



Ambidexterity in entrepreneurial universities and performance measurement systems. A literature review

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Abstract

The main purpose of this research is to analyze the exploration and exploitation of knowledge in universities that support innovation and entrepreneurship in their environment. For this, the Performance Measurement Systems (PMS) of the universities management are analyzed as a proxy for the implementation of the strategic vision of the universities. This study is based on a systematic literature review on the subject, supported by the technical possibilities offered by the MAXQDA (The Art of Data Analysis) program. The databases used were the following: Elsevier (Science Direct), Springer, Wiley and Taylor & Francis. The main findings suggest that organizational ambidexterity, in general, develops unevenly and from different approaches, among which innovation, learning and strategy stand out. However, organizational ambidexterity hardly develops in a university context, where most of the university activities require some knowledge of the technological frontier. Therefore, it is necessary to analyze and understand these two dimensions (exploration and exploitation) and their positive influence on entrepreneurship. In a context where the development of technology and science happens at an ever-increasing speed, a balance between exploration and exploitation is necessary, which should be reflected in the different control mechanisms in academic environments, such as the Performance Measurement Systems (PMS). The analysis of these systems will allow to know the position of the universities in the face of ambidexterity.

Keywords Ambidexterity · Innovation · Performance measurement system · Universities · Entrepreneurial

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Introduction

The triple helix model proposed by Etzkowitz and Leydesdorff (1995) is based on the following three axes: industry, university and government. This model rethinks the role of the university in science and technology. In this sense, the university, in collaboration with the industry, establishes mechanisms that promote entrepreneurship in businesses by supporting activities such as business incubators (Nicholls-Nixon et al., 2020). Shane (2004) defines entrepreneurial university as “*an important catalyst for the facilitation of academic entrepreneurship, which in turn generates regional economic and social development through the added value created by the identification and exploitation of entrepreneurial opportunities.*” In response to the dynamism of the environment, entrepreneurial universities become a natural incubator and provide structural support to entrepreneurs to start new companies.

In order to achieve outstanding results in an activity linked to the limits reached in science, it is necessary to balance the exploration and exploitation of knowledge (Burgess et al., 2015). Exploitation entails refinement and extension of existing competencies whereas exploration requires experimentation with new alternatives (March, 1991, p. 85). The organizational ability to combine exploration and exploitation strategies has been named as ambidexterity in the literature (Duncan, 1976).

Recent studies show the need to balance technology transfer (exploitation) and research development (exploration) at the same time. In the context of entrepreneurial universities, the role of ambidexterity and its positive influence on the performance of the organization has been recognized. The literature considers ambidexterity in the university as a balance between research and commercialization activities (Chang et al., 2016) such as collaborative relationships between university and industry (Pangarso et al., 2020; Sengupta & Ray, 2017). However, from the university point of view, the balance between these two strategies (exploitation vs. exploration) continues to be a topic poorly studied (Centobelli et al., 2019).

The implementation of combined strategies of exploration and exploitation is a crucial challenge for universities (Centobelli et al., 2019). The management of these processes requires, in the first place, the use of control elements which has been developed in other activities but have improved the Management Control System (MCS) of universities (Nisio et al., 2018; Peris-Ortiz et al., 2019). However, MCS should be transferred to a university environment and adapted to their management needs. (Al-Hosaini & Sofian, 2015; Pietrzak et al., 2015).

In the general approach of MCS, the importance of Performance Measurement Systems (PMS) in strategic implementation is clear. However, in the context of the exploration and exploitation of knowledge in entrepreneurial universities, there is lacking of studies that address the use of PMS. Therefore, the main objective of this article is to evaluate the exploration and exploitation of knowledge in entrepreneurial universities and its relationship with the PMS.

The specific objectives of the study are the following: (1) To evaluate the exploration and exploitation activities used by entrepreneurial universities, (2) To

evaluate the implementation of PMS for the control of exploitation and exploration in Higher Education Institutions (HEI), and (3) To determine the indicators related to exploration and exploitation activities.

The structure of this article is as follows. The first section presents the theoretical framework. Afterwards, the method followed in the literature review is described. The analysis and results of the literature review are commented in the fourth section. Subsequently, the outcomes related to the theoretical development of the exploration and exploitation strategies are presented. Afterwards, these strategies and the exploration and exploitation activities are analyzed in the HEIs. Finally, this article presents the conclusions extracted from the literature analysis performed.

Theoretical framework

This section is focused on presenting the necessary background for the current study. First, a brief review on the ambidexterity strategy in universities is presented. Afterwards, the MCS as a management tool for knowledge exploration and exploitation activities is analyzed.

Ambidexterity in universities

The mission of universities has gone beyond teaching and nowadays has a great variety of objectives. Most of the universities consider the interaction with the environment as one of their main objectives because the development of competencies and knowledge transfer can be achieved through their relationship with public organizations and private companies in the near context (Abramo et al., 2011; Giones, 2019). The goal is to become an entrepreneurial university, a generator and promoter of knowledge that bases its development on innovation and problem solving for the benefit of society and the economic growth. The outcomes of these university-industry (U-I) links is an increase in regional innovations (Parmentola et al., 2020).

The current environment is characterized by continuous innovations, and universities must redefine their strategy in terms of exploration and exploitation to improve their performance in the long term (Benner & Tushman, 2003). Universities must achieve different objectives in research (exploration) and in the transfer and commercialization of knowledge (exploitation). The organizational ability to combine exploration and exploitation strategies has been termed ambidexterity in the literature. (Duncan, 1976).

However, exploration and exploitation are contradictory and necessary processes (Hiebl, 2015). The literature suggests some ways to solve the existing conflicts between exploration and exploitation. On the one hand, the establishment of alliances: the exploratory efforts of one company contribute to the exploitation capacities of another (Bedford, 2015). Another solution would be for the organization to alternate between periods of exploitation and exploration (Nickerson & Zenger, 2002; Siggelkow & Levinthal, 2003). However, universities need to divide their resources between exploration and exploitation at the same time.

In order to achieve outstanding results in an activity linked to the limits reached in science, it is necessary to balance the exploration and exploitation of knowledge (Burgess et al., 2015). Universities that adopt exploration strategies seek to produce radical changes in knowledge, or at least absorb the knowledge generated without becoming obsolete. These actions will allow them to get the capacity to generate innovations that significantly transform the existing products and processes (Nguyen et al., 2016). Exploration includes aspects captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation (March, 1991).

On the other hand, exploitation refers to the application of knowledge to promote the production of innovations, refine the organization's existing products, and improve its processes. It is conceptualized as refinement, selection, production, efficiency, implementation and execution of existing technologies (March, 1991).

In general, for a company, activities related to exploitation allow increasing the effectiveness of the technical system through routine and successive repetitions, but also by making modifications to established procedures which will increase the outcomes (Bedford, 2015). However, for a university, exploitation means applying its knowledge by collaborating with companies and generating, thanks to the explored knowledge, radical innovations.

MCS for ambidexterity

According to Bisbe and Otley (2004), the Simons (1991) levers of control is one of the best approaches to analyze the influence of MCS in the processes of exploration and exploitation of knowledge. Simons (1991) argues that the full potential of control is achieved when a dynamic tension is created to maintain a balance between ensuring the achievement of predetermined objectives and allowing the necessary flexibility for innovation and creativity. The framework proposed by Simons (1991, 1995) integrates four levers and recognizes three main tensions: (1) unlimited opportunity vs. limited attention, (2) intended vs. emergent strategy, and (3) self-interest vs. desire to contribute (Simons, 1995, p. 153). The framework focuses primarily on the tensions between the organizational need for innovation and the organizational need to achieve pre-established goals, and the resulting tensions created between elements of the formal MCS (Bisbe & Otley, 2004; Mundy, 2010).

Simons (1991) levers of control proposal are one of the most interesting conceptual frameworks to analyze the influence of MCS on ambidextrous organizations. Research studies have analyzed the effectiveness of MCS by considering their design and use. In this sense, the main findings indicate that the form of use (interactive or diagnostic use) plays a fundamental role (Agostino & Arnaboldi, 2012; Bedford, 2015).

More recent approaches such as the PMS try to overcome the problems of traditional MCS, which are focused on financial and budgetary control mechanisms (Franco-Santos & Otley, 2018). PMS developed from planning elements including objectives and performance. They are designed from measurement and reward elements. Measurement elements include the metrics used to operationalize

performance and the monitoring used to evaluate performance and feedback information. Reward elements are linked to performance, and can be extrinsic (i.e. bonuses) or intrinsic (i.e. social recognition of achievements) (Franco-santos & Otley, 2018).

Method

In order to analyze the abundant literature about the ambidextrous organizations and the implementation of PMS, we have followed a systematic review methodology suggested by (Ridley, 2012; Tranfield et al., 2003). The first phase consists in planning the review. The steps for this phase are the following: (1) to identify the need to outperform a literature review and (2) to develop the review protocol.

It was necessary to perform a preliminary literature review in order to define the scope and evaluate the relevance and size of the literature on the subject. The review protocol implemented includes information on the objective of the study, the research questions, the search strategies, and the design of the data extraction form.

The second phase of the review is the documentary analysis, supported by the technical possibilities offered by the MAXQDA program (Kuckartz & Rädiker, 2019). Previous studies have used MAXQDA to facilitate the coding of data obtained from interview and secondary sources (Adiloglu & Besler, 2021; Bausch et al., 2021). In the systematic literature review, MAXQDA has been used as the main tool because it allows step-by-step categorization (Birkel & Müller, 2021). The MAXQDA's qualitative analysis package contains tools that combine automatic coding of results with manual analytical work that enables paraphrasing and searching for combinations or strings of texts. This phase consists in four steps (Fig. 1).

The identification of the relevant literature was conducted on the following databases of recognized validity: Elsevier (Science Direct), Springer, Wiley, and Taylor & Francis. These Publishers have recognized prestige in the area of economics and management (Giménez-Toledo & Tejada-Artigas, 2015). To identify relevant studies on these databases, a search for scientific articles that used the combined terms of “ambidexterity + innovation” in the period from 2000 to 2020 was performed. Articles from conferences, books, or any other scientific publication different from journal articles were excluded. As it can be seen in Fig. 2, the area that has generated the most articles was Management, with 2,226 articles in the last 20 years.

The preliminary list of articles was built with the articles found on the Management discipline. The analysis of the articles with the MAXQDA tools (automatic coding, lexical searches and word tree) showed different lines of arguments that in many cases do not answer our research questions.

In order to reduce the field to articles related to the subject of this research, we apply other inclusion and exclusion criteria. We focused on the last 15 years, which is also the time span with the most significant increase in articles published on the subject. We identified relevant studies that used the combined terms of “ambidexterity + innovation/ university”. Figure 3 shows the results distributed in the different databases, showing a notable increase in the literature that addresses the issue of ambidexterity and performance in organizations.

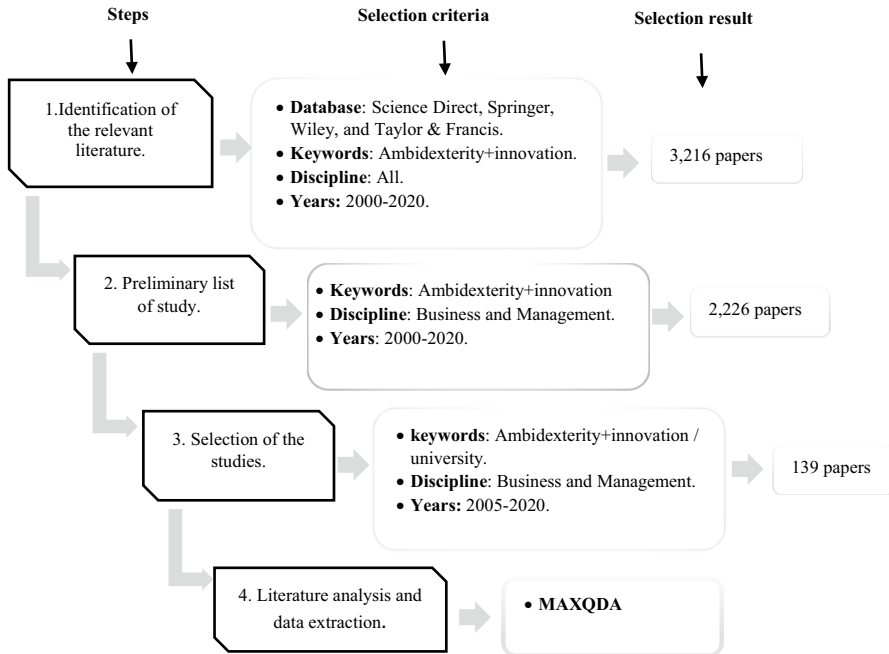


Fig. 1 Bibliographic documentary analysis

Analysis and results

Ambidexterity in the development of innovations

In recent decades, the scientific literature dealing with the contradictions between exploitation and exploration and the need to link these two orientations has boomed. Table 1 shows an analysis of the articles published in prestigious journals that are mainly focused on the different modes of ambidexterity and their relationship with innovative performance.

The current environment in which organizations develop, characterized by the need to keep up with competitors by introducing innovations much more frequently, raises the question of which strategy (exploration or exploitation) is better to achieve successful innovative performance. The answer to this question lies on the balance between exploitation and exploration, which implies that organizations have the capacity to pursue and achieve two different types of related objectives in the adaptation to the market, the radical innovation (exploratory) and the incremental innovation (exploitative) (Birkinshaw & Gupta, 2013; Hiebl, 2015). However, these two approaches (exploration and exploitation) compete for the allocation of resources and require different organizational structures, strategies, contexts and capacities, and can have different impacts on the performance of the organization. In this sense, organizations can develop modes of ambidexterity in different areas such as structure, strategies, knowledge management,

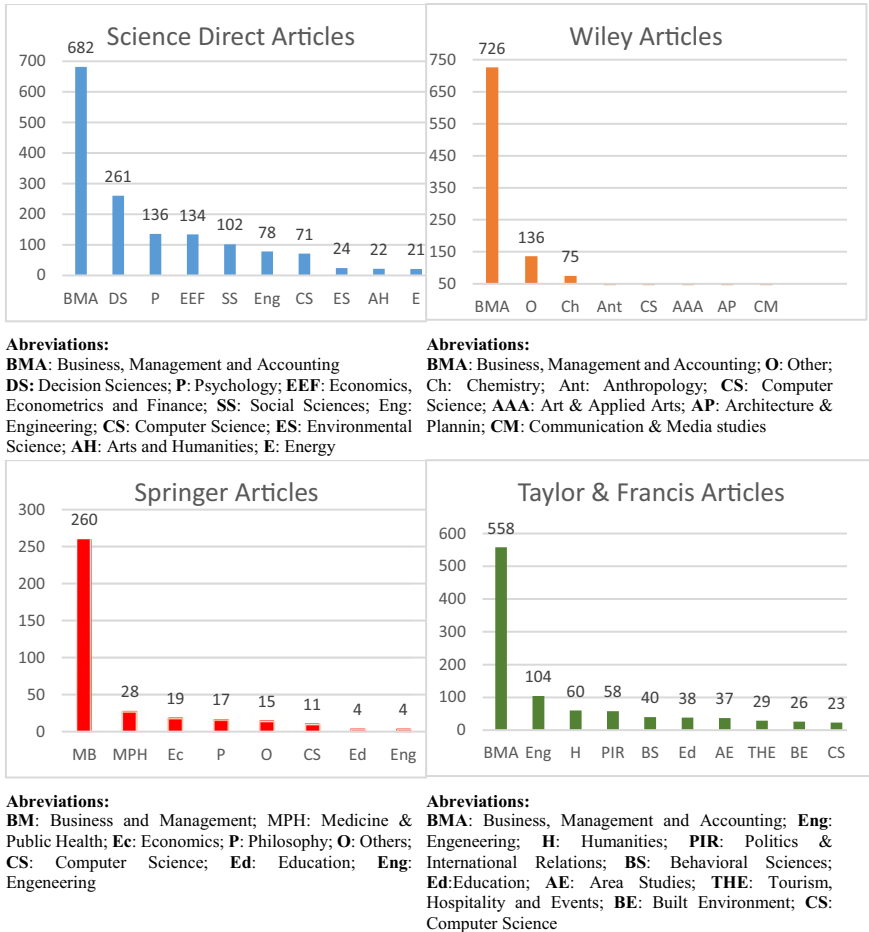


Fig. 2 Distribution of articles with ambidexterity and innovation in the keywords by areas

organizational learning, behavior, innovation, open innovation, and PMS (see Table 1).

Ambidexterity in the context of entrepreneurial universities

In entrepreneurial universities, the crucial role of ambidexterity and its positive influence on their innovative performance has been widely recognized in both public and private universities (Table 2). Ambidexterity stimulates the development of innovation processes and ensures successful performance (Cabeza-Pulles et al., 2020). However, the importance of balancing exploitation and exploration periods in entrepreneurial universities remains as a poorly researched topic (Centobelli et al., 2019).

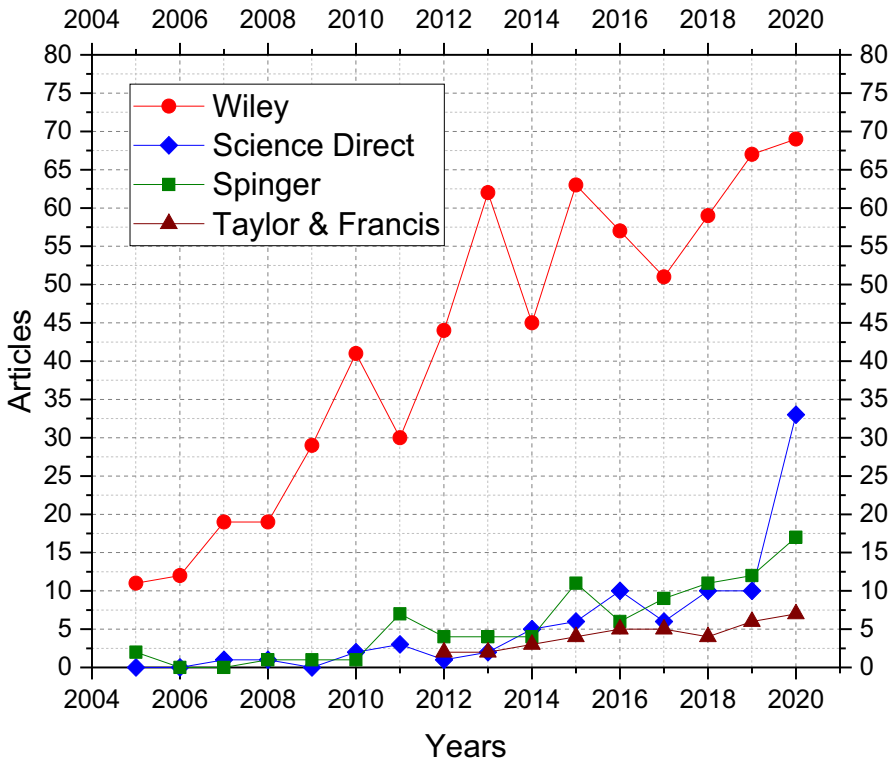


Fig. 3 Articles related to ambidexterity published in the management area

The university has the obligation to satisfy social needs, either as objectives set by the administration or by the market demand. The first one of these needs consists on promoting quality human capital that could contribute to increase the competitiveness and the development of a region (Hsu & Chen, 2020; Valero & Van Reenen, 2019). In formation activities, the university can promote entrepreneurship by balancing theory and practice (Blankesteijn et al., 2021).

In addition to the training of professionals and entrepreneurs, universities are an important external source of innovation for companies (Ferreira & Carayannis, 2019). Innovation support from universities can take different forms of collaboration, including the creation of joint research facilities, research contracts and consulting agreements (Almeida et al., 2019).

In the U-I relationship, a distinction is made between public and private HEIs. The results of the articles that study the public–private relationship in research and technology transfer show that imbalances can occur due to the inconsistency of objectives (Lascaux, 2019). Kivleniece and Quelin (2012) argue that public–private ties are marked by inherent tensions between private profit-oriented goals and public goals. This means that the knowledge generated by collaboration between universities and private companies could be made later available to other

Table 1 Articles with content based on ambidexterity

Context and frequency of the term	Reference	Journals
Ambidextrous contexts (15)	(Lee & Lee, 2016); (Li et al., 2020a, b);	-Asian Journal of Technology Innovation
Ambidextrous behaviors (5)	(Chen et al., 2018); (Hsiang-Lin & Huang, 2021) (Li, 2018); (Liu & Li, 2019); (Rhee & Kim, 2019); (Foss & Kirkegaard, 2020); (Junni et al., 2019); (Posch & Garaus, 2019)	-Long Range Planning
Ambidexterity Management (4)		
Ambidextrous orientation (11)		
Innovation ambidexterity (671)	(Cho et al., 2020); (Li et al., 2016); (Suzuki, 2018);	-Industry and Innovation. -European Management Journal
Organizational ambidexterity (951)	(Xie et al., 2020); (Cabeza-Pulles et al., 2020);	-Research Policy
Ambidextrous leadership (214)	(Donada et al., 2021); (Kassotaki, 2019); (Nowacki & Ashby, 2020); (Revilla & Rodríguez-Prado, 2018); (Sengupta & Ray, 2017); (Hu & Chen, 2016); (Kuo et al., 2018); (Lin & Chang, 2015); (Xie & Gao, 2017)	-Technology Analysis & Strategic Management
Strategic ambidexterity (95)	(Bustinza et al., 2020); (Chang & Gotcher, 2020);	-International Business Review
Environmental innovation ambidexterity (10)	(Khan et al., 2020); (Wu et al., 2020); (Bocquet & Mothe, 2015); (Donate & Guadamillas, 2015)	- Knowledge Management Research & Practice
Ambidexterity Knowledge (4)		
Structural ambidexterity (195)	(Nowacki & Ashby, 2020); (Revilla & Rodríguez-Prado, 2018); (Sengupta & Ray, 2017); (Jakhar et al., 2020); (Khan & Mir, 2019); (Xie & Zhu, 2020)	-Research Policy
Contextual ambidexterity (325)		-Business Strategy and the Environment
Performance Measurement System ambidexterity (13)	(Asif & Vries, 2014); (Fundin et al., 2021); (Rafailidis et al., 2017); (Harmancioglu et al., 2020); (Purchase et al., 2016); (Strese et al., 2016)	-Management Accounting Research
Ambidextrous organization (231)		-Total Quality Management & Business Excellence
Cultural ambidexterity (6)		-Industrial Marketing Management
Ambidextrous commercialization (2)		

Table 2 Ambidexterity in entrepreneurial universities with different status

Papers	Ambidexterity university	University status	
		Public	Private
(Cabeza-Pulles et al., 2020)	Knowledge absorption processes to stimulate ambidexterity of innovation and achieve innovative performance	X	X
(Centobelli et al., 2019)	University ambidexterity to analyze the development process of entrepreneurial universities	X	X
(Chang et al., 2016)	Ambidexterity of the research, simultaneously achieving the publication and commercialization of the research	X	X
(Jackson, 2019)	Ambidextrous strategies and the need to balance both competition and innovation	X	X
(Sengupta & Ray, 2017)	Interrelationships between the two pillars of ambidexterity (research and knowledge transfer) in universities	-	-
(Pangarso et al., 2020)	Nexus between absorption capacity, and sustainable competitive advantage	-	X

companies through the universities. However, this tension, derived from who has the right to exploit the knowledge generated, is not different from the tensions found in open innovation.

The reputation of universities in the exploration of knowledge can be measured in an international context through global rankings. These rankings could classify the most competitive universities by using an academic and research excellence criterion. In the context of rankings, the radical nature of exploration can be seen in the first-level research indicators, which show the development of scientific production that is published and reaches a high impact.

Incremental innovations are those that produce minor changes in existing activities, products, processes and practices (Damanpour, 2017). In the case of universities, incremental innovation are linked to small upgrades and concrete improvements in existing knowledge, which, although they may be published and disseminated in top-level scientific journals, their impact is smaller than a radical innovation.

Exploration in universities, therefore, is not only limited to the generation of worldwide cutting-edge knowledge. Universities can simply update their knowledge absorbing what was generated by other universities and technology centers. This updated knowledge allows universities to collaborate and support businesses. In this case, universities with fewer resources can act as followers in the generation of knowledge (exploration) without thereby ceasing to be competitive in its technology transfer (exploitation). On these cases, it is important to consider the exploration in universities through the concept of absorption capacity.

Absorption capacity is a critical element in knowledge exploration activities. It is conceptualized as the ability to identify, process, create and use new knowledge. The literature examines different mechanisms that promote the absorption of knowledge in universities, which not only involves internal management but also the relationship with stakeholders from the public and private sectors. On this topic, Lascaux (2019) argues that the absorption capacity in HEIs can be increased through the U-I relationship, which allows identifying the potentialities of the application of new technology in public and private sectors through research projects. This author highlights the importance of strengthening the absorption capacity in the U-I relationship. An initiative to improve the absorption capacity is the informal exchange between the personnel who collaborate with companies and institutions. A second initiative is associated with the establishment of formal mechanisms in structures and activities that foster collaboration. Sharing the acquired knowledge through formal or informal mechanisms increases the potential for the creation of new knowledge and innovative performance (Benitez et al., 2017). This is the reason why the relationships between organizations are particularly important in exploration activities towards the search for innovative performance.

The analysis of the literature shows that there is a focus on the exploitation of knowledge through the commercialization of products and services in the U-I relationships (Robertson et al., 2019). In this sense, the U-I associations emphasize the transformation of knowledge into products and processes that can be commercially exploited. The transfer of technology is achieved through mechanisms such as research contracts, consulting, mobility between researchers, licenses and patents (Da Silva & Segatto, 2017).

Performance measurement systems and ambidexterity in entrepreneurial universities

The university faces serious difficulties to control its processes due to the intangible nature of its exploitation activities and its multiple functions (teaching, research, relationship with the environment). These characteristics of universities and HEIs in general have encouraged their managers to look for management tools. One of these tools is PMS, applied mainly to for-profit organizations, but that can be transferred to universities and adapted to their management needs. However, attempts to adopt PMS can be unsuccessful if the complex and specific nature of entrepreneurial universities are not considered. Table 3 shows a summary extracted from the literature review where the elements of the PMS are exposed by means of using a perspective of exploration and exploitation of knowledge.

Universities pursue multiple and sometimes incompatible objectives that go beyond their traditional role. It is recognized that universities must create new knowledge and apply it through entrepreneurship and innovation (Sengupta & Ray, 2017). Thus, the development of ambidextrous strategies, based on the management of knowledge in a strategic way, is conditioned by more complex systems that force universities to balance priorities in the creation and transfer of knowledge (Tsen et al., 2020). Table 4 shows the analysis of the literature generated on the topics of U-I collaboration and entrepreneurship initiatives in recent years.

The evidence from the literature analysis reveals that the control element most explicitly or implicitly addressed has been the organizational structure (Apa et al., 2021; Cabeza-Pulles et al., 2020; Fudickar & Hottenrott, 2018).

Fudickar and Hottenrott (2018) analyze the formal and informal U-I relationships in innovation activities and consider that the exploitation of knowledge through commercialization requires clearly defined objectives to better develop formal interactions. Similarly, Barra and Zotti (2018) suggest that technology transfer offices are a formal intermediate structure between the university and the companies that play an important role in the innovation process. Additionally, Apa et al. (2021) mention that the informal dimension is important, since it has a positive influence on the performance of innovation, even in the absence of formal structures. The results that suggest that formal collaborations that are not accompanied by an informal relationship do not influence innovative performance have important repercussions for the management of the human relations of the U-I collaborative teams.

The reward systems are the second most studied control element in the entrepreneurial university. An incentive mechanism reflects rewards, including salary increases, bonuses or promotions, which are crucial for the success of knowledge transfer and the exploitation of opportunities with companies. Monetary rewards attract more productive researchers and are positively associated with knowledge production. Similarly, Khadhraoui et al. (2016) argue that incentives for successful technology transfer activities can act as a driving force for further innovation in universities.

One of the key components within the control system are the performance indicators. They allow checking if the results of the implementation of the strategy match the objectives (Franceschini et al., 2019). Knowledge exploration indicators

Table 3 Differences between traditional and entrepreneurial universities

PMS elements	Traditional University	Entrepreneurial University	Bibliographic references
Mission and vision	Creation of new knowledge	Entrepreneurship and innovation	(Chang et al., 2016)
Strategy and plans	Strategies based on research and teaching. Lack of institutional development plans	Strategies based on research, teaching and innovation They formalize their goals in strategic planning documents	(Blass & Hayward, 2014); (Khalid et al., 2014)
Objectives	Creation and dissemination of knowledge	Creation and dissemination of knowledge. Transfer and commercialization of university innovations. Efficiency and effectiveness objectives	(Chang et al., 2016); (Pilonato & Montfardini, 2020)
Structures	Research departments, laboratories and centers	Research departments, laboratories and spin off centers Incubators and alliances with other institutions	(Chang et al., 2016); (Fudickar & Hottenrott, 2018)
Indicators	Indicators for internal management	Performance indicators that can be used for both internal management and external communication	(Khalid et al., 2014)
Incentives	For teaching and research performance	For teaching, research and commercialization performance	(Tsen et al., 2020)

Table 4 Control elements in the university-industry relationship analyzed by researchers

Author	Year	Database	Study focus	Journal	Document type	Methodology	PMS element	Analysis level	type of university
Colombo et al.	2015	Springer	Ambidextrous innovations	The Journal of Technology Transfer	Empirical	Mixed	Organizational structure	Academic spin-offs	Private and public
Sandstro et al.	2016	Springer	Academic entrepreneurship initiatives	The Journal of Technology Transfer	Systematic review	Qualitative	Contexts (public and institutional policies)	Organizational	Private and public
Barra & Zotti	2018	Springer	Regional innovation system	The Journal of Technology Transfer	Empirical	Quantitative	Organizational structure	Organizational	Private and public
Chang et al.	2016	Science Direct	Research ambidexterity	Technovation	Review	Qualitative	PMS in general	Departmental	Private and public
Kobarg et al.	2018	Springer	University-industry collaborations	The Journal of Technology Transfer	Empirical	Quantitative	absorptive capacity and innovation competencies	Organizational	-
Sengupta & Ray	2017	Science Direct	Innovation ambidexterity	Research Policy	Empirical	Quantitative	Organizational structure	Organizational	Private and public
Tsen et al.	2020	Springer	University-industry collaboration	J Technol Transf	Empirical	Quantitative	Management mechanisms, reward systems	Organizational	-
Fudickar & Hortenrott	2018	Springer	University-industry interaction	The Journal of Technology Transfer	Empirical	Quantitative	Organizational structure	Organizational	-
Centobelli et al.	2019	Science Direct	University ambidexterity	Technological Forecasting & Social Change	Systematic review	Qualitative	PMS in general	departments and faculties	Private and public

Table 4 (continued)

Author	Year	Database	Study focus	Journal	Document type	Methodology	PMS element	Analysis level	type of university
Pilonato & Monfardini	2020	Science Direct	Performance Measurement	The British Accounting Review	Empirical	Qualitative	Levers of control (Simons, 1995)	Organizational	Public
Apa et al.	2021	Springer	University-SME collaboration and innovation performance	The Journal of Technology Transfer	Empirical	Mixed	Organizational structure	Organizational	-
Cabeza-Pulles et al.	2020	Science Direct	Innovation ambidexterity	European Management Journal	Empirical	Quantitative	Organizational structure	Investigation groups	Public

are generally measured in the number of publications and citations in specialized, international, peer reviewed, indexed journals (Amador et al., 2018). This explicit knowledge in the form of scientific publications is usually evaluated according to the impact of the publication. However, the distinction between the creation of knowledge that is simply incremental (linked to a position of follower by scientists in that field), and the knowledge that is a radical innovation (leader of the area of knowledge) is not always made. An interesting indicator to establish the leadership position of the university in a certain field and the type of knowledge it generates are the prestigious awards the university and its researchers have received.

Conclusions

The dynamics of processes in HEIs have changed in recent years. The new trends position the university as an entrepreneurial organization, as a creator and promoter of knowledge that bases its development on innovation and problem solving for the benefit of society and economic growth. This change of position is given by the speed in the creation of scientific knowledge by society. It is an increasingly complex and specialized knowledge, which updates and progresses much faster. This is the society of knowledge, of scientific knowledge. The fourth sector, constituted by highly qualified and specialized professionals dedicated to creating or at least keeping pace with scientific knowledge in order to apply it, is probably what will define the type of society in the near future. How can this fourth sector be articulated? Which role must play the universities in the knowledge society?

The excessive specialization of knowledge workers and the time necessary for their formation seem to be detrimental to the development of the fourth sector in a completely productive business world. In this context, universities appear as the best positioned organizations to play a central role in the scientific knowledge creation and absorption if they learn how to balance and coordinate exploration and exploitation activities, which in other words means that they become ambidextrous organizations.

The concept of ambidexterity is very present in the business world. The analysis of the literature indicates the growing need to manage exploration and exploitation as two necessary dimensions in organizations. The term ambidexterity has increased its presence in publications in the last 10 years. Articles related to the words ambidexterity, innovation and performance predominate in business, management and accounting journals.

The results show that ambidexterity is developed in different organizational contexts (Revilla & Rodríguez-Prado, 2018). Different factors are addressed such as innovation (Cabeza-Pulles et al., 2020; Donada et al., 2021; Pangarso et al., 2020), learning (Duc et al., 2020; Li et al., 2020), management (Li, 2018), business models (Hu & Chen, 2016), strategies (Bustanza et al., 2020; Wu et al., 2020), structures (Nowacki & Ashby, 2020), culture (Rafailidis et al., 2017) alliances (Song et al., 2016), processes (Kwak et al., 2019) and PMS (Bedford, 2015). However, only a few of these studies focuses on the university context (Centobelli et al., 2019), where the need to link exploitation and exploration and their positive impact on innovation

performance has been proven. Ambidexterity in universities has been studied fundamentally from an entrepreneurial approach. In this sense, the university must develop the ability to build capacities and incorporate processes that promote and enhance the activities of exploitation of knowledge, while maintaining its focus on fundamental research (knowledge creation) (Sengupta & Ray, 2017). In relation to exploration activities, the evidence indicates that these activities are associated with the production of new knowledge that generates an impact on the university community through articles, books, new methodologies or the creation of pioneering technologies (Chang et al., 2016; Sengupta & Ray, 2017). On the other hand, knowledge exploitation activities are fundamentally based on the commercialization of products and services through U-I relationships (Robertson et al., 2019).

In the context of entrepreneurial universities, a balance between exploration and exploitation and its management through different control mechanisms is necessary. That is why, in recent years, PMS have been implemented in academic organizational structures. The results reveal that PMS are applied mainly for exploitation activities, while activities related to exploration are scarcely analyzed (Centobelli et al., 2019). From the PMS approach proposed by Ferreira and Otley (2009), the control elements that have been addressed in the literature related to organizational ambidexterity were identified. Among the most studied control mechanisms are the organizational structures and reward systems. However, a crucial point in this control process is to identify the correct indicators that properly represent the key performance results and the processes that have led to these results (Franceschini et al., 2019). If we want to measure the exploitation and exploration of knowledge in universities, it is necessary to determine which indicators reflect these two dimensions and which organizational processes should be used in a coordinated way to improve them.

Evidence from the literature review indicates that little attention has been paid to management indicators to establish a balance between exploration and exploitation. The analysis of the research literature on ambidexterity in universities shows that there is not clear distinction between exploration and exploitation in these institutions, and that relevant factors, such as the effectiveness in exploitation of the follower universities, have not been sufficiently analyzed compared to factors dominated by leading universities.

Regarding the traditional role of universities, the formation and teaching activities, there is not a clear distinction, among the indicators usually implemented in universities, between indicators that measure the training of new professionals and the ones used for measuring the knowledge updating of people who have already a professional career. Further, there is no distinction between the indicators for incremental and radical innovative activities in companies collaborating with universities, nor if these companies are at the same time followers or leaders in the industry. All this information is crucial for the management of universities, the selection of the most suitable strategy to follow, and the use of different management tools to achieve the objectives.

Future research should study the performance of universities on both dimensions, exploitation and exploration, with standardized indicators, and link this performance with resource, strategy and incentive systems. Universities play an essential role in

the knowledge society and medium and small HEIs should understand how to establish their strategy and to employ their limited resources to improve the competitiveness of the industry and society that finance their activity.

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