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Sălăgeanu, Bianca-Roxana; Bejinaru, Ruxandra

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Investigating Sustainable Business Ecosystems and the University Role: A Cluster Analysis

Bianca-Roxana SĂLĂGEANU (ŞOLDAN)[1], Ruxandra BEJINARU[2]

[1] National University of Political and Administrative Studies (SNSPA), 30A Expozitiei Blvd.,
    Sector 1, Bucharest, RO; bianca.salageanu.21@drd.snspa.ro
[2] "Stefan cel Mare" University of Suceava, 13 Universitatii St., 720229 Suceava, RO;
    Academy of Romanian Scientists, Ilfov 3, 050044 Bucharest, RO; ⓘ ruxandrab@usm.ro
    (corresponding author)

Abstract: This research paper aims to identify the factors, components, and key aspects that significantly contribute to the establishment of a sustainable business ecosystem through a comprehensive bibliometric analysis. By analysing prominent publications, we seek to describe coherent strategies with an expected impact. Our objectives encompass exploring trends from both theoretical perspectives, such as predictions by scientists, and empirical perspectives, including figures derived from studies. We outline several secondary objectives that guide our step-by-step approach. Firstly, we identify defining elements of a sustainable business environment based on insights from specialized literature. Secondly, we categorize ecosystems into different types, such as economic, digital, ecological, and entrepreneurial, providing further elaboration later in the paper. Thirdly, we present an updated understanding of the dynamic evolution of ecosystems and their components. This includes examining the influence of digital advancements and digitalization on the business environment, as well as the opportunities and threats they generate. Of particular importance is the role of universities as a significant landmark within the business ecosystem. We discuss the university's involvement in technological and informational transfer to ensure sustainability, focusing on the levers through which universities consolidate and stimulate the business ecosystem. To achieve our objectives, we employ bibliometric analysis, utilizing the VOSviewer software, which offers valuable insights for constructing diagnostic schemes and development models tailored to specific business environment challenges. The research methodology relies on the VOSviewer software for processing academic publication databases. To align with the theme and purpose of this study, we selected the SCOPUS database for its implicit certification of superior academic quality in the publications it contains.

Keywords: business ecosystem; entrepreneurship; digital ecosystem; digitalization; sustainability; university.

Introduction

A business ecosystem can be understood as a network of interconnected organizations, individuals, and resources that collaborate and depend on each other to create value and thrive within the global context. It is similar to how different species in a natural ecosystem rely on each other for survival. In a business ecosystem, companies, entrepreneurs, suppliers, customers, investors, and other stakeholders interact and form relationships to exchange goods, services, knowledge, and resources. They work together, sometimes even with competitors, to create innovative products or services, develop new markets, and meet customer needs (Schmidt et al., 2020).

The concept of a business ecosystem emphasizes the interdependence and symbiotic relationships among participants. It recognizes that no single company or entity operates in isolation but is part of a larger interconnected system. The ecosystem can include

traditional companies, startups, industry associations, educational institutions, government bodies, and other entities that contribute to the overall growth and success of the ecosystem. By collaborating and leveraging each other's strengths, businesses within the ecosystem can achieve collective goals, drive innovation, and create a thriving economic environment. The concept of a business ecosystem highlights the importance of collaboration, shared value creation, and adapting to changes in the external environment to ensure long-term sustainability and competitiveness (Cobben et al., 2022).

Today, the university is an active and important player on all levels of economic, social, ecological, and cultural life, etc. The university is advancing in terms of material, technological and informational resources, but especially its intellectual capital (Bratianu, 2007; Bratianu, Prelipcean, & Bejinaru, 2020). Teaching staff, researchers and students are enhancing - with each generation. More advanced, better performing, smarter resources facilitate the work of individuals and thus the results increase exponentially. This system, which produces a considerable advance in the academic environment, has the potential to be extended to the business environment and produce similar effects. However, these two environments differ in the influence exerted by competition, risks and vulnerabilities (Bejinaru, 2022; Bratianu, 2002, 2018). Business collaboration is different from academic collaboration. That's why the university can play the role of mediator, facilitator, or guide for the business environment in order to offer fair support to any entrepreneur in order to ensure a sustainable business ecosystem (Jarvi et al., 2018; Neamtu, Hapenciuc, & Bejinaru, 2019).

We consider it important to emphasize that university's role in supporting a sustainable business ecosystem implies that universities have a responsibility to promote and support sustainable business practices by providing education and research opportunities, fostering partnerships with businesses, and creating a culture of sustainability on campus (Van der Borgh et al., 2012; Clarysse et al., 2014; Jarvi et al., 2018; Lupan & Bejinaru, 2019). This can involve integrating sustainability concepts into curricula, conducting research on sustainable business models, and working with local businesses to develop and implement sustainable practices. Universities can also play a role in developing future business leaders who understand the importance of sustainability and are equipped to drive positive change in the business world (Bratianu & Bejinaru, 2016; Schaeffer & Matt, 2016).

In line with the previous arguments, we pose the following *Research Question*: *"What are the key contributions of universities to different types of business ecosystems and how do universities play a crucial role in supporting for entrepreneurship, and driving sustainable business growth within these ecosystems?"* This research question aims to explore the diverse roles of universities in various business ecosystems and how they contribute to each ecosystem's development and sustainability. It also seeks to understand the specific ways in which universities foster innovation, support entrepreneurship, and facilitate sustainable practices within these ecosystems. By addressing this research question, we intend to provide valuable insights into the multifaceted role of universities in shaping and nurturing different business environments, helping policymakers, business leaders, and academics understand the strategic significance of universities in promoting economic growth, innovation, and sustainability.

Literature review

Types of business ecosystems

Universities can be involved in various types of business ecosystems depending on their expertise, resources, and strategic goals. Taking action in the business sector is assigned through the third mission of the university (Bejinaru & Baesu, 2013). We have identified some relevant types of business ecosystems where universities often play a significant role (Faber et al., 2019; Li et al., 2023; Scaringella & Radziwon, 2018).

Technology and Innovation Ecosystems: Universities are often at the forefront of research and development, making them key players in technology-driven ecosystems. They collaborate with industry partners, startups, and research institutions to advance technological innovation, foster entrepreneurship, and drive economic growth (Alves-Scaliza et al., 2022; Appio et al., 2019; Cai et al., 2020).

Entrepreneurial Ecosystems: Universities actively contribute to entrepreneurial ecosystems by providing incubation programs, startup support, mentorship, and access to funding. They cultivate a culture of innovation and entrepreneurship, encouraging students, faculty, and alumni to create new ventures and contribute to the startup ecosystem (Cho et al., 2022; Padilla-Meléndez & del-Aguila-Obra, 2022; Prokop, 2022).

Industry-Specific Ecosystems: Universities can be involved in business ecosystems specific to certain industries, such as healthcare, renewable energy, or biotechnology. They collaborate with industry partners, conduct industry-focused research, and provide specialized education and training to support the growth and development of these sectors (Landoni, 2020; Kolomytseva & Pavlovska, 2020).

Regional Development Ecosystems: Universities play a vital role in driving regional economic development by engaging with local businesses, government entities, and community organizations. They contribute to workforce development, knowledge transfer, and technology commercialization, creating a conducive environment for sustainable business growth within the region (Birkner et al., 2017; Markkula & Kune, 2015; Thomas et al., 2021).

Sustainability and Environmental Ecosystems: As sustainability becomes increasingly important, universities contribute to ecosystems focused on environmental conservation, clean technologies, and sustainable practices. They conduct research, provide expertise, and collaborate with industry and government stakeholders to promote sustainable business models and address environmental challenges (Oh et al., 2016; Zmiyak et al., 2020). It's important to note that the relevance of these ecosystems may vary based on the university's strengths, research priorities, geographical location and other factors. Universities often tailor their involvement to align with their core competencies and make a meaningful impact in specific areas of expertise. The university agenda is dynamic and proactivity makes it possible to generate exponential effects for society and business.

Mapping the university entrepreneurial role

The university has become a major component in the entrepreneurial ecosystem by providing resources and support for students who want to start their own businesses or enter the entrepreneurial world (Bejinaru & Prelipcean, 2017). In this sense, we bring some arguments that can support this point of view. The basic mission of the university is to educate. Many universities offer specialized programs in entrepreneurship and business management that prepare students with the skills and knowledge to start their own businesses or work within an existing business. Business performance and competitive advantage can be achieved with the necessary resources and funding. Universities struggle to offer access to resources and funding for students who want to start their own businesses. These may include mentoring programs, consulting services, access to investor networks and grant funds. Another critical issue in the entrepreneurial ecosystems, especially for start-ups, is partnerships with local companies. Universities can create partnerships with local companies to provide students with opportunities to learn directly from experienced entrepreneurs and business leaders. These partnerships can provide students with access to resources such as internships and employment opportunities, as well as access to valuable networks of contacts (Bejinaru et al., 2023).

The second mission of the university is research & development, thus contribution to innovation is another area of supporting the business ecosystem. Universities are also an important source of innovation in terms of developing new and innovative technologies and services. In this context, research and innovation centers that work on developing

new technologies and products that can be used in the business world. An important dimension that the universities can influence and model is the entrepreneurial culture. By encouraging entrepreneurship among students and the university community, universities can help create an entrepreneurial culture in their region and stimulate local economic development. This can attract investors and entrepreneurs, which will help create a strong and sustainable business ecosystem (Bejinaru et al., 2018). We target to point out several arguments that can be used to support the fact that the university has become a major component in the entrepreneurial ecosystem.

Research methodology

Purpose and methodology

In order to fulfil the proposed objectives, we used a bibliometric analysis at this stage, as this can provide us with a series of guiding information. The processing of databases with the VOSviewer software provides results on the basis of which diagnostic schemes can be built as well as development models for the business environment, depending on the analysed problem. The methodology used in this research is based on the VOSviewer software for processing academic publications databases. Corroborating the theme and purpose of the work, we chose the SCOPUS database because, implicitly, it offers a certification that the publications have a superior academic quality (Agostini et al., 2020).
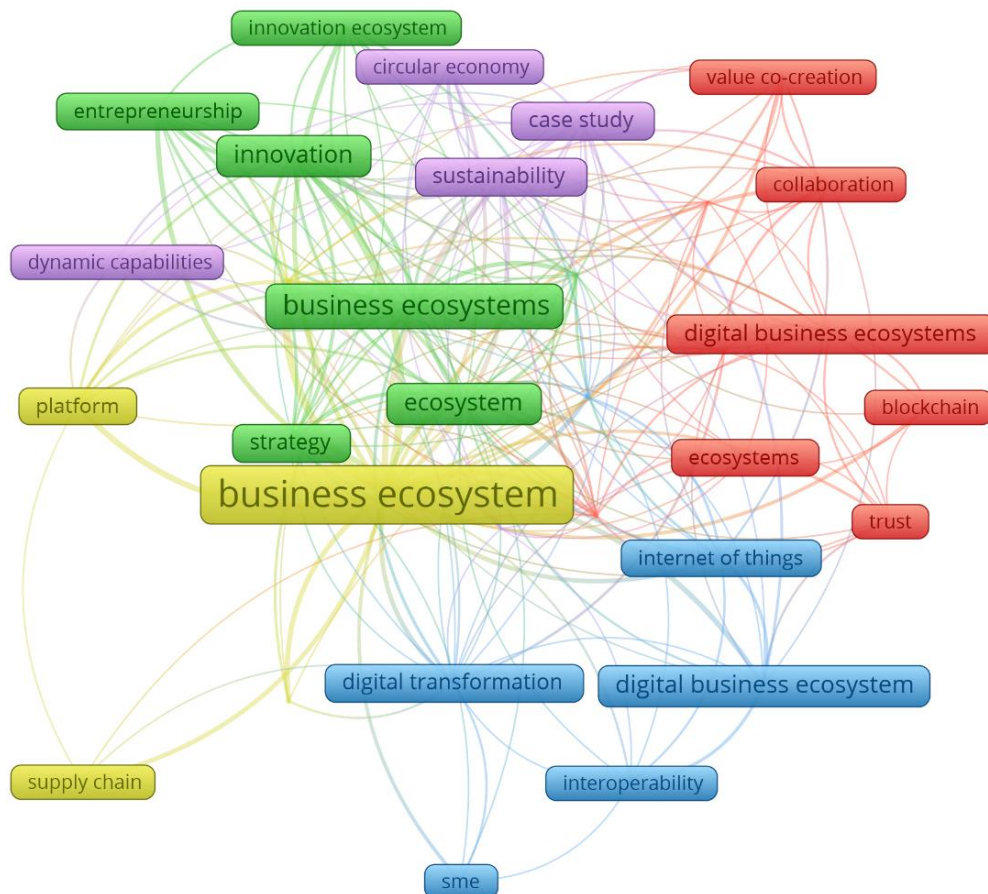

Figure 1. Cluster network of keywords co-occurrence
Source: own elaboration in VOSviewer

Results and discussions

Cluster network of keywords co-occurrence

In order to implement the analysis, we launched the search for the key phrase "business ecosystem*" and obtained 1823 papers. We extracted them from the SCOPUS database and analysed them with all the details available in the bibliometric analysis program. First of all, we were interested in the network output of keywords calculated based on the number of co-occurrences and their cross-occurrence. This type of analysis offers both visual results such as maps: co-occurrence map, overlay map and density map as well as numerical results by associating indexes to each keyword according to its number of occurrences in the analysed articles (Ellegaard & Wallin, 2015). More concretely, the formation of clusters can be easily observed based on the colours on the map and can be interpreted based on the indices in the table provided by the program. For an overview, we specify that we have five clusters, which we will detail and discuss in the following. From the analysis of the specialized literature, we extracted a series of edifying findings regarding the essential components of an ecosystem. In the same way, we identified different typologies of economic, digital, social or ecological ecosystems. The purpose of the research was also related to highlighting the role that the university, as a player, has in the process of consolidating a sustainable business ecosystem. The results of the bibliometric analysis gave us significant evidence about these aspects. It can be easily observed based on Figure 1 that the following types of ecosystems are discussed in the specialized literature, in various fields: business ecosystem, digital ecosystem, innovation ecosystem. All these being connected at the same time with sustainability and digitalization.

A co-occurrence keyword analysis is a method of analysing the relationship between keywords or phrases in a given text or set of texts. It involves identifying the frequency and proximity of keywords or phrases to one another in the text, and using this information to infer the relationship between them. For example, if two keywords or phrases are found to frequently appear near one another in a set of texts, it can be inferred that they have a strong relationship. Co-occurrence keyword analysis (illustrated in Figure 1) can be used in a variety of fields, such as natural language processing, information retrieval, and marketing research. It can help identify patterns in large sets of unstructured data, such as social media posts, customer reviews, or news articles (Zupic & Cater, 2015).

Clusters' composition

The concept of business ecosystems encompasses interconnected networks of organizations, individuals, and resources that collaborate and coexist to create value. In relation to the clusters mentioned, each cluster addresses different aspects relevant to business ecosystems, emphasizing various elements and perspectives. Following we shall explore the composition and connectivity of these clusters within the context of business ecosystems.

The first cluster, as the most powerful in visual and numeric aspects, is the RED one. This cluster is called: Digital business ecosystems, after the keyword with the highest value of occurrences. To extract a meaning from this picture we must understand the links and interconnectivity between all the keywords, starting with, "collaboration" and "digital business ecosystems". Collaboration is a core aspect of digital business ecosystems, enabling businesses to work together to create new products, services, and business models. Collaboration between businesses, customers, and suppliers can lead to more efficient and effective value creation -thus it is undoubtedly necessary that researchers discuss them. Artificial Intelligence (AI) and blockchain are key technologies that enable digital business ecosystems to operate more efficiently, securely, and transparently. AI enables businesses to analyse large amounts of data to gain insights, while blockchain provides a secure and transparent platform for transactions and data exchange (Dwivedi

et al., 2023). Ecosystems can provide SMEs with the resources, networks, and support they need to succeed, while SMEs can help ecosystems to grow and evolve (Bejinaru et al., 2023). Trust is a critical factor in digital business ecosystems, as it enables businesses to work together effectively and to share data and information securely. Value co-creation refers to the process of creating value together with customers, suppliers, and other stakeholders, which can help to build trust and foster collaboration in the ecosystem (Martinez-Martinez et al., 2022). Overall, these keywords are interrelated and play important roles in the development and growth of digital business ecosystems, as they enable businesses to collaborate effectively, create new value, and drive progress towards a more sustainable future. In this context, we could assume that the university's role facilitating knowledge exchange and research collaboration within the red cluster.

The GREEN cluster is named Innovation, after the most representative item in the group. Innovation plays a crucial role in the sustainable business ecosystem as it helps businesses create and implement new, more sustainable products, services, and business models (Burciu et al., 2023). "Business ecosystems" are critical for companies to thrive in today's rapidly changing and interconnected business environment. This refers to a network of businesses, customers, suppliers, and other stakeholders that are interconnected and interdependent. "Business Models" refer to the way a company creates, delivers, and captures value from its products and services. Following "entrepreneurship", "innovation" and "strategy" refer to a plan of action that a company takes to achieve its goals. Companies must develop a strategy that enables them to compete effectively in the marketplace, deliver value to their customers, and achieve their goals (Bejinaru, 2018; Mazzei, Ketchen, & Shook, 2017). In essence, these words are significant as they describe the critical components of a thriving and sustainable business environment. Companies that understand the importance of business ecosystems, business models, entrepreneurship, innovation, and strategy will be well-positioned to succeed in today's rapidly changing business environment. Business ecosystems provide an environment where innovation can flourish through collaboration and knowledge sharing. Business models and entrepreneurship are essential for leveraging opportunities within ecosystems, while strategic thinking guides decision-making and orchestrates ecosystem activities. In brief, we can appreciate that the university's role in the GREEN cluster refers to fostering innovation, supporting entrepreneurship, and providing strategic guidance for sustainable business ecosystems.

The BLUE cluster is comprising the fo'lowing keywords "digital business ecosystems", "digital transformation", "Internet of Things (IoT)", "interoperability", "open innovation", and "SME" which are all interconnected and related to each other in several ways. A digital business ecosystem refers to a network of businesses, customers, suppliers, and other stakeholders who are interconnected through digital technologies and platforms. The digital Transformation is the process of using digital technologies to fundamentally change the way businesses operate and interact with their customers, suppliers, and other stakeholders. A more recent concept like the "Internet of Things (IoT)" has emerged and refers to the growing network of connected devices, including sensors and other types of devices, that collect and exchange data in real-time. IoT technologies play a key role in the digital business ecosystem by enabling businesses to collect and analyse data to make more informed decisions (Sestino et al., 2020). Open innovation is an important aspect of the digital business ecosystem because it enables businesses to leverage the collective knowledge and resources of their network to drive growth and competitiveness. Open innovation is different than the traditional innovation and can take various forms, including crowdsourcing, collaborative research and development, licensing, joint ventures, and spin-offs. The key to open innovation is creating a culture of collaboration, trust, and openness that allows for the free flow of ideas and knowledge between different organizations and individuals (Bigliardi et al., 2021; Saura et al., 2023). This cluster shows what issues play important roles in the development and growth of digital business ecosystems, enabling businesses to operate more effectively and efficiently and to drive progress towards a more sustainable future. Synthetically, digital transformation is a catalyst for adapting business processes and operations within ecosystems. Open

innovation encourages collaboration and knowledge sharing across ecosystem boundaries, while SMEs continue to play a significant role in driving digital innovation within ecosystems. At this point we can observe that, when referring again to the university's role, the conclusions are partially repeatable in terms of its role in driving digital transformation, fostering open innovation, and supporting SMEs in leveraging digital technologies within digital business ecosystems.

The YELLOW cluster includes the concepts of "business ecosystems", "business model", "collaborative networks", "platform", and "supply chain" which are often put together because they are all critical components of a modern, connected, and sustainable business environment. Further we consider several reasons why these concepts are put together. A business ecosystem refers to a network of businesses, customers, suppliers, and other stakeholders that are interconnected and interdependent. In a business ecosystem, companies collaborate and share resources to create new products, services, and business models that drive progress and create value (Zbuchea et al., 2023). As we previously mentioned, companies need to have a well-defined business model that enables them to compete effectively in the marketplace and deliver value to their customers. Collaborative networks are a critical component of business ecosystems, as they enable companies to work together effectively to create new products, services, and business models. Also, collaborative networks and platforms provide companies with the resources, networks, and support they need to succeed and grow (Graça & Camarinha-Matos, 2017; Gupta, Mejia, & Kajikawa, 2019). The supply chain refers to the network of businesses, suppliers, and other stakeholders that are involved in the production and delivery of products and services and is critical for companies to compete effectively. The yellow cluster includes keywords that are critical components of a modern, connected, and sustainable business environment. The papers comprised within this cluster consider that companies that understand the importance of business ecosystems, business models, collaborative networks, platforms, and supply chains will be well-positioned to succeed in today's rapidly changing business environment. The interconnectivity of keywords in the yellow cluster is revealing the fact that collaborative networks and platforms provide the infrastructure for ecosystem participants to interact, collaborate, and exchange resources a framework within which the university has a key role. Business models define how value is created and captured within ecosystems, while supply chains ensure an efficient and effective flow of goods and services among ecosystem partners.

Table 1. Composition of co-occurrence keywords clusters

Cluster	Items	Occurrences	Link strength
[red cluster] **Digital business ecosystems**	Artificial intelligence	15	15
	Blockchain	19	12
	Collaboration	19	23
	Digital business ecosystems	**43**	23
	Ecosystems	20	12
	SMES	24	23
	Trust	16	15
	Value co-creation	15	18
	Value creation	24	36
[green cluster] **Innovation**	Business ecosystems	128	61
	Business models	30	30
	Ecosystem	71	61
	Entrepreneurship	27	36
	Innovation	64	**79**
	Innovation ecosystem	17	25
	Strategy	30	43
[blue cluster] **Digital transformation**	Digital business ecosystems	60	32
	Digital transformation	**34**	**33**
	Internet of things	23	32
	Interoperability	15	13
	Open innovation	29	27
	SME	17	10

[yellow cluster] **Business ecosystems**	**Business ecosystems**	**393**	**239**
	Business model	47	64
	Collaborative networks	20	17
	Platform	21	36
	Supply chain	16	11
[purple cluster] **Sustainability**	Case study	31	39
	Circular economy	15	19
	Digitalization	15	14
	Dynamic capabilities	16	17
	Sustainability	**32**	**39**

Source: own elaboration based on VOSviewer

The following keywords: "case study", "circular economy", "digitalization", "dynamic capabilities" and "sustainability" form the PURPLE cluster and provide insight into the current state and future of business and the economy, thus we called it after the core term which is "sustainability". Sustainability is a critical consideration within business ecosystems, as it encompasses environmental, social, and economic dimensions. Sustainable practices and goals are integrated into the strategies, operations, and decision-making processes of ecosystem participants to create long-term value while minimizing negative impacts on the environment and society. Discussing the keywords according to their order, a "case study" is a research method used to examine a specific real-life situation or issue in detail. By examining case studies of businesses that have adopted circular economies or digitalization, we can gain insight into the challenges and benefits of these approaches (Campos et al., 2020). The circular economy is a model of production and consumption that aims to reduce waste and minimize negative environmental impacts. In a circular economy, resources are kept in use for as long as possible, extracting the maximum value from them before recovering and regenerating them (Ghisellini, Cialani, & Ulgiati, 2016). In this context, digitalization refers to the increasing use of digital technologies and digital data in all aspects of life, including business and the economy. Digitalization is transforming the way businesses operate and interact with their customers, suppliers, and other stakeholders (Hagberg, Sundstrom, & Egels-Zandén, 2016; Van Veldhoven & Vanthienen, 2022).

Dynamic capabilities are an emerging concept that refer to a company's ability to adapt and respond to changes in its environment (Bejinaru & Baesu, 2017). In the context of a circular economy and digitalization, dynamic capabilities are critical for companies to respond to the changing needs and demands of customers and to remain competitive (Cegarra-Navarro et al., 2021; Cepeda-Carrion, Cegarra-Navarro, & Jimenez-Jimenez, 2012). In this picture, we consider that sustainability refers to the ability of a system, such as a business or an economy, to remain viable and productive over the long term. In the context of a circular economy or digitalization, sustainability is critical for businesses to meet the needs of their customers and to reduce their negative impact on the environment. Overall, the keywords of this purple cluster (presented in Table 1) provide insight into the current state and future of business and the economy. According to the keywords in the purple cluster, the university's role, is critical in advancing research and knowledge on sustainable practices, circular economy, digitalization, dynamic capabilities, and their integration into business ecosystems.

In summary, these clusters contribute to the understanding and connectivity of various elements within business ecosystems. They highlight the importance of collaboration, digital technologies, innovation, business models, entrepreneurship, sustainability, and other key factors that shape the dynamics and success of business ecosystems. By considering these interconnected elements, organizations can navigate and thrive within complex and evolving business ecosystems.
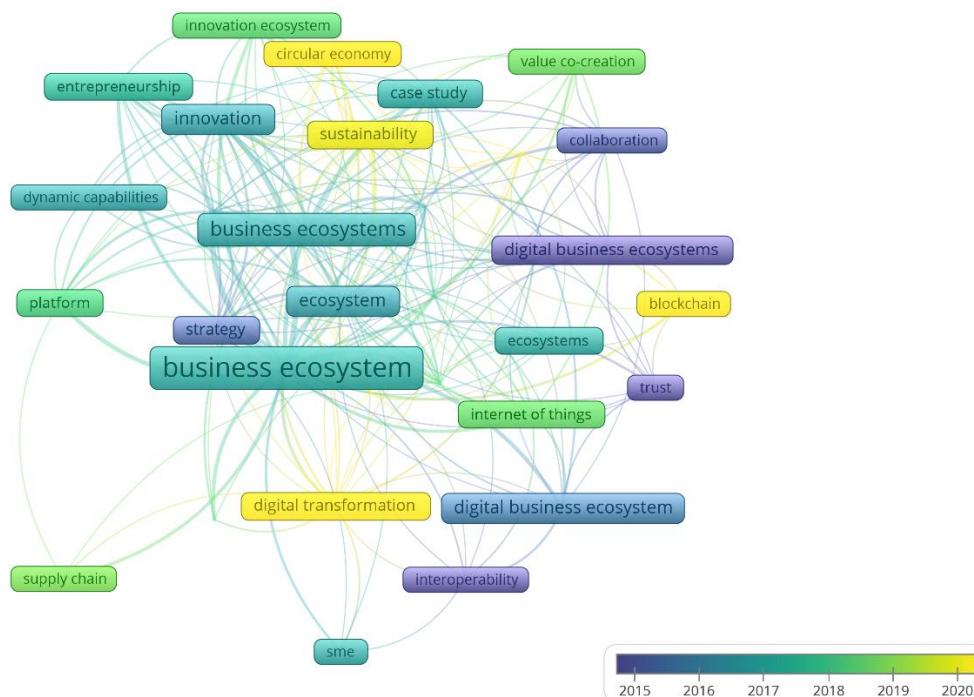
Figure 2. Overlay map of keywords co-occurrence
Source: own elaboration in VOSviewer

Overlay map of keywords co-occurrence

Another type of cluster analysis is represented in Figure 2 as the Overlay map of keywords co-occurrence. This gradient colour visualization shows the evolution in time of literature theory and research associated with the key concept of "business ecosystems". Chronologically, since 2015, first links, are between keywords in dark purple colour like: "collaboration", "strategy", "trust" and "interoperability" which belong to the business and management domains. The next couple of years 2016-2017, reveal the items in nuances of blue and turquoise, like: "innovation", "case studies" and "business ecosystem". The display on the overlay map is the same as on the network visualisation of clusters but here the significance is based on the colours distribution and timeline. The concepts may belong to the same cluster but they might correspond to different years. The green colour items, associated to the years 2018-2019, are: "innovation", "value-co-creation", "internet of things". Corresponding to the recent period we have keywords in yellow colour like: "digital transformation", "blockchain", "sustainability" and "circular economy". This combination of keywords is both confusing and challenging in terms of anticipating what the perspectives are. In this regard, we can appreciate that the publications in the field (as visualised in Figure 2) shall evolve and intensify research towards a digital & mobile technology approach (Han et al., 2023; Piscicelli, 2023).

Density map of keywords co-occurrence

Through the bibliometric analysis, the density map of keywords co-occurrence provides information about the frequency and the way keywords (terms) appear together in scientific publications from a certain field or subfield. This analysis (represented in Figure 3) can provide a visual and detailed picture of research trends and models in the respective field. Within a density map, keywords are represented as nodes, and the links between nodes indicate the frequency with which these keywords appear together in scientific publications. Thus, the areas with a high density of nodes indicate the keywords that are more closely related and that are more frequently used together in a certain scientific area (Vargas et al., 2022). The information provided through the density map of keywords co-occurrence is useful as it reveals: the main research topics in the respective

field; the degree of interconnection and interdependence between the various research topics; the evolution and changes in research themes over time; identifying gaps in research in the field and identification of potential collaborators in research. In general, the density map of keywords co-occurrence can provide a general vision of the research field and help orient researchers towards relevant and innovative research topics within the respective field (Zupic & Cater, 2015).

From Figure 3, we can clearly observe that purple and green clusters are closely connected while the blue and the red ones are somehow distant. We can conclude that digitalization is not yet so much approached in relation to the business ecosystem until now. This density map shows that the core elements related are business ecosystems, innovation, sustainability and digital transformation. It will be interesting to discover more about this issue in the next couple of years.
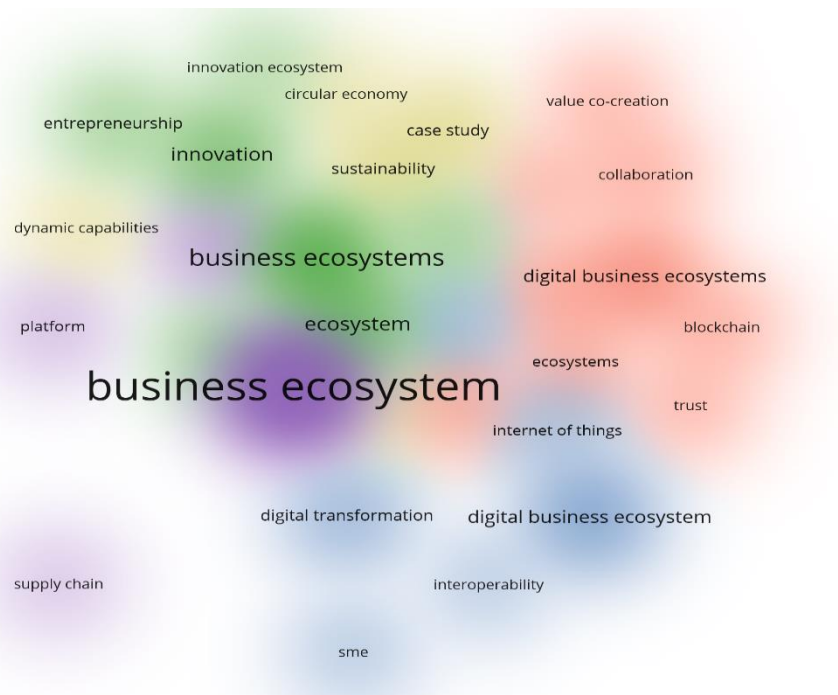

Figure 3. Density map of cluster keywords
Source: own elaboration in VOSviewer

Conclusions and implications

In the last years, the economic and management literature has largely stressed the importance of knowledge assets for company's competitiveness. As we previously argued throughout the sections, the university has an important role to play in various aspects of life, including economic, social, ecological, and cultural. The university is constantly advancing in terms of material, technological, and informational resources, and especially human resources. The university's academic environment has the potential to be extended to the business environment and produce similar effects. However, the two environments differ in terms of the influence exerted by competition, which implies that the university can play the role of mediator, facilitator, or guide for the business environment to ensure a sustainable business ecosystem.

From another perspective, the university's basic mission of educating students includes specialized programs in entrepreneurship and business management that prepare students with the skills and knowledge to start their own businesses or work within an existing business. Universities can also offer access to resources and funding for students who want to start their own businesses, including mentoring programs, consulting

services, access to investor networks, and grant funds. Additionally, universities can create partnerships with local companies to provide students with opportunities to learn directly from experienced entrepreneurs and business leaders. Universities are also an important source of innovation and can encourage entrepreneurship among students and the university community, creating an entrepreneurial culture in their region and stimulating local economic development.

Throughout the bibliometric analysis we extracted several perspectives on the topic and thus we resume the following ideas. We discussed the interconnectivity and importance of different concepts in the development and growth of digital business ecosystems. The RED cluster focuses on collaboration, digital business ecosystems, AI, blockchain, SMEs, trust, and value co-creation. The GREEN cluster emphasizes innovation, business ecosystems, business models, entrepreneurship, and strategy. The BLUE cluster discusses digital business ecosystems, digital transformation, IoT, interoperability, open innovation, and SMEs. The YELLOW cluster highlights business ecosystems, business models, collaborative networks, platforms, and supply chains. The PURPLE cluster is focusing on sustainability issues.

The overall analysis suggests that businesses need to understand and utilize these concepts to succeed in today's rapidly changing business environment. Collaboration, innovation, well-defined business models, and supply chain are crucial for companies to create new products, services, and business models that drive progress and create value. Meanwhile, digital technologies, such as AI, blockchain, IoT, and interoperability, provide secure and transparent platforms for transactions and data exchange that enable businesses to operate more efficiently and effectively. In the sense of what we previously analysed and according to the bibliometric analysis, we propose a series of possible ways to develop the university's contribution to business ecosystems: -*Collaboration and Networking:* Partnership between business leaders, employees, and universities can provide opportunities for collaboration, networking, and knowledge sharing. This can help businesses stay informed about the latest trends and developments in their industry, and identify new opportunities for growth and innovation. -*Access to Talent:* Universities can provide access to talented individuals, including students and alumni, who can bring new skills, perspectives, and ideas to businesses. -*Access to Research and Development*: Universities often have research and development capabilities that businesses can tap into to develop new products, services, and technologies. -*Promoting Sustainability*: Universities can help promote sustainability by engaging businesses in sustainable business practices, supporting sustainable business initiatives, and promoting sustainability research and development. -*Knowledge Transfer*: Universities can facilitate the transfer of knowledge and technology between academia and industry, which can help businesses stay ahead of the curve and compete in a rapidly changing business environment. -*Continuous Learning*: Universities can provide opportunities for employees to continue learning and developing their skills, which can help businesses stay competitive and innovative. -*Social Impact*: By partnering with universities, businesses can contribute to the creation of a more sustainable and equitable society and demonstrate their commitment to social responsibility and sustainability. By establishing partnerships between business leaders, employees, and universities, all parties can work together to create a more sustainable and innovative business ecosystem. Finally, the article highlights the main role of SMEs in driving innovation and growth in digital business ecosystems and the secondary role of universities in this equation.

In conclusion, the university plays a crucial role in supporting the business ecosystems. By providing a platform for researchers, students, and industry professionals to come together, the university fosters an environment of learning and innovation. The university integrates collaborative efforts and promotes the exchange of ideas, encourages interdisciplinary research, and drives the advancement of knowledge in various fields. This knowledge exchange and research collaboration form the foundation for the development of sustainable business ecosystems. Throughout the paper, we emphasize that the university's role extends beyond knowledge exchange to encompass fostering

innovation, supporting entrepreneurship, and providing strategic guidance for sustainable business ecosystems. By nurturing a culture of innovation, it inspires creativity and encourages the development of new ideas and solutions. The clusters' analysis revealed the sustainability dimension of the university through strategic guidance to businesses, helping them navigate the complexities of the rapidly changing business environment and align their strategies with sustainability goals. This holistic approach contributes to the growth and success of businesses within the ecosystem, while also promoting sustainability and responsible business practices.

The literature and cluster analysis clearly frame the university's role in driving digital transformation, fostering open innovation, and supporting SMEs in leveraging digital technologies within digital business ecosystems, thus it becomes evident that these conclusions align with the university's overarching responsibilities. The university serves as a catalyst for digital transformation by providing education and training on emerging technologies, conducting research on their applications, and collaborating with industry partners to drive innovation. Additionally, the university plays a crucial role in supporting SMEs in adopting and leveraging digital technologies, providing them with the necessary guidance, resources, and networks to thrive in the digital era. These efforts contribute to the overall development and sustainability of digital business ecosystems.

Concerning the limitations of the research, we shall point out the following: limited scope of data sources – due to the fact that the research relies primarily on bibliometric analysis using the VOSviewer software and the SCOPUS database. While this approach provided valuable insights from academic publications, it might not have captured all relevant data sources, such as industry reports, surveys, or data from non-academic sources. In this regard, certain perspectives or emerging trends from the business ecosystem might be missed, limiting the comprehensiveness of the findings. Another obvious limitation is the lack of in-depth qualitative analysis. The research mainly focused on quantitative analysis and identifying interconnections between keywords in the clusters. However, a more in-depth qualitative analysis, such as interviews or case studies with key stakeholders, could provide deeper insights into the practical implications of the university's role in supporting business ecosystems. Qualitative methods can offer a better understanding of real-world practices, challenges, and opportunities related to the university's involvement in fostering innovation, driving digital transformation, and supporting SMEs in digital business ecosystems. We shall consider overcoming these limitations for future studies to enrich the understanding of the subject.

Summing up the previous analyses, we come to the conclusion that the university's role in supporting business ecosystems is a multidimensional one, which encompasses a series of actions such as: facilitating knowledge exchange and research collaboration, fostering innovation and entrepreneurship, providing strategic guidance, driving digital transformation, promoting open innovation, supporting SMEs, and advancing research on sustainable practices. This multifaceted role highlights the university's significance in shaping and nurturing business ecosystems, driving progress, and addressing the challenges of the modern business landscape. By actively engaging in these activities, the university plays a pivotal role in creating an environment conducive to growth, innovation, and sustainability.

References

Agostini, L., Nosella, A., Sarala, R., Spender, J.-C., & Wegner, D. (2020). Tracing the evolution of the literature on knowledge management in inter-organizational contexts: a bibliometric analysis. *Journal of Knowledge Management, 24*(2), pp. 463-490. https://doi.org/10.1108/JKM-07-2019-0382

Alves-Scaliza, J. A., Jugend, D., Chiappetta Jabbour, C. J., Latan, H., Armellini, F., Twigg, D., & Andrade, D. F. (2022). Relationships among organizational culture, open innovation, innovative ecosystems, and performance of firms: Evidence from an emerging economy context. *Journal of Business Research, 140,* 264-279. https://doi.org/10.1016/j.jbusres.2021.10.065

Appio, F. P., Lima, M., & Paroutis, S. (2019). Understanding smart cities: Innovation ecosystems, technological advancements, and societal challenges. *Technological Forecasting & Social Change, 142*(1), 1-14. https://doi.org/10.1016/j.techfore.2018.12.018

Bejinaru, R., & Baesu, C. (2013). Approaches to organizational change within modern companies. *The USV Annals of Economics and Public Administration 13*(17), 127-134. http://www.annals.seap.usv.ro/index.php/annals/article/viewFile/509/552

Bejinaru, R., & Baesu, C. (2017). Connecting approaches of sustainable development and organizational change in business companies. *The USV Annals of Economics and Public Administration 17*(26), 87-94. http://www.annals.seap.usv.ro/index.php/annals/article/view/1025/897

Bejinaru, R., Neamţu, D. M., Condratov, I., Stanciu, P., & Hapenciuc, C. V. (2023). Exploring the effectiveness of university agenda for developing students' entrepreneurial behavior. *Economic Research-Ekonomska Istraživanja, 36*(1), 1317-1337, https://doi.org/10.1080/1331677X.2022.2086597

Bejinaru, R., (2022). Cluster analysis of risks and vulnerabilities for environment sustainable management. *Oradea Journal of Business and Economics*, *7*(2), 35 – 48, http://doi.org/10.47535/1991ojbe155

Bejinaru, R., Hapenciuc, C. V., Condratov, I., & Stanciu, P. (2018). The university role in developing the human capital for a sustainable bioeconomy. *Amfiteatru Economic, 20*(49), 583-598. http://doi.org/10.24818/EA/2018/49/583

Bejinaru, R. (2018). Assessing students' entrepreneurial skills needed in the knowledge economy. *Management & Marketing. Challenges for the Knowledge Society*, *13*(3), 1119–1132. https://content.sciendo.com/view/journals/mmcks/13/3/article-p1119.xml

Bejinaru, R., & Prelipcean, G. (2017, March 30-31*). Successful strategies to be learnt from world-class universities* [Paper presentation]. 11th International Conference "Business Excellence Strategy, Complexity and Energy in changing times", Bucharest, Romania. https://www.degruyter.com/view/j/picbe.2017.11.issue-1/picbe-2017-0037/picbe-2017-0037.xml

Bigliardi, B., Ferraro, G., Filippelli, S., & Galati, F. (2021). The past, present and future of open innovation. *European Journal of Innovation Management*, *24*(4), 1130-1161. https://doi.org/10.1108/EJIM-10-2019-0296

Birkner, Z., Máhr, T., & Berkes, N. R. (2017). Changes in responsibilities and tasks of universities in regional innovation ecosystems. *Naše gospodarstvo/Our economy*, *63*(2), 15-21. https://doi.org/10.1515/ngoe-2017-0008

Bratianu, C. (2002). *Management strategic*. Universitaria Craiova.

Bratianu, C. (2007). An integrated perspective on the organizational intellectual capital. *Review of Management and Economical Engineering*, *6*(5), 107-112.

Bratianu, C. (2018). A holistic approach to knowledge risk. *Management dynamics in the Knowledge Economy, 6*(4), 593-607. https://doi.org/10.25019/MDKE/6.4.06

Bratianu, C., & Bejinaru, R. (2016). Evaluation of knowledge processes within learning organization. In O. Nicolescu, & L. Lloyd-Reason (Eds.), *Challenges, performances and tendencies in organisation management* (pp. 125-136). World Scientific.

Bratianu, C., Prelipcean, G., & Bejinaru, R. (2020). Exploring the latent variables, which

support SMEs to become learning organizations. *Management & Marketing. Challenges for the Knowledge Society, 15*(2), 154-171. https://doi.org/10.2478/mmcks-2020-0010

Burciu, A., Kicsi, R., Danileţ, A.M., Bostan, I., & Condratov, I. (2023). The nexus between innovation and internationalization. Evidence from a micro-level survey of the Romanian ICT business sector. *Eastern European Economics, 61*(2), 131-151, http://doi.org./10.1080/00128775.2022.2152051

Cai, Y., Ma, J., & Chen, Q. (2020). Higher education in innovation ecosystems. *Sustainability,* 12, 4376. https://doi.org/10.3390/su12114376

Campos, D. A., Gómez-García, R., Vilas-Boas, A. A., Madureira, A. R., & Pintado, M. M. (2020). Management of fruit industrial by-products—a case study on circular economy approach. *Molecules, 25,* 320. https://doi.org/10.3390/molecules25020320

Cegarra-Navarro, J. G., Martínez Caro, E., Martínez-Martínez, A., Aledo-Ruiz, M. D., & Martínez-Conesa, E. (2021). Capacities, competences and capabilities as knowledge structures to build relational capital. *Kybernetes, 50*(5), 1303-1320. https://doi.org/10.1108/K-02-2020-0115

Cepeda-Carrion, G., Cegarra-Navarro, J. G., & Jimenez-Jimenez, D. (2012). The effect of absorptive capacity on innovativeness: Context and information systems capability as catalysts. *British Journal of Management, 23*(1), 110-129. https://doi.org/10.1111/j.1467-8551.2010.00725.x

Cho, D. S., Ryan, P., & Buciuni, G. (2022). Evolutionary entrepreneurial ecosystems: a research pathway. *Small Bus Econ 58,* 1865–1883. https://doi.org/10.1007/s11187-021-00487-4

Clarysse, B., Wright, M., Bruneel, J., & Mahajan, A. (2014). Creating value in ecosystems: Crossing the chasm between, knowledge and business ecosystems. *Research Policy,* 43(7), 1164–1176. https://doi.org/10.1016/j.respol.2014.04.014

Cobben, D., Ooms, W., Roijakkers, N., & Radziwon, A. (2022). Ecosystem types: A systematic review on boundaries and goals. *Journal of Business Research*, *142*, 138-164. https://doi.org/10.1016/j.jbusres.2021.12.046

Dwivedi, Y. K. (2023). "So what if ChatGPT wrote it?" Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy. *International Journal of Information Management*, *71*, 102642, https://doi.org/10.1016/j.ijinfomgt.2023.102642

Ellegaard, O., & Wallin, J. A. (2015). The bibliometric analysis of scholarly production: How great is the impact? *Scientometrics, 105,* 1809–1831. https://doi.org/10.1007/s11192-015-1645-z

Faber, A., Riemhofer, M., Rehm, S.-V., & Bondel, G. (2019, August 15-17). *A systematic mapping study on business ecosystem types* [Paper presentation]. 25th Americas Conference "Information Systems", Cancun, Mexico. https://web.archive.org/web/20200709183750id_/https://aisel.aisnet.org/cgi/viewcontent.cgi?article=1437&context=amcis2019

Graça, P., & Camarinha-Matos, L. M. (2017). Performance indicators for collaborative business ecosystems — literature review and trends. *Technological Forecasting and Social Change, 116,* 237-255. https://doi.org/10.1016/j.techfore.2016.10.012

Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production*, *114*, 11–32. https://doi.org/10.1016/j.jclepro.2015.09.007

Gupta, R., Mejia, C., & Kajikawa, J. (2019). Business, innovation and digital ecosystems landscape survey and knowledge cross sharing. *Technological Forecasting and Social Change*, *147*, 100-109. https://doi.org/10.1016/j.techfore.2019.07.004

Hagberg, J., Sundstrom, M., & Egels-Zandén, N. (2016). The digitalization of retailing: An exploratory framework. *International Journal of Retail and Distribution Management, 44*(7), 694–712. https://doi.org/10.1108/IJRDM-09-2015-0140

Han, Y., Shevchenko, T., Yannou, B., Ranjbari, M., Shams Esfandabadi, Z., Saidani, M., Bouillass, G., Bliumska-Danko, K., & Li, G. (2023). Exploring how digital technologies enable a circular economy of products. *Sustainability, 15*, 2067.

https://doi.org/10.3390/su15032067

Jarvi, K., Almpanopoulou, A., & Ritala, P. (2018). Organization of knowledge ecosystems: Prefigurative and partial forms. *Research Policy, 47*(8), 1523–1537. https://doi.org/10.1016/j.respol.2018.05.007

Kolomytseva, O., & Pavlovska, A. (2020). The role of universities in the national innovation system. *Baltic Journal of Economic Studies*, *6*(1), 51-58. https://doi.org/10.30525/2256-0742/2020-6-1-51-58

Landoni, M. (2020). Urban universities as a start-up ecosystem: The case of academic spin-offs in Milan. In A. Novotny, T. Clausen, E. Rasmussen & J. Wiklund (Eds.), *Research handbook on start-up incubation ecosystems* (pp. 402-417). Edward Elgar Publishing. https://doi.org/10.4337/9781788973533.00031

Li, A. Q., Lahy, A., Found, P., Kumar, M., & Claes, B. (2023). Developing PSS business ecosystems in the digital era. *Industrial Marketing Management, 109*, 121-134. https://doi.org/10.1016/j.indmarman.2022.12.017

Lupan, M., & Bejinaru, R. (2019). Perspectives of university governance for the development of entrepreneurship. *The USV Annals of Economics and Public Administration, 19*(29), 74-81. http://www.annals.feaa.usv.ro/index.php/annals/article/viewFile/1126/954

Markkula, M., & Kune, H. (2015). Making Smart Regions Smarter: Smart Specialization and the Role of Universities in Regional Innovation Ecosystems. *Technology Innovation Management Review, 5*(10), 7-15. http://doi.org/10.22215/timreview/932

Martinez-Martinez, A, Cegarra-Navarro, J. G., Garcia-Perez, A., & De Valon, T. (2022). Active listening to customers: eco-innovation through value co-creation in the textile industry. *Journal of Knowledge Management*, *22*(3), 633-652. https://doi.org/10.1108/JKM-04-2022-0309/full/html

Mazzei, M. J., Ketchen, D. J., & Shook, C. L. (2017). Understanding strategic entrepreneurship: a "theoretical toolbox" approach. *International Entrepreneurship Management Journal 13*, 631–663, https://doi.org/10.1007/s11365-016-0419-2

Neamtu, D., Hapenciuc, V., & Bejinaru, R. (2019). The impact of digitalization on business sector development in the knowledge economy. *Proceedings of the International Conference on Business Excellence, Bucharest, Romania, 13*(1), 479-491.

Oh, D.-E., Phillips, F., Park, S., & Lee, E. (2016). Innovation ecosystems: A critical examination. *Technovation*, *54*, 1-6. https://doi.org/10.1016/j.technovation.2016.02.004

Padilla-Meléndez. A., & del-Aguila-Obra, A.-R. (2022). Governance of entrepreneurial universities in the context of entrepreneurial ecosystems: the perspective of the university technology transfer offices. *Studies in Higher Education, 47*(5), 973-981. https://doi.org/10.1080/03075079.2022.2055321

Piscicelli, L. (2023). The sustainability impact of a digital circular economy. *Current Opinion in Environmental Sustainability, 61*, 101251. https://doi.org/10.1016/j.cosust.2022.101251

Prelipcean, G., & Bejinaru, R. (2018, October 11-12). *University agenda for developing students' skills in the knowledge economy* [Paper presentation]. 6th International Conference "Strategica – Challenging the Status Quo in Management and Economics", Bucharest, Romania.

Prokop, D. (2022). The composition of university entrepreneurial ecosystems and academic entrepreneurship: A UK study. *International Journal of Innovation and Technology Management, 19*(6), 1-23. https://doi.org/10.1142/S0219877022500201

Saura, J. R., Palacios-Marqués, D., Ribeiro-Soriano, D. (2023). Exploring the boundaries of open innovation: Evidence from social media mining. *Technovation, 119*, 102447. https://doi.org/10.1016/j.technovation.2021.102447

Scaringella, L., & Radziwon, A. (2018). Innovation, entrepreneurial, knowledge, and business ecosystems: Old wine in new bottles? *Technological Forecasting and Social Change, 136*(1), 59-87. https://doi.org/10.1016/j.techfore.2017.09.023

Schaeffer, V., & Matt, M. (2016). Development of academic entrepreneurship in a

nonmature context: The role of the university as hub-organisation. *Entrepreneurship & Regional Development*, *28*(9–10), 724–745. https://doi.org/10.1080/08985626.2016.1247915

Schmidt, M. C., Veile, J. W., Müller, J. M., & Voigt, K. I. (2020). Ecosystems 4.0: Redesigning global value chains. *The International Journal of Logistics Management*, *32*(4), 1124-1149. https://doi.org/10.1108/IJLM-03-2020-0145

Sestino, A., Prete, M. I., Piper, L., & Guido, G. (2020). Internet of Things and Big Data as enablers for business digitalization strategies. *Technovation, 98*, 102173. https://doi.org/10.1016/j.technovation.2020.102173

Thomas, E., Faccin, K., & Terje Asheim, B. (2021). Universities as orchestrators of the development of regional innovation ecosystems in emerging economies. *Growth and Change*, *52*, 770– 789. https://doi.org/10.1111/grow.12442

Van der Borgh, M., Cloodt, M., & Romme, G. (2012). Value creation by knowledge-based ecosystems: Evidence from a field study. *R&D Management, 42*(2), 150–169. https://doi.org/10.1111/j.1467-9310.2011.00673.x

Van Veldhoven, Z., & Vanthienen, J. (2022). Digital transformation as an interaction-driven perspective between business, society, and technology. *Electron Markets, 32*, 629–644. https://doi.org/10.1007/s12525-021-00464-5

Vargas, A. C., Espinoza-Mina, M., López Alvarez, D., & Navarro Espinosa, J. (2022, October 27-29). *Bibliometric software: the most commonly used in research* [Paper Presentation]. 5th International Conference "Applied Informatics", Arequipa, Peru. https://ceur-ws.org/Vol-3282/icaiw_aiesd_1.pdf

Zbuchea, A., Dinu, E., Iliescu, A.-N., Stăneiu, R.-M., & Salageanu, B.-R. (2023). Managing knowledge in Romanian KIBS during the COVID-19 pandemic. *Knowledge, 3,* 18-39. https://doi.org/10.3390/knowledge3010002

Zmiyak, S. S., Ugnich, E. A., & Taranov, P. M. (2020). Development of a regional innovation ecosystem: the role of a pillar university. In E. Popkova (Ed.), *Growth poles of the global economy: emergence, changes and future perspectives. Lecture Notes in Networks and Systems* (pp. 567-576). Springer. https://doi.org/10.1007/978-3-030-15160-7_57

Zupic, I., & Cater, T. (2015). Bibliometric methods in management and organization. *Organizational Research Methods*, *18*(3), 429-472. https://doi.org/10.1177/1094428114562629