Academic Spin-offs through the Lens of Pragmatism and Mixed Methods

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Abstracts

Academic spin-offs (USOs) play a key role in technology transfer and economic development, encouraging entrepreneurship and innovation. This study explores the nature and application of the pragmatic paradigm and mixed methods in the study of USOs. The research addresses the central question of how mixed approaches can deepen the understanding of USOs, for which a review of relevant scientific literature was conducted. Furthermore, in our article we approach pragmatism from the principles: combination of methods, synergy of methods, triangulation and validation, flexibility and adaptability, focus on practical utility, practical problem solving, and iteration and theory development, allowing us to examine the applicability of mixed methods and the appropriateness of pragmatic principles in the study of USOs. The findings reveal that the pragmatic paradigm is particularly useful for addressing concrete problems in this context and provides an essential guide for navigating the complex ecosystem of USOs, supporting broader and more effective research efforts that enhance understanding and encourage deeper exploration towards research that integrates mixed methodologies and explains the complexity of academic entrepreneurship, its creation, performance and impact on society.

Keywords: Academic spin-offs, Pragmatic paradigm, Mixed methods, Academic entrepreneurship, Methodological flexibility.

Introduction

Academic spin-offs (USOs) have been demonstrated to be a vital component of regional and national economic development, frequently outperforming other avenues of technology transfer (Lawton, 2023). They play a pivotal role in value creation, innovation promotion, employment growth, and regional economic development (Iacobucci & Micozzi, 2015). This topic is receiving increasing attention in both research and practice, although it remains a specialized area within the field of entrepreneurship (Wright et al., 2012). USOs that originate from research and innovation are ideally situated to commercialize technology and establish sustainable businesses (Dickel et al., 2007). Furthermore, they facilitate job creation and socio-economic development (Hossinger et al., 2020). The extant literature underscores the value of employing mixed methodologies to study USOs, as this enables a more nuanced comprehension of their genesis and performance.

This study aims to address a significant gap in the existing literature on the creation of USOs, which has been limited by a lack of research in a previously unresearched area within this complex ecosystem. The objective of our research is to provide actionable insights that can inform the strategic planning and implementation of USOs in academia, offering valuable guidance to stakeholders. It is our hope that our findings will serve as a guide for navigating the complex landscape of scientific study and analysis of university spin-offs, and that they will contribute to broader research efforts (Mathisen & Rasmussen, 2019).

This study addressed the following research question: What is the nature of the pragmatic paradigm and mixed methods for the study of USOs?

Theoretical Background

1. The nature of the pragmatic paradigm and mixed methods for the study of USOs

qualitative methodology of in-depth analysis of scientific articles was employed to address both the object of study of the USOs and those that suggest the need for research with a mixed approach. The pragmatic paradigm was analyzed, which is characterized by its focus on the practical usefulness of research and its ability to solve concrete problems. This paradigm is flexible and adaptable, allowing for the combination of qualitative and quantitative methods to obtain a more comprehensive understanding of the phenomenon under study. Pragmatism prioritizes the practical application of knowledge and the resolution of pertinent and pressing issues (Kelly & Cordeiro, 2020). Furthermore, mixed methods integrate qualitative and quantitative techniques to provide a comprehensive view of the subject matter (Meixner & Hathcoat, 2019). This strategy permits the triangulation and corroboration of findings across diverse data sources and methods. The implementation of mixed methods can be conducted in a sequential or concurrent manner (Chiang-Hanisko et al., 2016).

The remainder of this study is organized as follows: Section 2 provides a definition of the pragmatic paradigm, exploring its genesis, evolution, and application in scientific research. Section 3 provides an overview of mixed methods, including a description of their key characteristics and an examination of their integration within the pragmatic paradigm. Section 4 presents the designs of the mixed methodology, detailing the different approaches. Section 5

addresses the sampling of the mixed methodology, outlining the methods used to combine data sets in order to obtain representative results. Section 6 is devoted to the data collection and analysis techniques employed in the mixed methodology. In Section 7, we provide a comprehensive account of USOs and mixed methods, with illustrative examples drawn from previous research and a discussion of the benefits of this approach. Section 8 presents a comprehensive analysis of the findings, elucidating their implications within the context of the pragmatic paradigm and mixed methods applied to USOs. In conclusion, we present a summary of the research and discuss its limitations.

2. Definition of the pragmatic paradigm

In the context of scientific research, paradigms are sets of philosophical assumptions and viewpoints that serve as fundamental premises, establish a shared worldview among a group of scientists, and generalize consensus within a scientific field. Paradigms play a pivotal role in guiding research, influencing the interpretation of results, and contributing to the construction of theories and explanatory models in a scientific discipline. They are indispensable for the advancement of science by providing a common framework that facilitates communication and unification of perspectives within the scientific community. A framework that facilitates communication and the advancement of knowledge in the scientific community is proposed by Burrell and Morgan (1979). They suggest that paradigms are a frame of reference that aims to emphasize the joint perspectives that unify the research of a group of theorists (Guba and Lincoln 1994; Lincoln et al., 2018). Four distinct paradigms have been identified: positivist, postpositivist, constructivist, and pragmatic. The latter is notable for its flexibility and comprehensive vision of the object of study.

Pragmatism offers a redefinition of the nature of knowledge, moving away from the notion of a static representation of reality towards a conception of knowledge as a dynamic and evolutionary process. In the context of pragmatism, knowledge is regarded as an instrumentally oriented phenomenon that arises from engagement with the surrounding environment and is validated through practical application. In the view of Peirce, the significance of an intellectual concept is determined by the practical outcomes that can be derived from its veracity (Peirce, 1878). Dewey further develops this concept by proposing that knowledge is generated through an active and experimental process of inquiry, whereby hypotheses are tested within the context of lived experience (Dewey, 1938). In contrast, William James posits that the veracity of an idea is contingent upon its capacity to resolve issues and direct efficacious action (James, 1907). In this way, pragmatism provides an epistemology that is inextricably linked to practical life, where knowledge is perpetually transformed and adapted in order to meet the challenges of the real world.

Pragmatism, from its inception, has been a reaction against rationalism and the prevailing theoretical stance in traditional philosophy. He rejects the notion that philosophy should be a mere contemplation of truth and criticizes the objectifying and impartial character of the researcher (Rorty, 1991). This perspective challenges the dualistic assumptions inherent in traditional philosophical thought, advocating for a view that seeks to restore the continuity of human life. In contrast, pragmatism advocates for the integration of theory and practice. It suggests that knowledge and truth emerge from a dynamic interaction with the environment and

should be evaluated based on their practical utility in addressing concrete problems (Silver, 2022). Pragmatism posits that ideas and beliefs are not fixed representations of an external reality; rather, they are constituted through their use and interpretation in practice (Misak, 2016). Interpretation is a situated and contextual process, whereby meaning emerges from the interaction between the individual and their social and material environment (Bernstein, 1983; Rorty, 1989). From this perspective, interpretation is not merely a mental act; rather, it is an activity that is embodied and mediated by language and cultural practices (Brandom, 1994).

From an ontological perspective, pragmatism presents a vision of the world in a state of constant change and evolution. This view challenges the notion of a fixed and independent reality, suggesting instead that it is shaped by the observer. In accordance with this perspective, reality is perpetually constructed and reconstructed through human actions and experiences. This suggests that the categories and concepts we utilize to comprehend the world are perpetually subject to reevaluation and adaptation in accordance with their practical efficacy (Brandom, 2004; Thoma, 2006; Earley, 2015). In light of these considerations, pragmatism rejects the traditional dichotomy between subject and object, proposing an integrative perspective that considers knowledge as a situated and contingent construction. Pragmatism posits that ideas and beliefs are not fixed representations of an external reality; rather, they are constituted through their use and interpretation in practice (Boersema, 2009; Misak, 2016). Interpretation is a situated and contextual process, whereby meaning is derived from the interaction between the individual and their social and material environment (Bernstein, 1983; Rorty, 1989). From this perspective, interpretation is not merely a mental act; rather, it is an activity that is embodied and mediated by language and cultural practices (Brandom, 1994). In this sense, the pragmatic paradigm is aligned with both an objective and subjective point of view, considering that external reality exists and can be approached through rational and natural methods. This is in contrast to traditional dualism (rationalism/empiricism, subjectivism/objectivism) (Vargas & Acuña, 2020).

Furthermore, pragmatism highlights the significance of interpretation in the human experience. Every interaction with the environment entails an interpretive process whereby knowledge and beliefs are evaluated and adjusted according to their practical utility. This dialectical view of interpretation suggests that critical reflection on actions and their outcomes can lead to new forms of knowledge and action, thereby promoting a continuous process of learning and adaptation (Macarthur, 2017; Baert, 2004; Bernstein, 1983; Rorty, 1989; Brandom, 1994). By conceptualizing epistemology as a theory of research, pragmatism offers a more dynamic perspective on social life, wherein knowledge is constructed through practice and continually adapted to address evolving challenges.

In accordance with Peirce's pragmatist maxim, the notions and objects of conception not only define pragmatism and its method, but also incorporate a realistic semantics and ontology (Beisecker, 2020). The focus of realist semantics is on the meaning of conceptions, whereas the focus of realist ontology is on the real objects that these conceptions represent (Peirce, 1878). Peirce's formulations from 1878 and 1903 exemplify these commitments, demonstrating that ideas and concepts must be evaluated both for their internal coherence and for their practical effects and their capacity to produce tangible results in objective reality (Peirce, 1903). This reinforces the interconnection between theory and practice in pragmatism, suggesting that

intellectual conceptions must be verifiable and grounded in objective reality (Soto, 2021). This integration of thinking and action fosters a continuous feedback and improvement cycle based on empirical experience, thereby establishing a robust framework for the effective application of knowledge (Salas, 2016). Dewey (1938) further asserts that pragmatism places significant emphasis on the role of experience and action in the formation of knowledge. He maintains that ideas must be subjected to rigorous testing and revision in light of their practical consequences.

Conversely, the same author in 1903 emphasizes a realistic semantics, stating that the meaning of an intellectual conception is determined by the practical consequences that could be derived from its truth: "To ascertain the meaning of an intellectual conception, one should consider what practical consequences could conceivably necessarily result from the truth of that conception; and the sum of these consequences will constitute the entire significance of the conception" (Peirce, 1903, p. 59). One should consider what practical consequences could conceivably necessarily result from the truth of that conception; the sum of these consequences will constitute the entire significance of the conception (Peirce, 1903, p. 59). These consequences can only be valid if there is a real object that instantaneates them, implying that the meaning of a conception is intrinsically linked to reality (Allmark & Machaczek, 2018). Scientific realism finds a point of support in the pragmatist notions and objects of conception. These notions acquire relevance to the extent that they generate concrete effects and practical consequences in the way in which individuals relate to the world. The manner in which an object is conceived affects not only the behavior directed towards it, but also the causal interactions that are established between it and other elements, according to their specific characteristics (Kitcher, 2011). In this framework, the concept of an object, interpreted as a mental representation, is considered real within pragmatism, insofar as it is functional and linked to a tangible object that exceeds the mere idea (Pihlström, 2013). From the pragmatist point of view, reality is not exhausted in conceptual constructions; it is manifested in the interaction of objects and their relationships in the physical world. The concept of an object is not merely an abstract idea; rather, it is a tangible entity that has the capacity to produce discernible effects and influence human behavior. In this way, scientific realism finds a basis for affirming the existence of an objective reality in pragmatism, which transcends subjective interpretations and is based on practical experience (Vihalemm, 2013).

The implications of the pragmatic maxim extend to both the realism of theoretical entities (representations, concepts, conceptions, and hypotheses) and ontological realism (the very objects of these representations and concepts). This approach offers a vision of pragmatism in which ideas and theories must be coherent and verifiable through their practical effects and their ability to generate meaningful results in the real world (Allmark & Machaczek, 2018). From the perspective of pragmatism, conceptions are not merely theoretical abstractions; rather, they are operational tools that reflect and affect objective reality. The veracity of a conception is substantiated by its practical consequences and its capacity to yield tangible and pertinent outcomes (Korte & Mercurio, 2017; Kelly & Cordeiro, 2020).

The pragmatic paradigm addresses both deductive approaches derived from quantitative methodology and the incidence of qualitative methodology, which allows for an inductive view. This makes it a useful approach for addressing complex social problems (Hothersall, 2018). In

this paradigm, deductive logic is employed to construct coherent and robust arguments, thereby facilitating the attainment of valuable conclusions within defined contexts. In contrast, inductive logic operates in a process that progresses from the particular to the general. Individual cases or concrete examples are observed, and from these, broader patterns, trends, or generalizations are inferred. In the pragmatic paradigm, inductive logic is employed to generate hypotheses and theories that are grounded in observation and experience of the real world. While these generalizations may not be universally applicable, they are deemed useful and pertinent in specific contexts, as opposed to focusing on abstract reasoning or theoretical premises (Magalhães et al., 2022). The inductive logic is particularly beneficial in circumstances where definitive premises or robust theoretical principles are lacking. In the pragmatic paradigm, it is acknowledged that a considerable number of real-life scenarios are intricate and cannot be adequately addressed through straightforward deductive reasoning. A significant feature of inductive logic in the pragmatic paradigm is its capacity to generate provisional and useful explanations.

It is not a matter of adhering exclusively to one approach or the other; rather, it is a matter of leveraging both approaches as needed, according to the circumstances and the desired outcome. Deductive logic enables the construction of robust arguments based on premises and principles, whereas inductive logic facilitates the generalization of concepts from concrete examples. When employed from a pragmatic perspective, both approaches facilitate informed decision-making and effective problem-solving in the real world (Vargas & Acuña, 2020).

In the pragmatic paradigm, it is acknowledged that each individual interprets and understands the world based on their personal experiences, beliefs, values, and perspectives. This subjectivity influences how information is processed, and knowledge is constructed. This recognizes that subjectivity should not be eliminated or dismissed, but rather, it is an essential component in the construction of meaning (Brau, 2020).

This perspective acknowledges that knowledge is not merely a passive representation of objective reality; rather, it entails an active role of the subject in the construction of knowledge. This participation can range from minimal involvement to near total participation, and it can be shaped by individual and social factors (Vargas & Acuña, 2020).

With regard to the domain of axiology, values assume a significant role in the interpretation of results within the pragmatic paradigm. In contrast to the positivist and postpositivist paradigms, which view values as external to the research process, pragmatism acknowledges the influence of values and perspectives on the selection of explanations and decision-making. This is distinct from constructivism, where these factors play a dominant role throughout the research process, extending beyond the analysis of results (Biddle & Schafft, 2015). Nevertheless, these values are not regarded as insurmountable impediments; rather, they are regarded as components that influence the construction of knowledge and the adoption of practical solutions (Goldkuhl, 2012).

Methodologically, the pragmatic paradigm is flexible and eclectic, allowing the use of different approaches and methods as the situation requires. It advocates action and problem-solving rather than speculation. With regard to causal relationships, the pragmatic paradigm accepts the

possibility of their existence but recognizes that complete and definitive knowledge may be unattainable. Instead of seeking a totality of knowledge, pragmatism focuses on obtaining practical and useful results in research.

Research Objective, Methodology and Data

Mixed Methods

An epistemological analysis of the concept of method in the social sciences reveals two principal approaches. In the continental academic field, the term "method" is used to refer to a set of logical issues, rules, and criteria that serve to guide research practices. In contrast, the Anglo- Saxon approach defines "method" as a set of procedures and techniques that underpin research (Block et al., 2017). The recognition of the diversity in the understanding of the method implies the acceptance that each investigation is a complex process that requires critical decisions at multiple points.

These decisions are not always based on a set of defined rules; a rigid approach may result in automatic decisions without sufficient reflection. This is particularly pertinent in the investigation of intricate social phenomena such as academic entrepreneurship in higher education institutions. Academic spin-offs frequently encounter distinctive challenges that necessitate comprehensive analysis and a malleable methodology to capture the multifaceted dynamics between researchers and their parent institutions (Treibich et al., 2013).

The distinction between quantitative and qualitative knowledge is being challenged by the complexity and variability of social phenomena (Amaturo & Punziano, 2016). In the case of USOs, the challenge of adopting and promoting what has been called the fourth purpose of higher education institutions involves advancing human well-being through the complex process of integrating academic knowledge and the distinctive intellectual capacities of academic groups and units with the necessary skills to generate initiatives that contribute to regional socioeconomic development (Romero et al., 2023), an analysis that requires not only the qualification of the phenomenon for its specificity but also the quantification for its reproduction. These considerations guide the researcher to adjust the techniques to the context instead of forcing the context within predefined techniques.

It is imperative to make traditional positions more flexible and incorporate innovative solutions in the selection of methods. This approach aims to mitigate the weaknesses of individual approaches while enhancing their strengths through their combination. In mixed approaches, the comparison, synthesis, and integration of different techniques present additional challenges (Bezzi, 2012). In the context of USOs, this adaptability is of paramount importance to overcome obstacles and optimize the performance of entrepreneurial teams (Tagliazucchi et al., 2018). In this context, the term "mixed techniques" refers to an emerging approach in the literature on social research in Great Britain and the United States. This approach, known as "mixed methods," is still relatively unknown and underutilized in Latin America (Miller, 2017).

Mixed Methods represent a convergence of two distinct approaches to understanding reality. In the context of an ongoing international debate, a third approach or third movement in social research has emerged (Onwuegbuzie, 2004; Rocco et al., 2003). Mixed Methods is currently

aligned with the pragmatist current, wherein it is presented as an approach to knowledge that considers both theoretical and practical perspectives, as well as qualitative and quantitative positions (Allmark & Machaczek, 2018).

Although the methodological framework has been typified by a dichotomy between quality and quantity, and the positions that support the different ontological, epistemological, and methodological assumptions, the pragmatic approach emerges as an alternative that rejects the paradigmatic divide and advocates the efficient and juxtaposed use of both approaches.

Tab. 1 – Quantitative, qualitative and mixed methodology. Source: Own elaboration.

	Quantitative Methodology	Qualitative methodology	Mixed methods
Definition	Quantitative methodology is an approach to research that focuses on the collection, analysis, and presentation of numerical and quantifiable data to understand patterns, relationships, and regularities in social and natural phenomena. This methodology is based on an objective and positivist perspective that seeks to establish causal relationships and generalizations through measurement and statistical analysis (Babones, 2016).	Qualitative methodology is a research approach used in various disciplines, including the social sciences and humanities, that focuses on understanding and exploring in depth the underlying meanings, interpretations, and contexts of social and human phenomena (Negou et al., 2023).	Mixed methods combine quantitative and qualitative perspectives in research to analyze complex issues in greater depth. It goes beyond simply combining numerical and descriptive results; it is an approach with its own worldview, terminology, and techniques, based on a pragmatic philosophy that emphasizes the implications of action in real-world practice (Grim et al., 2006).
Associated paradigms	It is mainly related to positivism and postpositivism. These paradigms emphasize objectivity, measurement, and the search for regularities and patterns in phenomena (Niño-Zarazúa, 2012).	The qualitative methodology is related to constructivism and interpretativism. These paradigms emphasize the social construction of reality and the subjective interpretation of phenomena (Kolstad, 2013).	Mixed methods reflect pragmatism, which seeks to use the most effective combination of methods to address complex research questions (Lo et al., 2020).
Purpose of Research	it tends to have a confirmatory approach, meaning that it seeks to test or verify previously formulated hypotheses by collecting and analyzing numerical data (Grim et al., 2006).	Qualitative research tends to be exploratory, seeking to understand in depth the meanings and contexts of the phenomena from the perspective of the participants (Mahoney, 2010).	Mixed methods combine confirmatory and exploratory purposes, allowing both the validation of hypotheses and the in-depth exploration of phenomena (Nooraie et al., 2018).
Methods	It mainly uses quantitative methods, such as surveys, experiments, and statistical analyses, to collect and analyze numerical data (Briggs, 2006).	It uses qualitative methods, such as in-depth interviews, participant observations, and content analysis, to collect and analyze rich, contextual data (Verweij, 2013).	It uses both quantitative and qualitative methods, combining approaches to gain a more complete and enriching understanding (Zhou et al., 2024).
Information Collection	Data collection tools in quantitative research include surveys, trials, experiments, quasi-experiments (Turner & Lambert, 2015).	Data collection tools in qualitative research include interviews, observations, document reviews, and visual data analysis (Negou et al., 2023).	Mixed methods can use a variety of data collection tools used by quantitative and qualitative methodologies (Martínek, 2021).
Data	Data collected in quantitative research is typically numerical and is analyzed using statistics to identify relationships, quantitative patterns, and predictions (Western, 2014; Rana et al., 2021)	The data collected in qualitative research is primarily narrative and contextual, capturing the experiences and perspectives of participants (Dewi, 2021).	The form of data in mixed methods can be narrative and numerical, with a preponderance of the latter, allowing a comprehensive analysis of the phenomena (Lo et al., 2020).
Role of logical theory	Theory in quantitative research is based on a hypothetical-deductive model, where hypotheses based on existing theories are proposed and tested using empirical data and statistical analysis (Kim, 2015).	In qualitative research, logical theory follows an inductive logic, where theories emerge from collected data rather than being predefined (Ilic, 2015).	In mixed methods, the theory can follow either an inductive or deductive logic (Proudfoot, 2023)
Sample	The selection of the sample in quantitative research is based on probabilistic methods, where an attempt is made to represent a larger population and generalize the results to this population (Briggs, 2006).	Sample selection in qualitative research is based on intentional methods, where specific participants are chosen who can provide rich and meaningful information (Negou et al., 2023).	Mixed-methods sample selection can combine probabilistic and intentional approaches to obtain a diverse and representative sample (Grim et al., 2006).
Data analysis	Statistical analyses: mainly descriptive and inferential (Grim et al., 2006).	Thematic strategies: categorization and contextualization (Verweij, 2013).	Integration of statistics and thematic strategies (Nooraie et al., 2018).
Reliability and validity	Internal and external validation (Mohajan, 2020).	Integrity, credibility and transferability (Kim, 2015).	Validation and transferability of inferences (Mahoney, 2010).

Table 1 illustrates the fundamental role of quantitative, qualitative, and mixed methodologies in social research. Each methodology is underpinned by a distinct philosophical approach. Quantitative methodology, rooted in positivism and postpositivism, emphasises objectivity and numerical measurement to ascertain causal relationships and regular patterns through experiments and surveys. It aims to confirm pre-existing hypotheses through statistical analyses

(Maksimović and Evtimov, 2023). In contrast, the qualitative methodology, which is based on constructivism and interpretativism, employs tools such as interviews and content analysis to gain a profound understanding of the experiences and meanings associated with social phenomena (Phillips, 2023; Negou et al., 2023). The mixed approach is pragmatic in nature, combining quantitative and qualitative methods to offer both confirmation and exploration. This integration of statistical analyses and thematic strategies allows for a more complete and holistic understanding of social phenomena (Creswell & Plano Clark, 2007; Tashakkori and Teddlie, 1998; Åkerblad et al., 2021).

The intricacies of USOs cannot be fully elucidated through the exclusive use of quantitative or qualitative methodologies. The integration of both approaches offers a more comprehensive and meaningful understanding of the phenomenon (Jick, 1979; Matsui et al., 2020; Wallwey & Kajfez, 2023; King, 2022; Dossett et al., 2020).

Qualitative and quantitative data may be merged, retained as separate entities, or combined in a multitude of ways. Separate but interconnected databases may be maintained (Proudfoot, 2023), or data may be collected simultaneously and subsequently merged through the transformation of qualitative aspects into counts, which are then compared with descriptive quantitative data (Creamer, 2018; Creswell & Plano Clark, 2017).

Nevertheless, this approach may give rise to reproducibility issues and is only applicable insofar as the research question is theoretically sound. The mixed approach is costly and time-consuming, and therefore requires careful consideration. The collection of data necessitates ingenuity, while the interpretation of data requires intuition. However, it is imperative that creative possibilities do not replace critical thinking. Furthermore, practical relevance should not supersede theoretical relevance. The theory remains a fundamental aspect of research (Johnson & Onwuegbuzie, 2004).

Designs of the mixed methodology

These mixed approaches have been gradually developed at the international level in various disciplines (Mertens et al., 2016). Creswell and Plano Clark (2017) posit that the integration of qualitative and quantitative approaches facilitates a comprehensive understanding of a phenomenon by combining the constructivist paradigm with the positivist paradigm, thereby acknowledging the existence of multiple realities (Mertens et al., 2016; Erdmann et al., 2020).

The use of mixed methods entails defining the philosophical assumptions that inform data collection and analysis, as well as determining the optimal timing and manner for employing qualitative and quantitative approaches (Mertens et al., 2016; McKim, 2017). In the field of management, the use of mixed methods has been demonstrated to be an effective approach for the investigation of complex phenomena related to human diversity (Oliveira, 2020). They provide a valuable instrument for addressing the intricacies of academic entrepreneurship (Erdmann et al., 2020).

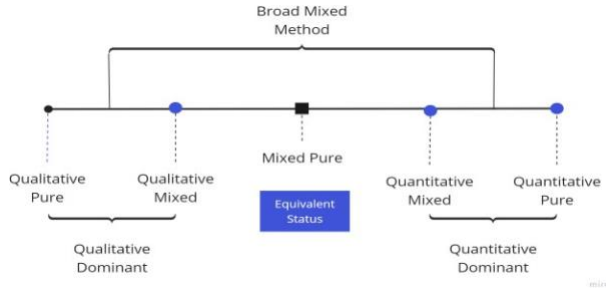

Fig. 1 – Mixed method in the broad sense. Source: Own elaboration based on Johnson and Onwuegbuzie (2004)

There are multiple categories and classifications of mixed methods. When selecting the design of a mixed study, it is crucial to ensure that the research question encompasses both quantitative and qualitative aspects. The decision to utilize mixed methods may vary depending on the circumstances (Adu et al., 2022). This could be due to the need to expand and deepen the findings of a study through the use of a second data source or the inability of either a qualitative or quantitative approach to fully address the complexity of the research problem (Younas et al., 2023). This is particularly relevant in the field of academic entrepreneurship. To ensure the validity of a mixed study design, Creswell and Plano (2017) have identified key points, including: (i) determining a priori the level of interaction between qualitative and quantitative data (partially fused data, completely fused data, or a combination of both); (ii) determining the priority of the research question (predominance of the quantitative or qualitative question or both); and (iii) the timing (simultaneous or sequential) of the collection and analysis of quantitative or qualitative data, thus also determining whether there is dominance between any of the methods or concurrence of both. These considerations are illustrated in the following figure (see Figure No. The most well-known and widely utilized classification of mixed methods (MM) design types, as delineated by Creswell and Plano Clark (2017), is based on the integration timeline and the purpose of integration. The aforementioned classification of mixed methods (MM) design types can be further delineated as follows: (i) convergent parallel design or triangulation, (ii) incorporated design, (iii) explanatory sequential design, and (iv) exploratory sequential design (Figure 2)

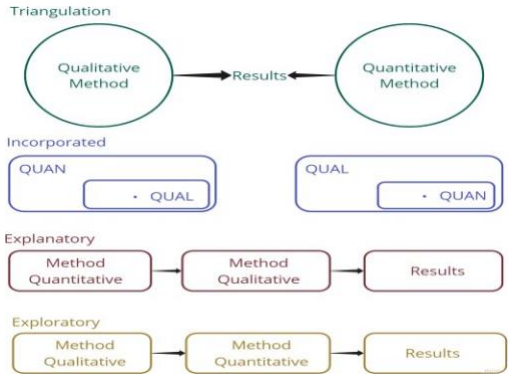

Fig. 2 - Types of Mixed Methodology Design. Source: Own elaboration based on Creswell and Plano Clark (2007); Creswell (2017)

The triangulation approach is one of the most well-known models within the field of mixed methods. In this approach, the researcher collects and analyzes both quantitative and qualitative data simultaneously, with the objective of identifying convergences, differences, or a combination of both. These findings are then interpreted through the lens of confirmation, refutation, cross-validation, or corroboration (Johnson & Onwuegbuzie, 2004). The objective is to offset the shortcomings of each method while leveraging its respective strengths. While ideally both methods are afforded equal weight, in practice, there are instances where one is given precedence. The integration and comparison of the results of both types of data are conducted during the interpretation or discussion phase. This involves presenting the quantitative results initially, followed by the qualitative citations that either support or refute them (Onwuegbuzie & Johnson, 2021). The concurrent collection of quantitative and qualitative data allows for a reduction in the overall time required for data collection compared to sequential approaches (Onwuegbuzie and Johnson, 2021). However, this model has inherent limitations, including the considerable effort and experience required to utilize two distinct methods in an optimal manner. The process of comparing the results of analyses conducted with different forms of data can prove to be challenging (Guetterman & Molina-Azorin, 2023). The resolution of discrepancies when comparing results can be challenging. However, the literature proposes a number of procedures that may be employed to address such discrepancies. These include the collection of additional data, a review of the original database, the development of new insights into the disparity in question, or the undertaking of a new project that addresses the discrepancy in question (Guetterman et al., 2020).

The second approach, the incorporated design, involves the simultaneous or sequential collection of qualitative and quantitative data, with a predominant emphasis on one of the methods (Younas et al., 2023). In most cases, quantitative data are the primary focus, while qualitative data are employed to gain insight into specific aspects of the phenomenon under study. In contrast to the triangulation model, this approach employs a primary method that serves as the project's guiding principle, with a secondary method serving a supportive role. The secondary method is integrated into the predominant method, addressing a different question or searching for information at a

different level of analysis. The integration of data from both methods is conducted in the discussion section of the study; however, they can also be presented in a side-by-side format to provide an overall assessment of the problem (Onwuegbuzie & Johnson, 2021). The concurrent built-in model employs an explicit theoretical perspective to inform the primary method of the study and to obtain broader perspectives through the use of different methods. For example, Morse (1991) proposed that a primarily qualitative design could be enhanced by incorporating quantitative data, thereby improving the description of participants. Similarly, qualitative data can provide insights into aspects of a quantitative study that are not quantifiable. This approach allows for the examination of diverse groups or levels, such as employees and managers in an organizational study, utilizing quantitative methods for some and qualitative methods for others (Proudfoot, 2023; Tashakkori and Teddlie, 1998).

(iii) The explanatory sequential design is a prevalent approach in mixed methods research, particularly among those who favor quantitative methods. This approach comprises two phases: initially, quantitative data are collected and analyzed, followed by the collection and analysis of qualitative data based on the findings of the preceding phase (Hitchcock & Onwuegbuzie, 2020; Quinn, 2023). In general, there is a greater emphasis placed on quantitative data, and the integration of both types of data occurs when the quantitative results inform the qualitative data collection process. Although the data are discrete entities, they are linked by their relationship to the research question and may or may not be informed by an explicit theoretical framework (Creamer, 2022). The explanatory sequential design is employed to elucidate and interpret the findings of a quantitative study through the collection and subsequent qualitative follow-up analysis. This approach is particularly advantageous when the results of a quantitative study yield unexpected outcomes (Morse, 1991; Liu-Lastres, 2024). However, the primary limitation of this approach is the time required for data collection across the two distinct phases, particularly if both phases are of equal importance.

The sequential exploratory strategy is analogous to the explanatory sequential approach, albeit with the phases in reverse order. The initial phase of the study involves the collection and analysis of qualitative data, which is then followed by the collection and analysis of quantitative data based on the findings of the initial qualitative phase (Liu-Lastres, 2024). In this design, greater emphasis is placed on the initial phase, with the qualitative analysis integrated with the subsequent quantitative data collection. The implementation of an explicit theoretical perspective may vary depending on the circumstances. The objective of this strategy is to utilize quantitative data to interpret qualitative findings, with an initial focus on exploring a phenomenon (Grilletes & Tajima, 2022). This design is intended to test elements of an emerging theory of the qualitative phase and to facilitate the generalization of qualitative findings to different samples. Morse (1991) indicated that one of the objectives of this approach is to ascertain the distribution of a phenomenon within a specified population. This strategy is the preferred approach when a researcher is required to develop an instrument due to a lack of suitable or available instruments (Proudfoot, 2023). Conversely, Tashakkori and Teddlie (1998) propose a taxonomy for organizing the design of a research study with a mixed method, based on different designs, which outlines the following procedure:

Tab. 2 – Mixed methodology nomination. Source: Tashakkori and Teddlie (2003).

Nomination	description	Authors
WHICH + WHEN	Both the quantitative and qualitative methods occur at the same time (concurrently)	Morse (1991); Creswell (2015)
WHICH → WHEN	Both the quantitative and qualitative methods occur at the same time (concurrently)	Morse (1991); Creswell (2015)
WHEN → which	Methods occur in a sequence, with qualitative methods occurring before and building upon quantitative methods.	Morse (1991); Morse and Niehaus (2009); Creswell (2015)
WHEN(which)	Capital letters indicate the theoretical impulse or priority (basic methods) given in a study; lowercase indica (complementary methods)	Creswell & Plano Clark, 2007; Plano Clark & Creswell, 2008; Creswell (2015)
WHEN + WHICH= convergence	The equal sign identifies the purpose or justification of the design.	Morse and Niehaus (2009)
WHICH → [HOW → WHICH] → [HOW + WHICH]	The brackets indicate an autonomous project within a series of interrelated studies. The largest source indicates basic methods or theoretical impulse; Smaller font indicates complementary methods	Morse and Niehaus (2009); Creswell (2015)

In both designs, the symbol "+" denotes that the secondary method is being utilized concurrently with the primary method during the same data collection period. Conversely, the symbol "→" signifies that the secondary method was employed subsequent to the collection of the primary data. In terms of capitalization, this indicates the method or approach that is most prevalent within the design. "Which" pertains to qualitative approaches or methods, whereas "when" is associated with quantitative approaches or methods (Cooper et al., 2023), as illustrated in Table 2 (see Table No. 2).

Tashakkori and Teddlie (2003) established that mixed designs are based on the pragmatic paradigm and are part of the third methodological movement. In this sense, Rocco et al. (2003) argue that mixed designs are based on a pragmatic or dialectical stance. Conversely, the dialectical stance posits that a more profound comprehension of a phenomenon can be attained through the integration of disparate paradigms (Schoonenboom, 2019).

Mixed methodology sampling

In mixed methods research, the data collected is typically disordered and rarely suitable for immediate analysis. It is uncommon for researchers to determine the sample size, population, and data collection simultaneously, and the various components of a project are often carried out in sequential phases. In the first component, a quantitative sample is selected and fully analyzed, as this informs the development of the subsequent phases, including the sampling and design of questions. Subsequently, upon completion of the final phase of data collection, further combined analyses may be conducted, and the discussion will synthesize the findings from each phase (Bazeley, 2019).

In mixed methodology, the sampling process requires the researcher to make two key decisions: one regarding the selection of subjects for instrument administration and the other concerning the sample size. The term "sample" denotes a subset of the population chosen to participate in the study, whereas the term "sample size" refers to the number of participants included in the sample. Accordingly, the sample in combined qualitative and quantitative methodologies must ensure representativeness and validity (Johnson & Onwuegbuzie, 2004; Teddlie & Yu, 2007). However, the challenge of selecting both the sample (Uprichard & Dawney, 2019) and the sample size remains. In qualitative studies, smaller samples are typically required, whereas in

quantitative studies, larger samples are necessary (Tashakkori & Teddlie, 2010; Onwuegbuzie & Leech, 2007).

Notable contributors to this field include Hernández et al. (2014); Onwuegbuzie et al. In 2007, the authors recommended minimum sample sizes for both quantitative and qualitative research, which depend on the type of analysis. For correlational analysis, the number of cases should be 64 for statistical hypotheses or single-tailed tests, and 82 for two-tailed tests. For causal or comparative analyses, a minimum of 51 cases per group is recommended for statistical hypotheses or tests of one tail, and 64 for two tails. The decision between a one-tailed or two-tailed hypothesis depends on the research question and the direction of the anticipated effect. If there is a theoretical rationale or a prior hypothesis that suggests a specific direction of the effect, a one-tailed hypothesis may be appropriate. Conversely, if no specific direction of the effect is anticipated or if it is expected that the effect can manifest in either direction, a two-tailed hypothesis can be employed (Cohen, 2007).

In qualitative analysis, Brand (2017) begins with the premise that if the research instrument is the minimum interview, six of these instruments are required. This does not imply a consensus, however, as the author notes that other researchers, such as Krueger and Casey (2014), recommend interviews with six to nine participants, while Johnson et al. (2008) suggest a range of six to twelve. With regard to focus groups, Brand (2017) establishes ranges between six and twelve or eight and twelve participants per focus group. However, there is no established minimum sample size for qualitative research conducted via interview or focus group.

As mixed research is based on a research paradigm that combines qualitative and quantitative methods, the same is true of the minimum sample sizes for research (Johnson & Onwuegbuzie, 2004). The above description can therefore be considered an alternative for determining sample size in mixed methods.

Data collection and analysis technique for the mixed methodology

In a mixed methodology, the techniques employed for data collection and analysis are a combination of quantitative and qualitative approaches (Molina-Azorin, 2016). The quantitative approach involves the use of numerical data to obtain quantitative statistics and patterns. This approach may employ structured surveys, questionnaires, objective measurements, secondary data (records, databases), and controlled experiments (Wallwey and Kajfez, 2023; Zhu et al., In contrast, the qualitative approach is concerned with obtaining descriptive data that helps to understand contexts, meanings, and experiences. This is achieved through the use of in-depth interviews, focus groups, participant observation, content analysis, discourse analysis, and other similar techniques (Zahle, 2023; Opara, 2021).

With regard to the analysis of mixed methodology, it involves the combination of quantitative and qualitative designs in a research study (Johnson & Onwuegbuzie, 2004). Tashakkori and Creswell (2007) and Onwuegbuzie et al. (2009a) indicate that this combination of designs can be conducted through cross-over and non-cross-over analyses. In cross-analysis, the utilization of disparate designs and analytical techniques facilitates the reduction, visualization, correlation, or integration of data, thereby underscoring a heightened integration between quantitative and qualitative paradigms. In non-cross-over analyses, data analysis is conducted within the same

paradigm, either quantitative or qualitative. However, Plano-Clark and Ivankova (2017) acknowledge the challenges associated with integrating different research designs, citing the lack of guidance and experience among researchers. It is, therefore, essential to consider these challenges and identify strategies to overcome them. This mixed methodology has the potential to address complex research questions and enhance the understanding of the phenomenon under study (González & Ricalde, 2021).

In her 2017 proposal, Brand outlines various types of analysis within a mixed methodology, including the number of data types, which can be either single or multitype. In the single-type approach, a single type of data, either quantitative or qualitative, is employed for the purpose of analysis. To illustrate, a study may employ solely quantitative data for the analysis of survey responses. In the multitype approach, both quantitative and qualitative data are employed in the analysis. For instance, a study may integrate quantitative data from a survey with qualitative data from interviews to gain a more comprehensive understanding of the phenomenon under investigation. The second category is that of data analysis type number, which encompasses mono-analysis. This refers to the use of a single type of analysis, either quantitative or qualitative, in a research study. In this approach, a single method of analysis is employed to examine the data collected. Multi-analysis, in contrast, entails the utilization of both quantitative and qualitative analytical techniques within a single research study. This approach entails the application of both quantitative and qualitative analysis methods for the examination and comprehension of the data collected.

Additionally, the analysis of data mixtures is a further category of analysis (iii). 1. The process of triangulation entails the utilization of a plurality of data sources or methodologies to examine a research phenomenon from disparate perspectives. 2. Complementarity refers to the use of different methods or approaches that are mutually reinforcing. 3. The term “development” is used to describe the process of building and improving a mixed methodology over time. 4. Initiation represents the commencement of a research study employing a mixed methodology. The concept of expansion implies that the methodology should be expanded and enriched as the study progresses (Forni & De Grande, 2020).

Finally, the forms of data analysis can be classified into four categories. These include parallel, concurrent, and sequential approaches. In the parallel approach, an independent analysis of quantitative and qualitative data is conducted prior to further analysis. In the concurrent approach, the data are analyzed simultaneously. In the sequential approach, the data are analyzed in a series of specific stages (Onwuegbuzie et al., 2007b; Onwuegbuzie et al., 2009; Onwuegbuzie & Poth, 2015).

Validity and reliability of the mixed methodology

The concept of validity, as it pertains to the accuracy and robustness of the results obtained through the mixed methodology, is of particular significance. In the context of this methodology, achieving validity necessitates the use of multiple data sources in conjunction with comprehensive analysis. The strategy of triangulation, which involves the convergence of diverse data sources and research approaches, is fundamental to the raising of validity in mixed methodology (Greene et al., 1989).

In terms of reliability, the mixed methodology is notable for its emphasis on consistency and stability of results. A meticulous approach to data collection and analysis, together with transparency and clarity in procedures, is the foundation for achieving consistency in results (Johnson & Onwuegbuzie, 2004). It is crucial to underscore that the validity of any research, irrespective of the methodology employed (whether quantitative, qualitative, or mixed), ensures that empirical measurements meet the minimum requisite standards. Accordingly, the resulting findings are optimal for supporting the inferences proposed in the conclusions.

Tab. 3 – Validity and reliability of the Mixed methodology. Source: own research

Precept	Description	Authors
Triangulation	It involves the convergence of multiple data sources and research methods to increase validity in the mixed methodology.	Forni and De Grande. (2020)
Solid conceptual framework	Use a strong conceptual framework to guide the design and implementation of mixed research to improve validity.	Turner et al. (2017).
Well-established methods and techniques	Use well-established methods and techniques in the mixed methodology to achieve the reliability of the results.	Zhang y Smith. (2023)
Systematic and replicable process	Follow a systematic and replicable process in data collection and analysis to ensure reliability in the mixed methodology.	Nessle et al. (2023)
Suitable mixed research design	Use an appropriate mixed research design that fits the objectives of the research to improve reliability.	Sharma et al. (2023)
Content validity	Evaluate content validity to ensure that empirical measurements meet established minimums.	Greene y Hall, J. (2010). Hair et al., (2020)
Construct Validity	Evaluate construct validity to ensure that measurements adequately reflect theoretical concepts.	Hair et al. (2016), Aldas(2016), Martínez et al., (2020), Hair y Alamer (2022)
Criterion validity	Evaluate the validity of criteria to establish the relationship between measurements and external criteria.	Zhou y Wu. (2020), Fetters y Molina-Azorin (2017)
Methods for quantitative and qualitative methodologies	Develop the methods for each methodology separately up to the interface point.	Nessle et al. (2023)
Sampling Principles for Quantitative and Qualitative Methodologies	Determine the strategy and sample size for each methodology, bearing in mind the data analysis priority decision.	Zhou and Wu. (2020)
Interface point in quantitative and qualitative methodologies	Interface in the data analysis step or in the research results section.	Nessle et al. (2023)

In order to ensure the integrity and reliability of mixed methodologies, it is essential to consider certain aspects related to the previous table (No. 3), which is based on the pragmatic approach. Firstly, triangulation is identified as a crucial methodology, facilitating the convergence of disparate data sources and research approaches to enhance the validity of results. Furthermore, the necessity of a robust conceptual framework is underscored, as it not only directs research but also enhances validity by anchoring inquiry in robust theories (Nessle et al., 2023). Similarly, the use of established methodologies and techniques, in conjunction with adherence to systematic and replicable processes, serve as fundamental tenets in ensuring the reliability of the resulting data. It is of the utmost importance to employ an appropriate mixed research design that is aligned with the stated objectives in order to guarantee the cohesion and reliability of the findings. Furthermore, the assessment of content, construct, and criterion validity is underscored. The necessity of developing particular sampling techniques and principles for each quantitative and qualitative methodology is underscored prior to initiating the interface process, which may occur during data analysis or in the presentation of results (Hair et al., 2016; Aldas, 2016).

USOs and mixed methods

The concept of USOs has been defined by a variety of taxonomies in order to facilitate comprehension of the diverse phenomena that it encompasses. The taxonomy based on the university's attitude differentiates between passive and planned spin-offs. Passive spin-offs may

be initiated by any member of the university community without the necessity of institutional support. In contrast, planned spin-offs are created with the support of the university and have clear objectives, such as promoting entrepreneurship and technology transfer (Buratti et al., 2021; Klein & Pereira, 2021; Lemes, 2015). Another classification is based on the status of members of the academic community, differentiating academic entrepreneurship initiatives according to the role of the participants, which may include researchers, doctoral students, professors, support staff, and external individuals (Kromydas, 2017; Soetanto & Jack, 2016). In particular, spin-offs established by students and alumni necessitate institutional involvement to be classified as such, thus preventing confusion with start-ups (Fryges & Wright, 2014; Beraza & Rodríguez, 2012).

Additionally, the taxonomy takes into account whether the researcher responsible for the concept ultimately assumes the role of an entrepreneur. If the spin-off is promoted by the researcher, it is classified as an initiative developed within the university for the purpose of commercialization (Poponi et al., 2020). In contrast, orthodox spin-offs are those in which the researcher remains at the university while the venture is commercially exploited by third parties. Hybrid vaccines, in contrast, integrate aspects of both modalities (Vega et al., 2018). A technology spin-off may be led by the developer of the technology in question, who may be referred to as the "LED inventor," or it may be led by an external buyer, who may be referred to as the "LED shopper." In the first case, the creation process is conducted by the developers of the technology themselves, whereas in the second, external entrepreneurs exploit the invention through licenses granted by the university (Fryges & Wright, 2014; Beraza & Rodríguez, 2012). Furthermore, a distinction is made between patented and non-patented technology. Patented technology-based companies are created to exploit a license, whereas non-patented technology-based companies are based on generic developments or specific knowledge of the researcher (Meoli & Vismara, 2016). In terms of financing, two categories of spin-offs can be identified: those that receive external capital and those that do not. Spin-offs that receive external capital are typically supported by large organizations or angel investors, which can be seen as an indicator of quality and success in the evaluation processes (Beraza & Rodríguez, 2012). Spin-offs are also distinguished by the type of activity in which they engage: consulting and R&D contracts, the development of specific products or processes, and those focused on technological assets (Beraza & Rodríguez, 2012).

Despite the existence of various taxonomies and definitions of USOS in the literature, the analysis of these lacks a holistic approach that addresses their creation and development, considering the combination of diverse actors and resources involved in the process. Additionally, it should be noted that studies on the creation of USOs are scattered, with the majority of articles on academic entrepreneurship and USOs adopting a quantitative methodology, as reported by Hossinger et al. In 2020, 74.61% of studies employed a quantitative approach, while only 21.24% utilized a qualitative approach, and only 4.15% employed a mixed methods approach. This illustrates a significant gap in research that addresses both approaches.

Similarly, Romero et al. (2024a) indicate in a systematic literature review that of the 37 studies selected for analysis of university-industry collaboration in the creation of public university spin-offs, only 11 employed mixed methods, while the remaining 26 were conducted using traditional

approaches, namely qualitative and quantitative. In their study on the intention of academic entrepreneurship, Neves and Brito (2020) identified only two articles employing mixed methodologies, in comparison to the 51 articles employing a quantitative approach and the 13 articles employing a qualitative approach.

The scientific community has shown a marked increase in interest in academic entrepreneurship and spin-offs within the university environment. However, the literature on this topic continues to be fragmented and presents limitations in its theoretical development (Guerrero et al., 2017; Clauss et al., 2018; Mathisen & Rasmussen, 2019). As Teran et al. (2020a) have noted, there is a need for more systematic and holistic research (Hayter, 2015; Wright et al., 2017). With regard to the methods used, there has been a growth in quantitative studies that apply various statistical and econometric techniques. However, the existing research evidence reveals a number of gaps in the current knowledge base, indicating a need for further investigation into the economic, social, institutional, organizational, and individual factors affecting USOs in future studies. Furthermore, it is advised that future research integrate both qualitative and quantitative approaches to offer a more comprehensive and nuanced understanding of the phenomenon of academic entrepreneurship and USOs within the university context.

Similarly, Romero et al. (2024b) conducted a systematic review of literature on academic entrepreneurship and the performance of USOs. Of the 40 articles reviewed, only four employed a mixed approach, while 22 were quantitative and 14 were qualitative. Dabić et al. (2020) employed a combined qualitative content analysis and quantitative multiple correspondence analysis approach to examine the evolution and future of USOs. This combination enabled the authors to map trends and provide a comprehensive reflection on the background, decisions, and outcomes of USOs over time. They also highlight that those authors such as Taheri, Ye, and Geenhuizen employ a mixed methodology to explore how USOs manage openness in their knowledge networks, using a quantitative approach to analyze 105 spin-offs to assess the background and effects of diversity in knowledge networks on company growth. Furthermore, a qualitative approach is employed through case studies, which facilitate an in-depth examination of the distinctive dynamics of these companies. This mixed approach allows for a comprehensive understanding of how to comprehend academic spin-offs and management companies in terms of their openness in knowledge networks and the impact of this openness on their growth. Furthermore, it explores the background factors that influence the diversity of these companies' knowledge networks, such as the previous experience of the founders, geographic location, and examines how this diversity affects business performance and growth (Taheri et al., 2018)

Conversely, Terán (2020) examines the methodologies utilized in the most cited articles and the research methods employed in studies pertaining to academic entrepreneurship and the establishment of USOs in his doctoral thesis, entitled “Academic Entrepreneurship: Determinants in the Entrepreneurial Intention of University Researchers.” The majority of these studies are empirical in nature. No research was identified that combined qualitative and quantitative data from the same set of individuals, firms, industries, or countries. The most frequently cited authors are as follows: Rasmussen et al. (2014) with The influence of university departments on the evolution of entrepreneurial competencies in spin-off ventures, Rasmussen and Wright (2015) with How can universities facilitate academic spin-offs? An entrepreneurial

competency perspective, Rasmussen et al. (2015) with The transformation of network ties to develop entrepreneurial competencies for university spin-offs, Hayter (2015) with Public or private entrepreneurship? Revisiting motivations and definitions of success among academic entrepreneurs, Criaco et al. (2014) with "To have and have not": Founders' human capital and university start-up survival, Czarnitzki et al. (2014) with University spin-offs and the "performance premium", Berbegal-Mirabent et al. (2015) with Can a magic recipe foster university spin-off creation?, Meoli and Vismara (2016) with University support and the creation of technology and non-technology academic spin-offs, Muscio et al. (2016) with The effects of university rules on spin-off creation: The case of academia in Italy, and Bolzani et al. (2014) with University spin-offs and their impact: Longitudinal evidence from Italy. Of the studies identified, only four employ a qualitative methodology, while six utilize a quantitative approach. Notably, none of the studies employed a mixed methodology.

Civera et al. (2019) posit that a paradigm shift is necessary to address the multifaceted factors influencing the commercialization of university knowledge. However, extant studies tend to overlook the role of entrepreneurial behavior beyond the creation of USOs, which constrains our understanding of the economic impact of academic entrepreneurship. This is due to the inherent difficulty in identifying a single, comprehensive approach to address this complex phenomenon. Laage-Hellman et al. (2020) emphasize that the majority of previous studies have approached USOs from a linear perspective. They suggest that the interaction between USOs and academia is dynamic and continuous, and therefore cannot be analyzed from traditional approaches alone.

The extant literature presents a scattering of studies on the creation of USOs. However, the topic has not been addressed predominantly with comprehensive methods that take into account the determining factors that influence the creation and performance of USOs. This is in accordance with the findings of Teran et al. (2020a) and Gilsing et al. (2010). Consequently, there is a need to integrate more holistic paradigms, such as pragmatics, and to carry out mixed methodology approaches that allow for a comprehensive understanding of their creation and development.

Results and Discussion:

Some implications of the pragmatic paradigm applied to USOs

Methodological research based on mixed methods and pragmatism is informed by a series of key principles that guide the design, implementation, and analysis of studies. These principles are fundamental to enhancing the validity, applicability, and robustness of findings, integrating diverse methodological perspectives and adapting to research questions (Johnson et al., 2007; Tashakkori & Teddlie, 2003; Creswell, 2015). These principles facilitate an understanding of the investigated phenomenon and describe seven key principles: (i) Combination of methods, (ii) synergy of methods, (iii) triangulation and validation, (iv) flexibility and adaptability, (v) adaptation to research questions, (vi) practical problem solving, (vii) iteration and development of theories

(i) The combination of methods refers to the integration of qualitative and quantitative approaches, as outlined by Johnson et al. (2007) and Tashakkori and Teddlie (2003) emphasize the significance of capturing both the contextual depth and richness of qualitative data, as well as the generalization and quantification provided by quantitative data. Creswell (2015)

underscores that this integration facilitates triangulation, whereby the combination of methods not only enhances the value of individual findings but also provides a more comprehensive and nuanced understanding of the phenomenon under investigation.

To illustrate this principle, we may cite the article "University spin-off firms' struggle with openness in early knowledge relationships: in search of antecedents and outcomes," by Taheri et al. In 2018, surveys and qualitative interviews were employed to examine the openness in the knowledge relationships of USOs. This approach enabled the collection of qualitative data in depth and facilitated a more contextualized understanding of the study phenomenon. The quantitative component aimed to generalize the analysis of the object of study. This would allow the replication of how knowledge relationships, which are crucial for the creation and behavior of USOs, can be applied in diverse contexts. This is in line with the findings of Johnson et al. (2007) and Tashakkori and Teddlie (2003). In the article "University spin-offs: the past, the present, and the future" (Dabić et al., 2022), the principle of Method Combination is evident in the study's methodology, which incorporates a systematic review of the literature in conjunction with a Multiple Correspondence Analysis (MCA). The systematic review offers a structured and comprehensive approach to identifying and evaluating the existing literature on USOs, while the MCA provides an in-depth qualitative analysis by mapping the relationships between multiple variables.

The article "A market for ideas intermediator framework for academic spin-off companies: expanding understanding of the commercialization of technology" (Hamanaka-Gusberti et al., 2018) employs a combination of methods, including qualitative case studies and quantitative analyses. Qualitative case studies facilitate a comprehensive and detailed understanding of the context and specific dynamics of spin-offs, whereas quantitative analyses offer generalizable data and patterns that can be applied to a broader spectrum. This integrated methodology is essential for navigating the intricate dynamics of technology commercialization in academic and business settings. The qualitative data obtained from interviews with entrepreneurs and technology evaluation discussions provide an in-depth understanding of the experiences and decisions made during the period preceding the establishment of the spin-off. Conversely, quantitative data derived from surveys and other sources enables the identification of trends and statistical relationships that complement and validate qualitative findings, thereby providing a more comprehensive perspective of the phenomenon under investigation.

The second principle, that of methodological synergy, entails the complementary use of qualitative and quantitative methods to enhance the analytical process. As Johnson et al. (2007) and Greene et al. (1989) have observed, this integration allows researchers to capitalize on the strengths of each approach while compensating for its weaknesses.

As demonstrated by the article "University spin-off firms' struggle with openness in early knowledge relationships: in search of antecedents and outcomes" (Taheri et al., 2018), the application of the principle provided a comprehensive overview of knowledge relationships in USOs. This approach enabled researchers to leverage the strengths of each method while addressing its limitations. The study revealed intricate and non-linear dynamics in knowledge relations, emphasizing that open innovation is a more expansive concept than merely openness in knowledge relations. It encompasses both the innovation process and the innovative activities,

which are distributed among multiple partners within a network. This openness in knowledge relationships is specific to USOs. A comprehensive approach necessitates the use of both qualitative and quantitative analyses, which allows for the mitigation of the weaknesses of the approaches as suggested by Johnson et al. (2007) and Greene et al. (1989).

Meanwhile, the article "University spin-offs: the past, the present, and the future" (Dabić et al., 2022) illustrates the integration of quantitative and qualitative methods from the perspective of the principle of Synergy of Methods. This integration creates a synergy that enriches the analysis and deepens the understanding of the phenomenon of USOs. From one perspective, the deployment of quantitative bibliometric techniques enables the identification and quantification of trends and patterns in the literature on university spin-offs over a period of 35 years. Conversely, a systematic review of the qualitative literature provides a more detailed context, thus enabling bibliometric data to be interpreted in a more comprehensive manner. This combination of complementary approaches enables the authors to not only map the existing research landscape but also to identify gaps and suggest future research directions. These include exploring the role of digital transformation and venture capital in different regions and fostering entrepreneurial talent in the context of higher education and the quadruple helix. This offers a complete understanding of the connections between USOs and the needs of stakeholders. By integrating these methods, the study succeeds in providing a nuanced understanding of trends and patterns in research on USOs, such as the importance of entrepreneurial culture, governance, and innovation. Furthermore, it advocates for the use of mixed and multidisciplinary methodological approaches in future research. Furthermore, the study underscores the necessity for efficacious policies and the advancement of entrepreneurial ecosystems to enhance the efficacy and productivity of USOs.

In the study "A Market for Ideas: An Intermediary Framework for Academic Spin-Off Companies: Expanding Understanding of the Commercialization of Technology" (Hamanaka-Gusberti et al., 2018), the data collection strategy encompasses both qualitative interviews and quantitative survey data. Qualitative data obtained from interviews permits researchers to explore participants' experiences and perceptions in depth, thereby revealing contextual and detailed understandings that would not be evident through quantitative methods. For instance, interviews can discern factors that inform marketing decisions and interaction dynamics among stakeholders. Conversely, quantitative data obtained from surveys permit the identification of general patterns and trends, thereby providing empirical validation of qualitative findings. For example, intermediaries, networks, and innovative business models affect the success of academic spin-offs. Furthermore, it underscores the significance of grasping the perceptions and experiences of spin-off founders and managers to devise more efficacious marketing strategies. Furthermore, the research revealed the pivotal role of intermediaries in the commercialization of technology, the significance of networks and collaborations, and the necessity for innovative business models that facilitate the effective transfer of knowledge and technology from universities to the market. This synergistic approach, which combines the methods, allows the study to offer an understanding of the complexities involved in technology commercialization in the context of USOs.

(iii) Triangulation and validation are essential processes to improve the credibility and validity of findings. As Johnson et al. (2007) and Allmark and Machaczek (2018) have observed, the use of multiple data sources and methods allows for the validation of results through the convergence of evidence from different perspectives. This approach serves to reduce bias and increase confidence in the accuracy of findings, thereby ensuring robust and reliable results.

In the context of the article "University spin-off firms' struggle with openness in early knowledge relationships: in search of antecedents and outcomes" (Taheri et al., 2018), the use of multiple methods and data sources is employed to investigate the influence of organizational background on the openness of knowledge relationships and their impact on the growth of USOs. The objective is to enhance the credibility and robustness of the findings by corroborating results applying diverse approaches and perspectives. The triangulation and validation of findings can be observed in several aspects of the study. For example, the triangulation of methods involved the use of a quantitative approach based on structured surveys to collect data from 105 university spin-offs in the Netherlands and Norway. The quantitative data were subjected to analysis using both linear and nonlinear regression techniques, with a view to identifying the influences of various factors on openness and growth. The qualitative approach is complemented by case studies, which provide a more profound and contextually nuanced understanding of the dynamics within USOs. The presented cases illustrate contrasting scenarios and trends pertaining to the openness and growth of USOs. While openness in knowledge relationships is a crucial factor, it is not a guarantee of linear growth. In some instances, the returns diminish. The research identifies factors such as the size of the founding team and educational diversity as key influences on openness, thereby underscoring the existence of critical points in the evolution of openness and their impact on the growth of USOs.

The principle of triangulation and validation is clearly demonstrated in the article "University spin-offs: the past, the present, and the future" (Dabić et al., 2022). The study validates its findings through the combined use of multiple correspondence analysis (MCA) and a systematic review of the literature. Multiple correspondence analysis offers a visual and statistical representation of the relationships between the various variables and descriptors utilized in studies on university spin-offs. By employing this technique, the authors are able to identify significant patterns and trends, including the exponential growth in research on USOs after 2013, driven by policies supporting technology transfer. Additionally, the definitions of USOs have evolved to include both formal and informal technology transfer, and social networks are crucial to the success of USOs, providing access to resources and financing. Furthermore, there is an increasing emphasis on sustainability, particularly in emerging economies, underscoring the significance of national innovation systems and competitiveness. Concurrently, the systematic review of the literature serves as a secondary validation method, whereby the findings of previous research are collated and synthesized. This convergence of multiple studies not only serves to reinforce the robustness of the conclusions reached, but also allows for the identification of recurring and empty themes within the existing literature. The integration of these two methodological approaches ensures that the results are not based on a single type of analysis, but rather represent the product of a triangulation of methods, thereby enhancing the reliability and validity of the conclusions. Notwithstanding the absence of triangulation of data from multiple qualitative sources, the methodology employed by the authors evinces a high

degree of rigor. The convergence of results from numerous previous studies provides indirect validation, confirming the robustness of the interpretations presented. This methodological strategy, although primarily quantitative, provides a robust and validated foundation for the article's assertions and recommendations, emphasizing the significance of triangulation and validation in academic research.

In the article "A Market for Ideas: An Intermediary Framework for Academic Spin-Off Companies: Expanding Understanding of the Commercialization of Technology," (Hamanaka-Gusberti et al., 2018), multiple data sources and methods were employed for triangulation, thus enhancing the validity of the results by reducing bias and increasing accuracy. This approach ensures the robustness and reliability of the results, as it allows for the comparison and contrasting of disparate data and insights, thereby providing cross-validation. In this study, triangulation was achieved through a combination of three methods: interviews with entrepreneurs, technology evaluation discussions, and direct observations. The interviews yielded qualitative data pertaining to experiences and challenges, while technology assessment discussions focused on capabilities and opportunities. Direct observations, in turn, offered a practical perspective. The integration of data from multiple sources enabled the results to be validated from disparate perspectives, thereby enhancing the credibility of the findings. The use of triangulation is particularly pertinent in the field of technology commercialization studies, as it enables the examination of a range of factors, including networks and personal contacts, access to financial resources, and institutional support. The integration of these perspectives enables the capture of the complexities and nuances of technology commercialization in the context of university spin-offs.

Methodological designs that are flexible and adaptable allow for the adjustment of research strategies according to the objectives and needs of the study. As Johnson et al. (2007) and Allmark and Machaczek (2018) have noted, it is crucial to adapt the methodology in response to the preliminary findings and the evolving circumstances of the research environment. Pragmatism, as proposed by Dewey (1931), also supports this principle, emphasizing the necessity for researchers to be receptive and adjust their methodological approaches in order to maximize the relevance and usefulness of their research.

As observed in the article "University spin-off firms' struggle with openness in early knowledge relationships: in search of antecedents and outcomes" (Taheri et al., 2018), the principle of flexibility and adaptability is reflected in the necessity to adjust and capitalize on capabilities to survive and reach the subsequent stage of growth, despite facing uncertainty and risk. Furthermore, it is evident that founders must remain flexible and explore a range of external knowledge opportunities to prevent the stagnation and obsolescence of knowledge interactions and routines.

The principle of flexibility and adaptability is clearly evident in the article "University spin-offs: the past, the present, and the future" (Dabić et al., 2022). This study illustrates adaptability through the inclusion of a diverse range of organizational and contextual factors, including the size of the founding team, the prior experience of the founders, the level of education, and educational diversity. Additionally, control factors such as geographic region and sector type are also considered. The research addresses the complexity of USOs by employing a combination

of linear and nonlinear models, as well as a range of regression techniques and multiple correspondence analysis. Furthermore, the longitudinal design of the study enables the observation of changes and developments in the establishment and expansion of USOs. However, the absence of formal qualitative methods constrains the flexibility with which the results can be interpreted. The incorporation of qualitative methodologies could have furnished a more nuanced and contextualized understanding of the factors that shape openness and growth, particularly in relation to specific backgrounds. Notwithstanding this limitation, the study evinces considerable flexibility and adaptability through its integration of multiple factors and non-linear relationships, as well as its ability to adapt to the diverse contexts of USOs in different regions and sectors.

In the article "A Market for Ideas: An Intermediary Framework for Academic Spin-Off Companies: Expanding Understanding of the Commercialization of Technology" (Hamanaka-Gusberti et al., 2018), the methodology employed was continuously adapted throughout the study in order to address emerging problems and changing needs of USOs. The researchers integrated interviews with entrepreneurs and technology assessment discussions into an action-based case study, thereby enabling real-time adjustments to research strategies. This methodological integration permitted the researchers to collect pertinent data and modify their methods in accordance with the particular requirements of the USOs and the evolving circumstances of the investigated environment. The study demonstrated flexibility in methodology at various stages. For instance, during the data collection phase, the researchers identified particular challenges encountered by USOs in the initial stages of commercialization and adjusted their data collection strategies to gain a more profound understanding of these challenges. Similarly, the methodology was adapted to incorporate a range of data sources, including interviews, direct observations, and technology assessment discussions. This approach facilitated effective triangulation of data and cross-validation of findings. Moreover, the researchers' capacity to adapt their methodology allowed them to respond to the evolving needs of the USOs as they developed. Moreover, when new issues emerged or when USOs altered their marketing strategies, researchers modified their analytical techniques to align with these developments.

(v) The emphasis on practical utility entails the assessment of theories and research in accordance with their capacity to address tangible issues. The article assesses the applicability and utility of extant theories and research in the context of university spin-offs. The practical knowledge provided is directly applicable to the improvement of spin-off management and performance, ensuring the findings are useful to the relevant actors. Pragmatism, as posited by Allmark and Machaczek (2018), entails the production of knowledge that is immediately applicable and beneficial in tangible settings.

The article "University spin-off firms' struggle with openness in early knowledge relationships: in search of antecedents and outcomes" employs a pragmatic approach, offering practical recommendations on how USOs can enhance their openness and management practices to facilitate growth. The practical implications of the study are clearly delineated in the discussion, offering specific advice on the importance of factors such as educational diversity, previous experience of founders, and experience in innovation. For instance, the study proposes that diversity in founder education and innovation experience are pivotal factors in enhancing

openness in knowledge networks, which can subsequently facilitate company growth. Furthermore, the necessity of establishing an appropriate equilibrium between openness and the avoidance of information overload in the context of managing relationships with multiple partners is underscored. These practical recommendations provide USO managers with clear and actionable guidelines to improve their openness and management strategy, thereby demonstrating the study's focus on practical utility and its ability to address real-world problems in the context of USOs.

The article "University spin-offs: the past, the present, and the future" (Dabić et al., 2022) presents a clear focus on practical utility, providing a solid framework for the implementation of strategies that improve the openness and management of USOs. This practical approach is articulated through specific recommendations derived from a systematic literature review and multiple correspondence analysis, thereby ensuring that the proposals are based on robust empirical evidence. The practical implications of the study are delineated in exhaustive detail in the discussion. For CEOs of spin-off companies, the article underscores the significance of maintaining a diverse and open knowledge network, outlining effective strategies for its management. This approach enables CEOs to integrate the study's findings into their daily management practices, thereby enhancing the growth and sustainability of spin-offs. Moreover, the study offers invaluable guidance for university administrators, emphasizing the necessity for institutional policies and practices that promote collaboration and knowledge sharing. The recommendations include the implementation of specific support programs within universities, the facilitation of technology transfer and academic entrepreneurship, and the promotion of a more favorable environment for the development of spin-offs. The article offers policymakers guidance on the creation of regulatory frameworks that facilitate the development of USOs. It provides suggestions for the design of financing programs, tax incentives, and other support mechanisms. By directly addressing the needs of USOs from a policy perspective, the study contributes to the formulation of more effective policies adapted to the realities of academic entrepreneurship.

In their article, "A Market for Ideas: An Intermediary Framework for Academic Spin-Off Companies: Expanding Understanding of the Commercialization of Technology" (Hamanaka-Gusberti et al., 2018), the authors emphasize the significance of practical utility, elucidating their findings and proffering actionable insights that can enhance technology commercialization practices in USOs. By identifying the specific difficulties encountered by these companies during the initial stages of commercialization, the article presents practical solutions that can be implemented without delay. For instance, the implementation of flexible and adaptable business models is advised, as this allows USOs to respond effectively to market challenges and capitalize on emerging opportunities. These strategies enhance the capacity of USOs to oversee technology transfer while optimizing their innovation processes, thereby increasing the probability of long-term success. Furthermore, the emphasis on the practical applicability of the results is reflected in the fostering of robust networks and collaborations with industrial partners and investors, as well as the active pursuit of funding from a range of sources. Furthermore, it is of paramount importance to leverage the available institutional support, conduct periodic technology assessments, and maintain a flexible and adaptive approach to market changes. Furthermore, investments must be made in continuous team training and adequate protection of intellectual

property to maximize the commercial value of innovations. These practical recommendations ensure the applicability and relevance of the results obtained. The concrete and actionable recommendations can improve the efficiency and effectiveness of the commercialization of technologies, thereby contributing significantly to the growth and sustainability of the USOs.

(vi) The central tenet of pragmatic inquiry is the resolution of practical problems and the improvement of practice. Pragmatism and Allmark and Machaczek (2018) emphasize that research should concentrate on offering tangible and efficacious solutions to the observed issues, thus enhancing the applicability and relevance of the findings. This practical approach ensures that research has a tangible and positive impact on the contexts in which it is applied, aligning with Dewey's (1938) perspective on the usefulness of knowledge.

In the wake of the article "University spin-off firms' struggle with openness in early knowledge relationships: in search of antecedents and outcomes" (Taheri et al., 2018), research has increasingly focused on the practical challenges faced by USOs, including the lack of legitimacy and financial resources, the difficulty in managing the diversity of knowledge flows, and the challenge of striking a balance between openness and management capacity. Furthermore, the size of the founding team and the diversity of educational backgrounds also present challenges in the establishment of open knowledge networks. In order to address these issues, the article recommends that USOs diversify their knowledge partners and encourage training in market-related areas in order to facilitate the resolution of practical problems. Furthermore, the article proposes that USOs enhance flexibility in managing their partner relationships and utilize patents as a means of augmenting the legitimacy and visibility of these entities.

The research presented in the article "University spin-offs: the past, the present, and the future" (Dabić et al., 2022) addresses critical practical issues facing USOs, with a particular focus on strategies for enhancing their performance and growth. The study examines the evolution of USOs, identifying successful practices and common challenges. It furnishes an empirical foundation for USOs to gain a deeper comprehension of the dynamics of technology transfer and the role of public policies in its advancement. The article also offers recommendations to different actors of the USOs. For CEOs of USOs, it determines the importance of collaborative networks and efficient management of resources. For university managers, it emphasizes the need to foster an entrepreneurial culture and provide adequate structural support. For policymakers, it underscores the relevance of designing programs that facilitate collaboration between universities and industry in such a way that USOs address and overcome the specific challenges they face, ensuring their competitiveness and long-term sustainability.

In the article "A Market for Ideas: An Intermediary Framework for Academic Spin-Off Companies: Expanding Understanding of the Commercialization of Technology" (Hamanaka-Gusberti et al., 2018), the authors underscore the significance of problem-solving through a discussion of their findings and the presentation of actionable insights that can enhance technology commercialization practices in USOs. By identifying the specific issues encountered by these enterprises during the initial stages of commercialization, the article presents practical solutions that can be implemented without delay. For instance, the implementation of flexible and adaptable business models is advised, as this allows USOs to respond effectively to market challenges and capitalize on emerging opportunities. These strategies enhance the capacity of

USOs to oversee technology transfer while optimizing their innovation processes, thereby increasing the likelihood of long-term success.

(vii) The development of theories is an ongoing process that involves a continuous cycle of data collection and analysis, through which theories are refined and improved. As Allmark and Machaczek (2018) and Johnson et al. (2007) have observed, this iterative process allows theories to be adjusted and improved based on new data and evidence, thereby enhancing conceptual understanding and increasing the robustness of the theories developed. This approach guarantees that the theories are dynamic and reflect the complexity of the phenomenon under investigation, in accordance with the pragmatist philosophy of Dewey (1931).

In the article "University spin-off firms' struggle with openness in early knowledge relationships: in search of antecedents and outcomes" (Taheri et al., 2018), the study employs an iterative approach, whereby hypotheses are formulated and then reviewed based on the results of empirical research. In the initial stages of the study, hypotheses are formulated regarding the impact of diverse organizational backgrounds on the formation of knowledge networks within USOs. Additionally, various theories are considered, including the resource-based view and dynamic capabilities theory, which examines how companies cultivate and adapt their capabilities to navigate challenges and seize opportunities. Furthermore, it makes reference to organizational legitimacy theory, which concerns the manner in which startups establish their credibility and obtain the resources they require. Furthermore, the theory of openness in knowledge networks is discussed, which examines the diversity of partners and their impact on innovation and growth. In conclusion, contingency theory underscores the nonlinear correlation between antecedents and openness. This iterative approach not only permits the validation or refutation of the initial hypotheses, but also contributes to the theoretical development associated with the openness and growth of USOs.

In their article "University spin-offs: the past, the present, and the future" (Dabić et al., 2022), the authors demonstrate the principle of iteration and development of theories through their analysis of the evolution of research on USOs over different periods (1986-2013 and 2014-2020). By employing multiple correspondence analysis (MCA), the authors are able to map the trajectory of research, thereby enabling them to refine their models in order to more accurately capture the inherent complexity and evolution of USO-related practices and theories. This cyclical process of data collection, analysis, and theoretical adjustment enables researchers to identify and respond to emerging patterns and changes within the academic and innovation context. By continually refining theories and models based on empirical evidence, the study provides more precise guidance for USO managers, university administrators, and policymakers, enhancing their capacity to foster the growth and sustainability of USOs.

In the article "A market for ideas intermediator framework for academic spin-off companies: expanding understanding of the commercialization of technology" (Hamanaka-Gusberti et al., 2018), the principle of iteration and development of theories was employed. This iterative process permitted the adjustment and improvement of theories based on new evidence, thereby enriching the conceptual understanding of the phenomenon under investigation. This iterative approach guarantees that the developed theories accurately reflect the intricacies of the technology commercialization process within the context of USOs. The study employed a

combination of primary and secondary data, supplemented by direct observation and technology assessment discussions. This methodology permitted the researchers to review and adjust their theoretical models on an ongoing basis, incorporating new data and emerging insights. For example, the researchers were able to identify patterns and anomalies by analyzing 24 start-ups and 21 pre-spin-off research groups. This allowed them to refine their theories about technology commercialization and the role of intermediaries in this process. The capacity to iterate between theory and data was instrumental in capturing the dynamic and multifaceted nature of technology commercialization in USOs. This iterative process permitted researchers to modify their models in response to new findings, thereby ensuring that these remained dynamic and relevant to the ever-changing context of technology commercialization. The iterative process enhanced the validity and applicability of the developed theories, facilitating a more profound and sophisticated comprehension of the phenomenon under investigation.

Conclusion

This study explored the phenomenon of academic spin-offs (USOs) through the lenses of pragmatism and mixed methods, illuminating the intricate and multifaceted nature of their genesis and evolution. The analysis of various taxonomies and classifications has demonstrated that USOs play a pivotal role in technology transfer and the advancement of regional and national economic development. The combination of qualitative and quantitative methods has facilitated a more comprehensive and intricate comprehension of the phenomenon in the analyzed studies.

The pragmatic approach, which prioritizes practical utility and problem-solving, has proven to be a valuable lens for examining USOs. The flexibility and adaptability of this paradigm facilitate the integration of multiple methods and enable the adjustment of research strategies in response to preliminary findings and changing circumstances. Furthermore, the triangulation and validation of results through the use of multiple data sources and approaches have enhanced the validity and credibility of the findings, providing a robust foundation for future research in this field. As interest in USOs continues to grow, it is imperative that comprehensive methodological approaches be adopted that address both qualitative and quantitative aspects. This will advance our understanding of the creation and performance of USOs, as well as the support of these endeavors in academia.

Limitations

Notwithstanding the considerable headway made in the investigation of USOs through the employment of mixed methods, this research is beset with inherent limitations associated with the methodology utilized. First, the implementation of mixed methods can be costly and time-consuming due to the necessity of comprehensive data collection and analysis across both qualitative and quantitative domains. This process can result in a significant workload and the requisite resources, which can limit the ability of researchers to delve deeply into certain aspects of the study (Johnson & Onwuegbuzie, 2004). Furthermore, the integration of disparate data types presents challenges in terms of comparability and consistency, as it can be difficult to harmonize findings from different methodological approaches (Sieber, 1973; Guetterman & Molina-Azorin, 2023).

Secondly, the veracity of mixed-methods studies may be undermined by the challenge of reproducing qualitative studies due to their idiosyncratic nature. The subjectivity inherent in the interpretation of qualitative data can result in findings that are not easily reproducible, which affects the generalizability of the results (Mertens, 2016). Furthermore, the integration and analysis of data from disparate sources is contingent upon the researcher's ability and experience, which can introduce biases and variability in the results (Dellinger & Leech, 2007). Notwithstanding these constraints, the mixed-methods approach remains a valuable tool for addressing the complexity of USOs, provided that it is implemented with due care and consideration of potential weaknesses and challenges (Greene et al., 1989).

Data Availability Statement.

We are committed to ensuring the transparent and open availability of all data that is integral to the composition of this paper. Researchers, scholars, and other interested parties are encouraged to explore and utilize the provided dataset for further analysis and scholarly endeavors. This commitment to data accessibility is consistent with the principles of openness and reproducibility in scientific research, and it fosters an environment conducive to collaborative inquiry and the advancement of knowledge. Should further inquiries arise, they should be directed to the following email address: aromero@uceva.edu.co

Conflict of interest statement

The authors declare that they have no conflicts of interest to disclose. The views expressed in this document are solely those of the authors and do not necessarily reflect the position of the institution to which they belong.

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