



# How Universities' Dynamics and Initiatives Are Related to Entrepreneurial Ecosystems: A Systematic Literature Review

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**Abstract.** Universities are increasingly being pressured to perform their third mission, playing as a catalyst of technological change, innovation, and societal and economic development. Universities respond to the emerging challenges combining their traditional roles with an entrepreneurial agenda. This entrepreneurial academic spirit allows a collaboration, as equal partners, with government and industry, creating the conditions for innovation and the emergence of the Entrepreneurial University (Ent\_Uni). This scenario is crucial to address how universities' dynamics and initiatives are related to entrepreneurship and entrepreneurial ecosystems (Ent\_Eco). Despite being widely explored concepts, the Ent\_Uni and Ent\_Eco are still fragmented and muddled in the literature, holding a wide margin for theorization development. Based on the bibliographic coupling of document references performed in Bibliometrix, a spectrum of six main research topics was identified to understand the dynamics of the Ent\_Uni and Ent\_Eco concepts. Lastly, we offer a future research agenda that could deepen the scientific knowledge on entrepreneurial settings.

**Keywords:** entrepreneurial universities, entrepreneurial ecosystems, systematic literature review, bibliometrix, bibliographic-coupling analysis.

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## 1. Introduction

Globalization is a reality (Kim and McLean, 2015), characterized by an emergent global economy composed of knowledge-intensive organizations (Tenkasi and Boland, 1996). It is crucial to acknowledge knowledge as a critical resource (Liu and Lin, 2012). Knowledge will be possible based on cooperation relationships that potentiate innovation, particularly technological innovation (Fischer and Varga, 2002).

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The establishment of partnerships will make possible the existence of new and unique knowledge (Nonaka and Takeuchi, 1995) that makes innovation possible (Lockett *et al.*, 2009; Gallego, Rubalcaba, and Suárez, 2013; Fernández-López, Calvo and Rodeiro-Pazos, 2019). One of the main pillars of an ecosystem is the university (Guerrero, Urbano, and Gajón, 2017). In this context, universities seek to respond to emerging challenges, assuming a key role as producers and disseminators of knowledge (Kirby, 2006), contributing to economic development, innovation, and competitiveness of companies, regions, and countries (Fernandes and Ferreira, 2022; Huggins, Johnston, and Stride, 2012), enabling the existence of sustained competitive advantages (Teixeira, Veiga, and Fernandes, 2019).

It is in the increase of the dynamics of interactions between university and industry (Uni\_Ind) that universities start to be oriented towards the latest knowledge transfer (Miller, McAdam, and McAdam, 2018). Knowledge transfer between Uni\_Ind is widely recognized and stimulated by governments to enhance a knowledge-intensive economy (Jackson *et al.*, 2013). The importance of the Bayh-Dole Act of 1980 is now recognized, which gives universities financial incentives and enables universities to support and monitor technology commercialization activities (Crow, Whitman, and Anderson, 2020).

Combining its traditional mission, based on teaching and research, and the emergence of an entrepreneurial academic spirit, it is possible to position universities as equal partners to industry and the government, creating the necessary conditions for innovation based on knowledge-based economies (Etzkowitz, 2003a).

Government-University-Industry cooperation is usually aggregated in the concept of Triple Helix (TH), which proves to be fundamental for economic progress, where universities emerge as inventors of new technologies, as enablers of the existence of qualified and specialized labor, while also assuming the role of mediator between economy and society (Chen, Wu, and Yang, 2016). The results may be significantly enhanced by the correct alignment of research and training priorities by universities with organizations' goals in the region (Hewitt-Dundas, 2012).

The whole framework reinforces the fact that in the last decades, universities have shown themselves in the role they play in regional development and knowledge transfer, resulting in an emphasis on the universities' third mission and the emergence of entrepreneurial universities (Ent\_Uni) (Rubens *et al.*, 2017), even when they face highly state-regulatory constraints (Yoshioka-Kobayashi, 2019). The Ent\_Uni develops multiple efforts (Kirby *et al.*, 2011), and it is possible to observe cases in which the correct interaction between entrepreneurial activity (Ent\_Act) and education for entrepreneurship creates very favorable conditions for the development of entrepreneurial ecosystems (Ent\_Eco) (Lu and Li, 2016). In this innovation dynamic, the TH model works as a moderator of communications and negotiations between the various

institutional partners, creating a constant interaction that continuously reorganizes subliminal agreements (Etzkowitz and Leydesdorff, 2000). The Ent\_Eco dynamics develop and evolve over time, which is fundamental for the analysis of the dynamics of an Ent\_Eco trajectory and future performances (Audretsch *et al.*, 2021).

Within a transformation into competitive organizational actors (Kosmützky and Krücken, 2015), the Ent\_Uni is seen as a catalyst for regional economic and social development, considering the generation and exploitation of knowledge as entrepreneurial opportunities (Urbano and Guerrero, 2013). Promoting entrepreneurial opportunities requires an ecosystem where universities have a fundamental role in the collaboration between all the stakeholders (Wadee and Padayachee, 2017). Despite being widely explored concepts, the Ent\_Uni and Ent\_Eco are still considered fragmented and muddled, holding a wide margin for development in the face of their theorization (Forliano *et al.*, 2021; Spigel, 2017). The themes Ent\_Uni and Ent\_Eco have been deepened in the last year, being explored from different perspectives. It is possible to identify the emergence of the university approach as an Ent\_Eco (Prokop, 2021; Wang *et al.*, 2021) and the conceptualization of the Ent\_Uni concept (Radko *et al.*, 2022). Also focusing on the analysis of the Ent\_Uni, there have been developments in the analysis of the transformation process of universities into Ent\_Uni with the need for articulation of university missions (Audretsch and Belitski, 2021), the Uni\_Ind collaboration (Johnston *et al.*, 2021), and entrepreneurial architecture of the Ent\_Uni (Cunningham *et al.*, 2021). Within the concept of Ent\_Eco, Schaeffer *et al.* (2021) explore the interrelation between universities and ecosystems in a mutualistic perspective where it is possible to identify a bidirectional flow of resources and capabilities. Therefore, according to Fernandes and Ferreira (2022), it is important to explore the role of universities, particularly the Ent\_Uni, in the growth, evolution, and outcomes of the Ent\_Eco. This study aims to narrow these gaps by systematizing the most relevant literature, trends, and dynamics of the Ent\_Uni on the Ent\_Eco. This study can be a relevant contribution for the actors of TH — Universities, Industry, and Government — since it can prove to be important in the reasoning of future decisions.

Considering that we have not identified Systematic Literature Reviews (SLR) that approach the concepts of Ent\_Uni and Ent\_Eco, the research purpose is to systematize the existing studies and address the need for an SLR that approaches both concepts simultaneously, characterizing the existing literature and identifying the current trends and future research agenda.

Since an SLR seeks to address specific research questions (Snyder, 2019; Torraco, 2016), in this study, we attempt to answer the following research questions: Which are the most relevant trends in the literature on Ent\_Uni and Ent\_Eco? And how are Ent\_Uni dynamics performed within an Ent\_Eco perspective?

A systematic approach was followed based on a rigorous and predefined protocol. The articles were obtained within the SCOPUS and Web of Science databases. The sampled studies were then statistically analysed to characterize the existing literature based on Bibliometrix software. Afterwards, and from the 114 selected articles, the software allowed the formation of six clusters, which are classified as follows: (1) University Entrepreneurial Anatomy and Ent\_Eco, (2) Universities' Third Mission Performance and Impacts, (3) Balance the Ent\_Uni's Different Roles, (4) Entrepreneurial Education and Ent\_Uni Support, (5) University Entrepreneurial Mindset, and (6) Entrepreneurial Orientation and Knowledge Capitalization.

This study intends to contribute to a better understanding of the Ent\_Uni and Ent\_Eco, the most relevant literature, trends, and dynamics of Ent\_Uni on Ent\_Eco throughout a systematization of existing literature and presenting how Ent\_Uni' dynamics are performed within an Ent\_Eco perspective. This knowledge could represent a stakeholders' competitive advantage considering the complexity of the knowledge economy environments.

This article is structured as follows. After this Introduction (Section 1), Section 2 presents the theoretical background. Section 3 describes the research methodology. Section 4 shows the results of Bibliometrix software and systematizes the main themes of the clusters. Section 5 offers a discussion of the results. Finally, Section 6 presents conclusions, contributions, limitations, and a future research agenda.

## **2. Theoretical Background**

The institutions have shaped and ruled the human interactions throughout economic history, creating a political, socio-cultural, and economic context to respond to special forces: managed economy or entrepreneurial economy (Guerrero *et al.*, 2015). Knowledge capital is the dominant production factor in the entrepreneurial economy, seen as a source of competitive advantage, that when complemented with entrepreneurship capital, provides the capacity to engage in and generate Ent\_Act through the exploration and exploitation of knowledge economic opportunities (Guerrero *et al.*, 2015). In this context, the Ent\_Uni is recognized as a catalyst for social development and regional economic growth by creating and exploiting entrepreneurial opportunities identified in the knowledge they generate (Santos and Caseiro, 2017). In addition to their traditional mission, centered on teaching and research, the Ent\_Uni is characterized by seeking to place graduates on the labor market who are destined for existing jobs or assume the creation of new jobs (Schulte, 2004).

There are many existing contributions towards theorizing the Ent\_Uni's concept, as we can see in publications such as Ruiz, Martens, and da Costa (2020) that sought to bring together some of the existing definitions. The definition of

Ent\_Uni, which is still the subject of discussion, can be based on factors of a formal or informal nature. Formally, they are characterized by the development and implementation of a training offer in the area of entrepreneurship, by the creation of a support structure for the transfer of technology, support for the formation of start-ups, flexible organizational structures, and a commitment to the design of links with the industry (Kirby *et al.*, 2011). Informally, it depends on students' and teachers' entrepreneurial attitudes, on the presence of entrepreneurs who can serve as an example, and on the existence of a reward system (Kirby, Guerrero, and Urbano, 2011). Other criteria may also be considered, namely that universities are involved in large-scale scientific projects, carry out research that is contracted to them, consultancy, patenting, licensing, spin-offs, external education, and development of new products (Bernasconi, 2005; Jacob, Lundqvist, and Hellsmark, 2003; Klofsten and Jones-Evans, 2000; Zhao, 2004).

In a very contemporary perspective, Ruiz *et al.* (2020) proposed a conceptual integration of the Ent\_Uni definition. It is identified as an institution integrated into an entrepreneurial and innovation ecosystem, skilled in altering, innovating, recognizing, and creating opportunities. In this context, the Ent\_Uni has an academic community — administrators, teachers, students — who are characterized by their proactivity, a propensity to deal with risk and deal with challenges, with a view to internal and external development through the creation of value originated in knowledge (Ruiz, Martens, and da Costa, 2020).

After 1980, there was a recognition of the importance of universities' participation in economic and social development as an integral part of their third mission (Etzkowitz, 1983). The third mission's motivation is based on internal and external factors (Rhoades, 2006). Factors such as scientific progress, the emergence of new forms of collaborative research, the change in social expectations regarding the role to be played by universities, and the decrease in the funding allocated to them have made it possible for many universities to become more entrepreneurial (Guerrero *et al.*, 2014). Universities are now oriented towards the development of an entrepreneurial culture (Kirby, 2006), with a clear focus on the development of incubators that can help in the creation of new businesses (Etzkowitz, 2003b) and assist academics in the process of commercializing results of their investigations (Dill, 1995; Jacob *et al.*, 2003).

In developing universities as entrepreneurs, we will identify three phases that may not happen exactly in the order that we present below (Etzkowitz, 2013). Etzkowitz (2013) recognized the designation University Entrepreneur One that characterizes when the academic institution has a strategic vision that allows it to define the direction to follow, a stage in which some skills in setting priorities and obtaining forms of financing are required. Concerning the University Entrepreneur Two, this concerns when the academic institution takes an active role in commercializing intellectual property resulting from the activities developed by its collaborators, researchers, and students (Etzkowitz, 2013). The

University Entrepreneur Three refers to a proactive role for the academic institution that involves improving regional innovation's effectiveness involving collaboration with industry and the government (Etzkowitz, 2013). Following this perspective initiated by Etzkowitz (2013), Carayannis et al. (2018) present an Ent\_Uni "MODE 3". However, in their viewpoint, these only show some entrepreneurial qualities, transcending the conventional concept of an Ent\_Uni. They present a real potential that needs to be accompanied by contextual changes in business sectors and branches. According to Carayannis et al. (2018), there is a need to reproduce in an adequately structured ecosystem — based on the accessibility of markets, the existence of human capital and workforce, the capacity for investment and financing, the existence of support systems, and the availability of mentors, government intervention and existing regulations, the existence of education and training programs, considering universities as the main catalysts and the existence of cultural support — all movements and adaptations that have occurred in universities.

According to the study developed by Ruiz et al. (2020), Ent\_Uni activities — management, creation of infrastructures, internationalization, financing, and the Ent\_Eco and partnerships — must have an underlying structural organization that allows their articulation in the sense of the intended entrepreneurial performance. It is in this entrepreneurial anatomy that, according to Etzkowitz (2013), it is possible to create a game of legitimation between university roles — teaching, research, and entrepreneurship — which makes it possible, as the university increases its entrepreneurial incursions, to manage tensions emerging from the performance of their different roles enabling the improvement of previously existing functions.

It is increasingly common to see reciprocity between universities and industries, witnessing an exchange of knowledge (Ahmad *et al.*, 2018). There is an increase in the number of projects that count simultaneously with university and industry participation and articulation of Ent\_Act with education for entrepreneurship (Lu and Li, 2016). The development of Ent\_Eco is visible, with changes attributed to the shift in roles assumed by the various TH actors and how individual differences are reflected in the rest's evolution (Pique, Berbegal-Mirabent, and Etzkowitz, 2018).

### **3. Methodology**

#### **3.1. Systematic Review Protocol**

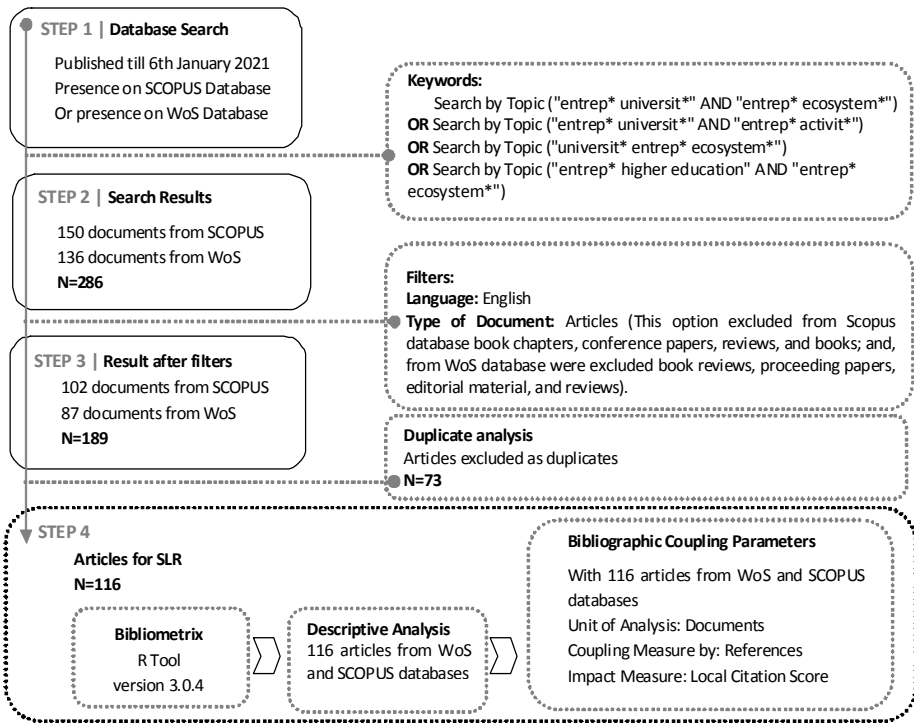
This study aims to systematise the most relevant literature, trends, and dynamics of the Ent\_Uni on the Ent\_Eco. Pursuing this purpose, an SLR was carried out, using an objective and rigorous research protocol to minimize the researcher bias

(Tranfield *et al.*, 2003). The SLR is developed based on a systematic, transparent, replicable, and structured summarized process, giving it a scientific character (Briner and Denyer, 2012). Since this study aims to systematize the most relevant literature, trends, and dynamics of Ent\_Uni on Ent\_Eco, identifying literature clusters, and presenting a future research agenda, we choose to apply Tranfield *et al.*'s (2003) methodology, based on the PRISMA method (Moher *et al.*, 2009), which includes four steps — identification of studies, screening, eligibility, and inclusion.

The search was carried out on January 6th, 2021, on WoS and Scopus databases and enabled a base of 116 articles included in the bibliometric analysis without any temporal limitations. The option for both databases was justified in its scope and relevance in the management areas. Figure 1 visualizes the research protocol where the articles' inclusion and exclusion criteria are presented. According to the defined research protocol, the search for relevant articles to the topic in the study took place on the Web of Science (WoS) and SCOPUS databases.

To gather a set of articles that allowed the articulation of the themes of Ent\_Uni and Ent\_Eco, we conducted a search considering the keywords (“entrep\* universit\*” AND “entrep\* ecosystem\*”) OR (“entrep\* universit\*” AND “entrep\* activit\*”) OR “universit\* entrep\* ecosystem\*” OR (“Entrep\* higher education” AND “Entrep\* Ecosystem\*”) as search topics, exploring titles, abstracts and keywords. The returned articles were 150 from SCOPUS and 136 from WoS. We also refined the search to consider only articles as the document type and English as the language. The option for “article” as document type relies on the fact that articles published in a journal, due to the peer revision process, where they were critically reviewed peer-approved, can be considered certified knowledge (Ramos-Rodríguez and Ruíz-Navarro, 2004). The English language was chosen considering that most scientific journals are published in English, representing 98% of publications (Ramírez-Castañeda, 2020). In this scenario, the English language emerges as almost universal in scientific interactions and scientific literature production (Gordin, 2017). The results after filter application were 102 from SCOPUS and 87 from WoS. Seventy-three articles were present in both databases.

Figure 1. Search Protocol



### 3.2. Approaches Selection

The results are presented in two distinct but complementary approaches. In the first approach, we show a descriptive characterization of the Ent\_Uni and Ent\_Eco existing literature based on version 3.0.4 of package Bibliometrix, an R tool software mapping analysis (Aria and Cuccurullo, 2017). In the second approach, we present bibliometric maps and identify bibliographic coupling on document references. Kessler (1963) proposed the bibliographic coupling method where two documents are considered bibliographic coupled when they use the same item of reference.

Bibliometrix is usually used to analyze and map bibliographic data, presenting the advantage of operating in R, an open-source environment ecosystem that runs in Windows and Linux operating system environment, with a graphical user interface RStudio — which makes it user-friendly for novice or expert users. It also presents the advantage of encompassing statistical algorithms, mathematical functionalities, and visualization capabilities suitable for bibliometric analysis. Bibliometrix emerges as software data combines the conceptual Factorial Analysis through a Text Mining approach with science mapping (Dervis, 2019).



To merge the two databases retained in the PRISMA method's inclusion step (Moher *et al.*, 2009), we follow the first two steps of the procedure proposed by Echchakoui (2020), which involved four steps. In the first step — convert WOS and Scopus databases to bibliography files — we save each database separately “\*.bib” files. In step two — convert both WOS.bib and Scopus.bib to “Bibtex” files — we use RStudio by loading the Bibliometrix package and the biblioshiny library.

When we process cited references to construct bibliographic coupling networks based on WoS or SCOPUS, we need to process the cited references in these database files. Considering that cited references of both databases are in different formats, we merged both database results and removed duplicates. The bibliographic coupling analysis was performed with the 116 articles included in the initial sample. The documents were submitted to the Bibliometrix, where we first select “documents” as the unit of analysis and “references” as coupling measure criteria. Afterwards, we choose “local citation score” as an impact measure and consider 250 as the number of units under analysis and five as the minimum cluster frequency.

The research uses version 3.0.4 of package Bibliometrix to present bibliometric maps and identify bibliographic coupling of document references. According to cited references, this approach recognizes the relations between authors, allowing identifying the most proactive research and giving a dynamic perspective of the area covered (Zhao and Strotmann, 2008). Boyack and Klavans (2010) demonstrated that considering the existent pure citation-based approaches, bibliographic coupling reveals accuracy advantages compared to other approaches.

Afterwards, we read the papers to identify the significant teams that emerge in each cluster formed in Bibliometrix - biblioshiny. The reading of the results also originated a table to identify the top 10 most cited articles in each cluster. The analysis also inspires the name given to each one of the clusters.

Finally, we can classify our study as a bibliometric review. Bibliometric reviews are characterized by analyzing an extensive amount of existing literature using statistical tools to figure out trends (Paul and Criado, 2020). Bibliometric review can be developed using Viewer software programs, ordinarily available such as VoS (Visualization of Similarities), widely used to carry out such a bibliometric review. Many bibliometric analyses are valuable when, given the number of existing articles, a relatively small number of articles represent a significant part of the analysis's total citations (Paul and Criado, 2020).

## 4. Results

### 4.1. Descriptive Analysis – Bibliometrix

The 116 articles were published in 72 journals. Regarding source level, it is possible to identify the most productive journals. Table 1 presents the sources with a production level greater than two articles and their number of publications. The *Industry and Higher Education* journal and the *Small Business Economics* journal stand out with ten and six publications, respectively.

**Table 1.** Source Articles Production

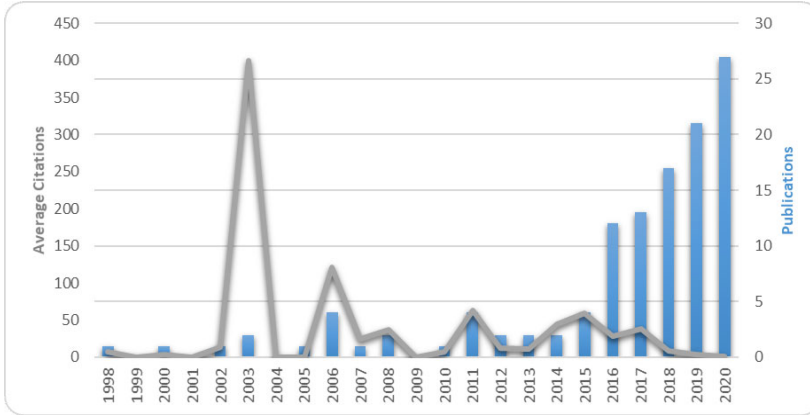
Sources	Articles
INDUSTRY AND HIGHER EDUCATION	10
SMALL BUSINESS ECONOMICS	6
INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT	5
JOURNAL OF MANAGEMENT DEVELOPMENT	5
JOURNAL OF TECHNOLOGY TRANSFER	5
SCIENCE AND PUBLIC POLICY	4
SCIENTOMETRICS	3
TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	3
TECHNOVATION	3
ACTUAL PROBLEMS OF ECONOMICS	2
FOUNDATIONS AND TRENDS IN ENTREPRENEURSHIP	2
HIGHER EDUCATION	2
INTERNATIONAL ENTREPRENEURSHIP AND MANAGEMENT JOURNAL	2
INTERNATIONAL JOURNAL OF ENTREPRENEURIAL BEHAVIOR AND RESEARCH	2
JOURNAL OF ENTERPRISING COMMUNITIES	2
MANAGEMENT DECISION	2
RESEARCH POLICY	2
SUSTAINABILITY (SWITZERLAND)	2

We also analyzed the source dynamics and time evolution of the nine most productive sources. This analysis emphasized the effective performance of the *Industry and Higher Education* journal from 1998 till 2020. We also observed the existence of five journals that significantly increased their production after 2012. These journals are *Small Business Economics*, *Journal of Technology Transfer*, *International Journal of Technology Management*, *Journal of Management Development*, and *Technological Forecasting and Social Change*.

The obtained articles were produced in 34 different countries. The most productive countries are the United Kingdom (18 publications), the United States of America (16 publications), Spain (13 publications), Brazil (11 publications), and Finland (8 publications).

In Figure 2, it is possible to observe the trend in the evolution of the number of publications and citations for the 116 articles included in the sample. The data collection retrieved articles published between 1998 till 6th January 2021.

**Figure 2.** Evolution of average citations per article and number of publications



The average medium citation per article reached its maximum in 2003 with 399 incidences. The maximum verified in 2003 average citation is associated with an article of paramount importance — Etzkowitz (2003b) — with the article entitled “Research groups as ‘quasi-firms’: The invention of the entrepreneurial university”, which currently has 740 citations.

Table 2 briefly presents the ten most cited articles on the analysed topic.

**Table 2.** Top 10 most cited articles

Authors	Article	Journal	Total Citations	Average Citations per year
Etzkowitz (2003b)	Research groups as ‘quasi-firms’: The invention of the entrepreneurial university.	Research Policy	740	39
Spigel (2017)	The relational organization of entrepreneurial ecosystems.	Entrepreneurship: Theory and Practice	390	78
Rasmussen & Sørheim (2006)	Action-based entrepreneurship education.	Technovation	238	15
Philpott, Dooley, O’Reilly, & Lupton (2011)	The entrepreneurial university: Examining the underlying academic tensions.	Technovation	214	19
Guerrero, Cunningham, & Urbano (2015)	Economic impact of entrepreneurial universities’ activities: An exploratory study of the United Kingdom.	Research Policy	185	26
Phan & Siegel (2006)	The effectiveness of university technology transfer.	Foundations and Trends in Entrepreneurship	160	10
Guerrero, Urbano, Fayolle, Klofsten, & Mian (2016b)	Entrepreneurial universities: Emerging models in the new social and economic landscape.	Small Business Economics	110	18
Guerrero, Urbano, & Fayolle (2016a)	Entrepreneurial activity and regional competitiveness: Evidence from European entrepreneurial universities.	Journal of Technology Transfer	81	14

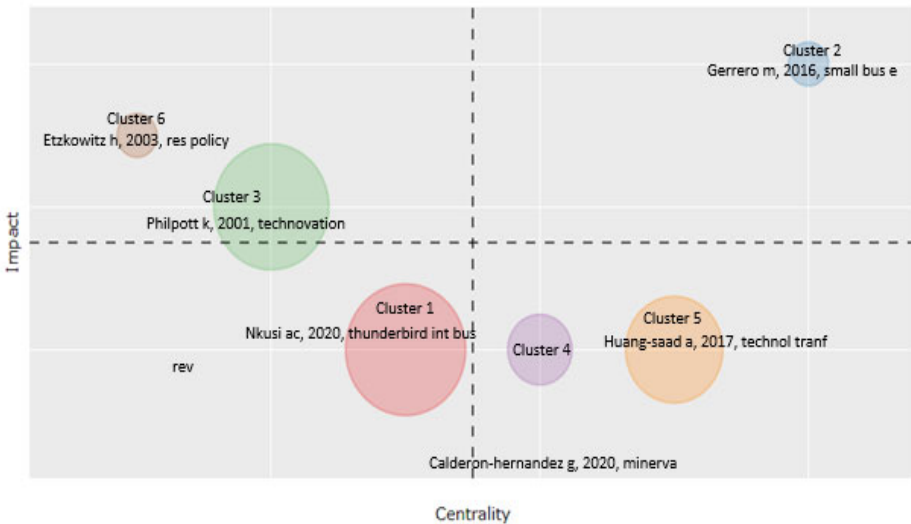
Guerrero & Urbano (2014)	Academics' start-up intentions and knowledge filters: An individual perspective of the knowledge spillover theory of entrepreneurship.	Small Business Economics	70	9
Coduras, Urbano, Rojas, & Martínez (2008)	The relationship between university support to entrepreneurship with entrepreneurial activity in Spain: A gem data-based analysis	International Advances in Economic Research	63	5

### 4.2. Bibliographic Coupling Analysis

The Bibliographic Coupling of documents' references performed as detailed in the Methodology section enabled the formation of six clusters that involve 114 articles of the 116 retrieved from the bibliometric search. This reduction is related to the Bibliographic Coupling parameters, accepting the largest set of connected items.

Figure 3 shows the cluster's map. The x-axis represents the cluster centrality, which can be read as the importance of the theme in the entire research field. The y-axis represents the cluster impact, a measure of the theme's development.

**Figure 3.** Cluster bibliometric map



The map is divided into four quadrants, and each bubble represents a network cluster where the bubble name is one of the authors of the cluster. The bubble size is proportional to the number of authors integrated into that cluster. The bubble position is calculated according to the cluster Callon centrality and density (Ahmi, 2022).

According to Ahmi (2022), Cluster 1, represented in Figure 3 by the name of the author Nkusi et al. (2020), is on the lower left part, destined for emerging or

declining themes. It is visible an eventual transition to the lower right area, destined to basic or transversal themes. In that quadrant are already positioned Cluster 4 – represented by Calderón-Hernández et al. (2020) and Cluster 5 – represented by the author Huang-Saad et al. (2017). In the upper left part, representing a high density but a lower centrality, are the clusters highly developed but isolated, also called “niches”. In this quadrant are situated Cluster 3 – represented by Philpott et al. (2011) – and Cluster 6 – represented by Etzkowitz (2003b). Cluster 2 – represented by the authors Guerrero et al. (2016b) – is positioned in the upper right part, destined to develop essential themes, named motor themes.

Table 3 presents the distribution of all the 114 papers resulting from the bibliometric search according to the assigned cluster, considering the methodological procedures adopted and described earlier.

**Table 3.** Authors per Cluster

Cluster 1   N=30 Total Citations: 521	Cluster 2   N=10 Total Citations: 604	Cluster 3   N=28 Total Citations: 653	Cluster 4   N=14 Total Citations: 369	Cluster 5   N=22 Total Citations: 141	Cluster 6   N=10 Total Citations: 797
Allahar & Sookram (2019b)	Abreu et al. (2016)	Ahmad et al. (2016)	Allahar & Sookram (2019a)	Ahmad et al. (2018)	Abdelkafi et al. (2018)
Amadi-Echendu et al. (2016)	Coduras et al. (2008)	Carayannis et al. (2015)	Alves et al. (2019)	Crow et al. (2020)	Abereijo (2015)
Bed et al. (2020)	Guerrero & Urbano (2014)	Formica (2002)	Calderón-Hernández et al.	Davey & Galan-Muros	Bazan et al. (2019)
Brem & Radziwon (2017)	Guerrero et al. (2015)	Fuller & Pickernell (2018)	Guerrero et al. (2017)	de Moraes et al. (2020)	Etzkowitz (2003b)
Budyldina (2018)	Guerrero et al. (2016a)	Genç et al. (2020)	Khassenova (2018)	Duval-Couetil et al. (2021)	Ferrandiz et al. (2018)
Carayannis et al. (2018)	Guerrero et al. (2016b)	Iscaro et al. (2017)	Markuerkiaga et al. (2018)	Fischer et al. (2019)	Huezo-Ponce et al. (2021)
De Jager et al. (2017)	Guerrero et al. (2018)	Kochetkov et al. (2017)	Marques et al. (2019)	Fogelberg & Lundqvist	Lamine et al. (2018)
de Sandes-Guimaraes et al.	Guerrero et al. (2020)	Krücken et al. (2007)	Matt & Schaeffer (2018)	Gianiodis et al. (2016)	Rialti et al. (2017)
Huang-Saad et al. (2018)	Urbano & Guerrero (2013)	Kutinlahti (2005)	Meyer (2006)	Gianiodis et al. (2019)	Sánchez-López & Pedraza
Johnson et al. (2019)	Zhang et al. (2016)	Levie (2014)	Meyer et al. (2003)	Huang-Saad et al. (2017)	Shekhar & Bodnar (2020)
Lahikainen et al. (2019)		Markuerkiaga et al. (2016)	Rasmussen & Sorheim	Ishizaka et al. (2020)	
Leitner et al. (2021)		Markuerkiaga et al. (2017)	Ribeiro et al. (2018)	Loi & Di Guardo (2015)	
Link & Sarala (2019)		Mathieu et al. (2008)	Sambo (2018)	Meusburger & Antonites	
Maritz (2017)		Pazos et al. (2012)	Shankar & Clausen (2020)	Miller et al. (2018)	
Mason et al. (2020)		Phan & Siegel (2006)		Padilla-Meléndez et al.	
Mudde et al. (2019)		Philpott et al. (2011)		Ricci et al. (2019)	
Nkusi et al. (2020)		Ranga et al. (2016)		Sá et al. (2018)	
O'Brien et al. (2019)		Reyes (2016)		Skute (2019)	
Pittz & Hertz (2018)		Riviezso & Napolitano (2010)		Soetanto & Van Geenhuizen	
Prencipe et al. (2020)		Roberts & Eesley (2011)		Tavella & Bogers (2020)	
Pugh et al. (2021)		Romanovsky (2011a)		Wibowo et al. (2020)	
Rybníček et al. (2019)		Romanovsky (2011b)		Wolf (2017)	
Sanadgol & Dadfar (2020)		Ruiz et al. (2020)			
Scheidgen (2021)		Salamzadeh et al. (2016)			
Secundo et al. (2021)		Secundo et al. (2019)			
Spigel (2017)		Sukowski et al. (2020)			
Stolze and Sailer (2021)		Yokoyama (2006)			
Wynn & Jones (2017)		Yordanova & Filipe (2019)			
Závodská et al. (2019)					
Zobnina et al. (2019)					

### 4.3. Thematic Clusters: Entrepreneurial Universities and Entrepreneurial Ecosystems

To solidly present each of the six literature clusters on the Ent\_Uni and Ent\_Eco subject, we have thoroughly analyzed each of the 114 articles. This content analysis made it possible to identify which themes were predominant in each cluster and understand each of the authors' contributions to the cluster specified by analyzing the documents' Bibliographic Coupling.

#### *Cluster 1: University Entrepreneurial Anatomy and Ent\_Eco*

Thirty studies involving 521 citations contribute to the understanding of Cluster 1 – University Entrepreneurial Anatomy and Ent\_Eco. In this cluster, multiple aspects are evidenced to consider in the analysis and construction of entrepreneurial anatomy. These aspects involve a collaboration between the concepts of Ent\_Uni and Ent\_Eco to allow the emergence of an actual entrepreneurial structure capable of dealing with the multiple challenges inherent to entrepreneurship and maximizing the generated opportunities and their benefits. The five most cited articles of Cluster 1 are briefly presented in Table 4.

**Table 4.** Top 5 Most cited articles of Cluster 1

Author(s)  Citations	Article	Objective	Methodology	Main Findings
Spigel (2017)   390	The relational organization of entrepreneurial ecosystems.	Explore the development of the theoretical concept of Ent_Eco to clarify how they are structured and their influence on the entrepreneurship process.	Qualitative	The author argues that ecosystems result from an articulation of 11 attributes of a cultural, social, and material nature from which benefits and resources emerge placed at entrepreneurs' service. It is in the relationships that are established between these attributes that ecosystems emerge.
Brem & Radziwon (2017)   31	Efficient Triple Helix collaboration fostering local niche innovation projects – A case from Denmark.	Approach how an efficient TH collaboration could foster and support the growth of regional Ent_Eco.	Qualitative	Networking, win-win situations, and a strong problem orientation were identified as key success factors, particularly in regional Ent_Eco. These factors may enhance an efficient future TH collaboration and cooperation for ensuring a higher innovation diffusion success based on the development of students' ideas.
Budyldina (2018)   21	Entrepreneurial universities and regional contribution.	Define the dimensions of entrepreneurial universities and their eventual application to the regional context.	Qualitative	Regional impacts of universities are broader than technology transfer and tangible outputs; however, the transformation of a university into a local entrepreneurial cornerstone demands massive government funding to conciliate innovative university activities without compromising its traditional functions.
Maritz (2017)   13	Illuminating the black box of entrepreneurship education programmes: Part 2.	Explore the increasing number of Ent_Uni programs developed in higher education institutions and the repercussion in empowering individuals to transform and become better entrepreneurs.	Qualitative	Improvement of Dimensions of Entrepreneurship Education framework contributes to the theoretical discussion and builds understanding of generating entrepreneurship education programs considering varied contextual boundaries.

Link & Sarala (2019)   9	Advancing conceptualisation of university entrepreneurial ecosystems: The role of knowledge-intensive entrepreneurial firms.	Contribute to deepening the understanding of university Ent_Eco's demand side based on entrepreneurial firms as the university knowledge's key user.	Quantitative	Clarification of universities' economic, societal, and technological contributions, illustrating the role of firm resources and capabilities used as moderators of value in university Ent_Eco.
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According to Spigel (2017), author of the most cited article of this cluster, despite the popularity of Ent\_Eco, where ecosystems represent the merge of localized cultural outlooks, social networks, investment capital, universities, and active economic policies that support innovation-based ventures, ecosystems research is still underdeveloped and undertheorized. To a better understanding of Ent\_Eco structure and its influence on the entrepreneurship process, Spigel (2017) proposed a set of 11 attributes — supportive culture, histories of entrepreneurship, mentors and role models, investment capital, networks, worker talent, support services, open markets, infrastructure, universities, policies — these attributes' relationship dynamics could originate different ecosystem configurations.

In this cluster, it is easily identifiable and undeniable the leading role played by universities — as knowledge-intensive environments — in the development of a supportive environment, involving the developing of culture, researching, creating incubators, and accelerators, growing co-working spaces, seminars, and teaching entrepreneurship, identifying this institution as the catalyst of the entrepreneurial process (Závodská *et al.*, 2019). Within the same general approach, Huang-Saad *et al.* (2018) approach the desired outcomes and impacts of university Ent\_Eco to bring practice closer to research focusing on technology and talent. Despite their relevance, we have to consider the institutionalized logics of universities — education and research — and acknowledge that the development of Ent\_Act could cause intentional and unintentional decoupling between these logics (Lahikainen *et al.*, 2019).

Zobnina *et al.* (2019), Pittz and Hertz (2018), and Maritz (2017) described that entrepreneurship education is increasingly growing — entrepreneurship programs, degrees, certificates, and entrepreneurial centers — revealing the universities' aim of creating a mindset that empowers individuals to be more and better entrepreneurs. In this sense, and as a redevelopment of Maritz and Brown's (2013) framework on entrepreneurship education, designed for understanding and evaluating entrepreneurship education programs, Maritz (2017) presents a framework that integrates several components — entrepreneurship ecosystems, outcomes, objectives, audience, assessment, content, and pedagogy — that enable the contextualization of entrepreneurship education ecosystems.

Within the role played by universities in the promotion of student and graduate start-ups, Závodská *et al.* (2019) and Mason *et al.* (2020) argue that the entrepreneurial education is not achievable by a single course; there is a need for coordinated programs, with the integration of entrepreneurship education,

activities, and infrastructures to support and accelerate the start-up process. There is also a need for integrated learning — involving action learning, masterclasses, peer-to-peer learning, and experimental workshops — with evidence of the need to include a reflexivity dimension in their everyday practice (Pugh *et al.*, 2021). To address Ent\_Eco stakeholders' preoccupation, clarifying universities' role in pursuing entrepreneurial pathways — managing opportunities and risks — Stolze and Sailer (2021) propose five future scenarios presenting as key drivers internationalization, digital transformation, collaborative networks, and co-creation processes which will condition future entrepreneurial pathways.

Furthermore, multiple studies approach the concept of University-centered Ent\_Eco (Brem and Radziwon, 2017; Johnson *et al.*, 2019; Secundo *et al.*, 2021), involving complex webs of entrepreneurs, researchers, institutional support structures, and the built environment that is a result of the dynamics of their relationships and responsible for the performance of ecosystem agents in the evolution of University-centered Ent\_Eco. Bed *et al.* (2020) explore the same concept within a resource-constrained environment (e.g., ecosystems in small cities, underpopulated rural areas, and university towns) and conclude building an Ent\_Eco in such contexts would be highly challenging. According to De Jager *et al.* (2017), the South Africa case is also challenging, presenting the lowest youth entrepreneurial propensity. The authors defend the need for a new philosophy of education, particularly in technology universities, to lead to work opportunity-enhancing outcomes. The article published by O'Brien *et al.* (2019) approaches a particular type of Ent\_Eco challenges, presenting a framework to support their expansion to under-represented communities.

Another perspective of the challenges to building an Ent\_Eco is brought by Nkusi *et al.* (2020), who undertook an exploratory study in a post-conflict economy where the pre-existent Ent\_Eco was destroyed. The author argues that in this scenario, several institutional factors (e.g., structures, systems, leadership, strategies, and culture) constrain the Ent\_Eco development, which evolves through several stages — embryonic, destruction, formation, and capacity building stages.

According to Scheidgen (2021), it is also essential to know how entrepreneurs acquire resources from an Ent\_Eco, considering the two distinct subsystems — spin-off or start-up — generating heterogeneity between Ent\_Eco's and within Ent\_Eco's. The author argues that this heterogeneity compromises the comparability and comprehension of Ent\_Eco and, consequently, the correct design of political instruments to promote entrepreneurship effectively.

Even while adopting another approach, according to students with international exchange experience, de Sandes-Guimaraes *et al.* (2020) emphasize the collaboration between the university and non-academic partners, in contrast to non-traveling counterparts, who stress the importance of existing university infrastructures. Within the theoretical construct of the TH interrelationships, and despite the slow progress towards achieving the universities' third mission, the



university-centered Ent\_Eco requires more proactive leadership and more significant internal and external involvement of stakeholders (Allahar and Sookram, 2019a).

Brem and Radziwon (2017) argue that collaboration between universities and their local stakeholders is a major success factor for regional Ent\_Eco development. An efficient TH collaboration and cooperation could foster and support niche innovations and enhance innovation diffusion success. According to Carayannis et al. (2018) and based on previous work (Carayannis and Campbell, 2009), the TH model should be extended to consider a ‘fourth helix’ that they identified as civil society — involving (1) media, (2) creative industries, (3) culture, (4) values, (5) life styles, (6) art, and (7) the creative class notion. Furthermore, the authors also argue that innovation structures within society result from a knowledge-based economy where universities emerge with a new knowledge production and transfer model proposition that considers the environmental dimension — pointing to the analysis of a “quintuple helix”.

Mudde et al. (2019) explore the Ent\_Uni framework of the European Commission/OECD, considering staff, students, university top-management, faculty, and external stakeholders’ responses — and argue the existence of a tension between a decisive say of the government in university activity and the need to develop an autonomous, integrated entrepreneurial culture. As the author states, within the Ethiopian Universities context — where universities are operating in a top-down, central governmental-led development — leadership is the lever for an entrepreneurial turn at the universities. Budyldina (2018) also refers that the evolution of the Ent\_Uni demands massive government funding during the initial stages and strategic policy coordination to leverage the university’s innovative activities without compromising its traditional teaching and research functions.

Also, within the Ent\_Eco concept, Carayannis et al. (2018) published an article to examine the concept of ‘Mode 3’ universities to clarify if they represent a new and advanced type of an Ent\_Uni. The authors define a ‘Mode 3’ university as “a type of organization capable of higher-order learning and in this regard an open, highly complex, and non-linear knowledge production system that seeks and realizes creative ways of combining, recombining, and integrating different principles of knowledge production and knowledge application (e.g., ‘Mode 1’ and ‘Mode 2’)” (p. 146). According to the authors, when compared to an Ent\_Uni, the concept of ‘Mode 3’ universities is better prepared to address the current and future challenges; however, it demands a strong linkage and contextualization with the Ent\_Eco. Even while adopting another perspective, it is possible to identify the impact of business and scientific experience of the heads of university departments (Leitner *et al.*, 2021), as well as industry leadership experience (Rybnicek *et al.*, 2019), on the performance of public universities.

The article published by Wynn and Jones (2017) stresses the importance of knowledge transfer partnership programs, which, through customer-facing roles, leverage relationships and linkages between initiatives and enable sustainable incomes from Ent\_Act. Within the concept of university Ent\_Eco, it is vital to observe the students' attitudes towards Ent\_Uni activities (Sanadgol and Dadfar, 2020) and explore the demand side regarding the entrepreneurial firm's role as the key user of university knowledge (Link and Sarala, 2019). The results of Link and Sarala (2019) unveil the role of firm resources and capabilities as moderators, leveraging the ability to create value from university knowledge. Another contextual dimension is explored by Prencipe et al. (2020), approaching the regional Ent\_Eco and incorporating university spin-off through the knowledge spillover process. Amadi-Echendu et al. (2016) explore the potential of a particular university — the University of South Africa — to approach university entrepreneurship as a solution to end unemployment in South Africa. The authors argue the need for alternative approaches to complement traditional teaching methods such as on-the-job training, assisting with incubating business ideas, and providing a platform for cross-pollination of knowledge between government, university, and industry.

#### *Cluster 2: Universities' Third Mission Performance and Impacts*

Ten studies contribute to understanding Cluster 2. This cluster represents a literature path focusing on the Ent\_Uni as a catalyst for regional economic and social development through the generation and exploitation of knowledge as entrepreneurial opportunities, emphasizing the need to enhance university technology transfer effectiveness and leverage the integration and collaboration between the multiple agents of an Ent\_Eco. One of the smallest clusters, it is responsible for 604 citations. The top five most cited articles of this cluster are briefly presented in Table 5.

**Table 5.** Top 5 Most cited articles of Cluster 2

Author(s)  Citations	Article	Objective	Methodology	Main Findings
Guerrero et al. (2015)   185	Economic impact of entrepreneurial universities' activities: An exploratory study of the United Kingdom.	Contribute to deepen the understanding of the economic impact of Ent_Uni teaching, research, and Ent_Act.	Quantitative	The authors identify a positive and significant economic impact of teaching, research, and Ent_Act. Entrepreneurial spin-offs explain the higher economic implications of the United Kingdom's Ent_Uni (the Russell Group). In the control group, the highest economic impact is associated with knowledge transfer.
Guerrero et al. (2016b)   110	Entrepreneurial universities: Emerging models in the new social and economic landscape.	Development of the theoretical, empirical, managerial, and political implications of emerging models that approach Ent_Uni contextualized in the new socio-economic landscape.	Qualitative	The authors argued the relevance of Ent_Uni in developing innovation and Ent_Act based on emerging models of Ent_Uni in the new socio-economic landscape. They highlight aspects related to individual-organizational interactions and the organizational-regional context interactions to outline a future research agenda based on Ent_Uni's role as drivers of innovation and entrepreneurship proposes.
Guerrero, Urbano, & Fayolle (2016a)   81	Entrepreneurial activity and regional competitiveness: Evidence from European entrepreneurial universities.	Analyze the impact of the university's Ent_Act on regional competitiveness to propose a conceptual framework.	Qualitative	The results show that informal factors (e.g., attitudes, role models) have a more significant influence on university Ent_Act than formal factors (e.g., support measures, education, and training). The results also evidenced a higher contribution of universities to regional competitiveness.
Guerrero & Urbano (2014)   70	Academics' start-up intentions and knowledge filters: An individual perspective of the knowledge spillover theory of entrepreneurship.	Explore the role of academics' start-up intentions and knowledge filters on Ent_Uni's knowledge transfer process.	Qualitative	The authors argue that Ent_Uni infrastructures and policies are correctly developed; however, they need to be appropriately implemented, reducing organizational barriers and reinforcing the perception that entrepreneurship is possible for academics.
Coduras et al. (2008)   63	The relationship between university support to entrepreneurship with entrepreneurial activity in Spain: A GEM data based analysis.	Analyze the statistical relationship between entrepreneurship university support and the level of Ent_Act.	Quantitative	The authors argue that there is no significant statistical relation between Ent_Uni's support and the Ent_Act level. However, it is possible to statistically relate entrepreneurial intention with university support, which denotes the improvement of high education in Spanish entrepreneurship.

An increasing pressure on universities to deliver on their third mission is undeniable, demanding a broader sense of knowledge exchange, involving research commercialization, Uni\_Ind partnerships, and all related enterprise engagements (Abreu *et al.*, 2016). There is now a recognition of the paramount importance of universities, particularly the Ent\_Uni, in the development of innovation and Ent\_Act, its influence on national innovation systems (NIS) development and performance, and the emerging eEnt\_Eco's literature (Guerrero *et al.*, 2016b). This scenario involves a broader range of Ent\_Act. Referred to as "problem-solving activities", they include consultancy, contract research, and joint research with external organizations; participation in research consortia, informal advice, prototyping and testing for external organizations, hosting personnel from external organizations, and secondments (Abreu *et al.*, 2016).

Also focusing on the critical role of Ent\_Uni's ecosystems, Guerrero *et al.* (2020) affirm that they increase graduates' employability options and identify

how the university business incubator positively influences graduates' risk aversion and the work effort is positively influenced by entrepreneurship. According to Coduras et al. (2008), there is a relation between entrepreneurial intention and university support. From a holistic perspective, we cannot fail to mention the importance of incubators, and we need to understand these initiatives' economic repercussions. Business incubators have an impact on graduates' entrepreneurship (Guerrero *et al.*, 2018).

Examining the associations between the intensity and performance of knowledge exchange activities undertaken between United Kingdom universities and non-academic actors, Zhang et al. (2016) clarify the nature of the existing interactions, based on the competitive level of the region where they occur and on the leverage of knowledge and partnership levels. As stated by the authors, there are differences between competitive and uncompetitive regions. In uncompetitive regions, it is common to verify a more intense engagement in academic Ent\_Act; however, the study identifies the generation of less income compared to competitive regions. On the other hand, in competitive regions, it is possible to affirm that the university's geographical distance represents a minor obstacle compared to uncompetitive regions (Zhang *et al.*, 2016).

The economic impact of Ent\_Uni's teaching, research, and Ent\_Act is the central theme of Guerrero et al. (2015). The theoretical criteria used to define entrepreneurship activities in Guerrero et al. (2015) were based on previous studies. Their study approaches Ent\_Act as activities performed at all university levels (university management, academicians, researchers, and potential entrepreneurs among students and alumni) that lead to the creation of new companies that could impact job creation and regional development, creating the conditions for partnerships between key regional clusters to generate the encounter of the current needs and their solution. Furthermore, these activities will produce several externalities — demography, economy, infrastructure, culture, mobility, education, and social challenges — with impacts on productivity, competitive advantages, regional capacities, regional networks, regional identity, and regional innovation. The authors argue that previous studies analyze universities' role in economic development without observing university outcomes' complexity and dynamic characteristics and their transformation into economic impacts. According to the conceptual model proposed by Guerrero et al. (2015), there exists a positive and significant effect of these activities on economic development, revealing different results when we approach Ent\_Uni, for which the performance of spin-offs is more relevant, and for the remaining universities, for whom the highest economic impact is associated with knowledge transfer.

Recognizing the relevance of the Ent\_Uni, and despite the progress made in analyzing the economic impacts resulting from Ent\_Act performed by them, evidence about this phenomenon is still fragmented and disorganized (Urbano and Guerrero, 2013). To provide a better understanding of the socioeconomic

impacts of the Ent\_Uni, Urbano and Guerrero (2013) present some practices able to stimulate the Ent\_Act of universities and thus foster their contribution to the development of the modern knowledge economy, particularly in times of crisis or in highly competitive environments. According to the authors, in these contexts, the most critical component will be the integration and collaboration of the multiple actors of the Ent\_Eco, and the university authorities must identify their core role to enhance the entrepreneurship ecosystem leveraging the entrepreneurial potential, stimulating skills, competencies, and tools to create a mindset that drives innovation.

The relationship between Ent\_Act and regional competitiveness is the central theme of Guerrero, Urbano, and Fayolle (2016a), paying special attention to the role of institutions in the establishment of political, social, and economic rules and because in many regions, universities are seen as potential engines of economic growth. This article presents shreds of evidence of a scenario where Ent\_Uni are increasingly generating and transferring knowledge and simultaneously are providing the leadership that enables and leverages the entrepreneurial thinking, actions, and institutions. The authors argue that informal factors (e.g., attitudes towards entrepreneurship, role models) significantly influence university Ent\_Act, more than formal factors (e.g., support measures to entrepreneurship, education, and training programs).

Guerrero and Urbano (2014) detailed it is possible to identify several filters that limit knowledge conversion into economically helpful knowledge. According to the knowledge spillover theory, the authors present insights valuable for policymakers to define policies that enhance social and educational benefits. Acknowledging that perceived behavioral control is a knowledge filter with implications on future knowledge diffusion (e.g., start-up intentions), the authors betoken the challenges faced by experimented academics when they face the possibility of becoming entrepreneurs and come across the lack of specific experience, skills, and capabilities (Guerrero and Urbano, 2014). Within the same general approach, Abreu et al. (2016) argue the relevance of academics' prior university and business experience in providing cognitive guidance in Ent\_Act. Previous experience will shape a person's engagement with various activities in different task domains with reflections on work performance, such as Ent\_Act. A broad range of prior experience benefits academics' performance on problem-solving activities, whilst a narrower range of previous experience will help academic's involvement in licensing and spin-out activities (Abreu *et al.*, 2016).

### *Cluster 3: Balance the Ent\_Uni's Different Roles*

Twenty-eight studies, responsible for 653 citations, contribute to understanding the Balance the Ent\_Uni's Different Roles cluster. Cluster 3 emphasizes that the university entrepreneurial transformation process clearly impacts balancing the different university roles. The university has to reconcile multiple aspects to achieve its third mission successful performance without compromising traditional teaching and research functions. There is a new university

entrepreneurial logic, with repercussions for Ent\_Act development and the knowledge exchange activities between universities and non-academic actors, with implications for the performance of Uni-Ind cooperation. We briefly present the five most cited articles of Cluster 3 in Table 6.

**Table 6.** Top 5 of Most cited authors of Cluster 3

Author(s)  Citations	Article	Objective	Methodology	Main Findings
Philpott et al. (2011)   214	The entrepreneurial university: Examining the underlying academic tensions.	Investigates the Ent_Uni concept, approached by Etzkowitz & Leydesdorff (2000) in the university context.	Qualitative	The Ent_Uni concept is a global phenomenon with an isomorphic development path due to several key barriers. Through this case study, it is possible to identify an attitudinal split that could cause disharmony amongst the academic community, which could compromise the achievement of the university's third mission. A top-down push towards the ideal of the Ent_Uni could reduce Ent_Act.
Phan & Siegel (2006)   160	The effectiveness of university technology transfer.	Present recommendations to enhance the effectiveness of university technology' transfer.	Qualitative	The authors argue that the proposed recommendations will depend on universities' mechanisms to stress, based on their technology transfer strategy. Universities should also be aware of social ethics and responsibility issues, which will become increasingly important as they become more aggressively involved in commercializing the technology they develop.
Yokoyama (2006)   51	Entrepreneurialism in Japanese and UK universities: Governance, management, leadership, and funding.	Analyze university governance changes, management, leadership, and funding and their influences on Ent_Act development.	Qualitative	The authors propose a theoretical model according to five types of institutional entrepreneurial culture.
Roberts & Eesley (2011)   41	Entrepreneurial impact: The role of MIT.	Contribute to understanding the economic impact of the entrepreneurial ventures of university graduates.	Mixed	Acknowledging that some universities play an essential role in many economies through their core education, research and development, and other spillovers, the authors also sustain the need to develop a culture and programs that make entrepreneurship widely accessible to students to support economic growth through entrepreneurship.
Krücken, Meier, & Müller (2007)   25	Information, cooperation, and the blurring of boundaries - Technology transfer in German and American discourses.	Examine technology transfer mechanisms for speeding up innovation, based on the assumption of increased competitiveness associated and considering a more complex model that allows networking and Ent_Act of the universities themselves.	Qualitative	The authors argue three ideal-typical models in technology transfer — information and documentation model, cooperation model, and blurring of boundaries model.

Universities are progressively gaining prominence as economic actors, balancing knowledge creation, knowledge dissemination, and knowledge exploitation functions, generating intellectual value and benefiting both society and the economy (Kutinlahti, 2005). It is essential to understand the economic impact of the Ent\_Eco in support of university graduates' firm start-ups and the importance of the programs and historical culture of entrepreneurship. As an example of paramount importance, emerges Massachusetts Institute of

Technology (MIT), which provides a benchmark to analyze the economic impact of their alumni entrepreneurs and identify some examples of programs and practices, widely accessible to students, that other universities might adopt towards entrepreneurial development (Roberts and Eesley, 2011).

As a result, the Ent\_Uni will perform Ent\_Act — spin-off firm formation, patenting, licensing, collaborative research, industry training courses, consulting, industry mobility, and networking — mechanisms for promoting social and economic development (Markuerkiaga *et al.*, 2016).

The Ent\_Act should cohesively encompass various entrepreneurship education dimensions due to an entrepreneurship strategy focusing on local needs and context (Markuerkiaga *et al.*, 2017). This theme was the base of the project UNEK, developed to analyze the academic entrepreneurial situation to propose an entrepreneurial maturity model.

Even while adopting another scope, the article published by Mathieu *et al.* (2008) also focuses on analyzing knowledge production and the changing relationships within the TH. The authors argue that it is possible to identify multiple ways to approach the universities' third mission and offer a different perspective. Universities do not have to transform themselves into fully entrepreneurial organizations to contribute substantially to economic development.

Emphasizing the Ent\_Uni's high expectations, Genç *et al.* (2020) argue that universities are expected to develop Ent\_Act and promote Uni-Ind cooperation, education, and training, contributing to the entrepreneurial transformation. Furthermore, universities have to embed entrepreneurship in an academic culture that allows entrepreneurial capacity development, bringing together entrepreneurial capacity and opportunities, a scenario where new opportunities are perceived, capitalized, and converted into marketable products or services (Formica, 2002). Salamzadeh *et al.* (2016) stated that the Ent\_Uni emerged as an efficient and effective university, conciliating its traditional mission and simultaneously pursuing a third mission.

Managing the Ent\_Uni's multiple missions, including teaching, research, and entrepreneurship, reveals complexity in achieving the university third mission, denoting the existence of dilemmas in the creation of the Ent\_Uni, encompassing challenges related to the academic resistance, internal factors, and social capital issues (Ahmad *et al.*, 2016). The authors stress the need for a proper balancing between teaching, research, and entrepreneurship, structured based on effective TH links to promote the transition to the Ent\_Uni concept. As stated by Ruiz *et al.* (2020), and in contrast with TH, based on university, government, and industry as protagonists, this study proposes that the Ent\_Eco includes multiple actors — university, industry, nonprofit organizations, financial institutions, civil society, among others. The actors can integrate the knowledge generated by the different areas, exploring potential partnerships to create economic, social, cultural, and environmental value.

Within the Ent\_Uni concept, Ruiz et al. (2020) published an article to clarify the characteristics of the Ent\_Uni, focusing on the commercial entrepreneurship aspects (e.g., social or different demands for solutions to problems in society) and integrating entrepreneurial practices with other university roles in the context of an Ent\_Eco. The authors present a theoretical-conceptual model of Ent\_Uni reorganizing the Ent\_Uni characteristics into several dimensions — management, infrastructure, internationalization, finance capital, the academic community, and Ent\_Eco and partnership. Education and training programs help students turn ideas into actual start-ups (Iscaro, Castaldi, and Sepe, 2017). The authors developed a virtual platform — ExperimentaLab — able to simulate its everyday dynamics through role-playing. The platform proved to effectively process an idea and make it potentially ready for the market and investors.

In the entrepreneurial transformation of universities into the Ent\_Uni, Yordanova and Filipe (2019) investigate barriers, facilitators, and best practices in transforming Bulgarian and Portuguese universities. The authors identified both internal and external barriers and facilitators of the entrepreneurial change in both countries. Yordanova and Filipe (2019) argue that the most significant barrier relates to the mindset/mentality of the academic and administrative staff in the Portuguese case, and the most significant facilitator is leadership and strategic vision and motivated and dedicated staff. Within the same general approach, Reyes (2016) states that institutional members' emotions or sentiments could impede institutional changes within institutions, especially if they have diffused feelings or skepticism in handling. Philpott et al. (2011) identify key barriers to achieving the entrepreneurial ideal. According to the authors, these barriers — the lack of entrepreneurial role models within the university, the absence of a unified entrepreneurial culture across the institution, and the academic progression processes adversely affecting academics' entrepreneurial efforts — are responsible for the disharmony amongst the academic community and compromise the progress towards the achievement of the third mission.

The universities are in a transformation process via entrepreneurial actions (Romanovskyi, 2011a). The architecture of an innovative Ent\_Uni should be built upon ideas of freedom and integration of education and science, independence and autonomy of the university, meeting the current requirements and challenges of the society, flexibility of university and its capability to change, and academic ethics and freedom (Romanovskyi, 2011b). These authors also defend that establishing an Ent\_Uni should follow some vital prerequisites, namely the presence of academic entrepreneurs and the support of entrepreneurial ideas by the consensus of university staff and the government and community support of a university's Ent\_Act.

That support could emerge from different entrepreneurial cultures, particularly how the university relates to the industrial sector, namely external funding, Ent\_Act, and organizational reform (Yokoyama, 2006). As Sukowski and Patora-Wysocka (2020) affirm, the Ent\_Uni involves incremental



organizational identity changes and culture and needs leadership intensely concentrated on sense-making and building the consensus around stakeholders' actions. Adopting the same general approach, Riviezzo and Napolitano (2010) present a study focused on the valorization and exploitation of university scientific knowledge analyzing the influence of the diffusion of Ent\_Act, the evolution of the organizational models to facilitate Ent\_Act, and the third mission commitment. The authors argue that despite the engagement of Italian universities with the stakeholder community — through consultancy, education and training, research and technology transfer and setting up of Technology Transfer Offices and other specialized organizational units — and the increasing acceptance of third mission demands local development, entrepreneurship is not yet a central part of the core strategy of universities in Italy.

To analyze the conceptualization of technology transfer mechanisms for speeding up innovation, Krücken et al. (2007) approach three ideal-typical models — the information and documentation model, the cooperation model, and the blurring of boundaries model. According to these authors, the emphasis was on knowledge and technology information and documentation available to potential users. On the other hand, the cooperation model emphasized the need for a more active and dialogue-oriented role for academic and industrial researchers across the different organizations and institutional contexts. The blurring of boundaries model is characterized by a blurring of clear-cut institutional boundaries between academia and industry (Krücken *et al.*, 2007).

The article published by Levie (2014) also focuses on technology commercialization and argues an interdependence of technology commercialization education and the Ent\_Eco. According to the author, the Ent\_Eco enables technology commercialization, relying on cooperation and coordination between university departments to promote joint work and leverage goodwill and energy for students, staff, and alumni.

Even while adopting another scope, the article published by Kochetkov et al. (2017) also focuses on the evolution of university type. According to the authors, it is historically possible to “allocate four university types by analogy to four industrial revolutions” (p. 477). This paper scrutinizes a radical shift in the university model due to the fourth industrial revolution's conditions unveiling a transition from research, development, and technology transfer. The university is moving towards the creation of intellectual capital (IC).

The challenges of Uni-Ind cooperation imposed by knowledge management could be analyzed according to six dimensions — institutional context, stakeholders, motivations, facilitators/inhibitors, benefits, and drawbacks — to leverage dynamic local innovation and Ent\_Eco (Ranga *et al.*, 2016).

Fuller and Pickernell (2018) approach university Ent\_Act to identify activity groups' eventual statistical emergence by adopting another perspective. The authors identified four groups of university Ent\_Act, three of them related to the ownership of spin-offs or start-ups — “Staff Spin-off Activity”, “Non-HEI

Owned Spin-Off Activity”, and “Graduate Start-up Activity” — and the fourth group encompassed a wide range of university knowledge creation, exchange and exploitation activities and was labeled as “University Knowledge Exploitation Activity (UKEA)”.

Four of the articles included in this cluster (Carayannis et al., 2015; Pazos et al., 2012; Phan and Siegel, 2006; Secundo et al., 2019) focus on several aspects of knowledge transfer and the need of enhancing the effectiveness of Technology Transfer Offices.

Phan and Siegel (2006) approach university technology transfer’s effectiveness (e.g., licensing agreements between the university and private firms, science parks, incubators, and university-based start-ups). Drawing attention to the entrepreneurial dimension of technology transfer, the authors emphasize the need to address skill deficiencies in technology transfer offices and create a reward system adapted to Ent\_Act, allowing better knowledge to start new ventures or interact with entrepreneurs. It is also essential to define a procedure to deal with ethics, and social responsibility, which will emerge as they intensify technology commercialization.

Increasing university entrepreneurialism will depend on a successful promotion of academic entrepreneurship — encapsulated in the performance of the Technology Transfer Offices — through strategic leverage of the intellectual capital (Secundo *et al.*, 2019).

Opening a new perspective on the analysis of Technology Transfer Offices of Ent\_Uni based on IC, and considering that previous approaches were based on patents and other forms of tangible intellectual property, failing to approach a broad set of Ent\_Eco’s activities, Secundo et al. (2019) argue that universities should seek to review their IP policies to consider IC (intellectual capital). These authors argue a possible alignment of the determinants of academic entrepreneurship, characteristics of Ent\_Uni, and IC indicators to place Technology Transfer Offices within the organizational structure that enables full access to an adjusted balance of IC subcomponents — Human Capital, Structural Capital, and Relational Capital — to leverage entrepreneurialism, the ideal spirit to entrepreneurial performance.

The success of university Ent\_Act carried out by transferring technology to industry, particularly by creating spin-off firms, depends highly on the university Ent\_Act expertise and the existence of a Technology Transfer Office (Pazos *et al.*, 2012). Also emphasizing the importance of universities’ technology commercialization and licensing, Carayannis et al. (2015) present a game-theoretical method to analyze, understand, and anticipate inventors, entrepreneurs, and innovators’ behavioral profiles. The model considers the university’s or research center’s linkages with their Ent\_Eco to enable optimal licensing (Carayannis, Dubina, and Ilinova, 2015). According to the authors, Intellectual Property is emerging as the essential “currency” for global trade in strategic capabilities; thus, their results stress the enormous potential of licensing.

For universities, the quality of their technology commercialization and licensing negotiation could be enhanced by the use of solid analytical models. The models could support the licensor and potential licensees to make substantiated decisions about optimal licensing and bargaining strategies (Carayannis *et al.*, 2015).

#### *Cluster 4: Entrepreneurial Education and Ent\_Uni Support*

Fourteen studies, responsible for 369 citations, contribute to the understanding of Cluster 4. The top five most cited authors of this cluster are briefly presented in Table 7. Cluster 4 focuses on Ent\_Uni as entrepreneurship leading agents, creating an educational, support, and collaboration environment that promotes Ent\_Act and innovation-driven entrepreneurship.

**Table 7.** Top 5 Most cited authors of Cluster 4

Author(s)  Citations	Article	Objective	Methodology	Main Findings
Rasmussen & Sorheim (2006)   238	Action-based entrepreneurship education	Explore the entrepreneurship education, which should evolve from a traditional approach, focused on teaching individuals, to a more action-oriented approach, emphasizing learning by doing.	Qualitative	Entrepreneurship education should focus on learning-by-doing activities in a group setting and a network context. The education should prepare entrepreneurs for the establishment of new ventures and university research commercialization.
Meyer, Similäinen, & Utecht (2003)   58	Towards hybrid triple helix indicators: A study of university-related patents and a survey of academic inventors	Develop a simplified model of the innovation process indicators to benchmark their relevance to the TH environment.	Mixed	The majority of patented academic inventions, normally publicly funded, originated from scientific research used in large firms more than in start-up companies founded by academic entrepreneurs.
Meyer (2006)   36	Knowledge integrators or weak links? Inventor-authors: An exploratory comparison of patenting researchers with their non-inventing peers in nano-science and technology	Examine whether researchers productivity, exploring interdependencies between publication and patenting performance of authors and. Also approach the collaborative activity of inventor-authors and the relevance of their position networks of scientific communication.	Qualitative	In the science and technology area, it is possible to conciliate publication and patenting activity. Patenting scientists appear to outperform their solely publishing, non-inventing peers in terms of publication counts and citation frequency, playing a prominent role within networks of scientific communication.
Alves et al. (2019)   5	Determinants of student entrepreneurship. An assessment on higher education institutions in Brazil	Analyze the impact of individual traits and systemic conditions on Ent_Act, potential entrepreneurs, high-impact entrepreneurship, serial entrepreneurship, and innovation-driven entrepreneurship.	Quantitative	The results suggest that student entrepreneurship seems to be a random phenomenon in Brazil.
Guerrero et al. (2017)   4	Higher Education Entrepreneurial Ecosystems: Exploring the Role of Business Incubators in an Emerging Economy	Explore the role of an Ent_Uni business incubators within the entrepreneurial process.	Quantitative	The results show a positive impact of Ent_Uni business incubators on students' start-up.

Achieving the Ent\_Uni status involves well more than a simple setup of generic conditions, forcing academic environments to rethink their dynamics and

performance (Alves *et al.*, 2019). The collaboration and Ent\_Act of university researchers point to the emergence of the Ent\_Uni with an increasing overlay of activities of TH actors (Meyer, Siniläinen, and Utecht, 2003). At the same time, the Ent\_Uni must integrate highly qualified managers and teachers with entrepreneurial vision, ready to embrace risk and change (Khassenova, 2018).

It is important to acknowledge understanding the systemic dynamics in which Ent\_Act occurs to guide future policy-making processes to harbor student entrepreneurship (Alves *et al.*, 2019). The transition to Ent\_Uni also reinforces the need to conceive entrepreneurship education programs, establish effective university-led business incubators, and build a TH collaboration (Allahar and Sookram, 2019b). The authors also emphasize a strong collaboration among key stakeholders to achieve a successful Ent\_Eco based on a quadruple helix system — university-enterprise-government-civil society collaboration — requiring Ent\_Eco sustainability where all stakeholders need to collaborate and simultaneously need to contribute.

Universities are the main pillars of the Ent\_Eco, generating an adequate environment to support the exploration and exploitation of Ent\_Act and create their Ent\_Eco, in which business incubators play a crucial role (Guerrero *et al.*, 2017). Marques *et al.* (2019) argue that universities pursue an entrepreneurial mission expected from today's educational institutions within the same general approach. There is now a recognition that there is no adverse relationship between publication and patenting activity, and it is possible to be entrepreneurial without compromising teaching and research missions (Leydesdorff and Meyer, 2006).

It is essential to develop a holistic approach to the institutional factors of organizations (e.g., missions, incentives, and role models, technology transfer offices, norms, rules, structures, processes, university organizational characteristics, and cultural traits) to overcome the obstacles to university spin-off creation (Calderón-Hernández *et al.*, 2020). In the particular case of universities in emerging countries, the challenges are related to developing structural mechanisms to facilitate the implementation of academic entrepreneurship. In this case, change the academic community's idea of spin-offs based on their perceived high-value for emerging contexts, the lack of specific incentives for spin-off creation, and cultural characteristic (e.g. social perceptions of corruption) (Calderón-Hernández, Jiménez-Zapata, and Serna-Gomez, 2020).

Shankar and Clausen (2020) also stress the relevance of accelerators as a fast-growing form of entrepreneurship support. Despite being considered the next-generation incubator model, the accelerator concept literature remains descriptive and disjointed (Shankar and Clausen, 2020). The authors' findings — distinguish their offerings based on ventures with the product-market fit, offering time-compressed scaling services and testing the ventures' ability to scale rapidly — stress the enormous potential of accelerators as a support component of the Ent\_Eco.

Emphasizing that students are more active than academic researchers in creating start-ups, Matt and Schaeffer (2018) affirm that universities should explore incrementing the Ent\_Eco integrating students’ entrepreneurship activities technology transfer policies.

Considering it has active contributors to regional economic and social development, universities are asked to promote entrepreneurship with a clear emphasis on entrepreneurship education (Rasmussen and Sørheim, 2006). Also focusing on the Ent\_Eco perspective, and based on a case study of Massachusetts Institute of Technology, Ribeiro et al. (2018) highlight the importance of educational practices that go beyond the classical model of classrooms — student-led activities, mentorship programs, competitions, project-based courses, experience-based activities, and active-based activities — and the need to see entrepreneurship education through the lens of ecosystems.

The Ent\_Eco concept is now focused on creating an environment for entrepreneurship within its system, setting the emphasis on Ent\_Uni (Sambo, 2018). As detailed by Markuerkiaga et al. (2018), there are universities in different stages within the Ent\_Uni path — (1) emerging Ent\_Uni; (2) en route Ent\_Uni; and (3) advanced Ent\_Uni —, and they could improve and move from one stage to the next one.

*Cluster 5: University Entrepreneurial Mindset*

Twenty-two studies contribute to understanding Cluster 5 and are responsible for 141 citations. Cluster 5 represents a literature path that emphasizes the multiple actors, factors, and mechanisms that the Ent\_Uni has to reconcile to achieve an entrepreneurial mindset engagement involving all entrepreneurial stakeholders. The five most-cited articles of Cluster 5 are presented in Table 8.

**Table 8.** Top 5 Most cited authors of Cluster 5

Author(s)  Citations	Article	Objective	Methodology	Main Findings
Loi & Di Guardo (2015)   25	The third mission of universities: An investigation of the espoused values.	Explore which are the organizational orientations that emerge by classifying the espoused values in the statutes of universities.	Qualitative	Universities need coherence focusing on balancing public functions and third-mission activities; exploitation — based on patent disclosure; openness — being able to participate in external change and satisfy external needs; and finally, old school — focused on Ent_Act as a source of funding.
Gianiodis et al. (2016)   23	Entrepreneurial universities and overt opportunism.	Address the relevance of information symmetry on researchers’ opportunistic behavior.	Quantitative	Despite the significant contributions of the Ent_Uni to local economies, it is possible to identify hidden costs. There are substantial revenue losses when scientists privately sell or license their inventions to the market.
Miller et al. (2018)   22	Entrepreneurial academics and academic entrepreneurs: A systematic literature review.	Explore the changing roles of academics to identify key distinct traits between entrepreneurial academics and academic entrepreneurs.	Qualitative	The authors identify two types of academics — entrepreneurial academic and academic entrepreneur — arguing that the university needs both kinds of academics to contribute to the Ent_Uni’s success.

Huang-Saad et al. (2017)   20	Closing the divide: accelerating technology commercialization by catalyzing the university entrepreneurial ecosystem with I-Corps™.	Describe the growth of NSF I-Corps™ Nodes, funded in 2012 and used for leveraged the program to catalyze the Ent_Eco at the University of Michigan.	Qualitative	The authors concluded a set of eight valuable lessons to administrators and policymakers emphasizing the need for more active promotion of academic entrepreneurship and commercialization in universities.
Fogelberg & Lundqvist (2013)   14	Integration of academic and entrepreneurial roles: The case of nanotechnology research at Chalmers University of Technology.	Analyzes how researchers in leading roles at a Swedish research university relate to integrating academic and entrepreneurial roles.	Qualitative	The authors argue that researchers can develop a positive approach towards entrepreneurship, leading to an innovation network and promoting commercialization.

There is a complexity in academic initiatives to promote higher Ent\_Act levels, with a clear need to assess faculty engagement with Ent\_Act (De Moraes *et al.*, 2020). Focusing on entrepreneurship education, particularly science and technology entrepreneurship education, Duval-Couetil *et al.* (2021) propose a model that stresses the need for a more active and informed role of academic researchers in the commercialization process of their discovery. The model has four significant priorities — (1) technology readiness and timing, (2) intellectual property pathway decisions, (3) engagement with the Ent\_Eco, and (4) personal career choices — and enables academics to pursue technology entrepreneurship and demonstrate the contributions of academic institutions to the community and the economy.

Adopting another perspective, Wibowo *et al.* (2020) approached the university environmental factors and universities' personal factors on academic entrepreneurial intention. They identified the role of orientation, culture, attitude, and self-efficacy as the determinants of academic entrepreneurial intention. Soetanto and Van Geenhuizen (2019) refer to the relevance of spatial and social proximity to universities, where the access to research orientation, entrepreneurial orientation, and market hostility encourage spin-offs to maintain closeness, maintaining the accessibility to resources and as a technology transfer facilitator.

As important drivers of technology, innovation, and economic development, Ent\_Uni leaders have to balance competing for logic to perform towards Ent\_Uni goals and achieve the desired outcomes of their Ent\_Act (Tavella and Bogers, 2020). The entrepreneurial culture concept is expected to integrate academic and entrepreneurial roles that enable a positive approach in research for entrepreneurship towards creating an innovation network to promote technology commercialization (Fogelberg and Lundqvist, 2013).

Beyond the scope of factors that impact entrepreneurial performance, the article published by Gianiodis *et al.* (2019) considers United States universities and government data to analyze the influence of consensus and stability on

entrepreneurial and commercial performance. The authors argue an association of political harmony and serenity with higher licensing revenues. On the other hand, political stability is negatively associated with new venture creation. According to this study's results, it is possible to link entrepreneurship policies and regional political processes with repercussions on university commercial outcomes.

It is possible to identify the impact of aspects related to academics' human, physical and organizational capital resources and the ownership and management structure — public or non-public university — on the engagement in Ent\_Act (e.g., commercialization of research results through patents, consulting, sponsored research, licensing/assignment of intellectual property and spin-off creation with industry, government, and civil society) (Meusburger and Antonites, 2016).

According to Davey and Galan-Muros (2020), academic entrepreneurship is seen as a pathway for universities to create value from their knowledge. However, their results stress the existence of a narrow view of academic entrepreneurship, which usually focuses only on spin-off creation and research and development (R&D) commercialization — despite the findings, less than 1% of academics undertake spin-off creation or R&D commercialization exclusively. Considering that the majority also engage in other Ent\_Act, a broader view of academic entrepreneurship is recommended, creating the mechanisms to enable academics to capitalize on their Ent\_Act results (Davey and Galan-Muros, 2020). Sharing the perspective of using Ent\_Act as a funding source, Loi and Di Guardo (2015) questioned if all universities conceive the third mission within the same basis. The authors undertake a content analysis of the espoused values embedded within the statutes of 75 Italian universities to unveil four orientation patterns in third mission conceiving. The authors highlight the (1) need for coherence, focused on balancing public functions and third-mission activities; (2) exploitation, focused on patent disclosure; (3) openness, readiness to participate in external change and to satisfy external needs and (4) old school, focused on Ent\_Act as a source of funding. As the work of Gianiodis et al. (2016) refers, the gains of Ent\_Uni activities may leverage an opportunistic behavior in faculty scientists, which generally persist due to substantial information asymmetry and where principals appear to be conniving despite the authority to apply sanctions.

Adopting another perspective, Ishizaka et al. (2020) characterize universities based on the diversity and intensity of their knowledge transfer activities, identifying four distinct groups — ambidextrous, broad, focused, and indifferent. The authors also apply the Preference Ranking Organization Method for the Enrichment of Evaluations — PROMETHEE — to rank 162 United Kingdom universities based on their knowledge transfer activities portfolio. Intending to identify a broad set of Ent\_Act and new university entrepreneurial models, Ricci et al. (2019) were able to characterize five Ent\_Act: (1) research commercialization, (2) entrepreneurship education for students, (3) support for technology development, new venture creation, and growth, (4) academic

engagement, and (5) creation of an entrepreneurial climate. The authors identify three main Ent\_Uni models: (1) engaged model focused on local economic development, (2) formal model focused on the systemic exploitation of research results, and (3) comprehensive model focused on local economic development and a university's financial advantage.

Crow et al. (2020) emphasize the necessary contextualization of individual behavior where university context has implications on actors' values and activities within that university and has repercussions on the performed Ent\_Act. The authors present an emergent concept — academic enterprise — inherently entrepreneurial, relying on faculty and student entrepreneurship to conduct social and economic transformations. Sá et al. (2018) affirm that Portuguese academics have embraced Ent\_Act and present a positive attitude towards applying research to real problems within the same general approach. However, the authors argue several significant differences in their attitudes, perceptions, and behaviors towards research activities, influenced by being involved or not involved in technology transfer processes in the previous academic year.

Emphasizing academic entrepreneurship as a complex, multifaceted and fragmented concept, Skute (2019) presents a bibliometric analysis indicating four interconnected literature clusters that can enhance entrepreneurial processes and contribute to policies stimulating academic entrepreneurship. The Uni-Ind cooperation faces several challenges imposed by knowledge management (Ahmad *et al.*, 2018). The academic environment shapes Ent\_Uni performance (Fischer et al., 2019) by the existence of innovation centers (Wolf, 2017) and the use of informal versus formal networks to develop their ventures (Padilla-Meléndez *et al.*, 2020). The ability of an academic to transfer knowledge to the industry effectively is key to universities achieving their entrepreneurial mission and ambition. Miller et al. (2018) categorize two types of academics — entrepreneurial academic and academic entrepreneur — arguing that we need both to achieve Ent\_Uni success. It is essential to involve faculty researchers to be their business development experts, empowering academic innovators with a better understanding of opportunity identification and the commercialization process; however, not all faculty want to be entrepreneurs due to the difficulty to balance their roles within the university (Huang-Saad et al., 2017).

#### *Cluster 6: Entrepreneurial Orientation and Knowledge Capitalization*

Ten studies contribute to understanding Cluster 6, a literature path that emphasizes the multiple aspects that an Ent\_Uni has to embrace to promote a dynamic between knowledge and finance, shaped by TH, creating the capacity to recognize opportunities and enable a successful knowledge capitalization. Table 9 presents the five most cited articles encompassed in Cluster 6, which are responsible for 787 citations.



**Table 9.** Top 5 Most cited authors of Cluster 6

Author(s) Citations	Article	Objective	Methodology	Main Findings
Etzkowitz (2003b)   740	Research groups as 'quasi-firms': The invention of the entrepreneurial university.	Analyze the transition from the research university to the Ent_Uni considering the TH implications for the relationship between finance and knowledge.	Qualitative	Academic entrepreneurship is both endogenous and exogenous, and we need to access what is developed within an institution versus what is imported into it. In a first approach, the scientific research organizations are seen as "quasi-firms", considering their resources and legitimations. In a second approach, it is evaluated the way they capitalize knowledge. The academic development relies upon the development of cluster firms supported in public and private venture capital.
Lamine et al. (2018)   24	Technology business incubation mechanisms and sustainable regional development.	Explores several aspects of technology business incubators (TBI), the role they play in the spatial context, and their use as platforms and drivers of regional Ent_Eco.	Qualitative	Presents the key themes of the emerging role of TBI in sustainable regional development, namely TBI biodiversity of ecosystems; accelerating startups in the Ent_Uni; TBI mechanisms challenged by green technology to sustain regional growth; and TBIs' connecting role between entrepreneurship education, experiential knowledge, and regional development.
Abereijo (2015)   9	Transversing the "valley of death": Understanding the determinants to commercialization of research outputs in Nigeria.	Approach the economic impact of scientific research and its potential contribution to economic growth to develop a model that integrates individual, organizational and institutional determinants of academic entrepreneurship, facilitating the ability to cross the "valley of death".	Qualitative	The exploitation of entrepreneurial opportunities is driven by previous collaboration with industry, cognitive integration, and prior entrepreneurial experience. Moreover, the university institutional environment must encourage and facilitate the creation of university spin-offs.
Ferrandiz et al. (2018)   7	Promoting entrepreneurial intention through higher education in entrepreneurship and the participation of students in an entrepreneurship ecosystem	Explore the effects on the students' entrepreneurial intention caused by a higher education program for entrepreneurs integrated into anEnt_Eco.	Qualitative	The higher education program positively influences students' entrepreneurial intention, especially in the medium term, considering that personal skills contribute to their entrepreneurial project's development.
Rialti et al. (2017)   7	Factors fostering students' spin-off firm formation: An empirical comparative study of universities from North and South Europe	Explore the role of entrepreneurial education on the internationalization process in transition economies.	Qualitative	In a transition economy context, such as those countries belonging to the former Yugoslavian republic, it is possible to consider internationalization as an advantage. In this scenario, entrepreneurs and their firms are able to overcome a limited internal market and local hostile conditions. Formal entrepreneurial education works as a facilitator of the internationalization process and affects the networking strategy, which seems to be fundamental in internationalisation processes in transition economies.

In this cluster, we have to emphasize the article published by Etzkowitz (2003b), representing the most cited article in our research results with 740 citations. This article considers the transition from a research university to the Ent\_Uni, where it is possible to identify a strategic orientation based on

formulating academic goals and consolidating their knowledge production into economic and social utility. Etzkowitz (2003b) approaches academic entrepreneurship based on the endogeneity and exogeneity — developed within an institutional sphere versus what is imported into it — of university-industry-government interactions. As stated by the author, these TH dynamics influence the relation between finance and knowledge, promoting an internal organization of research as “quasi-firms” — implying a resource collection system and legitimations — and enabling the knowledge capitalization. In keeping with Etzkowitz (2003b), Abereijo (2015) argue that entrepreneurial opportunities' exploitation originated in a previous collaboration with industry, cognitive integration, and prior entrepreneurial experience. Furthermore, the Ent\_Uni should embrace conscious efforts to facilitate the commercialization of their knowledge, encourage the development of marketable products, and, at the same time, assume a leadership role to ensure successful commercialization (Abereijo, 2015).

According to Abdelkafi et al. (2018), universities have become increasingly entrepreneurial during the last several years and embrace Ent\_Act, focusing on vocational education to generate funds independently. As detailed by Abdelkafi et al. (2018), it is possible to identify three evolutionary stages on Ent\_Uni models — consulting services, combining consultancy-teaching and modularization, and self-reinforcement — where the modularity of the business model seems to play a vital role in Ent\_Uni capability to change and scale up the business model over time. The authors also state that Ent\_Act shapes the business models. Therefore Ent\_Act should be developed according to an evolutionary Ent\_Uni business model, and the university has to develop capabilities that enable the business model adaptability to generate additional revenue sources (Abdelkafi, Hilbig, and Laudien, 2018).

Ent\_Act promotion assumes a particular relevance, and universities have to assess the efficacy of innovation and entrepreneurship initiatives to be better prepared to build the perceptions of venture feasibility and desirability and consequently increase students' perceptions of opportunity (Bazan *et al.*, 2019). Also focusing on the analysis of students' entrepreneurial intention, Ferrandiz et al. (2018) argue that educational programs for entrepreneurs positively influence medium-term students' entrepreneurial intention, and the working of personal skills in the program affects the development of the entrepreneurial project. The authors also emphasize the need for a methodical accompaniment performed by mentors with greater specialization. Educational programs expose students to entrepreneurial education, developing a workforce with an entrepreneurial mindset, and allow the opportunity to observe how students' different entrepreneurship-related skills and characteristics differ in a particular institution or Ent\_Eco in which students are situated (Shekhar and Bodnar, 2020).

Beyond the scope of entrepreneurial education, Huezco-Ponce *et al.* (2021) analyze the implications of university students' emotional competencies to

improve entrepreneurship programs that promote entrepreneurship and self-employment. The authors defend that university students' emotional competency is not associated with creating their own business; however, the emotional competencies will influence entrepreneurship as a career option. Also focusing on creating entrepreneurial capacity grounded on innovation and entrepreneurship education, Sánchez-López and Pedraza (2020) refer that universities deal with financial distress. The authors state that it is possible to stimulate innovation and entrepreneurship when the resources are scarce by developing an innovation and entrepreneurship mindset — increasing innovation and entrepreneurship awareness, creating spaces for interdisciplinary interaction, fostering collaboration between faculty and students across disciplines.

Rialti et al. (2017) present a particular use of networks and entrepreneurial education as facilitators, being instrumental in internationalization processes — allowing a better approach of the process and enhancing the ability for networking — offering to entrepreneurs and their firms a valuable advantage to overcome the limitations of their local environment.

From a holistic support perspective, we cannot fail to mention the importance of incubators, and we need to understand these initiatives' economic repercussions. TBIs are increasingly being used as platforms and drivers of regional Ent\_Eco (Lamine *et al.*, 2018). Their results stress the enormous potential of TBIs as bridging mechanisms and drivers of entrepreneurship, connecting entrepreneurship education, experiential knowledge, and regional development.

## 5. Discussion

The analyzed articles enabled the characterization of the existing literature that approaches Ent\_Uni and Ent\_Eco simultaneously. The Bibliographic Coupling of document references allowed us to identify six clusters: (1) University Entrepreneurial Anatomy and Ent\_Eco, (2) Universities' Third Mission Performance and Impacts, (3) Balance the Ent\_Uni's Different Roles, (4) Entrepreneurial Education and Ent\_Uni Support, (5) University Entrepreneurial Mindset, and (6) Entrepreneurial Orientation and Knowledge Capitalization.

The cluster identification and the analysis of the themes they approach unveils six distinct but complementary literature paths on Ent\_Uni and Ent\_Eco topics. The path identified as Cluster 1 — University Entrepreneurial Anatomy and Ent\_Eco — explores the building of entrepreneurial anatomy and the articulation of the Ent\_Uni and Ent\_Eco concepts that create the ability to respond to the multiple challenges inherent to Ent\_Act. The concept of 'Mode 3' universities could represent a new and advanced type of Ent\_Uni, better prepared to address the current and future challenges; however, their development relies on a solid linkage and contextualization with the Ent\_Eco. The story of a successful

Ent\_Eco should be based on the collaboration between universities and their local stakeholders and an efficient TH collaboration and cooperation (Brem and Radziwon, 2017). The TH model should be extended to consider a 'fourth helix' — civil society — and a "quintuple helix" that considers the environmental dimension — sustainability (Carayannis et al., 2018).

In Cluster 2 — Universities' Third Mission Performance and Impacts — it is undeniable the pressure on universities to deliver on their third mission (Abreu *et al.*, 2016), an engagement dependent on the competitive level of the region where they occur and on the knowledge and partnership levels (Zhang *et al.*, 2016). To perform their third mission, universities have to master the ability to respond to the Ent\_Act challenges approached in Cluster 1. It is essential to detain a broader sense of knowledge exchange involving research commercialization, Uni\_Ind partnerships, and all related enterprise engagements (Abreu *et al.*, 2016). Universities, particularly the Ent\_Uni innovation and Ent\_Act, influence NIS development and performance (Guerrero et al., 2016b). It requires a broader range of Ent\_Act oriented to problem-solving (Abreu *et al.*, 2016) with impact on graduates' employability options, on graduates' risk aversion (Guerrero et al., 2016b), and graduates' entrepreneurship (Guerrero et al., 2018). Ent\_Act should be performed at all university levels, creating an entrepreneurial potential and a mindset that drives innovation, leading to regional socioeconomic development, bridging regional needs and their solutions (Urbano and Guerrero, 2013). The third mission should be performed in the integration and collaboration of the multiple actors of the Ent\_Eco (Urbano and Guerrero, 2013) where Ent\_Unis are economic engines, leading the dynamics of formal and informal factors to potentiate knowledge generation and transferring (Guerrero, Urbano, and Fayolle, 2016a). The diffusion of economically helpful knowledge involves challenges that academics face when embracing an entrepreneurial path due to their lack of experience (Guerrero and Urbano, 2014).

Cluster 3 — Balance the Ent\_Uni's Different Roles — approaches the Ent\_Uni as an economic actor able to correctly balance the roles of knowledge creation, knowledge dissemination, and knowledge exploitation (Kutinlahti, 2005). Throughout the performance of Ent\_Act, universities are leveraging socioeconomic development (Markuerkiaga *et al.*, 2016). Ent\_Act should be integrated with entrepreneurship education and universities should pursue an entrepreneurship strategy based on local needs and context (Markuerkiaga et al., 2017). The Ent\_Uni could contribute substantially to economic development by transforming into fully entrepreneurial organizations (Mathieu et al., 2008). The complexity of managing multiple roles denotes several role conflicts (Ahmad, Halim, and Ramayah, 2016; Salamzadeh, Kesim, and Salamzadeh, 2016), unveiling the need for a proper balancing built upon effective TH links (Genç et al., 2020). The Ent\_Uni should integrate Ent\_Act and the other university roles in an Ent\_Eco context (Ruiz et al., 2020). The entrepreneurial transformation is related to constructing an entrepreneurial mindset, leadership, and strategic vision

(Yordanova and Filipe, 2019). The balancing of the Ent\_Uni's different roles affects University-Business Cooperation (Ranga, Perälampi, and Kansikas, 2016) and the effectiveness of Technology Transfer Offices (Carayannis et al., 2015; Pazos et al., 2012; Phan and Siegel, 2006; Secundo et al., 2019).

Cluster 4 — Entrepreneurial Education and Ent\_Uni Support — approaches the transition towards the Ent\_Uni, reinforcing the need for a systemic dynamic of entrepreneurship education programs, the establishment of university-led incubators, and an effective TH collaboration (Allahar and Sookram, 2019b). The Ent\_Eco collaboration should evolve to a quadruple helix system attaining sustainability based on the need for collaboration between the key stakeholders (Allahar and Sookram, 2019b). As the main pillar of the Ent\_Eco, the Ent\_Uni should develop an environment to support the exploration and exploitation of Ent\_Act in which incubators (Guerrero et al., 2017), start-ups (Matt and Schaeffer, 2018), university spin-offs (Calderón-Hernández, Jiménez-Zapata, and Serna-Gomez, 2020), and accelerators play a crucial role (Shankar and Clausen, 2020). The engagement in these entrepreneurial paths requires an entrepreneurial vision of highly qualified managers and teachers (Khassenova, 2018). In this scenario, it is possible to generate the will to embrace risk and change (Khassenova, 2018), supported by entrepreneurs' education (Rasmussen and Sørheim, 2006) with renewed educational practices oriented to an ecosystem performance (Ribeiro et al., 2018).

In Cluster 5 — University Entrepreneurial Mindset — the focus is on evaluating faculty engagement with Ent\_Act (De Moraes *et al.*, 2020). The Ent\_Uni should integrate active and informed academic researchers to participate in the research commercialization process (Duval-Couetil et al., 2021). The Ent\_Uni is expected to develop an entrepreneurial culture that creates a synergic integration of academic and entrepreneurial facets (Fogelberg and Lundqvist, 2013) without the idea of competitive logic (Tavella and Bogers, 2020). Entrepreneurial performance is impacted by political stability (Gianiodis et al., 2019), academics' human, physical and organizational capital resources and ownership and management structure (Meusburger and Antonites, 2016), and actors' values and activities within the university (Crow et al., 2020). Universities perform Ent\_Act in diverse forms and intensity levels (Ishizaka et al., 2020), but always to capitalize on their Ent\_Act results (Davey and Galan-Muros, 2020) as a source of funding (Loi and Di Guardo, 2015). The attitudes, perceptions, and behaviors towards research activities are positively influenced when they are applied to real problems (Sá, Dias, and Sá, 2018). In this sense, the entrepreneurial mindset will affect knowledge management and impose challenges to Uni-Ind cooperation (Ahmad *et al.*, 2018). The ability of academics to transfer knowledge affects university entrepreneurial performance (Miller et al., 2018). It is crucial to empower academic innovators allowing a balanced role performance within the university (Huang-Saad et al., 2017).

Cluster 6 — Entrepreneurial Orientation and Knowledge Capitalization — approaches Ent\_Uni as “quasi-firms” that perform to capitalize their knowledge production based on their economic and social utility (Etzkowitz, 2003b). The achievement of an Ent\_Uni status is an evolutionary process that involves acknowledging the need to integrate marketable products with the leadership of the commercialization process (Abereijo, 2015). In an interrelation with Cluster 4, and according to Abdelkafi et al. (2018), universities focus on vocational education, embracing Ent\_Act to create financial independence. The entrepreneurial orientation is built upon the efficacy of innovation and entrepreneurship initiatives, affecting university and students’ perceptions of opportunity (Bazan *et al.*, 2019).

## **6. Conclusions, Contributions, Limitations, and Future Research Agenda**

Performing a generation and exploiting knowledge as entrepreneurial opportunities, the Ent\_Uni is now seen as a catalyst of regional socio-economic development. The relevance of the Ent\_Uni and Ent\_Eco topics motivates multiple literature approaches. Despite being widely explored concepts, the Ent\_Uni and Ent\_Eco are still fragmented and disorganized. In the sense of contributing to their theorization, this study aimed to narrow these gaps pointed out in the literature towards the systematization of the most relevant literature, trends, and dynamics of the Ent\_Uni on the Ent\_Eco.

This study conducted an SLR that approaches Ent\_Uni and Ent\_Eco simultaneously, and it attempts to answer two research questions: Which are the most relevant trends in the literature on Ent\_Uni and Ent\_Eco? And how Ent\_Uni’s dynamics are performed within an Ent\_Eco perspective? The bibliographic analysis unveils six clusters denoting the existence of different thematic areas, and it is possible to identify relationships between the thematic areas.

With impacts on the performance and results of the other identified clusters, Cluster 1 is an emerging theme, with an eventual transition to a basic or transversal theme. Entrepreneurial anatomy is necessary to allow the Ent\_Uni to perform Ent\_Act — an interconnection with the thematic approach in Cluster 2. Cluster 2 is a motor theme of the literature on Ent\_Uni and Ent\_Eco topics which approaches universities’ third mission performance and the socio-economic impacts, motivated by the increasing pressure on universities to deliver on their third mission, in response to the emerging challenges inherent to Ent\_Act. Universities have to master Ent\_Act creating an entrepreneurial potential, and building an entrepreneurial mindset — explored in Cluster 5 — leading to innovation and socioeconomic development, bridging regional needs and their solutions. In Cluster 1, the need for a contextualized linkage with Ent\_Eco is also considered. This collaboration network established between universities and their

local stakeholders should also integrate a TH collaboration and cooperation with an extension to a ‘fourth helix’ that involves the civil society and a “quintuple helix” that considers a sustainability dimension. To perform Ent\_Act, universities have to balance their different roles — teaching, research, and entrepreneurship —, approached in Cluster 3. The legitimization of the performed roles will make possible the advantage of knowledge creation, knowledge dissemination, and knowledge exploitation. The Ent\_Uni should manage the complexity and conflict of multiple roles, strengthened by the presence of effective TH links and strategically structured thinking in an Ent\_Eco context. As approached in Cluster 4, this scenario is likely if the Ent\_Uni creates a dynamic fusion between entrepreneurship education, university support, and an effective TH collaboration. The entrepreneurial education, based on Ent\_Eco contextualization, will leverage the exploration and exploitation of Ent\_Act, where incubators, start-ups, spin-offs, and accelerators play an essential role. In Cluster 6, and as a guarantee of independence, universities must consider their entrepreneurial anatomy within the Ent\_Eco and perform Ent\_Act to capitalize on their knowledge and finance their activity.

To contribute to a better understanding of the Ent\_Uni and Ent\_Eco topics, our study also proposes possible paths for future research. Based on the established relations between clusters, we argue that each cluster raises its own challenges. However, to contribute to less fragmented and disorganized literature, we consider it important to explore the articulation of research paths and highlight the confluence of interests between the agendas. Considering the six research paths identified in our SLR, we believe it would be interesting to develop more studies to assess a scale that allows the identification of the Ent\_Uni entrepreneurial anatomy that confers the ability to perform Ent\_Act, maximizing its impacts better. This will make it possible to measure entrepreneurship and create a ranking of the Ent\_Uni.

The ongoing Covid-19 pandemic has had an overwhelming impact on labor markets worldwide (Fernandes *et al.*, 2022). In this scenario, and according to Guerrero, Heaton and Urbano (2021), it is essential to promote the discussion of the relevance of universities’ entrepreneurial strategies in the digital era. The pandemic has also intensified collaboration among many agents (N-Helix) powered by digital social entrepreneurship that can generate global social impacts (Ibáñez *et al.*, 2022). Moreover, considering the Covid-19 pandemic and its impacts on educational delivery, it would also be important to investigate how universities adapt to deliver teaching, research, and Ent\_Act while considering the perspective of different stakeholders. Such an attempt will shed light on the essential dimensions of Ent\_Act where universities should concentrate their efforts. The pandemic is affecting the scientific workforce, with notorious impacts on the commercialization process (Siegel and Guerrero, 2021). It is crucial to explore ways to better manage the process of research

commercialization in a period of such turbulence as we are currently experiencing.

It would also be interesting to assess how the Ent\_Uni could bridge its university and economic demands without compromising its core functions as a learning institution. In this regard, it would be relevant to explore entrepreneurial education and its impact and how they engage with knowledge transfer processes (e.g. technology transfer and commercialization). Considering that the Ent\_Uni should be structured from an Ent\_Eco perspective, it would indeed be important to analyze entrepreneurship education (e.g. development of entrepreneurship education curricula according to the area of knowledge). Future research should also focus on assessing the relevance of entrepreneurial education to an entrepreneurial mindset — exploring its relevance on skills, expertise, capacity, and competencies development — and the impact on third mission development and Ent\_Eco growth. Finally, future research may assess the impact of support activities on the Ent\_Uni's entrepreneurial activity.

This study presents contributions to the literature, providing a better understanding of the dynamics between the Ent\_Uni and Ent\_Eco concepts through the systematization of existing literature, narrowing the fragmentation. The systematization and interrelation of the research areas represent a relevant practical contribution, allowing Ent\_Uni and Ent\_Eco stakeholders to improve the future decision process, very important when immersed in a knowledge economy with extremely complex and competitive environments. Our findings presented the relations between Ent\_Uni and Ent\_Eco as a mutualistic dynamic process with bidirectional flows of resources and capabilities (Schaeffer *et al.*, 2021). This process is shaped by the academic environment, reinforcing the importance and influence of the development of the entrepreneurial process and context on entrepreneurial performance (Guerrero, Liñán and Cáceres-Carrasco, 2021).

Despite the contributions to the academic discussion on the Ent\_Uni and Ent\_Eco topics, this study also presents some limitations. We acknowledge that an SLR could be reductionist. As defined in our research protocol, we only consider peer-reviewed articles to ensure quality, excluding from our research book chapters, conference papers, book reviews, proceeding papers, editorial material, reviews, and books. We tried to expand the search scope by selecting keywords that we consider adequate for the simultaneous analysis of the Ent\_Uni and Ent\_Eco topics. Nevertheless, research that seeks a combined analysis of both themes may exclude relevant publications that address Ent\_Uni and Ent\_Eco issues in isolation.



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