Geissdoerfer et al. (2017)	Analysis of the circular economy as a new dominant paradigm of sustainability	Literature review	In the research, the authors emphasize that the circular economy is a regenerative approach that includes reducing the amount of emitted greenhouse gases, that is, all types of waste. Also, the research identifies a significant increase in the interest of researchers related to the circular economy. The authors also come to the realization that there is no significant difference in the literature between the terms of sustainability and

Reference	Goal of the paper	Type of Paper /Method	Contribution of the Paper
			circular economy. But despite this, the authors conclude that the circular economy is the basis of sustainability and sustainable development.
Despeisse et al. (2017)	The authors analyze the possibility of using 3D printers to achieve circular economy	Article	In the research, the authors look at the possibilities offered by application of 3D printers in the context of reducing the amount of required resources. One of the insights that the authors come to is that significantly larger amounts of sustainable products can be created by using 3D printers, that is, products that are based on the reuse of the already used resources, but which in this context are adapted for reuse.
Mangla et al. (2018)	Analysis of barriers to establishing a circular economy	Literature review	In the research, the authors analyze the barriers that can have a significant impact on the establishment of a circular economy in the context of India. It has been identified that one of the fundamental barriers that arises is the lack of legal legislation that would define the need for the establishment of a circular economy, which is why there are not enough initiatives by organizations related to the establishment of such a system. In other words, the authors emphasize that it is particularly important for governments to define the need for the establishment of a circular economy through the definition of legislation, since this will affirm the obligation of all organizations to act in accordance with the law.

Reference	Goal of the paper	Type of Paper /Method	Contribution of the Paper
Moktadir et al. (2018)	Analysis of the circular economy in the textile processing industry	Article	In their research, the authors analyze how the circular economy affects the leather industry in Bangladesh, which is considered one of the largest polluters of the environment. In the research, the authors present a methodology related to the transformation of industries such as textile industry, leather industry, and the like, i.e., introducing the entire supply chain of such industries into a circular economy in order to reduce their impact on the environment.

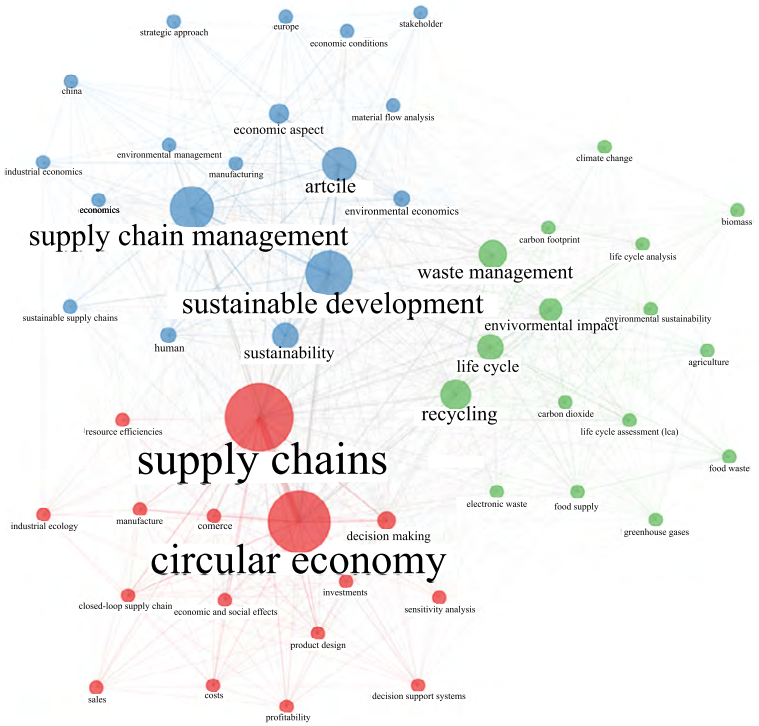
Source: Authors' research

Keyword Analysis

Figure 3 shows keyword analysis. As can be seen in Figure 3, the keywords can be categorized into three clusters which are shown and explained in Table 6. The dominant themes in the observed area include sustainable development, supply chains and waste management. Within the mentioned clusters there are several sub-topics that can be categorized into the topics of waste and waste management (green), circular economy and the links that production and product design have to the functioning of the circular economy (red). In the third cluster (blue), the dominant themes are reduced to sustainable development and the impact that sustainable development has on the supply chain, as well as the on production and the environment.

If we are talking about the interpretation of Figure 4, the larger the size of the circle, the higher the occurrence of the keyword and vice versa. On the other hand, the greater the thickness of the link between the keywords, the greater the link between the keywords or clusters with the corresponding keywords.

Figure 4. Keyword analysis



Source: Authors' research

Table 6. Keyword and sub-topic analysis in clusters

Cluster name	Under topics	Keywords
Red Cluster: Circular Economy and Supply Chain	Influence of product design and production on the supply chain	Supply chains Circular economy Resource efficiencies Industrial ecology Manufacture Commerce Decision making Closed-loop supply chain Sales Costs Profitability Product design Design support systems Sensitivity analysis

Cluster name	Under topics	Keywords
Blue Cluster: The Impact of Sustainable Development on Supply Chain Management	Supply chain and environment	Supply chain management Sustainable supply chains Sustainability Economic aspect Economic conditions Environmental economics Environmental management Manufacturing Industrial economics Economics Economic conditions
Green cluster: Waste management	Impact of waste management on sustainability and ecological environment	Waste management Environmental impact Life cycle Recycling Electronic waste Food supply Greenhouse gases Food waste Carbon dioxide Environmental sustainability Life cycle analysis Climate change

Source: The table is the work of the author

Red Cluster – Circular Economy and Supply Chain

In the red cluster, the dominant topic addressed by the authors is the relationship between the circular economy and the supply chain, and the subtopic identified within the red cluster is the impact of the product design and production on the supply chain. The transition to a circular economy brings with it several challenges that are primarily related to the development of strategies that will enable the production of environmentally friendly products. This includes defining a resource procurement strategy, i.e., selecting a supplier who will provide all the resources necessary to produce a sustainable product (Bocken et al., 2016). This is followed by research conducted by Den Hollander, M. C., Bakker, C. A., and Hultink, E. J., in which the authors describe the importance of recycling and reusing once used products, as otherwise

the challenge of failing to provide sufficient resources for the production occurs. In this context, the authors emphasize the need to develop strategies that will enable a different provision of all materials needed for production. (Den Hollander et al., 2017). To ensure such a strategy, it is necessary to develop strategic frameworks for product design and production (Van den Berg & Bakker, 2015). The development of product production strategies using recycled materials also affects resource efficiency. In other words, due to the growing market demand for raw materials and materials that can be used in production, the reuse of resources, i.e., recycling of materials can reduce the cost of purchasing resources needed for production (Di Maio et al., 2017). Furthermore, one of the mechanisms that encourages the reuse of resources, i.e., increases the efficiency of the use of available resources, is the legislation that state governments can define. One example of this is the European Union, which defines recommendations for the reuse of resources, i.e., recycling, which has proven to be a good measure that has resulted in reduced waste production and increased use of recycled resources (Domenech & Bahn-Walkowiak, 2019). Resource reuse, i.e., recycling of used resources, also results in changes in the supply chain design. In other words, there is the development of so-called closed loop supply chain which means reuse of used resources, i.e., their recycling. This also implies the need to adapt the organizations involved in the supply chain in the context of defining the mechanisms by which the used units will be reused in production. This means that it is necessary to develop return logistics that will enable the collection and classification of the used resources that have been collected, as well as the selection of those resources that can be reused in production (Guide et al., 2003). By closing the supply chains the circular economy effect is achieved, as all used products are returned to the supply chain, i.e., recycled. Thus, organizations involved in a closed supply chain may have lower costs due to lower requirements for resources, as once-used resources are recycled.

Sustainable development is based on the economic, environmental, and social pillars, which implies the importance of caring for a reduced impact on these components (Omer, 2008). In other words, sustainable development means a development that considers the needs for resources of the current generation, without compromising the ability of future generations to meet the same needs. This is particularly pronounced when it comes to the supply chain, as the supply chain must provide all the resources necessary to meet the identified needs. Irrational use of resources can result in unsustainability, as well as in the increase of the negative impact that the supply chain can have on the environment. To increase sustainability, i.e., rational use of resources, it is necessary to develop and encourage a culture of all stakeholders in the supply chain related to the sustainability and efficiency of resource use (Zimon et al., 2020). However, to promote the sustainability and rational use of resources in the supply chain, it is necessary to develop policies aimed at sustainability and sustainable development. The implementation of such policies brings with it several challenges, but on the other hand, it can also affect the reputation of the organization, as well as the entire supply chain (Oelze et al., 2014). The development and implementation of sustainability policies in the supply chain can also be encouraged by legislation, as is the case in the context of the European Union, i.e., the food supply chain. In other words, sustainability and social responsibility become the basis for the functioning of supply chains, such as the food supply chain in which there is a risk of disposing of large amounts of resources due to the expiration date, i.e., maintaining the market price of resources. With this in mind, the development of strategies and policies aimed at sustainability and promoting social responsibility can be a mechanism through which vertical integration of stakeholders in the supply chain, as well as easier implementation of environmental management policies (Stranieri et al., 2019) are achieved. However, care exclusively for the environmental segment is insufficient, since sustainability also includes economic and social segment. The social segment primarily refers to the concern for the human factor that is included in the supply chain

by reducing the risk of labor exploitation, taking care of inclusion and equal opportunities and the like. On the other hand, the economic segment of sustainability refers to the manner of resources' procurement, market performance, as well as the communication of organizations involved in the supply chain with the market.

Green Cluster – Waste Management

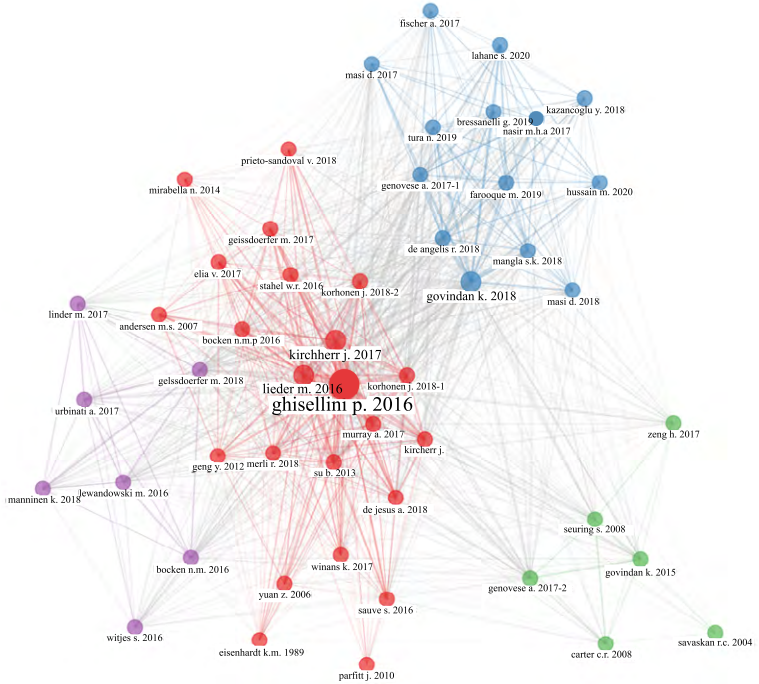
Waste management is the basis of ensuring a circular economy. The main reason for this is the need to have mechanisms in place that enable the sorting of waste, so that the part of the waste that can be reused is processed and sent back into the production process, or the part of the waste that cannot be reused is disposed of safely. The existence of waste management mechanisms influences the creation of so-called reverse supply chain (Mahajan & Vakharia, 2016). The need to develop mechanisms that will enable waste management is particularly pronounced in the industries where there is significant waste production, such as textile industry (Li & Ding, 2021), food industry (Papargyropoulou et al., 2014), or electronics industry, which is characterized by the production of large amounts of hazardous waste that can significantly negatively affect the environment (Rezayat et al., 2020). One of the mechanisms that can be used in waste collection, i.e., waste management, is the return logistics. The return logistics allows the creation of the so-called closed-loop supply chain, thus creating the basis for the establishment of a circular economy (Govindan et al., 2015). However, even though the establishment of a circular economy, i.e., reuse of once used resources causes lower needs for new resources, i.e., the production of new resources and the inability to fully recycle resources result in the need to dispose of non-recyclable resources in special landfills, depending on the type of the resource being disposed of (Reno, 2015). This means that there is a risk that the disposed resources would pose a threat to the environment, i.e., that they can negatively affect the environment in the phase of disposal, i.e., their decomposition. However, it should be emphasized that with proper waste management, the amount of such resources is lower than, the in the cases where all of the used resources are disposed of without recycling. This approach to waste management

can also reduce carbon dioxide emissions from the production of new resources, i.e., reduce carbon dioxide emissions through proper waste management and disposal (Qiyong & Jiaoju, 2011). Thus, it is evident that proper waste management can provide a basis for the establishment of a circular economy, i.e., that the amount of waste produced in the supply chain can be reduced, thus also reducing the carbon dioxide emission of the production of necessary resources, or decomposition of landfilled waste.

Co-autorship Analysis

Rawls reminds us that political pessimism precipitated the fall of the Weimar Republic; people "no longer believed a decent liberal parliamentary regime was possible," and Nazism followed (Rawls, 1993: lxi–lxii). Fascism has crept back into politics and now seriously threatens democratic stability. This is profoundly troublesome but also an opportunity to fortify liberal accounts of social stability with a conception of resilience by taking seriously the domestic-expansive problems that polarize societies. Although these problems are not among the ones for which liberalism was devised, liberal theorists have long used their experiences and observations to develop the tradition. J. S. Mill saw the tyrannical potential of the people, whereas previous generations of liberals saw only the tyrannical power of government (Mill, 2002). John Dewey reimagined liberalism's enduring values for an industrial age that, up until then, lacked the conceptual resources for protecting liberty from the marketplace (Dewey, 1935: 5–6). Rawls resuscitated Kant's account of liberal legitimacy to explain how citizens might come to share the same conception of justice for moral reasons despite their incommensurable yet reasonable conceptions of a good life. The COVID-19 pandemic has demonstrated how deeply engrained human-induced risks have become in the functionality of societies. Liberals must now reimagine the tradition for a set of new, cross-cutting challenges that cascade across global, regional, and local systems of governance. Developing the tradition to meet today's challenges will require discussions on a concept of resiliency, and those discussions will certainly reverberate back into the way we think about justice and stability.

Figure 5. Co-authorship analysis



Source: Authors' research

Within the red cluster, the authors who have the greatest influence are Ghisellini, P., Ripa, M. and Ulgiati, S. with the paper "Exploring Environmental and Economic Costs and Benefits of a Circular Economic Approach to the Construction and Demolition Sector, A Literature Review". The mentioned authors describe the basic settings of the circular economy, as well as its importance in the context of reducing the negative impacts that the traditional economy has. Also, the authors talk about the need to adopt a methodology that would be used in the transformation of the traditional economy into a sustainable economy, or an economy based on recycling, i.e., reuse of once used resources. (Ghisellini et al., 2018) Furthermore, within the red cluster it was identified that the paper "Conceptualizing the Circular Economy: An Analysis of 114 Definitions" by Kirchherr, J., Reike, D. & Hekkert, M. is the second paper in terms of significance. In the mentioned paper, the authors describe

114 conceptual definitions of circular economy and analyze in detail the content of each of the conceptual definitions. The authors conclude that circular economy is the basis for reducing the negative impact that the traditional functioning of the economy has (Kirchher et al., 2017).

When it comes to the purple cluster, it was identified that out of 7 included authors in total, not one significantly differs from others in terms of influence. However, the authors who represent a significant link with the red cluster are Geissdoerfer, M., Vladimirova, D., and Evans, S. with their paper entitled "Sustainable Business Model Innovation: A Review" in which they provide an overview of the literature related to innovation and the impact that innovation has on the development of system sustainability (Geissdoerfer et al., 2018b). Furthermore, if we talk about the authors who are links to other clusters, a particularly significant article that connects the purple cluster with the green cluster is the paper by Witjes, S., and Lozano, R. titled "Towards a More Circular Economy: Proposing a Framework Linking Sustainable Public Procurement and Sustainable Business Models, in which the authors link sustainability and the circular economy, and emphasize that the circular economy is the basis for increasing sustainability.

Like the purple cluster, the green cluster does not have a significant author who would address the area of sustainability, i.e., the circular economy. However, despite this, it was identified that the authors Genovese, A., Acquaye, A. A., Figueroa, A., and Koh, S. L. in their paper "Sustainable Supply Chain Management and the Transition to a Circular Economy: Evidence and Some Applications" emphasize the importance of the development of circular economy, i.e. green supply chain, and that the development of green economy is imperative given the increased consumption of resources (Genovese et al., 2017). The mentioned paper, i.e., its authors, are the link between the green cluster and the red cluster, i.e., the green cluster and the purple cluster. In addition, the second most important paper within the green cluster is the one by Seuring, S., & Müller, M entitled "Core Issues in Sustainable Supply Chain Management – a Delphi Study" in which the authors describe the results of research conducted using the delphi method, where four basic problems were identified, namely the pressure to transform the

supply chain into a sustainable chain, the need to measure the sustainability of supply chain development, supplier management, and supply chain management as a whole (Seuring & Müller, 2008).

Discussion

Ensuring the sustainability of supply chains becomes imperative. The reason for this is the importance of sustainable development and rational use of resources, due to the growing demand for resources, i.e., depletion of resources and use of resources from non-renewable energy sources (Balatsky et al., 2015). This approach to resources' use can have a negative impact on the environmental component of sustainability. But in addition to the growing concerns and interest of scientists to use renewable energy resources (Cerović et al., 2014), there is a need to consider the impact of the excessive consumption on the social and economic components of sustainability (D´Eusanio et al., 2019). The primary reason for this is the global distribution of the supply chain, which brings with it the risk of overexploitation of labor, i.e., inequality of the labor engaged in organizations that are stakeholders in the supply chain. Furthermore, ecological, and social imbalances, i.e., unsustainability of the supply chain, can determine and affect economic unsustainability and vice versa.

In response to the challenges of unsustainability, one of the directions of action is the establishment of a circular economy. A circular economy involves the reuse of resources that have been used once and then recycled. However, the circular economy addresses exclusively the environmental segment of sustainability, which means that the social component remains exposed to potential unsustainability. If we talk about the impact of the circular economy on the economic segment, resources' reuse may result in savings when it comes to the resources' acquisition costs (Murray et al., 2015), or reduction of greenhouse gas emissions from resource production (Mongo et al., 2022). However, the establishment of a circular economy in the supply chain brings with it several challenges related primarily to the need of defining mechanisms that will enable the collection of used resources and the development of mechanisms that will enable or prepare used resources for reuse. This approach

allows for a significant reduction in the waste generated, which can significantly affect the environmental component of sustainability (Ragossnig et al., 2019). But when it comes to adapting resources for reuse, one of the challenges that arises is the release of possible harmful gases resulting from the resources' processing (Wang et al., 2020). On the other hand, the disposal of used resources also affects the production of greenhouse gases, i.e., environmental pollution. Therefore, regardless of the approach to resource management, there is a risk of greenhouse gas emissions, or negative impact on the environmental segment of sustainability, which means that the establishment of a circular economy cannot eliminate the negative impact on the environmental segment but reduce it.

If we talk about the stakeholders involved in the supply chain who are most affected by changes due to the development of the circular economy, it can be said that the circular economy has a significant impact on stakeholders at the beginning of the supply chain. The reason for this is lower demand for raw materials due to recycling. However, in addition to the stakeholders at the beginning of the chain, the establishment of a circular economy in the supply chain may require adjustment of producers, since the production process needs to be adapted to the recycled resources whose characteristics may differ from those of the non-recycled ones. One of the main goals of every organization is foresight needs and requirements that customers have (Buntak et al., 2021). Ultimately, customers or users of supply chain's services should also be prepared to adapt, as the characteristics of the finished products produced with recycled resources may be different from those produced with non-recycled resources. One of the possibilities related to maintaining the satisfactory quality of the final products is the production of finished products with a share of recycled resources to which non-recycled resources are added, as is the case with polymers (Ignatyev et al., 2014). However, in order to increase the quality of the final products, i.e. services that contain recycled materials, it is necessary to develop technological procedures, as is the case with steel, where specially developed technological procedures maintain the quality of the final product based on recycled resources. (Boom & Steffen, 2001). It is especially important to emphasize that the establishment of a circular economy and the reuse of resources in

supply chains is due to global economic disruptions caused by political and other crises, which have slowed or completely disrupted the supply chain (Kovačić et al., 2023). Slowing down the supply chain also leads to a lower ability to supply enough resources needed for the production, which makes recycling imperative. In addition, the shortening of supply chains leads to the development of the need to reuse resources, as some production resources can be procured from distant countries, and due to the shortening of supply chains, the possibility of procuring such resources is diminished.

Therefore, to establish a circular economy in the supply chain, it is necessary to adjust the supply chain, which means to create and implement mechanisms that will enable the collection of used resources, i.e., their recycling and reuse. Organizations involved in the supply chain may face challenges related to the costs of implementing the technology that will enable recycling and reuse of resources, as well as challenges related to ensuring satisfactory quality of the products containing recycled resources.

Conclusion

The conducted research is based on a systematic review of the literature. The research was founded on a sample from the Scopus database, and the identified trends indicated an increase in the number of researchers, as well as in the number of papers dealing with supply chains, the analysis of the circular economy and its in society. The largest number of researchers come from European countries, i.e., the European Union and China, which are also the countries that have the largest number of produced and cited works.

The research identifies that the circular economy has a significant impact on the functioning of the supply chain in the context of the need to develop mechanisms that will enable the reuse of used resources. The circular economy as such is one of the mechanisms used to increase sustainability, i.e., primarily environmental, and economic sustainability. The main reason for this is the reduction of the costs of procurement of the resources needed for production due to the use of recycled resources, or the impact on the environmental component, primarily due to reducing the negative impact of resources' exploitation and disposal of used resources.

The conducted research has a fundamental limitation of focusing exclusively on the Scopus database, as well as excluding research of entire volumes or book, as it focuses only on professional and scientific papers. The recommendation for future researchers in this field is to conduct a study to examine the extent to which organizations involved in the supply chain use recycled resources, i.e., how willing they are to implement the principles of the circular economy.

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