

Advantages and barriers of university-business linkages: Analysis from an academic perspective

Ventajas y barreras de la vinculación universidad-empresa: análisis desde la perspectiva académica

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Abstract: This article addresses university-business linkages to promote innovation, examining the advantages, barriers and strategic actions observed by researchers and professors from Latin American academic institutions. To carry out the analysis, an online survey was applied to a sample of 305 participants residing in different Latin American countries, that is: Brazil, Panama, Colombia, Costa Rica, Bolivia, Ecuador, and Mexico. The core results reveal 15 clear advantages of university-business linkages, including the transfer of research results and greater visibility for universities and their research groups. The main barriers emerging from the analysis, including financing problems, lack of human resources and lack of time management, varied by country, gender and age of participants. The findings of the study provide guidance for strategic actions to strengthen university-business links in Latin America, highlighting the importance of adaptability and adaptation to changing environmental conditions in order to better exploit the mutual collaborative benefits of innovation and sustainable development.

Keywords: University-Business linkages, advantages. barriers. strategic actions, innovation.

Resumen: Este artículo aborda el vínculo universidad-empresa para promover la innovación, examinando las ventajas, barreras y acciones estratégicas observadas por investigadores y profesores de instituciones académicas latinoamericanas. Para realizar el análisis, se aplicó una encuesta en línea a una muestra de 305 participantes residentes en diferentes países de América Latina, es decir: Brasil, Panamá, Colombia, Costa Rica, Bolivia, Ecuador y México. Los principales resultados revelan 15 claras ventajas de los vínculos universidad-empresa, entre ellas la transferencia de resultados de investigación y una mayor visibilidad para las universidades y sus grupos de investigación. Las principales barreras que surgen del análisis, entre ellas los problemas de financiación, la falta de recursos humanos y la falta de gestión del tiempo, varían según el país, el género y la edad de los participantes. Los hallazgos del estudio proporcionan orientación para las acciones estratégicas para fortalecer los vínculos universidad-empresa en América Latina, destacando la importancia de la adaptabilidad y la adaptación a las condiciones ambientales cambiantes para aprovechar mejor los beneficios colaborativos mutuos de la innovación y el desarrollo sostenible.

Palabras clave: Relación Universidad-Empresa, ventajas, barreras, acciones estratégicas, innovación.

1. Introduction

Since the classic studies on innovation systems in which universities play a leading role (Freeman, 1987), it has been recognized that these institutions go beyond their two traditional missions of teaching and research. The “third mission” of universities is characterized by their potential to contribute significantly to the advancement of society through activities that include the generation, use, application and commercialization of knowledge (Etzkowitz & Leydesdorff, 2000), outreach, and social action (Picado -Arroyo et al., 2015). In this new reality, universities become a fundamental part of the triple helix concept, working together with businesses and governments to develop joint actions that promote innovation and economic, environmental and social development in different countries or regions (Etzkowitz & Leydesdorff, 1995; Fidanoski et al., 2022).

This collaborative approach to the generation of innovation and development demands that universities take an active role as an agent of knowledge creation and transfer (Bueno, 2007), identifying opportunities for improvement, problems and the real needs of society (Picado-Arroyo et al., 2015). As shown by recent research, the dynamic relationships between universities and other agents of innovation systems, such as governments and businesses, for example, are critical factors for science, technology and innovation, both in North American and European countries, as well as in Latin America and the Caribbean (Fidanoski et al., 2022; da Silva & Sartori, 2022). Underlining the relevance of additional research on this topic, the academic literature reaffirms the importance of collaboration between the academic and productive sectors in promoting innovation, considering the presence of numerous barriers, motivations and challenges (Ankrah & Omar, 2015; da Silva & Sartori, 2022; Nahla, 2023).

Currently, the role that universities play in the face of the changes that humanity is facing makes them not only a center of knowledge production, but also organizations capable of providing answers to the challenges facing an economy embedded in a context of world globalization and the 4.0 revolution, with social and environmental problems in most of the world. For Polaino and Romillo (2017), the collaboration of universities with the productive sectors and businesses is a powerful way to confront the challenges of a constantly changing, often adverse and uncertain environment.

Compared to their peers in developed countries, studies indicate that Latin American universities suffer from important gaps in their linkages with businesses (see, for example, Fidanoski et al., 2022; da Silva & Sartori, 2022). The formation of human capital and the generation and dissemination of knowledge, on many occasions, are not aligned with the needs and challenges posed by the productive sectors and businesses. According to Cohen-Granados, et al. (2020), Latin American

university institutions can be characterized by their traditionalism, rigidity and resistance to change, focusing primarily on teaching and research oriented towards stable and repetitive processes. The adoption of practices such as the development of patents, licensing, spin-offs and other forms of application and commercialization of knowledge, as well as effective linkages with productive sectors, are still scarce in this academic context (Aguilar-Barcelo & Higuera-Cota, 2019; Cohen-Granados *et al.*, 2020). Why does this happen? What are the main difficulties that universities in Latin America face in their linkages with businesses, and what are the benefits perceived and actions proposed by researchers from these institutions?

The purpose of this investigation is to explore in detail the advantages of and barriers to university-business linkages evaluated from a Latin American academic perspective, as well as to point out actions and strategies aimed at promoting and strengthening these linkages. The results of this research provide relevant information that allows Latin American universities to implement more effective strategies to link themselves with businesses, developing solutions and benefits that address their needs and problems.

2. Theoretical Framework

According to the concept of the triple helix, innovation is understood as the result of creative and collaborative processes that involve three key agents: universities, businesses and governments. This implies a continuous interaction between these agents, in which each one contributes their knowledge and resources to achieve shared objectives of innovation and development (Etzkowitz & Leydesdorff, 1995). Collaboration between different actors, including university institutions, directly affects the innovative process. This exchange of knowledge and university-business collaboration, from an organizational culture oriented towards innovation, are recognized as success factors for the promotion of innovative processes and results (Picado-Arroyo *et al.*, 2015). In this context, the participation of universities as knowledge-generating entities is especially important, providing critical contributions to the generation of high-value innovations.

According to recent research carried out by Fernandes *et al.* (2023), research and development collaborations between academic institutions and the productive sector play a fundamental role in promoting open innovation. This dynamic not only entails the creation of new products, processes and services with substantial value for customers, but also generates a broad social impact. The growing importance of collaboration between universities and businesses in national economies is an increasingly prominent topic in the literature (O'Dwyer, *et al.*, 2022), as shown by frequent discussions about the catalytic role that universities often play in collaborations between the different actors in innovation helices, as noted by Dolmans *et al.* (2022).

On the one hand, collaboration between universities and businesses arise from the resolution of real problems or the identification of specific needs of the business market. This approach can not only improve the relevance and quality of research, but also enrich the contents and topics analyzed in university teaching processes. Rossoni *et al.* (2023) highlight that the productive sector and businesses obtain significant benefits by accessing the laboratories and cutting-edge technologies of academia, as well as by taking advantage of knowledge to develop new technologies and products. At the same time, the universities maintain themselves up to date on business reality and market needs, thus strengthening the synergy between both sectors.

In the triple helix of innovation, each agent has a vertical dimension in which it develops its own strategy and a horizontal dimension, in which the helices interact with other actors (Piqué *et al.*, 2020). In the second dimension, authors such as Achuri and Álvarez (2022) recognize as a critical success factor the presence of facilitators in the collaboration interface, whose performance is dedicated to promotion and communication. The strategic role of universities in innovation ecosystems, as well as the competitive advantages of university-business linkages are clearly shown in the academic literature (Piqué *et al.*, 2020). This indicates that collaboration and interaction between both helices are essential to drive innovation in

different regions and countries (Fidanoski et al., 2022; da Silva & Sartori, 2022). Interaction is essential for the success of the collaboration, facilitating transfer of knowledge and resources from one helix to another, and generating synergies and mutual benefits.

Different authors, such as Achuri and Álvarez (2022), Borda-Rivera and Ortega-Paredes (2021), and Piqué et al. (2020), have directly or indirectly addressed the advantages derived from the relationship between universities and businesses. In general terms, these studies highlight significant benefits for universities, ranging from increased knowledge transfer to an improved image in society. López (2020) suggests that universities should actively seek to establish win-win relationships with businesses, especially if the economic environment is favorable, whether based on knowledge or industrial policies. The importance of considering public policies that do not hinder innovations in this process of linking universities and businesses has also been highlighted (da Silva & Sartori, 2022).

Other authors, such as Ankrah and Omar (2015) and Fernandes et al. (2023) have examined the persistent barriers that hinder effective linkages between universities and businesses. The most recent analysis, focused on the identification of critical success factors in joint projects, points out as the main limitations of such projects the cultural gap between these entities and the lack of rigorous governance. The cultural gap, by hindering effective communication and mutual understanding, can hinder the advancement of collaboration. Overcoming this obstacle may require a joint effort to establish a common language and a shared understanding of the objectives of both parties.

To overcome barriers and achieve success in collaborations between universities and businesses, it is essential to implement strategic actions. A clear and effective governance structure, which involves the definition of roles and responsibilities, as well as the establishment of decision-making mechanisms and clear agreements on intellectual property and exploitation of research results, plays a fundamental role. Furthermore, it is crucial to take steps to provide effective incentives for university researchers based on their levels of cooperation with businesses, thus encouraging their active and entrepreneurial participation (Cunningham & Link, 2015). This strategic approach will contribute to consolidate and strengthen effective collaboration between universities and businesses, overcoming obstacles and promoting an environment conducive to innovation and knowledge transfer.

Taking a strategic approach is crucial for universities when pursuing business collaborations. This involves identifying areas of synergy and mutually beneficial opportunities in an enabling cultural and economic environment. By considering industrial or knowledge-based policies, academic institutions can foster greater collaboration and promote joint innovation. To carry out this strategic linkage with businesses, universities must, for example, have technology transfer offices (da Silva & Sartori, 2022), as well as trained professionals who not only have technical knowledge, but also marketing skills and a deep understanding of the ecosystem in which they operate.

3 Methodology

Data was collected through a survey conducted by researchers from different countries that make up the Ibero-American Network of Universities for Innovation and Sustainable Development – REDUIS project, which covers nine countries (Bolivia, Brazil, Colombia, Costa Rica, Chile, Ecuador, Spain, Mexico and Panama). The survey included four blocks of information: (i) sociodemographic data to better understand the respondents (country of origin, gender and age); (ii) advantages or benefits of university-business linkages; (iii) barriers or problems; (iv) actions or strategies. After providing this initial data, participants were asked to evaluate levels of importance (using a Likert scale with values ranging from 1 = not at all important to 5 = very important) for 15 advantages or benefits of linkages with businesses, 17 barriers or problems associated with such linkages, and 15 actions or strategies for linking universities with businesses.

The questionnaire was designed online in Qualtrics and sent by e-mail to participants who act as researchers/professors at universities in the Latin American countries that are part of REDUIS. Data collection from each country was carried out between October 2021 and May 2022. A total of 305 complete questionnaires with valid answers were obtained. Once the responses were received, the data were coded, processed, and interpreted statistically using SPSS software version 25.

The results were initially summarized using univariate statistics (means and frequencies) to better understand the respondents. Initial statistical analyses included the number and percentage of participants by country of origin, gender (male or female), and age (histogram with frequency, mean, minimum, maximum, and standard deviation). Subsequently, the responses on the advantages or benefits of university-business linkages were also analyzed using univariate statistics, followed by an analysis of the responses related to barriers/problems and actions/strategies for linkages with businesses.

Additionally, parametric tests were carried out to compare means to determine if there was a significant difference between the composite scores of the responses by country, gender and age. Single-sample group comparisons were performed using two statistical tests. To analyze the groups according to gender and age, the *t* test was applied; while for the analysis of more than two groups (countries), the ANOVA test was used, which is a variance test that determines the probability that the differences in means between groups are due solely to sampling error. Following Hair *et al.* (2009), since the sample size was greater than 50, the typical values for the significance levels ($p < 0.05$) and Student's *t* test values ≥ 1.96 were adopted in the *t* test. To examine possible differences between countries, initial analyses were performed that showed compliance with the requirements for ANOVA, along with the test of means (Tukey). In addition, results of applying the Levene test were obtained, which indicated homogeneity in the variance of the data. Finally, in the analyses the value of *F* must be greater than the critical value of 3.68. Detailed findings are presented in the next section.

4 Results

With the aim of exploring the advantages, barriers and actions observed by researchers regarding university-business linkages, the results of data analyses related to country of origin, gender and age of the respondents are presented

4.1 Sample characterization

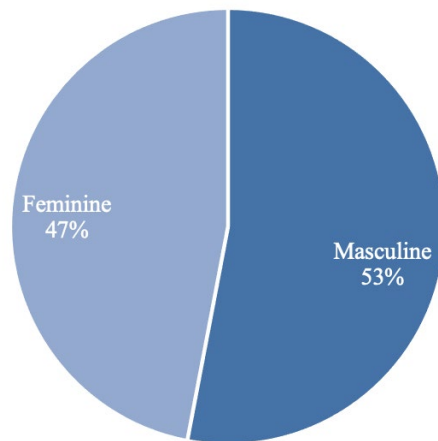
As can be seen in Table 1, of the 305 respondents, the majority came from Brazil (23.6%), followed by Panama (22.3%), Colombia (20.7%) and Costa Rica (15.1%). The remaining 18.4% correspond to answers provided by participants from other countries, such as Bolivia, Ecuador and Mexico.

Table 1: Country of origin

Country	Number of responses	%
Brazil	72	23.6
Panama	68	22.3
Colombia	63	20.7
Costa Rica	46	15.1
Others	56	18.4
Total	305	100.0

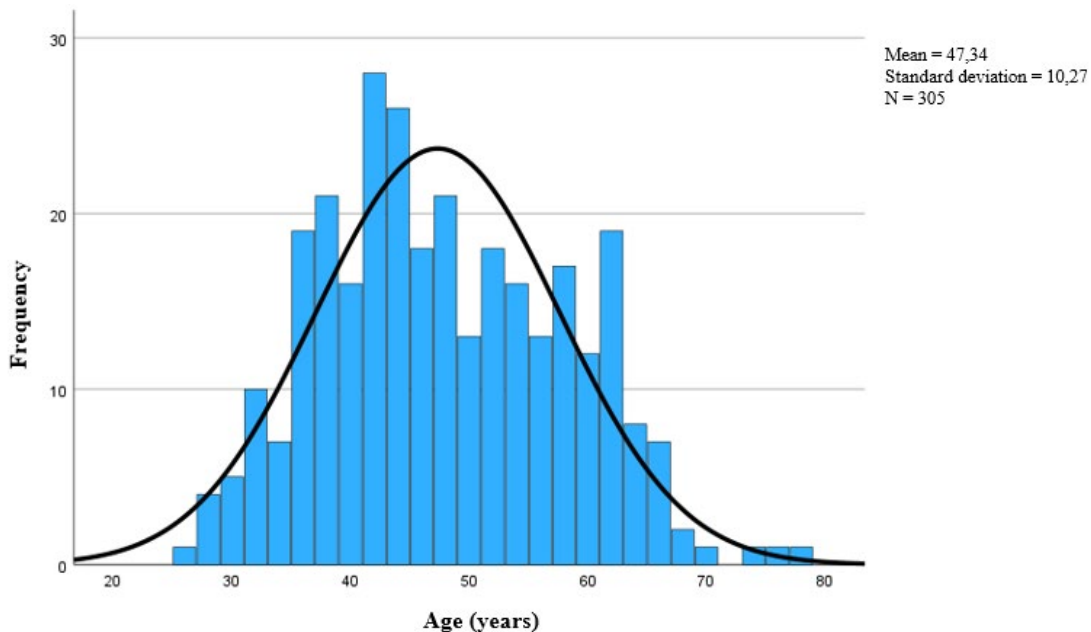
In the case of gender, a balance is observed in the number of respondents (Figure 1). However, when analyzing gender by country of origin, some differences can be observed. For example, responses from Panama were more frequent from women (40 respondents) than from men (28 respondents). In contrast, in Brazil, Colombia and Costa Rica the majority of respondents were men (47, 34 and 28, respectively).

Figure 1: Gender



The average age of the respondents was 47.3 years, with the minimum age being 26 years and the maximum age being 77 years (Figure 2). To carry out the analyzes that will be presented below, the 305 respondents were divided into two groups: (a) up to 45 years of age (47.9%) and (b) over 45 years of age (52.1%).

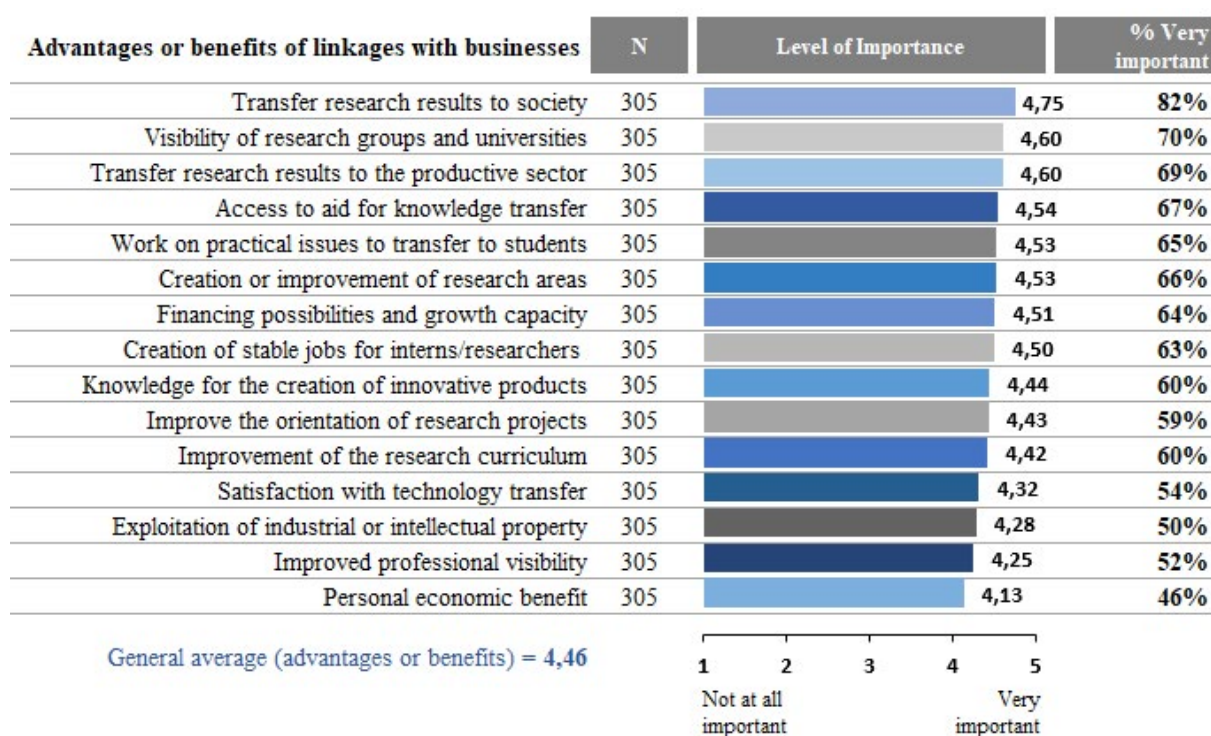
Figure 2: Age frequencies



4.2 Advantages of university-business collaboration

The results presented in Figure 3 show that all fifteen advantages analyzed obtained an average score greater than 4 (“important” or “very important”) and eight of them were ranked above the overall average (4.46), with average scores between 4.50 and 4.75. It can be seen that a large proportion of the survey participants evaluated as “very important” the advantage of transferring research results to society (82%) and the productive sector (69%). Seventy percent (70%) of those surveyed highlighted as a “very important” benefit of linkages with businesses the fact that it provides greater visibility in society for research groups and universities. On the other hand, the lowest averages were obtained for “greater professional projection” (4.25) and “personal economic benefit” (4.13). These results suggest that respondents give more importance to the possible practical implications at the collective level (for the organization and society) than to their own individual benefits.

Figure 3: Advantages or benefits



To further explore the eight benefits that exceeded the overall average, results were evaluated in terms of the countries of origin, gender and ages of the respondents. As can be seen in Table 2, the results indicate that there is a strong statistically significant difference between responses by countries of origin in three items: working on practical issues to transfer knowledge to students ($p = 0.004$; $F = 3.868$); creation or improvement of research areas ($p = .002$; $F = 4.265$); and financing possibilities and growth capacity ($p = .002$; $F = 4.341$). The other advantages or benefits do not show a significant difference between countries, having p values greater than 0.05.

Table 2: Advantages or benefits by country of origin

Advantages or benefits	Brazil	Panama	Colombia	Costa Rica	Others	Sig.
Transfer research results to society	4.75	4.82	4.70	4.85	4.64	-
Visibility of research groups and universities	4.46	4.71	4.62	4.76	4.48	-
Transfer research results to the productive sector	4.46	4.66	4.68	4.57	4.66	-
Access to aid for knowledge transfer	4.33	4.69	4.60	4.52	4.59	-
Work on practical issues to transfer knowledge to students	4.28	4.66	4.68	4.37	4.64	**
Creation or improvement of research areas	4.21	4.63	4.63	4.67	4.59	**
Financing possibilities and growth capacity	4.18	4.59	4.63	4.61	4.61	**
Creation of stable jobs for interns/researchers	4.31	4.62	4.62	4.54	4.41	-

On a scale of 1 = not at all important to 5 = very important
 Statistically significant differences: (**) $p < 0.01$; Non-significant differences: (-) $p > 0.05$

The results of the independent t test (Table 3) show that, on average, there is not a significant difference between male and female respondents in terms of their evaluation of the levels of importance of the items analyzed. The t test values for gender varied from -0.937 to 0.991 (p greater than 0.05). The results of the analysis of advantages or benefits by age were like those of the analysis by gender. There was no significant difference between the two groups (up to 45 years of age and over 45 years of age), with p values greater than 0.05 and t values ranging between -0.640 and 1.143. These results indicate that the respondents' perceptions of advantages and benefits is very similar regarding gender (male/female) and age group (age < 45 years and > 45 years).

Table 3: Main advantages or benefits by gender and age

Advantages or Benefits	Gender			Age (years)		
	Female	Male	Sig.	< 45	> 45	Sig.
Transfer research results to society	4.74	4.76	-	4.77	4.73	-
Visibility of research groups and universities	4.59	4.60	-	4.57	4.62	-
Creation of stable jobs for interns/researchers	4.45	4.53	-	4.51	4.48	-
Access to aid for knowledge transfer	4.58	4.52	-	4.58	4.51	-
Transfer research results to the productive sector	4.65	4.57	-	4.59	4.62	-
Financing possibilities and growth capacity	4.49	4.52	-	4.56	4.46	-
Work on practical issues to transfer knowledge to students	4.56	4.50	-	4.53	4.53	-
Creation or improvement of research areas	4.53	4.53	-	4.53	4.53	-

On a scale of 1 = not at all important to 5 = very important; Non-significant difference: (-) $p > 0.05$

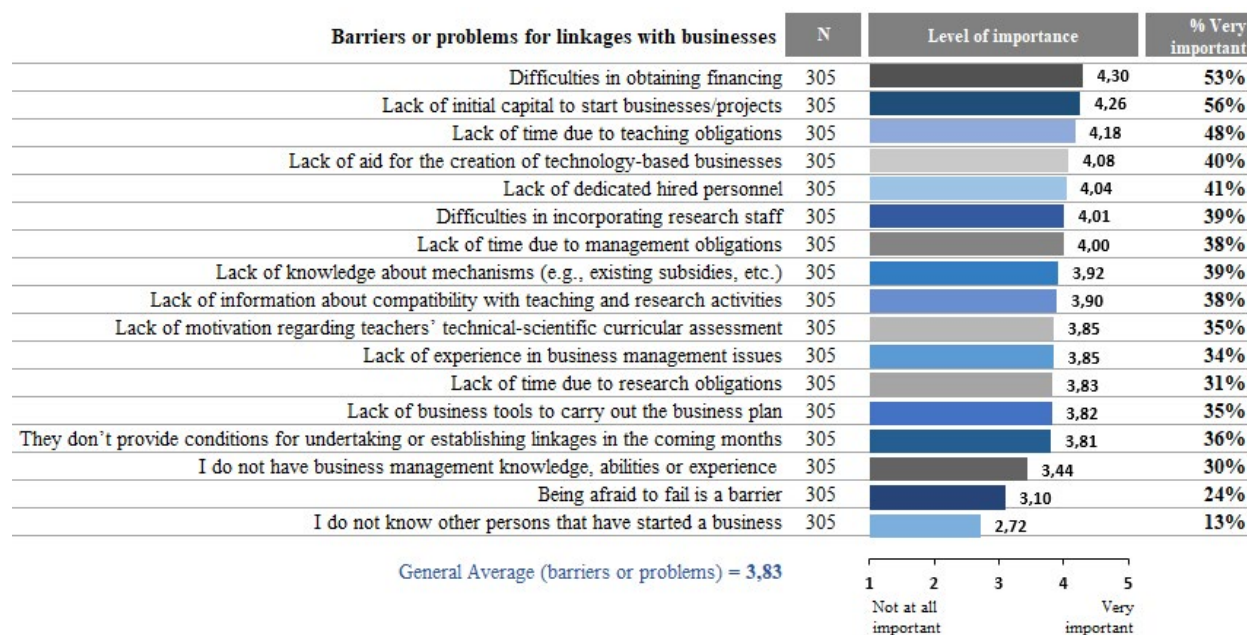
Among the countries with significant differences, statistical analyses indicated that Costa Rica and, especially, Brazil are the countries whose participants' responses explain these differences. The importance of "working on practical issues to transfer knowledge to students" as an advantage of university-business linkages differs between respondents from these two countries (Brazil and Costa Rica) as compared to respondents from the other countries whose response averages were closer to 5. On the other hand, the advantages of "financing possibilities" and "creation or improvement of research areas" when linking with businesses are perceived as less important by Brazilian respondents compared to those of the other countries,

possibly due to the fact that in Brazil, according to De Negri (2017), since the 2000s, policies and programs have existed in which subsidies are provided to businesses and financial support for research projects in universities, as instruments to promote innovation. This could explain why “financing possibilities” as an advantage of university-business linkages is perceived as less important than is the case in other countries. When the eight advantages of university-business linkages are comparatively analyzed in relation to gender and age, no statistically significant differences were observed. Gender inclusion in research centers is increasingly common, as documented in the Elsevier study (2017) entitled “*Gender in the Global Research Landscape*,” in which an analysis of research performance was carried out from a gender perspective during the years 1996–2016. A notable finding was that the proportion of women among researchers and inventors has increased among the countries analyzed, including Latin American countries, with an increasing percentage of women in research activities. These findings suggest that, regardless of the gender and age of the participants, the advantages of university-business linkages are widely recognized and considered to be relevant.

4.3 Barriers to university-business collaboration

Compared to the results of advantages and benefits, the averages of the importance assigned by survey participants to each of the barriers or problems associated with university-business linkages were lower. The general average of the mean of each of the items was 3.83. Figure 4 shows the level of importance of each of the 17 barriers or problems for linkages of universities with businesses. Eleven of the 17 barriers have an average ranking of more than 3.83, suggesting a significant number of obstacles to university-business linkages. The two most important barriers (difficulties in obtaining financing and lack of initial capital) are related to investments necessary for linkage projects. Five barriers were rated as least relevant (Figure 4), including lack of time due to research obligations (3.83) and lack of business tools for planning (3.82). Although these barriers are evaluated as less important, they point to challenges that can make linkage difficult.

Figure 4: Barriers or problems



To examine in more detail the eleven barriers that exceeded the general average, the results were analyzed by country of origin, gender and age of the respondents. The results presented in Table 4 reveal that there is very strong, statistically significant evidence of different perceptions of levels of importance between the countries of three barriers: lack of time due to teaching obligations ($p < 0.001$; $F = 4.790$); lack of time due to management obligations (p value = 0.001 ; $F = 4.545$); and lack of motivation regarding teachers' technical-scientific curricular assessment ($p < 0.001$; $F = 6.576$).

The results regarding the importance of two other barriers presented statistically significant evidence that suggests differences in responses depending on the country: lack of experience in business management issues (p value = 0.008 ; $F = 3.551$); and lack of aid for the creation of technology-based businesses, especially regarding the personnel section (p value = 0.004 ; $F = 3.956$). Other results suggest that there is a statistically significant difference between respondents from different countries in terms of the importance of difficulties in obtaining financing (p value = 0.017 ; $F = 3.059$); and difficulties in incorporating research personnel (p value = 0.011 ; $F = 3.337$). Finally, the other barriers did not show a significant difference between respondents from different countries (p values greater than 0.05).

Table 4: Barriers or problems by country of origin

Barriers or problems	Brazil	Panama	Colombia	Costa Rica	Others	Sig.
Lack of time due to teaching obligations	4.01	4.03	4.60	3.98	4.27	***
Lack of time due to management obligations	3.61	4.00	4.33	4.09	4.05	***
Lack of experience in business management issues	3.60	4.10	3.97	3.50	4.02	**
Difficulties in obtaining financing	4.42	4.25	4.35	3.91	4.45	*
Lack of dedicated hired personnel	3.88	4.13	4.24	3.78	4.13	-
Lack of knowledge about mechanisms (e.g., existing subsidies, etc.)	3.81	4.03	4.05	3.59	4.07	-
Lack of initial capital to start businesses/projects	4.15	4.43	4.27	4.02	4.36	-
Difficulties in incorporating research staff	3.68	4.12	4.14	3.89	4.25	*
Lack of aid for the creation of technology-based businesses	3.74	4.29	4.25	3.98	4.16	**
Lack of information on compatibility with teaching and research activities	3.67	3.84	4.19	3.78	4.02	-
Lack of motivation regarding teachers' technical-scientific curricular assessment	3.44	3.99	4.19	3.46	4.16	***

On a scale of 1 = not at all important to 5 = very important

Statistically significant differences: () $p < 0.05$; (**) $p < 0.01$; (***) $p < 0.001$; Non-significant differences: (-) $p > 0.05$*

The results of independent t tests (Table 5) show that there is a difference between men and women in their perceptions of the levels of importance of some barriers or problems for linkages with businesses. There are strong statistically significant results in the following items: lack of aid for the creation of technology-based businesses, especially regarding the personnel section (p value = 0.004 ; $t = 2.646$) and lack of motivation regarding teachers' technical-scientific curricular assessment (p value = 0.004 ; $t = 2.644$). Two other items showed statistically significant differences: difficulties in obtaining financing (p value = 0.012 ; $p = 2.278$); and difficulties in incorporating research personnel (p value = 0.019 ; $t = 2.092$). Finally, the other items did not show significant differences between female and male respondents (p values greater than 0.05).

The results also showed differences compared to the results of analysis by age. The barriers with statistically significant differences between the age groups were lack of experience in business management issues (p value = 0.015 ; $t = 2.177$) and lack of time due to management obligations (p value = 0.029 ; $t = 1.967$). The other items show no significant differences between the two age groups (p values greater than 0.05 and t values less than 1.96), indicating that the perceived importance of some barriers is similar between groups in terms of gender and age.

Table 5: Barriers or problems by gender and age

Barriers or problems	Gender			Age (years)		
	Female	Male	Sig.	< 45	> 45	Sig.
Lack of time due to teaching obligations	4.22	4.15	-	4.24	4.13	-
Lack of time due to management obligations	4.01	3.99	-	4.12	3.89	*
Lack of experience in business management issues	3.83	3.86	-	3.99	3.72	*
Difficulties in obtaining financing	4.42	4.19	*	4.33	4.26	-
Lack of dedicated hired personnel	4.11	3.98	-	4.03	4.04	-
Lack of knowledge about mechanisms (e.g., existing subsidies, etc.)	4.03	3.82	-	3.97	3.88	-
Lack of initial capital to start businesses/projects	4.35	4.17	-	4.25	4.26	-
Difficulties in incorporating research staff	4.14	3.89	*	4.00	4.02	-
Lack of aid for the creation of technology-based businesses	4.24	3.94	**	4.16	4.01	-
Lack of information about compatibility with teaching and research activities	3.99	3.81	-	4.00	3.80	-
Lack of motivation regarding teachers' technical-scientific curricular assessment	4.03	3.69	**	3.92	3.79	-

On a scale of 1 = not at all important to 5 = very important

Statistically significant differences: () $p < 0.05$; (**) $p < 0.01$; (***) $p < 0.001$; Non-significant differences: (-) $p > 0.05$*

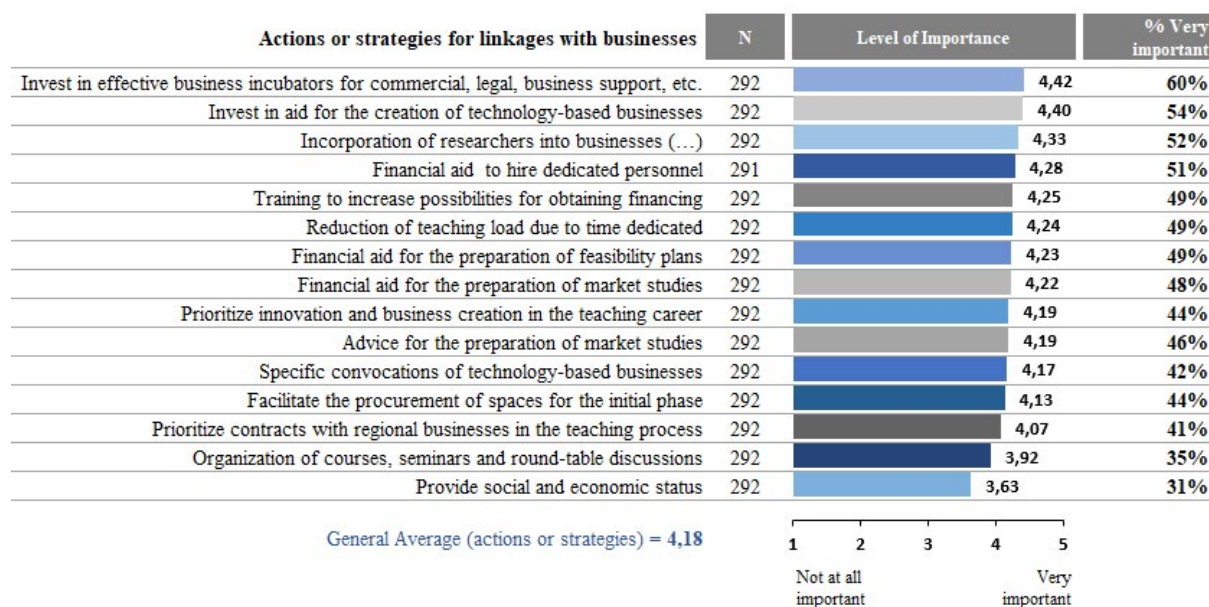
The results indicate that country, gender and age influence the perception of barriers to university-business linkages. Significant differences were observed in the importance of barriers depending on the country of origin of the participants, consistent with different development profiles in innovation and knowledge transfer in Latin American countries, according to [González et al. \(2019\)](#). Innovation capabilities and techno-economic characteristics vary, reflecting specific strategies and policies in each country. For example, compared to the other countries responses from Costa Rica had a lower average regarding the importance of lack of time due to teaching obligations, indicating that barrier may be considered as being less relevant or having a lower impact on university-business linkages.

In the specific case of Costa Rica, [Dutrénit and Nuñez \(2017\)](#) point out that researchers see the main difficulties in establishing a link between public universities and businesses to be internal bureaucracy and the lack of communication between universities and businesses, since businesses are not familiar with the activities that universities carry out. On the other hand, the barrier of lack of time due to management obligations received a lower average score from the respondents from Brazil than those from other countries, Furthermore, both Brazil and Costa Rican participants assigned less importance to lack of motivation regarding teachers' technical-scientific curricular assessment; their scores were close to 3, while scores from other countries were closer to 4, indicating that curricular aspects are given less emphasis in Brazil and Costa Rica and are somewhat more relevant in other countries. This suggests that the specific knowledge and skills that teachers have in the technical-scientific field of linkages with businesses are not recognized or are not given the importance that they should in the evaluation of their academic resumé. In summary, differences between country results may reflect variations in country-specific contexts and conditions. [Vega-Jurado et al. \(2007\)](#) agree with the perception of teachers from Latin American countries about relations with the productive sector that academics do not have the time required for linkage activities, since most of their time is dedicated to teaching, and to a lesser extent to research where they do not interact with the environment.

4.4 Strategic actions for university-business collaboration

Figure 5 shows the averages of scores assigned by participating researchers to each of the actions or strategies with respect to university-business linkages. For the 15 actions/strategies evaluated, only two average scores were less than four, and the general average for the entire group is 4.18. The 13 most important actions (with scores between 4 and 5 points) include investing in incubators that provide commercial, legal and business support to the researcher (4.42; 60% of those surveyed consider this action very important) and investing in aid for the creation of technology-based businesses (4.40; 54% consider it very important). These specific results emphasize the relevance of financial investments, support programs and practical training to promote effective linkages between universities and businesses. However, there is relatively less importance assigned to actions such as organizing courses, seminars and round-table discussions (3.92) and providing social and economic status (3.63). This suggests that intangible aspects related to the dissemination, social and economic recognition of university-business linkages may not be considered as relevant as other actions that offer concrete and tangible support.

Figure 5: Actions or strategies



As was done for benefits and barriers, an analysis was conducted of the actions/strategies that outperformed the overall average. The results of the ten actions that were identified were analyzed by country of origin, gender, and age of the respondents. The results obtained from the analyses showed that there were statistically significant differences between the responses in several countries (Table 6) with respect to innovation and business creation in the teaching career ($p = 0.003$; $F = 4.093$), financial aid for the preparation of market studies ($p = 0.005$; $F = 3.798$) and the preparation of feasibility plans ($p = 0.005$; $F = 3.811$), as well as reduction in teaching load due to time dedicated to businesses ($p = 0.022$; $F = 2.898$).

Table 6: Actions or strategies by country of origin

Actions or strategies	Brazil	Panama	Colombia	Costa Rica	Others	Sig.
Financial aid to hire dedicated personnel	4.16	4.27	4.44	4.27	4.24	-
Reduction of teaching load due to time dedicated	4.16	4.42	4.37	3.86	4.25	*
Training to increase possibilities for obtaining financing	4.06	4.43	4.43	4.05	4.24	*
Financial aid for the preparation of market studies	4.03	4.34	4.51	3.95	4.20	**
Financial aid for the preparation of feasibility plans	4.00	4.40	4.49	4.02	4.18	**
Prioritize innovation and business creation in the teaching career	4.04	4.31	4.41	3.80	4.27	**
Advice for the preparation of market studies	3.99	4.31	4.44	4.00	4.14	*
Incorporation of researchers into the business, making it compatible with their university activity	4.12	4.51	4.52	4.18	4.24	*
Invest in aid for the creation of technology-based businesses	4.21	4.49	4.52	4.34	4.41	-
Invest in effective business incubators for commercial, legal, business support, etc.	4.18	4.60	4.57	4.32	4.43	*

On a scale of 1 = not at all important to 5 = very important

Statistically significant differences: (*) $p < 0.05$; (**) $p < 0.01$; (***) $p < 0.001$; Non-significant differences: (-) $p > 0.05$

The results of the independent t tests (Table 7) showed that there was a statistically significant difference in perceptions between men and women in the cases of training to increase the possibilities of obtaining financing ($p = 0.014$; $t = 2.213$), and incorporation of researchers into the business, making it compatible with their university activity (p value = 0.014 ; $t = 2.210$). The other items did not show a significant difference between genders.

With respect to age, it was observed that there were statistically significant differences ($p < 0.05$) in four items, including financial aid to hire personnel dedicated to business creation ($p = 0.014$; $t = 2.213$). The other items did not show a significant difference between age (p values greater than 0.05 and t values less than 1.96), indicating that the perception of the actions or strategies is very similar.

Table 7: Main actions or strategies according to gender and age

Actions or strategies	Gender			Age (years)		
	Female	Male	Sig.	< 45	> 45	Sig.
Financial aid to hire dedicated personnel	4.22	4.32	-	4.39	4.17	*
Reduction of teaching load due to time dedicated	4.23	4.24	-	4.31	4.17	-
Training to increase possibilities for obtaining financing	4.38	4.15	*	4.36	4.15	*
Financial aid for the preparation of market studies	4.22	4.22	-	4.27	4.17	-
Financial aid for the preparation of feasibility plans	4.20	4.26	-	4.30	4.17	-
Prioritize innovation and business creation in the teaching career	4.26	4.13	-	4.27	4.11	-
Advice for the preparation of market studies	4.23	4.15	-	4.31	4.07	*
Incorporation of researchers into the business, making it compatible with their university activity	4.45	4.22	*	4.33	4.32	-
Invest in aid for the creation of technology-based businesses	4.38	4.41	-	4.48	4.32	-
Invest in effective business incubators for commercial, legal, business support, etc.	4.49	4.37	-	4.53	4.32	*

On a scale of 1 = not at all important to 5 = very important

Statistically significant differences: (*) $p < 0.05$; (**) $p < 0.01$; (***) $p < 0.001$; Non-significant differences: (-) $p > 0.05$

As discussed previously, only two actions/strategies did not show a significant difference between responses according to the country of origin. However, responses concerning these two strategies did have average importance scores greater than 4; financial aid to hire personnel dedicated to the creation of businesses, and aid for the creation of technology-based businesses. These results agree with findings of [Albornoz et al. \(2017\)](#) concerning favorable practices to establish university-business linkages, including the hiring of academic personnel to carry out non-academic activities related to forming linkages, and creating financing schemes through University convocations, collaboration, integration of mixed work teams, and results transfer agreements. Although no significant differences were found between countries in terms of the importance of these actions/strategies, these results suggest that respondents from different countries have a similar opinion about their relevance for university-business linkages.

With respect to differences in perceptions between men and women about the importance of difference strategies and actions for linkages with businesses, two cases stood out: training to increase the possibilities of attracting funding and the incorporation of researchers into businesses, making it compatible with their university activity. This implies that although men and women consider these actions relevant, members of these groups have different perceptions about the relevance of these actions in the context of university-business linkages. However, no significant differences were found between male and female respondents for the other items. The differences found may be due to various factors. For example, in the case of training to increase the possibilities of attracting financing, it is possible that there are differences in the previous experiences of men and women in accessing financial resources, which could influence their perception of the importance of this action. Regarding the incorporation of researchers in businesses, making it compatible with their university activity, the differences in perception between men and women could be related to the reconciliation of roles and responsibilities, since women have historically faced additional challenges in terms of balance between work and personal life.

Finally, in relation to the differences found according to the age of the respondents, it is important to consider that different generations may have different perspectives on university-business linkages due to their historical contexts and work experience. For example, younger respondents may be more familiar with technological advances and the importance of creating technology-based businesses, which could explain their more positive perceptions of the importance of financial aid to hire personnel dedicated to business creation, and support in incubators.

5. Conclusions

This results of this investigation demonstrate that respondents widely recognized the importance of university-business linkages and their benefits. The fifteen advantages analyzed obtained an average score greater than 4, reflecting positive and relevant perceptions. They also highlighted some advantages whose rankings exceeded the general average, such as the transfer of research results to society and the productive sector, as well as greater visibility for research groups and universities. When analyzing the highest-ranked advantages, differences were observed depending on the country of origin, highlighting the potential of university-business linkage projects to generate practical topics, improve lines of research and increase financing possibilities. No differences were recorded by sex and age, indicating similar perceptions among participants.

The results revealed differences in the perceived importance of barriers between countries, which reflects the particularities of each national context in university-business linkages. These findings are useful for understanding specific needs in each country and guide actions and policies that promote effective linkages. In addition, significant differences in perceptions were observed according to sex and age. The main barriers identified were related to access to financing, shortage of human resources for projects with businesses, difficulty in time management, and lack of knowledge about available opportunities.

By analyzing potential actions for the promotion and success of university-business linkages, the study highlights the importance of considering the context (country of origin), gender and age of researchers when designing policies and projects. Understanding the differences in the perception and needs of various groups facilitates the adaptation of actions to promote effective and timely engagement of the individuals involved. Furthermore, it points out the need to promote diversity and gender equity in this area, ensuring that all voices are heard and making the most of available human capital.

In conclusion, these results offer relevant information on the perception of university researchers concerning advantages, barriers and actions in the formation of university-business linkages. These findings can be considered in the formulation of policies and strategies for university-business collaboration, promoting synergies and taking advantage of mutual benefits. They also highlight the need to consider the particularities and specific contexts of each country when developing programs to strengthen university-business linkages in Latin America.

In future research, it is suggested to carry out more detailed comparative studies between countries to identify the specificities of each national context that are relevant to the formation of university-business linkages: deepening the analysis of differences in perception according to gender and age; exploring socio-cultural influences; investigating specific strategies and policies to address identified barriers, to foster more effective engagement; exploring additional factors such as the size and geographic location of institutions, organizational culture, and available resources; as well as carrying out longitudinal studies to evaluate changes in the perception and effectiveness of the actions implemented in university-business linkages over time.

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