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Benefits and challenges of graduate start-up and academic spin-off model integration: a systematic review

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ABSTRACT

Government representatives and university administrators must comprehend the reasons behind academics' desire to start their own businesses to create laws that effectively encourage academics to take up entrepreneurship. One may understand how seemingly difficult it might be to foster creativity and entrepreneurship in a varied community, considering how difficult it can be to teach entrepreneurship to university students. Consequently, the goal of this systematic review was to summarize the challenges and benefits of integration of graduate start-up and academic-spin off model. Three internet databases were searched for articles between 2010 and 2023 (i.e., a cumulative index using Scopus, the Web of Science, and Emerald to provide a summary of the challenges and benefits of graduate start-up and academic spin-off models). The study adds to a thorough understanding of the complex nature of business models by highlighting the models' dynamic evolution over time, the value of global collaboration, the necessity of carefully examining individual models, and the strategic diversity that comes from exploring several business models simultaneously. When taken as a whole, these observations offer insightful information that decision-makers, business owners, and academics may use to better understand, traverse, and navigate the terrain of innovation and entrepreneurial processes.

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1. INTRODUCTION

Universities are evolving into "entrepreneurial universities (EPU)" from being solely research and teaching establishments. The third mission is another term for this occurrence whereby academic institutions commit themselves to sharing their knowledge with business and the productive sector [1]. Over time, many methods of knowledge transfer have developed to meet this need. Technology knowledge can be shared through industrial research and development (R&D) partnerships, publications, licensing procedures, and academic spin-offs (ASOs), also called university spin-offs (USO) [2]. However, academic entrepreneurship is mostly dependent on driven faculty members. These people conduct entrepreneurial endeavors outside of their conventional responsibilities in research and teaching. Moreover, a university may engage in a variety of entrepreneurial endeavors, such as patenting, licensing, starting new businesses, promoting knowledge transfer through incubators and research parks, and promoting local economic growth is the definition of academic entrepreneurship, also known as university entrepreneurship [3], [4]. Also, government representatives and university administrators must comprehend the reasons behind academics' desire to start their own businesses to create laws that effectively encourage academics to take up entrepreneurial endeavors

[5]. Research has been done on how universities are evolving in terms of their responsibilities and attitudes as well as the mechanisms underlying academic entrepreneurship [4], [6].

To generate riches and improve quality of life, the world is shifting toward an economic society built on information [7]. Universities have long been important sources of cutting-edge research and highly skilled labor, but society and business are calling for universities to play more proactive roles as well. Examples of these include launching startups, turning knowledge into commercial products through R&D commercialization, and improving social impacts. Additionally, numerous academic institutions have endeavored to accommodate the requirements, and various investigations and endeavors have been undertaken to tackle the obstacles [8]–[10]. Many colleges are following the trend and transitioning from being research-centric to value-creating institutions. Similarly, many universities in the United States and Europe have been attempting to embrace an entrepreneurial mentality, and these developments highlight the changing responsibilities that universities play in society. Academic entrepreneurship refers to the actions made by colleges to support the financial viability of R&D on campus and in neighboring regions, which has seen a dramatic shift in recent years [11].

It is common information that the production and implementation of technologies, novel ideas, and scientific understanding are necessary prerequisites for economic expansion, employment formation, and the establishment of a competitive industrial system [12], [13]. Consequently, one of a manager's primary responsibilities in today's globalized and competitive marketplace is to develop new, creative businesses and products to foster the expansion and success of his own organization. Researchers and practitioners alike concur that some of the primary sources of innovations are universities and other public research organizations [14]. Creating a company from a research institution is a valuable strategy for turning public research results into commercial ventures and supporting local development, economic advancement, and societal well-being, as demonstrated by multiple studies [15], [16]. ASOs are the businesses that emerge from university startup accelerator programs. One may understand how seemingly difficult it might be to foster creativity and entrepreneurship in a varied community, considering how difficult it can be to teach entrepreneurship to university students. Thinking about developing nations with multiple pressing issues makes the work much more difficult [17], [18]. This calls for an examination of the factors that either strengthen or weaken a university's ability to meet its socioeconomic goals, which have changed significantly over time. Therefore, investigating the challenges and benefits of integrating graduate start-up and ASO models is critical to enhance innovation, commercial impact, and resource optimization in the academic and entrepreneurial ecosystems. It provides a way to overcome individual limitations while capitalizing on mutual strengths.

2. LITERATURE REVIEW

2.1. Academic spin-offs

USOs, also known as ASOs, represent a unique category of startup ventures that cannot be readily compared to other types of businesses such as college startups or technology-based startups in general. Various definitions of spin-off have been presented over time in the existing literature. For example, spin-offs were characterized by Roberts and Malonet [19] as a strategy used by governments to transfer information from the R&D function to a commercial organization to maximize the financial effect of their study and innovation. In a similar vein, spin-offs were characterized by Rogers *et al*. [20] as those businesses that sprang from their parent R&D organizations, which included government R&D laboratories, universities, university research centers, and commercial R&D organizations. A company created by former employees of the parent organization is known as a spin-off. In this case, the institution may be the source of both the technology and academic inventors.

On the other hand, the technology might break away from the organization while the university employs the academic originator. There is also a chance that the academic innovator retains their stock in the new company but that only the technology separates [21]. This concept considers the spin-off's human component. According to Festel [22], an ASO is a high-tech company whose main activity is the commercial valuation of research findings in science and technology. In a more contemporary definition according to Conti *et al*. [23], spin-off enterprises are those that come from a university where an entrepreneurial unit consisting of a group of academics uses the information and results from research undertaken within the institution. Whatever term is used, the transfer of vital technology from an academic institution to a new company, where the founders may or may not be employed, is known as an ASO.

2.2. Graduate start-ups

Universities are noteworthy among the organizations that currently exist and have transformed into productive, knowledge-intensive settings focused on entrepreneurship [24]. These institutions offer their

graduates a range of career options, including working for themselves as independent contractors (entrepreneurs) or joining businesses as intrapreneurs [25]. To facilitate the university community's investigation and/or application of entrepreneurial concepts, EPU develop the required frameworks, procedures, and initiatives and allot funds [26]–[28]. Successful university aids for the establishment and maintenance of new businesses include research parks, accelerator facilities, and incubation programs [29]–[31]. Just a few investigations, including those by Ateljević [32] and Guerrero [33] have looked at graduate entrepreneurship in EPU in transitional economies. Previous researches have examined the reasons for the disparity in the number of startups produced by developed country universities [34]–[37]. There are certain similarities and variations between developed and transitional economies in this regard. For example, most developed and transitional countries share the goal of increasing young achievement in the labor market, the economy's potential for production, and social cohesion [38]. Despite shared objectives, past investigations [38]–[44] have revealed distinctions in the challenges encountered by both economic types.

Specifically, demographic trends pose slightly different obstacles, such as the imperative in transitional economies to generate highly productive and satisfying jobs, contrasting with the heightened demand for opportunities and skills among smaller youth cohorts in most developed economies. Labor market issues diverge as well; developed economies have a problem with the quality of youth entry-level employment, whereas informal employment is the primary concern in transitional countries. Additionally, there are variations in educational enrollment rates, with transitional economies often experiencing lower rates than their developed counterparts. Furthermore, there are disparities in the formal institutions that promote youth entrepreneurship between transitional and developed economies. In transitional economies, the emphasis lies in strengthening weak institutions through constant adjustments amid uncertain conditions, while developed economies prioritize sustainability and efficiency in policy development and the utilization of public resources. Furthermore, there is a difference in the proportion of quality against quantity in entrepreneurship rates. Opportunity-driven entrepreneurship is more common in developed economies, while necessity-driven entrepreneurship—which frequently involves self-employment and increased informality—is more common in transitional economies. Additionally, informal institutions play a role in supporting youth entrepreneurship. In developed economies, social attitudes favor entrepreneurship as a commendable professional choice, while in transitional economies, there is a notable effort to reshape culture and social attitudes to encourage entrepreneurship [45].

3. METHOD

3.1. Search strategy

The search plan was designed with the help of an experienced librarian. The search terms were generated during an initial search process, and these terms were refined until they were confirmed. The terms “academic spin-offs” OR “graduate start-ups” OR “business model” OR “entrepreneurial skills” OR “university graduate” was employed for finding abstracts and titles. The Web of Science and Emerald databases employed the same search strategy that was developed for Scopus. Reputable and well-known electronic databases (Scopus, Web of Science, and Emerald) were searched for peer-reviewed and original research papers from 2010 to 2023.

3.2. Study selection

After extracting citations from three databases, duplicates were removed using the systematic review assistant-deduplication tool in EndNote. Following that, imported citations were screened using Covidence [46]. The full text of relevant articles was then utilized to repeat the process of determining the relevance of titles and abstracts in relation to the inclusion criteria [47]. The backdrop of interest was the advantages and difficulties of graduate start-ups and ASO models. This made it possible for any article about the advantages and difficulties of combining the graduate start-up and ASO models to be included. Studies that were not conducted in an environment where the advantages and difficulties of integrating graduate start-up and ASO models were present were ignored as shown in Table 1. Studies that were published in a peer-reviewed journal and employed an interventional, qualitative, or mixed techniques approach were categorized as observational or interventional research. Theses, conference abstracts, study protocols, editorials, comments, opinion articles, grey literature, and systematic or narrative literature reviews were among the acceptable submission forms.

3.3. Study selection

Database searches produced a total of 100,706 results since there is a dearth of information regarding the difficulties and advantages of graduate start-up and ASO scenarios. There were 11 duplicate articles eliminated after 100,644 articles that were published before 2010 and were not in English were eliminated. A thorough text review of 51 studies was conducted. By viewing them, the eligibility of

51 articles were determined. A total of 29 articles were removed during the full-text examination because some of them were off-topic and others could not be translated from other languages to English. Because there were a few research papers on the challenges and benefits of graduate start-up and ASO models, a total of 22 papers met the standards to be included in this review, as shown in Figure 1. The data collection for descriptive content analysis uses the preferred reporting items for systematic reviews and meta-analyses or PRISMA stage, which consists of four stages: identification, screening, eligibility, and inclusion.

Table 1. The selection criterion for articles searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Timeline	2010-2023	<2010
Literature type	Journal (conference proceeding and book chapter)	
Document type	Conference paper, article review, book, book chapter	
Subject area	Entrepreneurial and business	Besides entrepreneurial and business

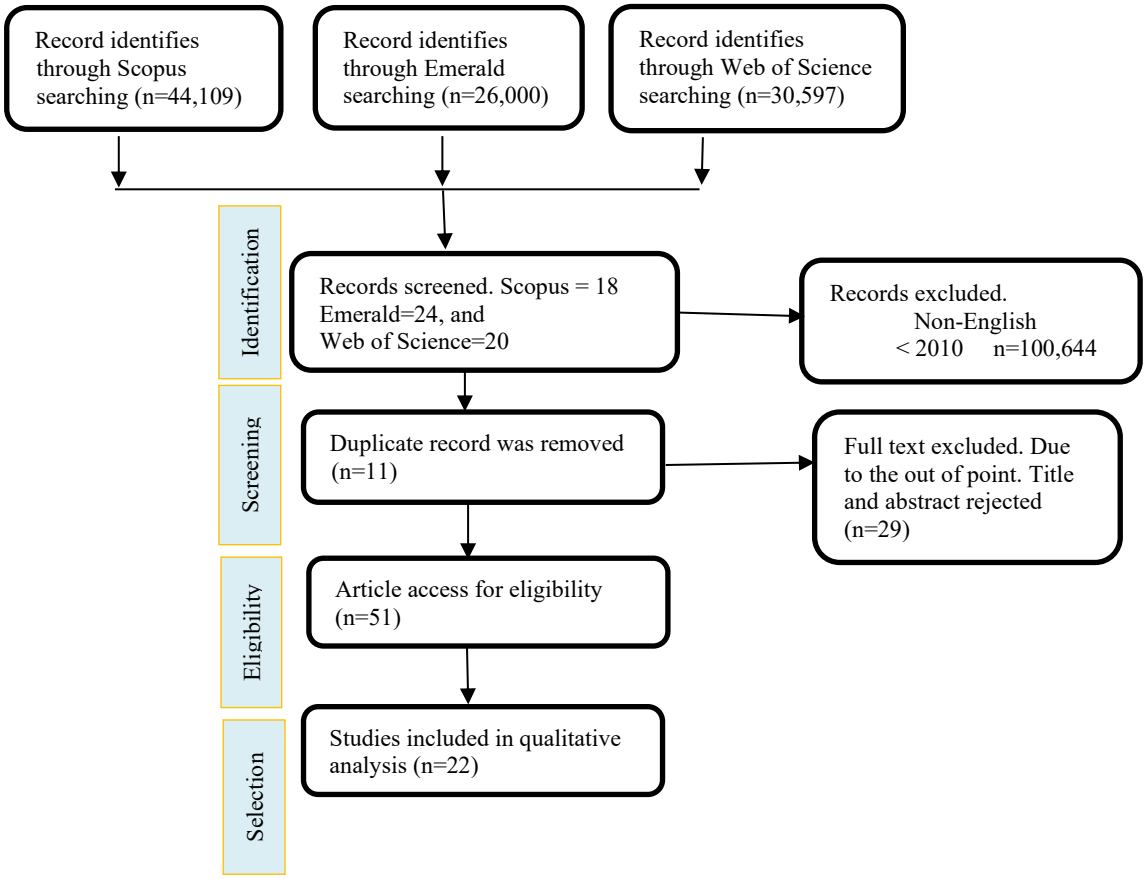

Figure 1. Flowchart of PRISMA stage

3.4. Coding procedures

Developing a coding framework for a systematic literature review (SLR) is a critical step in organizing and analyzing data from a large body of literature. The goal of a coding framework is to categorize, extract, and analyze relevant information from research studies in a way that is consistent, accurate, and replicable. The following are the concrete steps taken to develop and ensure accuracy and consistency in the coding process:

– The first step is to define the research questions and objectives. This was started with clarity on the research questions or objectives of the study. This ensures the coding process is focused on extracting data that directly addresses the purpose of the review. Key themes or variables were identified to answer these questions. These guide the initial structure of the coding framework.

- Selection of initial categories and codes is the second stage. Based on the research questions, preliminary categories or themes were developed to structure the coding. The categories were kept as inclusive and mutually exclusive as possible, allowing for a systematic analysis of diverse research papers.
- Development of a codebook is the third stage of this process. A codebook is an essential tool that contains detailed descriptions of each code or category in the coding framework. Each category was clearly defined and provided examples of what types of information should be assigned to each code. Instructions for how to handle ambiguous or overlapping content were included.
- Pilot the coding framework is the fourth stage where initial coding framework was tested on a small sample of studies (e.g., 5–10 articles). This pilot phase helps to identify whether the categories are too broad, too narrow, or need refinement, to determine if any important themes are missing or if there are overlapping categories that need to be merged, or to check whether the coding instructions in the codebook are clear. Then, after this initial trial, the framework was refined based on the results and challenges encountered.
- Establishment of inter-coder reliability is the fifth stage. To assess inter-coder reliability, we ensured that multiple coders independently code the same sample of studies and then measure the agreement between their coding decisions using statistical tests like Cohen's kappa.
- In this stage, the final coding framework was applied to the full dataset. During this stage, we adhered strictly to the codebook and guidelines to ensure accuracy and consistency.
- To ensure quality control and accuracy, double coding was done periodically to have two coders independently code the same articles to check for consistency.
- Once all studies were coded, aggregate and analysis of data using the categories from the coding framework was achieved. We revisit the research questions to ensure that the coding framework allows for a comprehensive analysis that answers the objectives of the systematic review.

Every article's content was frequently compared while keeping in mind the ongoing comparison method to re-evaluate and update the framework [48]. The aim of the coding process, involving the utilization of three coders to ensure the accuracy, consistency, and reliability of the results, was to identify themes and patterns related to the challenges and benefits of integrating graduate start-up and ASO models [49]. All the coders approved the results.

4. RESULTS AND DISCUSSION

4.1. Discussion

This study reveals in Tables 2 and 3 that an article (n=1) by Almeida [50] who identified low salary and nonwage financial advantages, little or no social security, and a lack of job security are the main obstacles to high-quality labor in spin-off universities. Likewise, article (n=1) by Naqvi *et al*. [51] reveals that students had reservations, especially considering the dearth of sufficient risk management and financial planning training sessions. Also, as stated by Anzola-Román and Bayona-Sáez [52] that ambidexterity is determined to be the primary obstacle for USOs. However, career shocks are important when deciding whether to start a business in the first place, but they also affect recently graduated grads who are starting their own companies [53]. Other articles (n=4) [54]–[57] stated that the graduates are reported to be hesitant about starting their own business such as limited ability to start their own business, challenging funding, and high startup costs, inadequate infrastructure and lack of maintaining a network with business partners. Rising levels of uncertainty is another obstacle as reveals by Sørheim *et al*. [58] in an article (n=1).

Table 2. Popular dimensions used in benefits and challenges of graduate start-up and ASO

Themes	Features Challenges of graduate start-up and ASO model integration
Theme 1	Low salary and nonwage financial advantages, little or no social security, and a lack of job security are the main obstacles to high-quality labor in spin-off universities as stated by Almeida [50]
Theme 2	Naqvi *et al*. [51] revealed that students had reservations, especially considering the dearth of sufficient risk management and financial planning training sessions
Theme 3	Ambidexterity is determined to be the primary obstacle for USOs [52]
Theme 4	Career shocks are important when deciding whether to start a business in the first place, but they also affect recently graduated grads who are starting their own companies by Rummel *et al*. [53]
Theme 5	The graduates are reported to be hesitant about starting their own business such as limited ability to start their own business, challenging funding, and high startup costs, inadequate infrastructure and lack of maintaining a network with business partners [54]–[57]
Theme 6	Rising levels of uncertainty is another obstacle as reveals by Sørheim *et al*. [58]

Table 3. Popular dimensions used in benefits and challenges of graduate start-up and academic spin-off model integration

Themes	Features Benefits of graduate start-up and ASO model integration
Theme 1	Pepin *et al*. [59] discusses the development of resource-based model of competitiveness (RBMC) to help new students and business owners incorporate sustainability into their business models
Theme 2	Beugré and Calvin [60] and Martínez-Martínez *et al*. [61] state that model usually supports the growth of students' entrepreneurial abilities, aspirations, and mindset
Theme 3	Igbo-Boi concept has long been used as a mechanism to develop Igbo businesses [62]
Theme 4	Strong theoretical support was discovered for the idea of the EPU multidimensionality by Bizri *et al*. [63]
Theme 5	Korea Advanced Institute of Science and Technology (KAIST) seeks to develop a top-tier workforce with superior knowledge and abilities, a collaborative mindset, and a perspective and attitude centered around ethics and social responsibility. This model illustrates how colleges' roles are evolving in students' entrepreneurial by Bae [7]
Theme 6	Cooperative relationship between higher education institutions (HEIs) and the corporate sector provides students with a rich ecosystem of support, resources, and connections to foster entrepreneurship and promote the growth of start-ups by Neves and Franco [64]
Theme 7	The addition of the "time factor" causes the business model to change from being one static representation to a series of representations. This occurs despite the initial ex-ante definition of the business model permitting the creation of a static representation detailing "how" the company generates value at specific moments by Corallo *et al*. [65]
Theme 8	Engaging in international collaboration within research projects and forming partnerships, along with implicit knowledge and management board experience gained abroad, strengthens the business plan for the industrialization of biotech spin-off research results by Bialek-Jaworska and Gabryelczyk [66]
Theme 9	Kitagawa and Robertson [67] argue that establishing more comprehensive protocols and well-defined pathways for the 'soft starter' business model would offer significant advantages
Theme 10	The typology method employed in academic entrepreneurship literature demonstrates how some company models are linked to higher degrees of innovation than others by Clausen and Rasmussen [68]
Theme 11	The program creates at least 100 new human capacity makers with software venture experience each year. At its best, it will boost the local economy as a whole and give all the cash and in-kind investors a respectable return [69]
Theme 12	It is obvious that modifications to the educational offering will call for modifications to the HE business model by Birch *et al*. [70]

Research by Pepin *et al*. [59] discusses the development of RBMC to help new students and business owners incorporate sustainability into their business models. Previous articles [60], [61] state that model usually supports the growth of students' entrepreneurial abilities, aspirations, and mindset. Correspondingly, Igbo-Boi concept has long been used as a mechanism to develop Igbo businesses as stated by Nkamnebe and Ezemba [62]. However, Bizri *et al.* [63] reveals that strong theoretical support was discovered for the idea of the EPU's multidimensionality. Bae [7] states that KAIST seeks to develop top-tier workforce with superior knowledge and abilities, a collaborative mindset, and a perspective and attitude centered around ethics and social responsibility. This model illustrates how colleges' roles are evolving. Neves and Franco [64] reveals that cooperative relationship between HEIs and the corporate sector provides students with a rich ecosystem of support, resources, and connections to foster entrepreneurship and promote the growth of start-ups. Furthermore, Corallo *et al.* [65] reveals in an article that the addition of the "time factor" causes the business model to change from being one static representation to a series of representations. This occurs despite the initial ex-ante definition of the business model permitting the creation of a static representation detailing "how" the company generates value at specific moments.

Engaging in international collaboration within research projects and forming partnerships, along with implicit knowledge and management board experience gained abroad, strengthens the business plan for the industrialization of biotech spin-off research results as stated by Bialek-Jaworska and Gabryelczyk [66]. Kitagawa and Robertson [67] argue that establishing more comprehensive protocols and well-defined pathways for the 'soft starter' business model would offer significant advantages. Likewise, Clausen and Rasmussen [68] reveals that the typology method employed in academic entrepreneurship literature demonstrates how some company models are linked to higher degrees of innovation than others. Moreover, the program at least creates 100 new human capacity makers with software venture experience each year. At its best, it will boost the local economy as a whole and give all the cash and in-kind investors a respectable return as stated by Cameron *et al.* [69]. It is obvious that modifications to the educational offering will call for modifications to the HEI business model in an article by Birch *et al.* [70].

The findings from the study highlight critical barriers that hinder the success of entrepreneurial ventures, particularly among USOs and recent graduates. These obstacles range from financial insecurity and a lack of training to operational inefficiencies and rising uncertainty in the market. To overcome these challenges, institutions and stakeholders need to implement targeted interventions such as providing financial incentives, improving educational programs, fostering ambidexterity, and developing support networks for entrepreneurs. Addressing these barriers holistically can create a more favorable ecosystem for entrepreneurship, leading to greater innovation and economic growth.

The findings also highlight various innovative and practical frameworks that support entrepreneurship and business model development. From the RBMC's focus on sustainability to the Igbo-Boi concept's emphasis on mentorship, these models provide valuable lessons for both students and business owners. Additionally, the multidimensionality of EPU, cooperation between HEIs and the corporate sector, and the dynamic nature of business models are all crucial in fostering an entrepreneurial mindset and ensuring businesses can adapt to the evolving global market. Institutions and stakeholders should continue to explore these models to provide better support to aspiring entrepreneurs, ensuring they have the knowledge, resources, and mindset necessary for success.

The importance of international collaboration, innovative business models, and educational reform in fostering entrepreneurship and driving the commercialization of research. International partnerships and implicit knowledge gained abroad provide critical insights that strengthen biotech spin-offs. The development of structured soft starter models can offer a clear pathway for startups to grow gradually, mitigating risks. Understanding the typologies linked to higher innovation helps entrepreneurs choose business models that align with their goals, while human capacity-building programs foster local economic growth and entrepreneurial ecosystems. Finally, educational institutions must evolve their business models to support these initiatives by offering more hands-on, industry-connected programs that prepare students for the challenges of entrepreneurship. This holistic approach can create a robust pipeline of innovative businesses, contributing to both local and global economic development.

4.2. Practical implications of study

The practical implications of this study are as: i) Educational institutions need to integrate more hands-on, industry-connected learning experiences into their curricula to better prepare students for entrepreneurial challenges; ii) Policymakers and universities should provide targeted financial incentives, such as seed funding, grants, or low-interest loans, specifically aimed at recent graduates and USOs. Educational institutions should emphasize the development of "ambidextrous" skills that allow entrepreneurs to balance exploration of new opportunities with the exploitation of existing resources. By encouraging partnerships with international institutions and corporations, universities can expose students and spin-offs to global best practices and innovations of the global. Policymakers and educational institutions should build and maintain networks that connect aspiring entrepreneurs with experienced mentors. Higher education institutions must adopt entrepreneurial university models that foster collaboration between academia and the corporate sector. Also, institutions should educate entrepreneurs on different business models and encourage flexibility in adapting to evolving market conditions.

5. CONCLUSION

This study clarifies the complex issues that USOs and startups encounter when trying to find top-notch labor. In conclusion, the thorough analysis carried out in this study highlights the complex dynamics impacting USO ecosystems, emphasizing the necessity of targeted interventions and a sophisticated comprehension of the various obstacles preventing their development. The study also emphasizes the ever-changing environment of entrepreneurship education and the resources available to budding business owners. All things considered, these varied studies help to provide a thorough grasp of the complex dynamics in entrepreneurial education by offering insights into models, tools, historical viewpoints, and the changing roles that educational institutions play in encouraging entrepreneurship.

The study's conclusion adds to a thorough understanding of the complex nature of business models by highlighting the models' dynamic evolution over time, the value of global collaboration, the necessity of carefully examining individual models, and the strategic diversity that comes from pursuing several business models simultaneously. When taken as a whole, these observations offer insightful information that decision-makers, business owners, and academics may use to better understand, traverse, and navigate the terrain of innovation and entrepreneurial processes. More research is needed on the flexibility of business models in response to dynamic market conditions, especially for startups. Also, the multidimensional nature of EPU and their collaboration with the corporate sector warrants further exploration.

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AUTHOR CONTRIBUTIONS STATEMENT

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

The authors confirm that the data supporting the findings of this study are available within the article [and/or its supplementary materials].

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