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Universities as orchestrators in digital innovation ecosystems

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Abstract

The aim of the literature review is to evaluate how universities can be the point of reference in steering the wheel of (digital) innovation in an ecosystem. This study was performed partially systematically and partially using a snowballing sampling. The results suggest that in various ways universities can be orchestrators of innovation ecosystems, taking the role of a trusted intermediary and have the potential of being the leaders in innovation ecosystems by steering the wheel of innovation. Indeed, the research indicates that universities, going beyond their traditional role of education and research, show their added value by embracing their third mission of contributing to economic development and direct contribution to industry and society. Future research should focus on exploring new tools to orchestrate digital innovation ecosystem and additional ways to better orchestrate innovation ecosystems.

Keywords: innovation ecosystems; digital innovation; universities; innovation networks; triple helix; third mission

Index

1. Introduction

In the modern world, new products, markets and industries are emerging rapidly, and so is the demand for new skills and professions that need to keep up with the pace of innovation. The transformation of the economy is the primary catalyst of these processes, and the results of such digital transformation can be found at the crossway between different industries leveraging on multidisciplinary knowledge, establishing new cross-industry processes, developing digital platforms, new infrastructure and new market models for the interaction of all players involved in the transformation process (Tolstykh et al., 2021).

In such a dynamic environment it is essential to identify the main macro-categories of actors that drive the innovation process. According to Etzkowitz and Leydesdorff (2000), such macro-categories are universities, industry and the government. The interaction and the macro-dynamics between those three players have been theorised in the triple helix model and from their continuous convolution, "new" innovation emerges. Hence, the triple helix model can be considered an ecosystem of evolving actors whose relevance in innovation generation cannot be ignored. For this reason, research has to be made on such an essential source of digital innovation, and especially the growing importance of researching the role of the university, embedded in such an ecosystem, as a knowledge integrator, consolidator and mediator (Cai and Etzkowitz, 2020; Tolstykh et al., 2021).

The concept of the digital innovation ecosystem has been generally recognised and debated in recent years. It is considered an indispensable component for enhancing the innovation capabilities of individual corporations, industries, regions and nations. The aim is to create innovation ecosystems where multiple innovation actors, such as universities, create a favourable environment for innovators to pursue value, additionally, in a sustainable way (Jackson, 2011; Xu et al., 2018). Nevertheless, considering that all the parties involved in an ecosystem tend to pursue their individual agendas, and since actors are unlikely to act on opportunities that do not catch their attention (Jacobides et al., 2018; Ocasio, 1997; Weick, 1979), there is a need for an actor with a broader overview of the potential innovation directions that acts as an orchestrator for the ecosystem for the pursuit and materialisation of value proposition. Many universities have recently focused on creating an environment that supports and

encourages academic entrepreneurship (Grimaldi et al., 2011), hence universities and, more specifically, academics, could potentially cover this orchestrator role.

This literature review will focus on past and present research on the potential of universities as the point of reference in steering the wheel of digital innovation in an ecosystem. In seeking to analyse the literature, I will focus on sources that measure the digital innovation ecosystem, taking influence from the triple helix model (Leydesdorff and Etzkowitz, 1997; 2000). In this study, the following sources address how universities can facilitate a digital innovation ecosystem and enhance knowledge exchange between the actors within the ecosystem and among academics and practitioners.

1.1 Research questions

This study evaluates universities and academics as orchestrators of innovation ecosystems, with a focus on digital innovation ecosystems.

The research questions are the following:

RQ1. How universities and academics orchestrate digital innovation ecosystems? In other words, which instruments do universities use to orchestrate?

RQ2. Do universities actually fit the orchestrators' role?

RQ3. Why is it beneficial and/or valuable that universities cover this role, with particular reference to digital innovation?

To investigate these research questions, I will first describe the methodology used for the selection of the articles for the aim of this study. In chapter two, the main definitions and concepts of this study will be explained. Then, in chapter three, relevant background related to the context of this study will be presented on the definition of innovation system. Chapter four presents previous studies and relevant literary background. I will end with acknowledging research limitations and conclusions on the key findings in this study, followed up by suggestions for further research.

1.2. Methodology: article selection

This paragraph describes the chosen research method.

The selection of the articles was performed partially systematically and partially using a snowballing sampling. For the part systematically part, the selection was made as follows: (1) I first conducted an extensive search on the titles, abstracts and keywords of published articles on the topic of interest (i.e. innovation ecosystems) from 1997, as it was a turning point year for the streamwork about innovation ecosystems following the publishing of the paper by Leydesdorff and Etzkowitz, (1997), to 2021 on the bibliographic database SCOPUS with the following query

> (TITLE-ABS-KEY ("universit*" OR academ* OR "Third Mission") AND TITLE-ABS-KEY ("innovation ecosystem" OR "digital innovation" OR "continuous innovation" OR "orchestration" OR "knowledge exchange" OR "Triple Helix" OR "Quadruple Helix" OR "Quintuple Helix") AND NOT TITLE-ABS-KEY ("social media" OR "social network*" OR "social movement*" OR "stock market" OR justic* OR stock*)) AND (LIMIT-TO (PUBSTAGE,"final")) AND (LIMIT-TO (SUBJAREA,"SOCI") OR LIMIT-TO (SUBJAREA,"BUSI") OR LIMIT-TO (SUBJAREA,"ECON") OR LIMIT-TO (SUBJAREA,"DECI")) AND (LIMIT-TO (LANGUAGE,"English"))

finding a total of 1598 articles, subsequently, (2) I filtered out the articles with less than eight citations from 1997 to 2016 (included), remaining with a selection of 1280 articles. Thirdly, (3) I made a selection based on Title which resulted in 753 articles and then (4) the selection was made on the abstract which resulted in 192 articles left.
I then (5) eliminated the remaining articles because out of scope or because thy were tacking the addressed issue from different perspectives and the final selection resulted in 21 articles left.
All other articles/book chapters cited in this paper were based on snowballing sampling on SCOPUS, Google Scholar and Web of Science.
This study is conducted through a literature review to evaluate the state of knowledge on the research questions mentioned in the previous paragraph.

2. Background: definitions and concepts around innovation ecosystem

This chapter starts with an introduction to the innovation ecosystem. It will describe the different definitions and dimensions around the innovation ecosystem, followed up by a brief history of the evolution of universities.

2.1 Key definitions of innovation ecosystem

The following paragraph introduces the innovation ecosystem. It will describe different definitions around the innovation ecosystem to understand the concept.

A critical concept to define is **ecosystem**, which was delineated and widely used in ecology science. According to Shaw and Allen (2018), it can be defined as "recycling flows of nutrients along pathways made up of living subsystems which are organised into process-orientated roles; connects living and non-living subsystems; energy gradients power recycling of scarce nutrients, e.g. a rainforest".

In addition, it is necessary to also define the concept of **innovation**, which has evolved and declined in various fields of knowledge over the years. Starting from Schumpeter's (1934) definition of innovation as "the implementation of new combinations. Innovation is a source of competitive advantage and the main source of progress through a process of "creative destruction". Many years later, Freeman (1974) elaborated the definition as "innovation is different from invention! Invention is "an idea, a sketch or a model for a new or improved device, product, process or system". Innovation [from an economic perspective] "is accomplished only with the first commercial transaction involving the new product, process". Recently, the Oslo Manual by OECD (2005) enhanced the concept to a more modern one, as "an Innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations". This study will adopt a more broad perspective; hence the following definition for **innovation** will be adopted:

> *"The design, invention, development and/or implementation of new or altered products, services, processes, systems, organizational structures, or business models for the purpose of creating new value for customers and financial returns for the firm"* (Innovation Measurement, 2007).

By combining the two of the abovementioned concepts, we can derive the idea of innovation system which can be declined at different levels such as national (Lundvall, 1992), regional (Asheim and Gertler, 2005), sectorial (Breschi and Malerba, 1997) and corporate (Granstrand, 2000). The definition adopted by this study is more general, and it is the one delineated by Edquist (1997) as "all important economic, social, political, organisational, institutional, and other factors that influence the development, diffusion and use of innovations". However, this is still not enough to appreciate the nuances of this research; hence, to sum up all the definitions mentioned above, this study will adopt the following definition for **innovation ecosystem** defined by Granstrand and Holgersson (2020):

> *An innovation ecosystem is the evolving set of actors, activities, and artefacts, and the institutions and relations, including complementary and substitute relations, that are important for the innovative performance of an actor or a population of actors.*

As this is a broad and very general definition, it is necessary to elaborate on it to explain better how it fits the following literature review. For the purpose of this research, an *evolving set of actors, activities, and artefacts* implies the ongoing research on the actors, the activities they perform and the assets they use (tangible and intangible resources and other types of system inputs and outputs) including innovations. Actors are academia/universities, industry, and government, according to the triple helix model of Etzkowitz and Leydesdorff (1997; 2000), see §4.1. The *complementary and substitute relations* within the innovation ecosystem refer to universities' relationships as driving actors for innovation (Granstrand and Holgersson, 2020). For example, are the relations created by the universities with the other actors of the ecosystem collaborative or competitive in the context of creating innovation? In other words, do universities substitute themselves to private research institutes and firms or are they the ones that enhance and promote collaboration between different entities to create value

for the ecosystem?

Nevertheless, to better appreciate the nuances of the interactions between individuals inside an ecosystem, another abstraction useful to illustrate is the concept of **network**, which can be defined as a graph in which nodes and/or edges have attributes. In this specific case, the nodes can be identified with single individuals (e.g. scholars) within an actor as defined in §2.2, and the edges are the connections within the same actor or between individuals belonging to different actors while the attributes are the weights or importance of each node inside the network (Iansiti and Levien, 2004; Vidgen et al., 2007).

In this context, it is interesting to understand how knowledge is created and exchanged within a network, as there is a strong connection between network structure and knowledge diversity (Tortoriello et al., 2015). Bozeman and Lee (2005) argue that the most promising way to produce high-quality output in research is through collaborative arrangements, which can be characterised as networks, as it adds more heterogeneity to the creative process in technological innovation. Moreover, by combining the concepts of network and innovation, we derive the notion of "**innovation network**", which according to Ahrweiler (2010), refers to the structural components of innovation (aforementioned individuals and relationships). In addition, Krohn (1995) argues that the point is not to unite causal innovation to networks but to see in networks the organisational conditions for the dynamics of innovation.
As the concept of network encapsulates to some degree the idea of staticity and does not consider the environmental variables with which a network is forced to interact, it was necessary to introduce the concept of ecosystem to consider the environmental variables and the dynamism it encloses.

2.2 Dimensions of the digital innovation ecosystem

After giving the definition of "innovation ecosystem" and how it fits in this study, it is necessary to specify a conceptual framework within which the definitions will be adopted; hence we introduce the concept of the triple, quadruple and quintuple helix.

Etzkowitz and Leydesdorff (1997; 2000) introduced the Triple Helix model of innovation. The essence of the model is the interaction and collaboration between three sets of actors: academia/universities, industry, and government, to steer innovation in the knowledge-based economy and knowledge society. This dynamic contributes to new ways of conducting business, policy and encourages innovation. The main objective is to create an innovative environment consisting of strategic alliances between small and large firms, trilateral initiatives for knowledge-based economic development, and university spin-off firms which operate in different areas, with different level of technology, academic research groups and government laboratories (Etzkowitz and Leydesdorff, 2000).

In recent years civic engagement and sustainable development have gained increasing importance in the innovation process. Accordingly, Carayannis and Campbell (2009) add a fourth player into the triple helix model, the organised civil society represented by users/end- users. Users take an increasingly important role in our networked society. By involving users more and connecting them to grassroots initiatives that emerge from the bottom-up from society besides top-down policies, innovation can be strengthened and accelerated, and public support can be maintained through co-creating knowledge and value. Universities, industry and governments will no longer be the experts who operate but take on the role of the architect, process supervisor or supporter (human capital of institutional organisations in the ecosystem), giving space to the input of users (Cohen, 2013).

A few years later, Carayannis, Barth and Campbell (2012) added a fifth helix, the natural environments of the society and further developed the model into Quintuple Helix (Roman et al., 2020). The transition from the triple helix to an n-uple helix model has been conducted by other authors, however, such studies will not be taken into account as they are out of the scope of this research.

2.3 Evolution of universities' role: from the ivory tower to "third mission"

The following paragraph gives a brief history of the evolution of universities and how their approach of teaching and learning evolved to a research institution, and in recent years embedded a mere entrepreneurial approach.

The most common concept of university is the one that was developed in western societies and has been widespread around the world; since the medieval age, teaching has been considered the primary mission of universities, and knowledge was transferred from teacher to student in small private groups (Kwon, 2011).

In the 19th century, scientific research became an integral part of universities missions even though it initially has been institutionalised outside of universities (Ben-David, 1984; Martin, 2003). At a later stage, research skills were transferred from professors to students through workshops and seminars, and universities and academics started to have a certain amount of autonomy in engaging research of their own preference while before the state had clear expectations in the research output. This "new'' university-research model was defined as the *Humboldt model* (Martin, 2003). Subsequently, Vannevar Bush's linear model of innovation became the dominant social contract. Universities were funded with the "*belief in a simple linear 'science-push' model of innovation, beginning with basic research, leading on to applied research, then technological development and finally innovation*", with the expectation of benefits in the long term in terms of wealth, health and homeland security (Bush, 1945). However, the outcome of such funded research was not clear when and if it would materialise at some specific point in time (Bush, 1945; Martin, 2003). According to Martin (2003), this remained the dominant model until the 80s when the following three forces started to drive a change into society:

- Growing competition in the global market;
- Tight constraint on government research funding;
- Growing importance of science and technology;

In this context, universities evolved and eventually arrived at an entrepreneurial format which in addition to teaching and research, embeds a "third mission" of economic development and direct contribution to industry (Etzkowitz and Leydesdorff, 2000).

3. Potential role of contemporary universities in digital innovation ecosystems

This chapter will present previous studies on the potential role(s) of the university beyond their traditional role as a teaching and research institute. Firstly, an elaboration on the universities as an entrepreneurial institution is presented, then I expand on their role as trustworthy intermediaries between different actors, and lastly, I explore the role of universities and academics as orchestrators of innovation ecosystems.

3.1 The entrepreneurial university

As stated before in §2.3, the role of universities has changed over the years from being a mere knowledge keeper to a research entity to having an active role in the economic development of countries, the so-called "third mission".

Starting from the concept of Triple Helix (Etzkowitz and Leydesdorff, 1997; 2000) (see §2.2), universities began to be more and more engaged in economic activities and innovation projects. Many universities transformed themselves into entrepreneurial universities, focusing on technology and knowledge transfer. As a result, they formed strong ties with industries and started to disseminate new knowledge to business and society (Guerrero et al., 2012).

The entrepreneurial university focuses on specific formal activities/relationships of knowledge transfer, such as intellectual property rights transfer as the primary outcomes of collaboration, for instance, patenting, licensing and the formation of spin-offs (D'Este and Patel, 2007). Moreover, also according to Etzkowitz (2001), "the concept of an entrepreneurial university is proposed to foster the commercialisation of academic results through patent application, out-licensing, and the establishment of new companies". Additionally, D'Este and Patel (2007) state that informal activities/relationships between businesses and academics have the same relevance as more formal activities. In many cases, they are the substrate for the formation of more formal collaboration. The interaction channels between universities and companies are of various nature, like applied R&D projects, conferences and meetings, training and consultancy and other individual academic-business contracts (Bekkers and Bodas-Freitas, 2008; Wright et al., 2008). Furthermore, many universities surrounded

themselves with spin-offs and incubators, which became one of the major means of knowledge transfer between the academic world and the industry (Guenther and Wagner, 2008). In contrary, some studies (Benner and Sandstrom, 2000; Geuna and Nesta, 2003; Rosenberg and Nelson, 1994) suggest that universities should not be "corrupted" or influenced by industries and should focus more on their original role of knowledge retainers and research as focusing on non-basic research might be detrimental to the "academic commons" (Hellstrom, 2003).

3.2 Universities as trusted intermediaries

Yun and Liu (2019) identify through literature and practice review the dynamic roles of university, industry, government and society (quadruple helix), as well as the micro- and macro-dynamics of open innovation. For the purpose of the present study, mentions of industry and government got omitted. The study highlights how "universities have become proactively engaged in multiple areas, from technology transfer to knowledge co-creation" (Yun and Liu, 2019), beyond their traditional role of education and research. Publication, conferences and meetings, contract research, co-supervising PhD students, consulting, and collaborative research are of particular importance in the process of knowledge transfer. The study however emphasises that this is rather linear communalization. The triple helix model, on the other hand, encourages non-linear simultaneous innovation between universities and industries. As a result, there are more research joint ventures for knowledge creation and exchange, and proactive engagement in open networks and interactive innovation. Moreover, universities can act as a link between producers and users of knowledge, they create trust and committed relationships as an intermediary.

The literature review of Perkmann et al. (2013) on university-industry relations argues that a wide range of factors may impact engagement with stakeholders during commercialisation processes. These include technology transfer support and formal incentives, university quality, climate, discipline, organisational culture, organisational strategic agendas, public policy and regulation, which can all impact individual motivations and attitudes to collaborate with industry and end-users.

The exploratory study on UK universities of Striukova and Rayna (2015) offers an example of the new role and capabilities of universities as trusted intermediaries. According to the study, this role goes beyond the traditional role of the university, as they can bring multiple parties together and let them join forces in a trusted environment. In doing so, they can orchestrate, control and share other parties and one's intellectual property. Consequently, this gives the university a more central position in the innovation ecosystem and should be acknowledged and adapted by public policies. Likewise, in a case study of the university MISIS in Moscow, Russia, Tolstykh et al. (2012) also conclude that innovative universities should and can play a key role in the changing processes of creating and transferring new knowledge. Notably, it is essential for all actors that the integrator maintains a favourable environment in the ecosystem. Tolstykh et al. (2012) identified three main functions of universities in a cross-industry ecosystem. Firstly, the formation of human resources with emphasis on high-tech businesses and industries, focusing on training programs and teaching methods, combining theoretical education with real case studies of individual enterprises, implementing digital competencies and developing entrepreneurial skills and thinking. Secondly, the joint production of knowledge reflecting cutting-edge research on global challenges, through the creation of interdisciplinary research and networks, specialisation, according to research expertise and region features, and an increase in revenues and applied joint research. Thirdly, the stimulation of knowledge sharing, collaborative interdisciplinary and innovation with other actors. The researchers argue, however that these approaches are a starting point to improve the universities' contribution to innovation development.

In another case study, Ferraris et al. (2018) highlight the role of universities in smart city projects (SCP), specifically their role in multi-stakeholder engagement and management processes. The study emphasises how universities play a crucial role in SCP, not only as knowledge retainer, but also as orchestrators of interactions between all the actors involved in the smart city ecosystem. For this reason, policymakers should facilitate the role of universities in fulfilling their coordination role by simplifying bureaucracy and giving them more freedom to act in such an ecosystem. In this way, universities could also develop solutions for policymakers themselves to increase their level of efficiency and reduce public spending. However, universities themselves should reposition in order to play a more active role in SCPs, and they should revolutionise their academic programs to be more aligned with future trends. Overall,

this study has limitations as it was conducted only in Italy and Russia and on a limited number of stakeholders; hence the implications cannot be generalised. Nevertheless, more and more literature is pointing towards the active role of universities in innovation ecosystems.

3.3. Academics as orchestrators

The line between the concept of entrepreneurial universities and universities as trusted entities is blurred. While the first concept (as mentioned in §3.1) refers more to the interaction between universities and industry, focusing on knowledge transfer and other types of relationships between university and industry (Bekkers and Bodas-Freitas, 2008; D'Este and Patel, 2007; Wright et al., 2008), the second one stresses more the roles of universities as convergence point for different actors within an ecosystem seeing universities as active orchestrators in knowledge sharing and innovation ecosystems (Ferraris et al., 2018; Striukova and Rayna, 2015; Tolstykh et al., 2012) (see §3.1). For this reason it is interesting to analyse the instruments with which academics can orchestrate innovation ecosystems and more specifically digital innovation ecosystems.

According to Gastaldi et al. (2015), academics can play an essential role as "orchestrators of innovation ecosystems" because of two main reasons:

- Their independence and neutrality within the innovation ecosystem.
- Their compliance and complementarity they have with the reasons for with knowledge is created and leveraged within an innovation ecosystem

The first point is self-explanatory, as universities do not have hidden agendas or interests, therefore they are trusted by the other actors of the ecosystem. Indeed academics are able to give companies the "rare gift or unbiased input" when practitioners seek to solve a problem with their help as they are not trying to monetise on a solution to a company problem (Burton et al. 2020).
The second point instead always needs more elaboration, according to Gastaldi et al. (2015) and Gastaldi and Corso (2016). There are four types of innovation ecosystems

in which the knowledge management expertise of academics can give a substantial contribution, these are:

- Professional innovation ecosystems, as academics, can help practitioners by providing them encounter opportunities and helping them to accomplish organisational initiatives of innovation.
- Learning innovation ecosystems, as academics can provide a safe psychological environment in which practitioners can exchange knowledge and reduce learning anxiety, since the learning environment can be considered a closed network. Tortoriello et al. (2015) argue that the willingness to share information in such a network is enabled because cooperative norms are easily created and enforced.
- Transformational innovation ecosystems, as academics can support innovation processes and identify the potential directions of transformational paths and,
- Strategic Innovation ecosystems, as academics can help to lead innovation processes towards common objectives. This is created by the interaction between actors around shared problems, thanks to their continuous research, maintenance of good relationships with the actors and support of the whole innovation ecosystem. Decoding the choices of each actor, assessing their efficacy and effectiveness and integrating the latter into the inter-organisational knowledge system of the ecosystem decreases the complexity in understanding decision-making.

Academics can play orchestrating roles as knowledge management experts. They can offer practical solutions and potential directions, because they have strong competencies in systematically identifying potential directions when such a request is presented to them by the actors involved in an ecosystem (Gastaldi et al., 2015). Moreover, the cross-discipline dialogue-driven approach between academics and practitioners provides an excellent opportunity (Burton et al., 2017) to stimulate creative and innovative research ideas (Gustafsson and Bowen, 2017).

Even though academics have potential for orchestrating innovation ecosystems, according to Gastaldi and Corso (2015), Muscio and Vallanti (2014) identified that four

main perceived obstacles between university collaboration with industry, namely, (1) misalignment between incentives and motives of researchers and firms causing conflict, (2) ineffective academic processes or intermediaries to help engagement and interactions with external stakeholders at micro levels, (3) disharmony between academic goals and technology commercialisation activities and (4) inherent distance between academic research and business needs.

To overcome potential obstacles, for an effective academics' orchestration, according to Gastaldi and Corso (2016), there are two main prerequisites:

- The extensive use of multiple approaches of collaborative research, as it implies the involvement of practitioners in all the phases of the research, namely: problem formulation, theory building, research design and problem-solving. Moreover, the use of collaborative research is a fast track towards research that matters, research that is being used and has an impact on society (Gustafsson et al., 2015).
- The creation and maintenance of a knowledge platform, also validated by Chen et al. (2020), allow academics to manage and progressively diffuse the ecosystem-based learning mechanisms. Underlying each interorganizational innovation increases the effectiveness of academics in orchestrating an innovation ecosystem.

Three main reasons stand at the base of the creation of the platform, namely: (1) strengthening the effectiveness of collaborative research in supporting any academic orchestration, (2) increasing the dialogue level between practitioners and academics, and between practitioners belonging to different companies facilitating networking, and (3) balancing the information gathering rhythm, allowing academics to perform timely research, "reflect on interorganizational issues, compare alternative network solutions and explore different orchestrating strategies", thus training their abilities to conduct collaborative research more quickly.

All the points mentioned above are supported by an extended case study based on collaborative research conducted by Gastaldi and Corso (2015) on an Italian healthcare ecosystem.

Thomas et al. (2020) analyse the role of universities as orchestrators for innovation, entrepreneurship and leadership, by examining three universities in Porto Alegre in Brazil. The data were collected via interviews, direct observation and ethnography. The results emphasised the potential role of the university as a serious and trustworthy organisation due to their long-term commitment and neutral position between government and industry. Universities as orchestrators can mobilise quadruple helix stakeholders in a broader region with a combined top-down and bottom-up approach. Thus, in addition to their missions of teaching, researching and collaborating with industry for innovation, they should broaden their horizons given their value on influencing actors to develop an ecosystem. This is, however, a small case study and is not conducted in other places throughout the country or Latin America. Therefore it is difficult to generalise the impact of universities as a whole.

Research by Heaton et al. (2019) also highlights the potential of the university as an ecosystem orchestrator, "applying its intellectual, reputational, and financial capital strategically to establish and maintain a strong ecosystem" while supporting their other core missions of education and research. Nevertheless, they point out that solid dynamic capabilities are required. Such capabilities include (1) "the entrepreneurial ability to identify emerging new fields and invest in research around them", (2) the building of partnerships for the creation and maintenance of ecosystem infrastructure and (3) the ability to help align the interests of the stakeholder inside the ecosystem. However, those capabilities need to be created, and this involves the fostering of a culture of collaboration, the decentralisation of authority and the dissemination of a shared vision among the actors. The university setting where governance is divided between administration and faculty are characteristics of particular relevance. Furthermore, a key finding suggests that it is essential to consider the university's role in a local innovation ecosystem with a more context-specific view, given the stage of the innovative ecosystem and the need to coordinate and align.

Thus, according to the aforementioned studies, academics fit the role of orchestrators in innovation ecosystems as they created instruments to take strategic and tactical decisions over the years (Chesbrough, 2003; Porter, 1979, 2008; Teece, 1986), in

addition to all the collaboration they have with industries, as mentioned in §3.1, and the trust they created with different actors within an ecosystem, as mentioned in §3.2 more specifically by Striukova and Rayna (2015) and Yun and Liu (2019). Whenever academics and practitioners interact in workshops, the former gives the possibility to solve relevant industry problems while receiving data, simultaneously the latter gains access to low cost unbiased consultancy (Burton et al., 2020). Moreover, considering that the line between applied research and basic research is more and more faded because of the advancement in technology (see §3.1) and digital innovation, there is a need to educate other actors in the ecosystem to use the instruments and tools developed by universities' basic research or research conducted in collaboration with industries. Burton et al. (2020) indeed argue that academics bring a more holistic understanding of how business activities generate value.

4. Digital innovation

Several scholars have outlined how a digital innovation ecosystem provides ways to change how to process, operate and deliver value, and will be further mentioned below. First, this chapter introduces the differences and the implications between digital innovation and traditional innovation. Secondly, it addresses the necessity to adopt digital technologies, highlighting the potential role of universities as orchestrators of digital innovation ecosystems.

4.1 Novelty of digital innovation

According to Dos Santos et al. (2014), digital innovation is defined as "a product, process, or business model that is perceived as new, requires some significant changes on the part of adopters, and is embodied in or enabled by IT". Curiously enough, this definition is broad by intention. In the case of Yoo et al. (2010), the definition is focused solely on product innovations: "the carrying out of new combinations of digital and physical components to produce novel products".

Digital innovation embodies two key characteristics that differentiate it from other types of innovation, and those are convergence and generativity (Ciriello et al., 2018; Yoo et al., 2010).

Convergence, as it combines and aggregates in a single entity different components that previously were separate. For instance, one could think about a smartphone or, to a greater extent, about digital platforms.

Generativity, as it enables the generation of content on digital platforms leveraging heterogeneous actors, components, and, more generally speaking, resources. The higher the heterogeneity, the more generative the platform becomes (Ciriello et al., 2018; Lusch and Nambisan, 2012; Yoo et al., 2010).

Additionally, it is essential to mention the intangibility factor of digital innovation, a feature that allows us to classify it as a non-rival good. According to Varian (2003), the main components of digital innovation are ideas, standards specifications, protocols, programming languages and software rather than "physical devices", consequently as innovations without physical constraints. Moreover, digital innovations rarely follow the traditional logic of coordination and governance, and they somehow stem from opportunities enabled by a digital ecosystem. This results in a sparse network, and digital startups, which are born in such networks, can grow and scale in unusual ways (Tumbas et al., 2015), compared to companies that follow more traditional forms of innovation using more tangible assets. Nevertheless, the non-rivalrous nature of digital innovation allows for massive scale economies, and market concentration as the marginal cost of diffusion and delivery is zero. Hence for any digital product, supply can virtually instantly adapt to demand, and in such conditions, companies with large pools of customers have an enormous advantage over competitors, which could lead to natural monopolies (Guellec and Paunov, 2017). Even though digital born companies, which strongly leverage on network effects, are all prone to become natural monopolies, because by nature they are placed in a "winner takes all" context, it is not necessarily true that they have zero marginal costs, contrary to what Rifkin (2014) states, as the example of Spotify is glaring.

4.2 Digital innovation into all areas of business

Related to the discussion of digital innovation is the emergence of the phenomenon of digital transformation.

Vial's (2019) study of information system research in the digital transformation phenomenon identifies the benefits and challenges, therefore emphasising its complexity. As it involves different layers, such as information, communication and connectivity, it is important to note how it enables various collaborative forms amongst actors. This study also points out how companies struggle to maintain a competitive advantage, while simultaneously leveraging on innovation and performances in their organisations, such as offering enormous opportunities for the company, and moreover for individuals, industries and society. The research was conducted through a review of 282 works, resulting in an inductively built framework. Based on these works and 22 extant definitions, Vial (2019) defined digital transformation as "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies". Furthermore, Burton et al. (2020) argue that companies need to re-innovate themselves constantly while having access to limited resources, and academics can help in this process by offering novel ways of solving problems. Indeed, assuming that practitioners are part of a learning innovation ecosystem, leveraging on a learning knowledge platform (as mentioned in §3.3) could be a potential solution to their struggle.

Digital Innovation has offered a new way of doing things, meaning when digital technology is used during the process of innovating (Nambisan et al., 2017). Like most innovative theories and ideas, this has significant consequences for how companies and industries organise and structure, and how consumers live, work and learn. The possibilities offered by it are growing at an unprecedented rate. This fast-changing market requires consistent transformation, adoption and innovation (Dos Santos et al., 2014). Universities, therefore, and more specifically academics could extend their orchestrating role also to digital innovation ecosystems by leveraging on its non-rivalrous nature, despite already using knowledge platforms by being a critical player in professional, transformational, strategic and learning innovation ecosystems.

5. Gaps in the literature

Many studies show that universities could have a positive impact as orchestrators in an innovation ecosystem. However, most cases are only small projects (Ferraris et al., 2018; Guerrero et al., 2012; Kwon, 2011; Thomas et al., 2020; Tolstykh et al., 2012; Vial, 2019; Xu et al., 2018) which have only been conducted in one setting and are not large enough to allow a solid generalisation. Therefore, a suggestion for further research would be for research to be carried out, which focuses on multiple settings to increase the applicability of findings.

The theme of academics as orchestrators has drawn attention from many scholars who point out that academics could help to achieve greater collaboration and development. In recent years, literature started to be more and more focused on the active role of universities in society and industry (Bekkers and Bodas-Freitas, 2008; D'Este and Patel, 2007; Guerrero et al., 2012; Guenther and Wagner, 2008; Muscio and Vallanti, 2014; Perkmann et al., 2013; Striukova and Rayna, 2015; Wright et al., 2008; Yun and Liu, 2019); however, not enough research has been done on the universities as key catalysts/orchestrators for innovation and specifically digital innovation ecosystems. Therefore, a suggestion for further research would be on validating the tools that universities are using to orchestrate innovation ecosystems and exploring new ways of orchestrating by developing a comprehensive framework that can be declinated to particular cases. Moreover, there is room for research on how universities can contrast the negative effects/externalities of digital innovation, such as fair income distribution and data protection (Guellec and Paunov, 2017), as to the extent of my knowledge based on this study, this particular topic has not been yet addressed by the academic world.

6. Conclusions

The literature addressed in this review has explored the critical questions of how universities and academics orchestrate innovation ecosystems, and whether this role is suitable and beneficial.

First of all, research on this topic has shown how universities can be orchestrators of innovation ecosystems in various ways, such as leveraging on knowledge platforms and collaborative research.

Secondly, the research field identifies that universities can create trusted and committed relationships by functioning as an intermediary between actors in different settings of innovation ecosystems, starting from knowledge innovation ecosystems, moving to transformational (and other) innovation ecosystems and potentially reaching digital innovation ecosystems.

Thirdly, research has also focused on the potential of using universities to be the leaders in many settings of innovation ecosystems by steering the wheel of innovation and helping the actors to achieve their objectives and strategic targets. Such possibility is given by universities' neutrality within an innovation ecosystem, their unbiased approach to problem solving, and their general overview of potential directions for the future for the whole ecosystem.

Overall, it has been frequently emphasised that universities should play an integral role in this process. Studies point out the added value of universities going beyond their traditional role of education and research, embracing their third mission of contributing to economic development and direct contribution to industry and society.

Unfortunately, given the gaps in the literature on universities as orchestrators for digital innovation ecosystems, not much has been researched on this specific matter. Further research should take into consideration the role of universities as orchestrators to prepare for global challenges when it comes to digital innovation ecosystems.

The literature on this topic has also yet to explore the more complex ways in which universities can better orchestrate innovation ecosystems and develop new tools to orchestrate digital innovation ecosystems, since studies tend to focus mainly on companies as orchestrators, while the role of universities is still underexplored, yet full of potential.

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