

Developing measures for higher education researchers' drivers and intentions to collaborate with firms



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ABSTRACT

Higher education institutions (HEIs), with their research output and researchers, can make significant contributions to firms. Nevertheless, what drives researchers' intention to collaborate with firms still requires further exploration. Taking a behavioral approach, this study developed and validated a model and corresponding survey instruments to assess in detail the conditions that influenced the intention of HEIs researchers to collaborate with firms. The results indicated that 1) the proposed model and instrument were valid for measuring researchers' intention to collaborate with firms, and 2) the correspondence between the hypothesized and observed empirical structures of the drivers and barriers for collaboration was supported. This research adds new insights into the roles and relevance of attitudes (appraisal of favorable or unfavorable outcomes), perceived behavioral control (instrumental-agency concerns), and subjective norms (internal and external actors facilitating or hindering collaboration) according to the HEI, government, and firm environments.

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Introduction

In the last two decades, the literature on collaboration between universities and firms has emphasized and recognized a wide variety of favorable outcomes of such partnerships at the regional and national levels (Skute et al., 2019). Firms and universities collectively advance proposals for solutions and create value through collaborative projects (Lascaux, 2019). The synergies between teaching and basic and applied research place universities in a unique position to offer solutions to different stakeholders, including firms (Debackere & Veugelers, 2005). Research on university–industry collaboration still requires attention at both individual and organizational levels. At the individual level of analysis, research can focus on knowledge transfer, interactions between universities and firms, and perceived facilitators of and obstacles to these interactions. At the institutional

level, research can use an ecosystem perspective to shed light on the interactions between universities and firms. Additionally, there is still a need to investigate the management of incentives and initiatives to improve both researchers' and industry partners' willingness to collaborate (Skute et al., 2019). This article posits that an entrepreneurial ecosystem requires individuals and organizations engaged in the creation of value and change and structures to develop products, processes, and services.

This investigation aimed at developing and validating an instrument that could integrate diverse strands of research exploring the rationale of HEI–Firm collaboration into a single testable model. This would help to scientifically analyze the researchers' intentions and corresponding drivers and barriers to collaborating with firms, and enable the replicability of the proposed model. Theoretically, this study contributes to HEI–Firm collaboration research by including different stakeholders and identifying that the combination of institution, government, and firm situations or elements helps understand the intentionality of researchers to collaborate with firms.

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Using the theory of planned behavior (TPB) as a framework to understand the determinants of researchers' intention to collaborate with firms, our research contributes to the literature on the determinants of individuals' willingness to develop a certain behavior. This can be replicated in future research addressing managerial purposes.

Our research also contributes to the literature on entrepreneurial ecosystems by focusing on researchers from HEIs as actors with the potential to contribute propitiously to the entrepreneurial ecosystem. Based on pattern matching, we identified interview findings consistent with the literature and new findings from interviews, which allowed us to offer new insights about attitudes, perceived behavioral control, and subjective norms, and relate them as mediators of intention to behave in specific situations and contexts. This information formed the basis of the development of the questionnaire for the survey intended for researchers at HEIs in Mexico. We then carried out an exploratory factor analysis and a confirmatory factor analysis to validate the instrument.

The remainder of this paper is organized as follows. In Section 2, first, we introduce a brief review of the entrepreneurial ecosystem literature to frame different stakeholders' interactions in the ecosystem. Second, we present TPB as a meta-theory to integrate disparate insights from the literature on HEI–firm collaboration into a single testable model. Third, we highlight factors related to HEI–firm collaboration and organize them according to the TPB model. Section 3 presents the research method employed to design and validate the instrument as well as the results obtained. Section 4 discusses the research findings, the implications, limitations, and future research directions, and concludes the paper.

Literature review

Cooperation and ecosystems

Recently, entrepreneurial ecosystems have gained importance because of their potential to create a favorable atmosphere for entrepreneurs, organizations, and different actors pursuing entrepreneurial goals (Bouncken & Kraus, 2021). Entrepreneurial ecosystems are expected to increase the prosperity and social welfare of a region. An essential element for ecosystem development are the connections (Wurth et al., 2021). The interconnection and productive work of different actors, including firms and universities, allow the construction of an entrepreneurial ecosystem (Bouncken & Kraus, 2021). Firms might overcome obstacles when they are part of ecosystems and exchange ideas, knowledge, and resources with different actors (Bouncken & Kraus, 2021). Universities can contribute to value creation through the development and support of any entrepreneurial activity (Wurth et al., 2021). Universities act as feeders of entrepreneurial ecosystems (Civera et al., 2019) through their interactions with other stakeholders (Schaeffer & Matt, 2016). For example, universities can help create startups and develop established companies (Schaeffer & Matt, 2016). However, there is limited research on how relational connections develop in entrepreneurial ecosystems and the contextual factors affecting them, including the role of actors as drivers of the ecosystem. Actors are heterogeneous with respect to their attitudes, abilities, domain-specific knowledge, and ability and willingness to collaborate with others. These characteristics are influenced by the context in which actors are situated and by the capacity to determine the origin and success of entrepreneurial actions (Wurth et al., 2021). In this sense, our study 1) contributes to the literature on entrepreneurial ecosystems by studying researchers as actors within an ecosystem with the potential to create value, and 2) adds knowledge about how researchers' perceptions of other stakeholders from the ecosystem can facilitate or hinder their intentions to collaborate with firms. Therefore, given the potential of researchers to cooperate and create value within an ecosystem and the presence of factors facilitating or hindering their intentions to collaborate

with firms, we use TPB as a meta-theory to understand the attitudes, subjective norms, and perceived behavioral control that might affect researchers' intentions to collaborate with firms.

Theory of planned behavior

TPB is designed to predict and explain human behavior in specific contexts (Ajzen, 1991, p.181). It states that an individual's planned behavior is preceded by the intention to perform a given behavior; the stronger the intention to engage in a behavior, the more likely it is to be a performance (Ajzen, 1991). The theory postulates three conceptually independent determinants or predictors of intention. The first is the attitude toward the behavior, which refers to the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question. The second is a social factor termed subjective norm, which refers to the perceived social pressure to perform or not perform the behavior. The third is the degree of perceived behavioral control, which is the perceived ease or difficulty of performing the behavior and expected to reflect past experience as well as anticipated impediments and obstacles (Ajzen, 1991).

Salient beliefs are considered the prevailing determinants of an individual's intentions and actions. These are classified into: behavioral beliefs that are assumed to form the attitudes toward the behavior, normative beliefs that constitute the underlying determinants of subjective norms, and control beliefs that provide the basis for perceptions of behavioral control (Ajzen, 1991). According to Ajzen (1991), people form beliefs about an object by associating it with certain attributes, with other objects, characteristics, or events. In the case of attitudes toward a behavior, each belief links the behavior to a certain outcome or to some other attribute, in which people favor behaviors with largely desirable consequences or, on the contrary, form unfavorable attitudes toward behaviors associated with mostly undesirable consequences. Normative beliefs regard that important referent individuals or groups approve or disapprove of performing a given behavior (Ajzen, 1991, p.195), while control beliefs are related to the presence or absence of resources and opportunities that individuals possess. The availability of resources increases the perceived control over behavior (Ajzen, 1991). Next, we present the factors related to HEI–firm collaboration and organize them according to TPB.

HEI–firm collaboration. The behavioral model

Previous researchers have studied the factors involved in university–industry collaborations. Galan-Muros and Davey (2019) proposed a conceptual framework to understand university–business cooperation; nevertheless, the relationships between factors were not empirically tested. Through an inductive qualitative approach, Siegel et al., and Link (2004) identified key organizational issues in promoting knowledge transfer. Following Siegel et al. (2004) qualitative approach, Franco and Hase (2015) conducted a case study to understand the interface between researchers' motivations and the interaction channels of university–firm cooperation.

In their survey, Olaya, Berbegal-Mirabent, Alegre and Duarte (2017) identified intrinsic and extrinsic motivations, and university support services as critical elements. Rajaeian et al., and Lane (2018) investigated the factors related to the effectiveness of academic researchers' engagement in disseminating research-generated knowledge to industry, highlighting their motivations, knowledge transfer mechanisms, and communication/interaction channels with industry. Davey et al., and Meerman (2011) examined drivers and barriers in university–firm cooperation in Europe through a survey. Sormani et al., and van der Sijde (2021) focused on identifying the incentives implemented by higher education institutions to engage academics in third mission activities and the effectiveness of incentives to engage business and economics academics in joint research

projects with society. Orazbayeva, Davey, Plewa, & Galán-Muros, 2020 explored the motivations underlying education-driven academic engagement with business, in the form of student mobility, curriculum design and delivery, and lifelong learning.

These research findings help to understand motivations, channels, mechanisms, and incentives, among other factors, influencing the interaction of HEIs and firms, as actors within an entrepreneurial ecosystem. Nevertheless, in this study, we adopted a behavioral theory designed to explain researchers' intention to collaborate with firms based on their attitudes, perceived behavioral control, and subjective norms related to different stakeholders. In addition, we use it as a meta-theory to integrate disparate insights from the literature on HEI–Firm collaboration.

Researcher's attitude toward collaboration with firms

Incentives have the potential to positively contribute to technology transfer and innovation (Bercovitz & Feldmann, 2006; Debackere & Veugelers, 2005; Siegel et al., 2004). Researchers perceive benefits from research publications, such as promotion, tenure (Rajaeian et al., 2018), and recognition (Fullwood et al., 2013; Olaya Escobar et al., 2017), which facilitate academic performance assessment and rewards from the academic system (Franco & Haase, 2015; Rajaeian et al., 2018). In addition, researchers expect to acquire further projects and obtain financing for them (Bodas Freitas & Verspagen, 2017), and to maintain collaborative contacts (Arzenšek et al., 2018). They also expect to learn from industry (Meng et al., 2019) and acquire innovative knowledge (Xu et al., 2018). Importantly, researchers expect collaborative research to increase practitioners' adoption of their research results (Berggren, 2017; Rajaeian et al., 2018). University–industry collaboration benefits students through the development and adaptation of education programs to meet regional skill needs (Gunasekara, 2006). As Davey et al. (2011) suggest, universities and firms can cooperate in the development of a fixed program of courses, modules, majors or minors, and/or planned experiences at different academic levels. Additionally, student projects can be developed in cooperation with firms. This may create a stronger regional focus on student recruitment and graduate retention (Gunasekara, 2006).

Researchers' control over collaboration with firms

Past collaborative experience provides researchers a basis to assess their decision to collaborate with firms (Bhullar et al., 2019). Institutional frame conditions can affect the behavior of academics to engage in knowledge transfer activities (Callaert et al., 2015; D'Este & Patel 2007). Some factors hinder collaboration, such as lack of internal rules, support from universities and communication and activities to encourage knowledge transfer, weak management processes (Olaya Escobar et al., 2017), and administrative bureaucracy (Cunningham et al., 2014). Universities and technological innovation centers need to improve the professionalization of internal processes related to innovation and entrepreneurial behavior, creating policies to be efficient in the transfer and protection of knowledge and technology (Ávila et al., 2017; Bercovitz & Feldmann, 2006; Callaert et al., 2015; Chais et al., 2018; D'Este & Patel, 2007; Fichter & Tiemann 2018; Siegel et al., 2004); access to specialized equipment and laboratories is an example (van der Sijde, 2012). Researchers face a lack of time to prioritize interaction, knowledge of how to contact industry, encouragement to interact with stakeholders, knowledge of successfully conducting stakeholder interactions, and funding for interaction (Knaggård et al., 2019).

In addition, researchers face a lack of government support regarding policies and regulatory frameworks and of overall funding (Fichter & Tiemann, 2018; Zhimin et al., 2016). However, leading public-funded projects can bring obstacles for researchers—Competing stakeholders' interests, inadequate institutional support, poor

recruitment of talented researchers, mismatch with industry timeline, and administrative bureaucracy (Cunningham et al., 2014).

Pressure on researchers to collaborate with firms

Researchers may feel pressure from different sources, such as their work colleagues (Arzenšek et al., 2018), postgraduate students (Davey et al., 2011; Debackere & Veugelers 2005; Schartinger et al., 2002; Wright et al., 2008), demand for R&D from industry (Bodas Freitas et al., 2013; Laursen et al., 2011), and government policy and evaluation system requirements (Zhimin et al., 2016).

In summary, researchers' intention to collaborate with firms is influenced by attitudes, perceived control, and pressure to collaborate. Fig. 1 shows the structural determinants of this collaboration.

Data and method

Instrument development—Matching theoretical concepts and empirical structures

Theoretical developments linked to the measurement of a set of relationships between constructs enable a better understanding of our reality. Support for theories comes from measurement, which entails finding empirical structures that support hypothetical relationships. One of the major challenges facing social sciences is designing a method to test and find support for empirical theories. Different methods of searching for empirical structures have been proposed over the last six decades (see Cronbach, 1994; Guttman, 1959; Guttman, 1971; Lazardfeld, 1954), and both present and past studies indicate that pattern matching is a robust method. Pattern matching consists of comparing a predicted theoretical pattern with an observed empirical pattern (Sinkovics, 2018). It allows continuous iteration between extant theories and empirical evidence from qualitative data, which provides the opportunity to develop theory (Bouncken et al., 2021). Therefore, researchers obtain dimensions from the literature review prior to data collection and analysis, allowing a comparison with new empirical dimensions emerging from the data (e.g., Corral, 2003; Wehn, 2003; and Montalvo, 2006; using the TPB to predict intentions and behavior via multi-dimensional scaling). We used the TPB as a conceptual framework (Bouncken et al., 2021) to understand the determinants of researchers' intentions to collaborate with firms. The use of pattern matching and TPB as a conceptual model enables the development of an instrument to measure the intentions of researchers to collaborate with firms and to make explicit the relationships and structure of other variables presented in the model. Therefore, we asked the following research question: What are the drivers and barriers influencing researchers' intentions to collaborate with firms? In addition, the following theoretical patterns are proposed.

Pattern 1. Researchers' intentions to collaborate with firms are influenced mainly by attitudes, subjective norms, and perceived behavioral control over the collaboration process between the government and firms.

Pattern 2. Researchers' intentions to collaborate with firms are influenced mainly by attitudes, subjective norms, and perceived behavioral control over the collaboration process with internal stakeholders (university officials).

We conducted 20 interviews using open-ended questions with researchers from HEIs that collaborated with firms, with the purpose of assessing attitudes (advantages, disadvantages, likely outcomes), subjective norms (e.g., institutional and peer pressures) and perceived control over the collaboration process (e.g., capabilities, resources, and time). We then compiled and processed the interview findings. Following Sinkovics (2018), and Bouncken et al. (2021), we identified the interview findings consistent with the literature and the new findings. This compilation was relevant because we

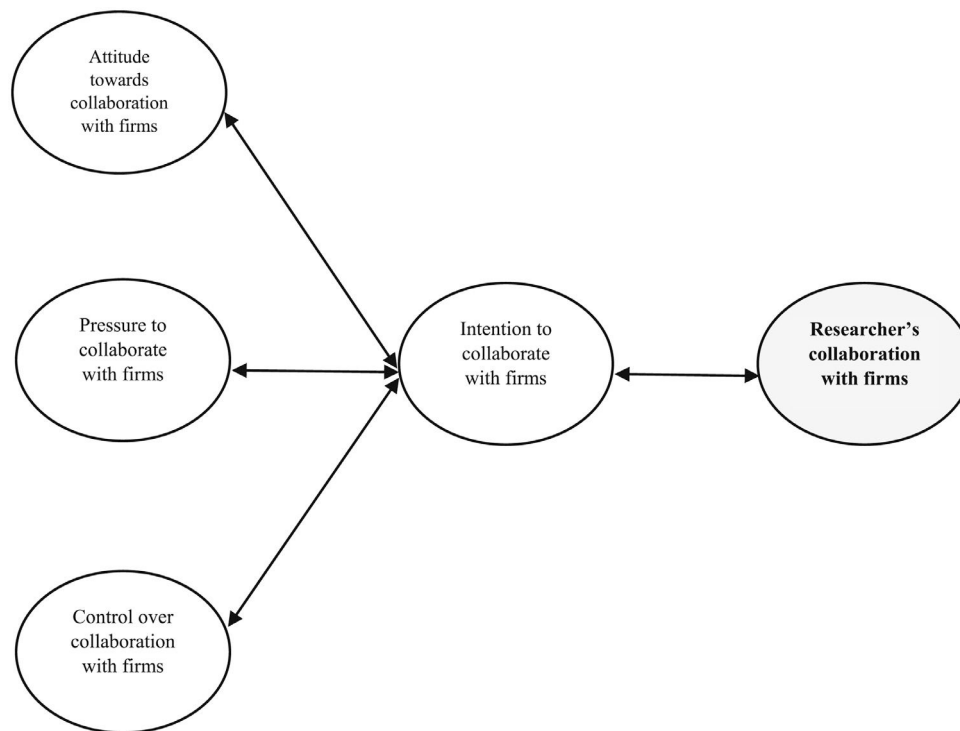


Fig. 1. HEI-Firm collaboration model—Structural determinants of researcher's intention to collaborate with firmsSource: Authors' elaboration.

connected the empirical findings from interviews with the theoretical concepts of attitudes, subjective norms, and perceived behavioral control to create the HEI–Firm collaboration intention questionnaire (HEI-F CIQ). Discussing the full implications of the interviews is beyond the scope of this study. However, we invite the interested reader to consult [Appendices A, B, and C](#) for the empirical findings on attitudes, perceived behavioral control, and subjective norms, respectively, and [Appendix D](#) for the HEI–F CIQ.

The HEI-F CIQ comprises five sections. Section 1 corresponds to attitude toward behavior, Section 2 to subjective norm, and Section 3 to perceived behavioral control. These sections were measured using a differential semantic scale. Section 4 describes the researchers' intention to collaborate with firms. To measure intention, we adapted five items from [Liñán and Chen \(2009\)](#). In Section 5, we request for personal data. We included the questions used in the survey developed by [Davey et al. \(2011\)](#). This section should not affect intention directly, but could provide useful information for understanding researchers' routines.

Measures

The following measures for the variables were used in this study. A researcher's attitude refers to the degree to which a person has a favorable or unfavorable evaluation or appraisal toward HEI–Firm collaboration. The researcher's attitude includes the impact of HEI–Firm collaboration on firms and society, researcher–firm relationships, student impact, institutional support, and government support.

A researcher's perceived behavioral control refers to the ease or difficulty of collaborating with firms, and includes the influence of institutional, governmental, and firm capabilities. Institutional capabilities involve the establishment of policies and processes to manage the HEI–Firm partnership, institution business position, and incentives. In terms of government capabilities, public funding, government incentives, and the country's economic and political situation appear to be issues of concern. For firm capabilities, the pattern

indicates a firm's willingness to collaborate with higher education institutions, funding research, and assignment of other resources.

A researcher's subjective norms refer to the perception of internal and external actors pressuring (or not) researchers to collaborate or not to collaborate with firms. Researchers' subjective norms include the institutions of affiliation, colleagues, and graduate and postgraduate students. External actors include government and firms.

HEI–Firm collaboration intention was measured using a Likert-type scale at three different times and five items for each—Currently, in the past three years, and the next two years

Data collection

A total of 3375 invitations were sent out to researchers of HEIs that might or might not collaborate with firms. The survey was administered in an electronic form to researchers of 14 recognized HEIs. The data were collected between January and April 2021. A total of 297 questionnaires were collected. All were retained, as the total number of questions was labeled as mandatory. [Table 1](#) shows the characteristics of researchers who collaborate with firms.

Factor analysis

According to [Kline \(2000, p.113\)](#) factor analysis (FA) is a statistical method in which variations in scores on a number of variables are expressed in a smaller number of factors. The resultant factors were defined by their correlations (factor loadings) with the original variables. We performed exploratory factor analysis (EFA) followed by confirmatory factor analysis (CFA). An EFA is used to simplify a large set of data to map the most important variables, and a CFA is used to confirm or support hypotheses ([Kline, 2000](#)).

Due to the length of the survey, we performed an EFA for each of the latent variables analyzed in this study (attitude toward the behavior, subjective norm, perceived behavioral control, and intention). To determine whether the FA was feasible, we performed Bartlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) test for

Table 1
Profile of the researchers collaborating with firms.

	Number	%
Gender		
Female	98	33
Male	199	67
Total	297	100
Age (years)		
<30	0	0
Between 30 and 39	43	14.58
Between 40 and 49	81	27.46
Between 50 and 59	98	33.22
≥60	73	24.75
Total	295	100
Institution		
Universidad de Sonora	13	4.38
Universidad Autónoma de Baja California	20	6.73
Universidad Anáhuac	8	2.69
Colegio de la Frontera Norte	2	0.67
Centro de Investigación en Alimentos y Desarrollo	10	3.37
Universidad Nacional Autónoma de México	49	16.5
Centro de Investigación y Asistencia en Tecnología y Diseño del Estado de Jalisco	21	7.07
Universidad Autónoma Metropolitana	18	6.06
Centro de Investigación Científica de Yucatán	8	2.69
Universidad Autónoma Chapingo	9	3.03
Universidad Autónoma de Nuevo León	38	12.79
Universidad Autónoma de Ciudad Juárez	45	15.15
Universidad de Guadalajara	35	11.78
Universidad Autónoma de Querétaro	21	7.07
Total	297	100
Knowledge field		
Engineering and Technology	105	35.5
Natural and Exact Sciences	41	13.8
Biologic and Health Sciences	59	19.87
Agriculture Sciences	28	9.43
Economic-Administrative Sciences	33	11.11
Social Sciences	14	4.71
Others	17	5.72
Total	297	100
SNI member		
Yes	205	69.02
No	92	30.98
Total	297	100
Years in collaboration with firms		
≤1	13	4.38
Between 1 and 5	96	32.32
Between 6 and 10	66	22.22
Between 11 and 15	54	18.18
Between 16 and 20	22	7.41
>20	46	15.49
Total	297	100

Source: Authors' elaboration.

sampling adequacy. The results found the data suitable for factor analysis. A Kolmogorov–Smirnov test was performed to check for normality in the distribution of items. Because the normality assumption was violated, and as Fabrigar et al., and Strahan (1999) suggested, principal axis factorization was selected as the extraction method. Promax was selected as the rotation method. Cronbach's alphas were calculated to test internal consistency reliability. For data analysis, we used two criteria: one more statistical, that is, based on factor loadings, and the other based on factor representation of factors so that no factor was over- or under-represented. In the case of subjective norms, the factor loadings could not follow the same criteria as attitude toward behavior and perceived behavioral control, but we acknowledge the opportunity to improve this variable in future research.

EFA results for attitude toward behavior

The KMO test provided a good value (0.888) and Bartlett's test of sphericity was significant ($p < 0.001$). Both statistics indicated the data were suitable for factor analysis. Following the EFA, we removed 14 items from the analysis to avoid cross-loading; finally, we had 27 items with significant loadings for five different factors, with eigenvalues greater than 1. The scree plot suggested a 5-factor solution, which was considered. These significant loadings were greater than 0.35, given our sample size (Hair et al., 2009). The cumulative variance explained by the extraction was 56.14%. Table 2 presents the rotated factor matrices.

Items referring to attitudes toward behavior were divided into five first-order factors. Factor 1: Impact of HEI–Firm collaboration on firms and society (items S1, S2, F1, RL1, and F2); Factor 2: Researcher–firm relationship (items from RFR1 to RFR8); Factor 3: Student impact (items from SI1 to SI5); Factor 4: Institutional support (items from IS1 to IS5); and Factor 5: Government support (items from GS1 to GS4) (see Table 3).

EFA results for perceived behavioral control

The KMO test provided a very good value (0.904), and Bartlett's test of sphericity was significant ($p < 0.001$). Both statistics indicated that the data were suitable for factor analysis. Following the EFA, we

Table 2
Attitude scales–Rotated factor matrix and Cronbach's Alpha.

Items	Scales				
	FS	RFR	SI	IS	GS
S1	0.876				
S2	0.837				
F1	0.729				
RL1	0.721				
F2	0.689				
RFR1		0.882			
RFR2		0.821			
RFR3		0.812			
RFR4		0.649			
RFR5		0.414			
RFR6		0.406			
RFR7		0.384			
RFR8		0.371			
SI1			0.793		
SI2			0.776		
SI3			0.693		
SI4			0.632		
SI5			0.577		
IS1				0.830	
IS2				0.782	
IS3				0.704	
IS4				0.678	
IS5				0.632	
GS1					0.839
GS2					0.819
GS3					0.743
GS4					0.695
Cronbach's Alpha	0.879	0.877	0.860	0.849	0.820

Source: Authors' elaboration.

Table 3
Attitude toward the behavior–Correlations between scales.

Scales	FS	SI	IS	GS	RFR
FS	1				
SI	0.484	1			
IS	0.390	0.297	1		
GS	0.245	0.158	0.335	1	
RFR	0.625	0.433	0.401	0.434	1

Source: Authors' elaboration.

Table 4
Perceived behavioral control scales—Rotated factor matrix and Cronbach's Alpha.

Items	Scales		
	IC	GC	FC
IC1	0.822		
IC2	0.793		
IC3	0.786		
IC4	0.771		
IC5	0.762		
IC6	0.743		
IC7	0.727		
IC8	0.724		
GC1		0.916	
GC2		0.907	
GC3		0.813	
GC4		0.808	
GC5		0.783	
FC1			0.921
FC2			0.844
FC3			0.844
Cronbach's Alpha	0.921	0.928	0.916

Source: Authors' elaboration.

removed 11 items from the analysis to avoid cross-loading. Finally, the EFA provided 16 items with significant loadings, grouped into three different factors with eigenvalues greater than 1. The scree plot suggested 3-factor solution, which was considered. These significant loadings were greater than 0.35, given our sample size (Hair et al., 2009). The cumulative variance explained by the extraction was 67.86%. Table 4 presents the rotated factor matrices.

The items capturing researchers' perceived behavioral control were divided into three first-order factors. Factor 1: Institutional capabilities (items from IC1 to IC8); Factor 2: Government capabilities (items from GC1 to GC5); Factor 3: Firm capabilities (items from FC1 to FC3; see Table 5).

EFA results for subjective norm

The KMO test provided an acceptable value (0.733) and Bartlett's test of sphericity was significant ($p < 0.001$). Both statistics indicated that the data were suitable for factor analysis. Following the EFA, we removed two items from the analysis to avoid cross-loading. Finally, the EFA provided seven items with significant loadings for two different factors; the eigenvalue of one factor was slightly less than 1. The scree plot suggested a 2-factor solution, which was considered. These significant loadings were greater than 0.35, given our sample size (Hair et al., 2009). Nevertheless, with the purpose of not underrepresenting any factor, we preserved one item that did not fulfil the criteria of factor loadings. The cumulative variance explained by the extraction was 48.87%. Table 6 presents the rotated factor matrices.

Items that referred to subjective norms were divided into two categories. Factor 1: Institutions (items INS1 to INS4) and Factor 2: Community (items from COM1 to COM3).

Confirmatory factor analysis

Based on the EFA results, we conducted three separate confirmatory factor analyses for the following latent variables—Attitude

Table 5
Perceived behavioral control—Correlations between scales.

Scales	IC	GC	FC
IC	1		
GC	0.42	1	
FC	0.473	0.41	1

Source: Authors' elaboration.

Table 6
Subjective norm—Rotated factor matrix and Cronbach's Alpha.

Items	Scales	
	INS	COM
INS1	0.917	
INS2	0.687	
INS3	0.444	
INS4	0.301	
COM1		0.910
COM2		0.734
COM3		0.406
Cronbach's Alpha	0.699	0.748

Source: Authors' elaboration.

toward behavior, perceived behavioral control, and subjective norms. For each analysis, we first examined the overall model fit, followed by an examination of individual parameters. The software package Mplus 7.11 was used to test our measurement models. Variables were treated as non-normally distributed. We reported a combination of absolute and incremental fit indices: Satorra-Bentler χ^2 , root mean square error of approximation (RMSEA), incremental fit index (IFI), and Tucker Lewis index (TLI). The cutoff scores for the minimum acceptable levels of model fit were RMSEA = < 0.10 and CFI and IFI > 0.90 (West et al., 2012).

Attitude toward behavior

Based on the EFA results of the and the conceptual developments of TPB (Ajzen, 1991), we tested a model with one higher-order factor, overall attitude, and five first-order factors with their respective indicators: impact of HEI–Firm collaboration on firm and society (five items), student impact (five items), institutional support (five items), government support (four items), and relationship between researchers and firms (eight items). The results for the measurement model showed an acceptable fit ($\chi^2 = 985.56$, $p < .001$, $df = 317$, RMSEA = 0.08, CFI = 0.92, and TLI = 0.92). An examination of the factor loadings showed all were significant and in the expected direction (ranging from 0.56 to 0.93). Latent correlations ranged from 0.28 to 0.67. In addition, the h coefficients had acceptable levels, above 0.86. Given the data, the hypothesized model in which the relationships between the five first-order factors were explained by a higher-order factor seemed reasonable.

Perceived behavioral control

As in the previous analysis, we used the EFA results and the conceptual developments to test a model with a higher-order factor, overall perceived behavioral control, and three first-order factors with their respective indicators: institutional capabilities (eight items), government capabilities (five items), and firm capabilities (three items). The results for the measurement model showed an acceptable fit ($\chi^2 = 337.11$, $p < .001$, $df = 317$, RMSEA = 0.09, CFI = 0.98, and TLI = 0.98). An examination of the factor loadings showed all were significant and in the expected direction (ranging from 0.65 to 0.94). Latent correlations ranged from 0.47 to 0.53. The h coefficients had acceptable levels, above 0.93. Consequently, the hypothesized model in which the relationships between the three first-order factors were explained by a higher-order factor seemed reasonable.

Subjective norm

Based on the EFA results, we conceptualized a simpler model with two latent variables and their respective indicators—Subjective norms from institution (four items) and community (three items). The results for the measurement model showed an acceptable fit ($\chi^2 = 40.99$, $p < .001$, $df = 10$, RMSEA = 0.10, CFI = 0.98, and TLI = 0.96). The factor loadings were significant and in the expected direction



Fig. 2. presents the hypothetical structure and content of the behavioral model developed. Source: Authors' elaboration.

(ranging from 0.50 to 0.72). The latent correlation was 0.78; the h coefficients were 0.72 and 0.72, respectively.

Based on the EFA and CFA results, we confirmed the hypothetical structure and content of the behavioral model developed (see Fig. 2).

Discussion

This paper presents the development and validation of a survey instrument by using a behavioral approach to assess the factors that facilitate or hinder the intentions of HEI researchers to collaborate with firms. The TPB suggests that attitude represents a favorable or unfavorable evaluation of the behavior of collaborating with firms, which comprises five factors: impact of HEI–Firm collaboration on firm and society (FS), researcher–firm relationship (RFR), student impact (SI), institutional support (IS), and government support (GS). The TPB indicates that perceived behavioral control plays a relevant role and is defined as the ease or difficulty of collaborating with firms. Consistent with this theory, perceived control was a higher-order

factor toward three important stakeholders: institution, firm, and government. These three factors are institutional capabilities (IC), government capabilities (GC), and firm capabilities (FC). Finally, the structure of subjective norms was relatively simple, indicating that institutions and academic communities set the norms that either support or hinder collaboration with firms depending on the directionality of the reported perceptions (being positive or negative). These are divided into two factors: institutions (INS) and communities (COM).

Contributions to the HEI–Firm collaboration literature

So far, the qualitative and empirical research exploring the factors influencing the collaboration between researchers and firms (Franco & Hase, 2015; Olaya Escobar et al., 2017; Rajaeian et al., 2018; Siegel et al., 2004) have not developed a comprehensive model that considers different perspectives of researchers' perceptions of the collaboration, beyond the factors related to the potential benefits or obstacles to the HEI in collaborating.

Unlike Olaya Escobar et al. (2017), who analyzed researchers' willingness to engage in knowledge and technology transfer activities, proposing intrinsic motivations, extrinsic motivations, and university support and services, our research focused on the sources of the propensity and intention of HEI researchers to collaborate with firms. Using TPB, we studied attitudes, perceived behavioral control, and subjective norms, but not limited to the HEI environment; that is, we highlighted the role played by HEIs, governments, and firms in each variable. Arzenšek et al. (2018) used TPB to explore the determinants of young researchers' intention to cooperate on research projects with industry. Rajaeian et al. (2018) similarly investigated the factors related to the effectiveness of academic researchers' engagement in disseminating research-generated knowledge to industry. Nevertheless, similar to Escobar et al. (2017), these studies did not explore the researchers' perception of all relevant components according to the HEI, government, and firm environments.

Our study generates new insights. We highlight that the iteration between literature review and evidence from interviews allowed us to develop an instrument that, alongside incorporating elements from previous investigations, posited new elements in the study of HEI–firm collaboration, according to HEIs, government, and firm environments. Relevant findings emerged from the interviews and were incorporated into questionnaire development. Regarding researchers' attitudes toward collaboration with firms (see Appendix A), we underline the following findings. First, researchers thought that collaboration with firms allowed them to identify new lines of research, and could therefore respond to the firms' needs. Second, researchers, to a large extent, perceived negative attitudes from firms in terms of interest and disposition to collaborate with HEIs. Third, researchers mainly consider collaboration with firms an important source of employment for students. Fourth, regarding institutional support, we identified institutions' lack of attention to researchers' needs and insufficient provision of infrastructure and equipment; researchers felt that their collaborative activities did not receive the attention it deserved. Fifth, government support might be unequal; that is, researchers felt that their research area was less important than others.

Although the findings on perceived behavioral control were consistent with the literature review (see Appendix B), in terms of institutional capabilities, we included and highlighted investigation of firms' needs, search for contacts inside companies, and purchase of supplies. Regarding firm capabilities, we underlined the firms' willingness to allocate resources and collaborate with the academy. Similar to perceived behavioral control, the interview findings of subjective norms were consistent with the literature (see Appendix C), but the dynamics between actors were slightly different compared to the literature. For example, at the beginning of the collaboration, firms represented a source of pressure for researchers; however, in the course of the relationship, firms stopped being a source of pressure. Unlike researchers who conduct basic research and focus on publishing articles, applied researchers construed pressure from firms as positive and sought support to collaborate with firms.

In sum, the HEI-F CIQ is an instrument that 1) includes different stakeholders and 2) allows one to identify that the combination of institution, government, and firm situations or elements (aforementioned) influences the intentionality of researchers to collaborate with firms. Our analysis provides key to what needs attention either for future research or for HEIs, governments, and firms seeking to enhance this collaboration and enhance the entrepreneurial ecosystem.

Contributions for the entrepreneurial ecosystem literature

This study contributes to the entrepreneurial ecosystem literature by focusing on the actors, that is, HEI researchers. This ecosystem's ultimate goal being to generate value and prosperity, with firms

playing an important role, it is relevant to know the researchers' intention to collaborate with firms, as well as the factors that could positively or negatively affect this relationship, including the role of other actors in the ecosystem such as government, firms, and HEIs. Researchers, through their knowledge and application of research results, could contribute propitiously to the entrepreneurial ecosystem. Therefore, it is important to study them and understand what influences their intention to collaborate.

Contributions for the theory of planned behavior applied to management

This research shows that the application of the TPB is useful and valuable for understanding and even prioritizing some factors related to the researchers' attitude toward the behavior, perceived behavioral control, and subjective norms related to the management of HEI–Firm collaboration. It contributes to the literature on the determinants of individuals' willingness to develop a certain behavior by focusing on researchers from HEIs as important actors in the entrepreneurial ecosystem. Future research could address managerial implications by conducting conceptual replications.

Managerial contributions

The proposed questionnaire represents a useful instrument for HEIs, education, and research policy, providing a deeper and holistic way to analyze researchers' intentions to collaborate with firms, and contributing to a better understanding of the researchers' experiences in collaboration with firms, and allowing HEIs and governments to develop policy instruments to support value creation through HEI–firm collaboration. HEI-F CIQ can serve as a basis for firms or governments to understand other stakeholders. The instrument could be adapted to study the interconnection of different actors with the purpose of creating value through engagement in entrepreneurial actions, either to create startups or develop new products or processes in existing companies. From a more governmental perspective, the HEI-F CIQ can be used to map or explore intentionality to support projects with a greater societal impact.

Limitations and future research

The main limitation relates to the subjective norm variable. This variable was measured using the general form. Therefore, the EFA solution followed a criterion based on the representation of the factors, that is, no factor was overrepresented or underrepresented. For future research, we suggest adding more specific items to analyze the internal and external actors pressuring (or not) researchers to collaborate with firms. For example, firms could be distinguished into high-tech and low-tech firms, or small, medium, or large firms. For the institution, researchers could be asked about different actors, such as the Dean and Research Director, among others. In addition, future research on subjective norms could assess which of these dimensions was more important for researchers and educational administrators. This research, although framed within the concept of a research ecosystem and acknowledging the influence of other actors, focuses primarily on understanding the rationales and intentionality of researchers engaging in collaborative projects with firms. Further research should complement these insights by focusing on understanding the rationales and intentionality of firms to engage in collaborative projects with HEIs. This will enable the assessment of mismatches and asymmetries between the two actors considered in a research ecosystem and creation of a more complete description of the potential interaction effects enabling dynamic analysis features in the model introduced. Regarding attitude and perceived behavioral control, future research could assess the unique contribution of each dimension to the success of the university–industry collaboration, as well as the presence of additive and multiplicative effects.

Conclusions

This research generated relevant findings for research addressing HEI–Firm collaboration and relational factors shaping, fostering, and hindering this partnership. The iteration between literature review and evidence from interviews allow us to develop an instrument that, although incorporating elements of previous investigations, also provided new elements in terms of attitudes, perceived behavioral control, and subjective norms that future research could explore. The proposed model and instrument are valid for measuring researchers' intentions, as well as the structure and content of the inventory of

drivers and barriers to collaborating with firms. Our research provides new insights into the field of university–industry collaboration research. This study also contributes to the literature on TPB by focusing on researchers from HEIs and offering replicability for research addressing behavioral managerial purposes. Regarding the entrepreneurial ecosystem literature, this research contributes to this topic by placing researchers as suppliers and developing agents of entrepreneurial and valuable creations for the ecosystem, and their intention to collaborate. For strategy and policy analysis, this study shows the need to continue studying attitudes toward behavior, perceived behavioral control, and subjective norm variables.

Appendix A. Attitude toward behavior findings

	Interview findings consistent with the literature	New findings from interviews	Sample quotes
Impact of HEI–Firm collaboration on firm and society	Applicability Industry	Identification of new lines of research	"Industry has many problems we can solve." "We have developed technological knowledge that industry could commercialize."
	Society		"Most research should be related to industry and society at large." "Collaboration with firms allows to help society." "You have the opportunity of identifying other lines of research."
Researcher–firm relationship	Satisfaction	Firms' interest to collaborate with the academy Firms' disposition to invest in research projects Lack of continuity of HEI–Firm collaboration	"Once industry states the problems, we modify our lines of research, not in general terms, but in particular." "We can modify our research lines to solve industry problems." "I feel happy because I do what I like, and the institution and government pay me satisfactorily."
	Mutual benefits		"We can complement industry knowledge with academic knowledge." "The collaboration brings the opportunity of comparing practices and equipment."
	Accumulation of knowledge and learning Communication		"We learn for further interactions with firms."
			"Sometimes, there is no clarity of the expected results." "Firms think that the university can solve anything." "If the agricultural producer doesn't see a problem or a need, he doesn't accept the collaboration with a university. He doesn't want to invest much in research, at least in Mexico's agricultural sector." "Firms don't perceive benefits from collaboration with universities."
Student impact	Curriculum development	Institutional indicators	"If some terms of the collaboration don't suit firms, the collaboration ends." "The linkage ends once the firm accomplishes its goal." "We can obtain industry feedback about professional requirements."
	Students' skills		"Collaboration allows updating of curriculum." "Collaboration with industry helps in training students to solve problems. There have been successful cases of postgraduate students working in national and international companies."
	Employability		"Students doing professional practices, social services or concluding their career can find employment sources."
	Involvement of students in projects		"We can involve students in applied projects."
Institutional support	Weak management process	Importance that the institution gives to the researchers' needs	"Collaboration with industry benefits institutional indicators." "Bureaucratic processes exist; we need to accelerate the agreements of collaboration."
	Support with intellectual property and technology transfer		"We need support in terms of intellectual property rights."
Government support		Equipment/infrastructure	"Managers don't understand researchers' needs." "Curiously, deductions proceed faster than refunds in researchers' use of resources for research projects." "The infrastructure of the university is sometimes insufficient." "There is a lack of government funding."
	Funding Policies and regulatory framework	Government support to different research lines	"Policy doesn't recognize nor reward the collaboration." "Current government has limited interest in environmental problems, we have to endure this administration six more years."

Appendix B. Perceived behavioral control findings

	Interview findings consistent with the literature	New findings from interviews	Sample quotes
Institutional capabilities	Management process		"There are no conditions and defined processes to collaborate with firms; the most restrictive is the university management. There is no platform for registering a project."
	Internal rules		"We need clear rules and flexibility to make decisions."
	University support		"We are a lagging institution in technology, we need more efficient collaboration."
		Investigation of companies needs	"The institution should know what and how to negotiate with companies."
Government capabilities		Search for contact with companies	"University managers do not consider that companies have different priorities. Companies can't stand that."
		Supplies purchase	"It would be of great help if the university investigated the research and innovation needs of companies."
	Funding		"Sometimes, researchers have to fund equipment or materials required in a project."
	Incentives		"The purchase of supplies is delayed."
Firm capabilities	Economic and political situation		"The elimination of government funding for projects with firms will complicate the collaboration."
	Funding		"We need suitable incentives, calls and funding."
		Firms' willingness to allocate resources and to collaborate with the academy	"New government strategies to repair or compensate bad habits of past governments don't help the collaboration with firms."
			"There is a lack of funding from firms to conduct research."
			"Firms need to be open to listening to researchers."
			"Firms are resistant to involving researchers in their projects."

Appendix C. Subjective norms findings

	Interview findings consistent with the literature	New findings from interviews	Sample quotes
Institutions	Government		"Government could improve the collaboration by providing funds"
	University		"Sometimes, members of the university community do not approve the collaboration with firms. Now they have understood this is necessary"
	Firms		"Initially, the industry shows willingness, but the relationship declines overtime"
			"It hurts companies to invest in research, they want to see results in a short time, but in research sometimes this is not possible"
Community			"Leading agricultural producers invest in research with the purpose of offering a bigger and sweeter grape, they don't care about the water consumption, they care about production, the volume of boxes and features of the product. Maybe, we are failing in the sense that we don't give them information or solutions at the moment, maybe because we are not technicians. There are groups of consultants competing among them to offer a better service to a producer, and then producers look for another consultant if they don't get the expected results".
	Postgraduate students		"Bachelor students almost finishing their career are more likely to get involved in projects with firms"
	Undergraduate students		"Researchers from applied research and technological development are more likely to collaborate with firms"
	Researchers from applied research		"Researchers expecting to publish research results don't look for collaboration with industry"

Appendix D. HEI–Firm collaboration intention questionnaire

Please indicate the potential outcomes that you have experienced during your collaboration with firms.

Item	1	2	3	4	5	6	7
S1 Solving problems of society through HEI–Firm collaboration is:	Very difficult						Very easy
S2 Focusing our research activities on the needs of society is:	Very difficult						Very easy
F1 Solving problems of firms through HEI–Firm collaboration is:	Very difficult						Very easy
RL1 Identifying new research lines in collaboration with firms is:	Very difficult						Very easy
F2 Focusing our research activities on the needs of firms is:	Very difficult						Very easy
RFR1 The collaboration between HEIs and firms often results in:	Great losses						Great benefits
RFR2 The personal satisfaction arising from the collaboration with firms is:	Very low						Very high
RFR3 The distribution of collaboration benefits between HEIs and firms is:	Very unequal						Very equal
RFR4 The learning of new things during the collaboration is:	Very low						Very high

(continued)

(Continued)

Item	1	2	3	4	5	6	7
RFR5 The interest of firms to collaborate with HEIs is:	Very low						Very high
RFR6 The communication of expected results from HEI–Firm collaboration is:	Very difficult						Very easy
RFR7 The propensity of firms to invest in collaborative projects with HEIs is:	Very low						Very high
RFR8 To gain continuity in collaboration projects with firms is:	Very difficult						Very easy
SI1 Updating students' professional curriculum via HEI–Firm collaboration is:	Impossible						Possible
SI2 Involving students in HEI–Firm collaborative projects is:	Impossible						Possible
SI3 Obtaining feedback from firms on the knowledge and skills professional profile for students is:	Impossible						Possible
SI4 The impact of HEI–Firm collaboration on HEIs performance indicators is:	Very bad						Very good
SI5 Hiring students to work in collaborative projects with firms is:	Impossible						Possible
IS1 The administrative procedures for collaboration with firms in my organization is:	Very inefficient						Very efficient
IS2 Access to state of the art equipment for my research in my organization is:	Very difficult						Very easy
IS3 Research infrastructure in my organization is:	Totally inadequate						Excellent
IS4 Support from my organization to manage intellectual property and the transfer of knowledge and technology is:	Totally inadequate						Excellent
IS5 In my organization, the supply of research infrastructure and support is:	Very irrelevant						Very relevant
GS1 Access to incentives for HEI–Firm collaboration is:	Very difficult						Very easy
GS2 Obtaining public funding for collaborative HEI–Firm projects is:	Very difficult						Very easy
GS3 Government funding for different research themes is:	Very unequal						Very equal
GS4 The impact of science, technology, and innovation policy on HEI–Firm collaboration is:	Very unfavorable						Very favorable

Please indicate the influence of the following individuals or institutions on engaging in collaborative projects with firms.

Item	1 Very negative influence	2	3	4	5	6	7 Very positive influence
INS1 Government							
INS2 National Council for Science and Technology							
INS3 Your organization							
INS4 Firms							
COM1 Postgraduate students							
COM2 Undergraduate students							
COM3 Colleagues working in applied research							

Please answer this question with the option that best reflects your experience in collaborative projects with firms.

	1	2	3	4	5	6	7
IC1 In my organization the administrative process and policy for collaborative projects with firms are:	Very inefficient						Very efficient
IC2 The organizational culture and attitude toward business in my organization is:	Very passive						Very active
IC3 My organization actively seeks contact with firms to do collaborative projects:	Strongly disagree						Strongly agree
IC4 In my organization the incentives for collaboration with firms are:	Very inadequate						Very appropriate
IC5 My organization's effort to adapt to firm's research scheduling and timing of results is:	Very low						Very high
IC6 My organization is aware of the research and innovation needs of firms:	Strongly disagree						Strongly agree
IC7 The administrative support that I receive in research activities is:	Very inadequate						Very appropriate
IC8 In my organization, the processes for the acquisition of materials needed for research are:	Very inadequate						Very appropriate
GC1 Government funding available for HEI–Firm collaborative projects are:	Very inadequate						Very appropriate
GC2 Government calls for proposals for collaborative projects with firms are:	Very inadequate						Very appropriate
GC3 The effect of current economic and political situation on HEI–Firm collaborative projects is:	Very inadequate						Very appropriate
GC4 Governmental incentives provided to HEIs to collaborate with firms are:	Very inadequate						Very appropriate
GC5 The effect of current science and technology policy of government in HEI–Firm collaboration is:	Very inadequate						Very appropriate
FC1 The level of investment by firms in collaborative projects with HEIs is:	Very inadequate						Very appropriate
FC2 The allocation of human resources and infrastructure by firms to collaborate with HEIs is:	Very inadequate						Very appropriate
FC3 The predisposition of firms to collaborate with HEIs is:	Very inadequate						Very appropriate

Please indicate the level of agreement or disagreement with the following statements.

Item	Currently	1 Strongly disagree	2	3	4	5	6	7 Strongly agree
INC1	I participate in HEI-firm collaborative activities							
INC2	I frequently contact firms to collaborate with them							
INC3	I take additional efforts to collaborate with firms							
INC4	I apply for funding to collaborate with firms							
INC5	I accept offers from firms to collaborate with them							
Item	In the past three years	1 Strongly disagree	2	3	4	5	6	7 Strongly agree
INP1	I participated in HEI-firm collaborative activities							
INP2	I frequently contacted firms to collaborate with them							
INP3	I made additional efforts to collaborate with firms							
INP4	I made additional efforts to collaborate with firms							
INP5	I accepted offers from firms to collaborate with them							
Item	In the next two years	1 Strongly disagree	2	3	4	5	6	7 Strongly agree
INN1	I will participate in HEI-firm collaborative activities							
INN2	I will contact firms to collaborate with them							
INN3	I will take additional efforts to collaborate with firms							
INN4	I will apply for funding to collaborate with firms							
INN5	I will accept offers from firms to collaborate with them							

Information about you

Gender
Age
Affiliation
Number of years of affiliation
Expertise area
Years performing collaborative projects with your current affiliation
SNI member
SNI level

Indicate the number of collaborative projects with firms in the last 3 years.

Joint research and development projects
Contract research
Staff-exchanges from HEIs to firms
Students internships in firms
Personnel exchanges from firm to HEIs
Guest lectures given by firms
Projects conducted by students in cooperation with firms
Hosting thesis (BSc, MSc, PhD)
Industrial projects as part of studies in HEIs

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