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Modeling of the Factors of Higher Education Institutions (HEIs) Influencing the Strategic Linking Decisions with the Industrial Sector: Whole-Institution Approach

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Abstract: Higher Education Institutions (HEIs) are dedicated to the professionalization of human capital; to accomplish this, the link with the productive sector is an active component that must be strengthened through formal mechanisms. The purpose of this paper is to estimate the relationships and effects from the Institutional Framework (IF), as well as from the independent variables in the context of linking HEI with the industrial sector. Survey data were collected from 47 HEIs in the Northwest of Mexico; a mixed research approach was applied and analyzed through the partial least-squares structural equations modeling (PLS-SEM) technique. Although the IF is identified as a relevant aspect for the model, this is not a problem for Mexican HEIs, since the analysis reflects a solid legal framework regarding the common basic levels and research. The main impact for experts who carry out research activities is that the route to creating, maintaining, and promoting integrated academic, technical, and administrative personnel as a specialized work team is not achieved. The main factor that does not contribute for researchers who carry out research activities is that the route to integrating (creating–maintaining–promoting) academic, technical, and administrative personnel as a specialized work team is not achieved. One finding is that the informants agree with the existing stimuli that are not aimed at research linked to the industrial sector and problem-solving through applied research. There is a need for retaining the groups of researchers to help make the benefits for the industry clear by offering advanced linkage levels.

Keywords: decision making in HEI; university–industry collaboration; Northwest of Mexico

1. Introduction

Universities represent a crucial part of solving sustainability challenges. The primary mission of universities is to train professionals, who, in the short term, will make decisions that directly affect the dimensions of sustainability—locally, regionally, or globally [1]. It is necessary to lay the foundation of

Sustainable Development (SD) locally and regionally to integrate a global perspective where the Higher Education Institutions (HEIs) encourage the participation of stakeholders (investors), civil society, and the public in general to boost regional development and innovation processes. The involvement of HEIs benefits the productive sector by generating bridge actions and institutions that could strengthen regional social capital and innovation capacity. Consequently, this guarantees a better social result [2,3].

Moreover, HEIs must include professionals capable of solving real problems in order to develop an emotional consideration, an esthetic, and ethical proportions of these personnel in the associations with a natural and socio-cultural context. Apprenticeship policies must allow the acquisition of updated, active, and relevant knowledge, as well as the progress of critical thinking [4,5]. A study conducted in Romania indicated that students' capacities were positively and directly influenced by the rank of the educational procedures and by the pragmatic and investigation activities as well [6]. Therefore, it is essential to ensure the training of future professionals, which should be as close as possible to real learning environments. This requires extension and linkage activities with the different sectors of society, but mainly with the productive area.

A literature review on international works affirms that extension and linkage activities are relevant components in the social dimension of sustainability in HEIs, which is based on the economic impact of HEIs, as well as on sustainability projects—services involving the community and alumni. [7]. As HEIs promote linkage, they become more productive and efficient, getting closer to the objective of meeting the needs of the environment. Expressly, linkage can be understood as any activity that involves five fundamental characters: University, business, society, state, and environment [8], according to the intelligent linkage model of the Autonomous University of Baja California; these are partially considered within the curricula. In addition, regional needs regarding the practical knowledge of graduates are required by society and the productive sector. Therefore, graduates may lack such knowledge. Linkage tasks may be affected due to ineffective bureaucratic efforts, as well as the lack of clarity in the institutional policies for the implementation of the same. The linkage must [9]:

(a) Contribute to professional training through the provision of services.
(b) Complement classroom teaching with focused learning in problem-solving approaches or case analysis.
(c) Complement student learning from the perspective of learning to do and learning in service.
(d) Promote and stimulate teacher interaction with productive sectors.
(e) Encourage the incorporation of successful professionals, who participate as teachers or lecturers that apply their professional experience and cutting-edge knowledge in the integral training of future professionals, as well as their interaction, which energizes the academic work of the institution.
(f) Associate the contents of the learning units with the development of professional practice in real scenarios in the workplace and in the development of research projects that apply or generate new knowledge.

Furthermore, linkage activities in Mexico operate at a basic level. Mostly, HEIs lack specific exchange programs with the productive sector, and at the same time, offer few solutions to social concerns. Considering that, the role of higher education (HE) in societies is unquestionable, and activities and plans are significant concerns of governments. This research aims to estimate the relationships that allow the Institutional Framework (IF), Support and Management (SM), and Physical and Professional Support Infrastructure (PPSI) to support Teaching, Research, and Technical Assistance (TRTA) activities in the HEI–industrial sector relationship. A model of multivariate complexity is suggested to recognize and measure the associations between variables and the intervening effects in the linkage of HEIs and the productive sector. If it is possible to identify the behavior of the system, it is possible to allocate resources, allowing higher linkage capacity, considering its restrictions; that is, enabling strategic decision-making. The specific objectives of this research are:

a) Apply an adapted survey [10–14].
b) Analyze variables, dimensions, and results of the survey as a national database to support the study.
c) Identify direct and indirect effects among variables to identify its relevance.
d) Generate a discussion by reflecting the research results against the literature review and the findings from other studies.

According to the previous context, the research questions in this paper are: Which specific activities or areas should be prioritized to have a more significant impact on the linkage developed by academics? How do different items influence the academics' performance? What can universities do to encourage their academics to collaborate with the industry? Are there any differences between Mexico and other countries? In addition, this research takes as a fundament five studies for the design of the applied questionnaire; these studies were developed in the context of Mexico:

- An analysis of the university–company relationship between the National Council of Science and Technology and the National Association of Universities and Higher Education Institutions (NCST–NAUHEI) [10].
- The academy and the productive sector in Baja California. The characters and their ability to link the production, the dissemination and transfer of knowledge, and innovation [11,12].
- The National Survey on Higher Education Institutions [13,14].

On the one hand, to make an analysis of the situation, Casalet and Casas [10] identified as relevant the determination of the main activities of HEIs, linkage coverage, institutional framework and functions, legal framework, funding sources, resources for linking, obstacles, benefits, and success factors. On the other hand, experts from the NCST of Mexico and the NAUHEI validated the instrument that is used; in some sections, open questions were made; questions with final answers were also included, and others were only Yes or No questions. There is the disadvantage of mixing different types of variables, which makes it challenging to adapt them to a model that identifies relationships between variables and effects.

Celaya and Barajas [11,12] analyzed the linking activities included in the previous questionnaire and identified its dimensions: 1. Institutional Framework (IF), 2. Teaching, Research, and Technical Assistance (TRTA), 3. Support and Management (SM), and 4. Physical and Professional Support Infrastructure (PPSI). The instrument of Casalet and Casas [10], the dimensions of Celaya and Barajas, and the National Linking Survey were the main inputs to adapt them into one, which could be useful in proposing a model of relationships and effects [13,14]. This study was limited to the variables of the previous studies because they were studies validated by experts and their relevance for decision-makers in Mexico. The paper begins with the development of the theoretical perspective on the critical success factors for establishing sustainable collaborative activities and their level of influence; this section provides insights from an academic debate perspective. The materials and methods section presents the study design, the survey application, general information about the sample, the validation of the data, and the model development. The analysis section introduces the results of the proposed model. The discussion section shows the outcomes by presenting the research results by contrasting the current literature review as well as findings from other similar studies. Finally, the contribution to the current stage of research is presented in the conclusion section.

2. Theoretical Perspective

The improvement in compliance with sustainability indicators is attributed to certain organizational factors, such as leadership, university policies, international collaboration, funding for projects, job satisfaction, and infrastructure, among others. Previous studies have identified the critical success factors that affect the performance of the SD implementation in HEIs. In European countries, the participation of entrepreneurial companies focused on innovation stands out through participation in

HEI study programs to develop students' competencies; therefore, the awareness of companies about the importance of linkage and its impact is relevant [15]. Leadership, in its different styles, interpreted through human, personnel, and organizational factors, was also considered as a variable that affects the SD of HEIs [16–18]. HE is undoubtedly an essential factor when it comes to Agenda 2030 for Sustainable Development; specifically, Goal 4 of Quality Education and Goal 8 of Decent Work and Economic Growth, because they indicate that human resource development is required to guarantee a sustainable society and national economic performance. In addition, they suggests that knowledge is the basis for social sustainability and development. The linking activities help in the quality assurance for educational programs; consequently, graduate students will have enough skills to solve problems in society, as well as to be able to face possible challenges in the industrial sector [19,20].

2.1. HEIs and Linkage

The linkage between companies and HEIs is a natural relationship due to the complementarity that can be expected between these two economic sectors. Still, the association between companies and educational institutions has not been automatic. For companies, the linkage with HEIs is one of the multiple options or means of achieving greater effectiveness in searching for other purposes, such as increased productivity, market positioning, growth, and increase in profits, among others. To obtain those linkages, a healthy balance of several aspects through the regional and national levels is required, which encourages a dominant national industrial innovation performance and quality in education with required knowledge [21–24]. That is why an updated development strategy always integrates higher education, science, and technology systems to increase human capital development, competitiveness, and sustainability indexes [25,26].

HEIs must always be the primary creators of knowledge, and are frequently considered as "knowledge suppliers"; therefore, they play an essential role in social sustainability, as they cover different sectors, including the manufacturing industry. However, recent studies are focused on short-term interactions related to knowledge transfer, and there are some barriers identified in this process, such as [27]: (a) Lack of communication between HEIs and industry, (b) the mindset of academic administration, (c) lack of research infrastructure, (d) poor research management in HEIs, (e) old research topics, (f) lack of marketing in showcasing academic research output, and (g) fear of sharing sensitive information by the industry and intellectual property rights issues. The status and capacity of HEIs for industry linkages is in a nascent stage in emerging economies. Quality of tertiary education, non-relevance of courses, and inadequate infrastructure, among others, have contributed to impeding of liaisons between the industry and higher education institutions. There is an urgent need for HEIs to develop competences and skills aligned with the industry and the national and regional demand, focusing on the establishment of industrial parks, Centers of Excellence, and Small–Medium Enterprises (SMEs) as projects as a platform for growth [28].

Nevertheless, HEIs' engagement is still weak, and they have yet to come out as a leading force in promoting innovation systems for getting a better efficiency and productivity. Fortunately, HEIs in developed countries aim to adopt leading-edge practices on innovation strategies and management. They improve their curriculum in human resources, support their staff, increase the reward systems in funding, have better infrastructure for research and teaching, and support research commercialization with the industry and community engagement [29]. Academic engagement can only be reached if the HEIs' policies are aligned with strengthening of university–industry relationships [30].

However, the design of the educational systems is in contrast with the industrial sector systems, which work with very different logic. Intermediary organizations, such as Technology Transfer Offices, University Incubators, or Collaborative Research Centers, emerge as a cover point that can be managed by this hybrid area for participants that intend to generate proximity for collaborative work. The above must be determined by considering cognitive, geographical, organizational, and social proximity [31], giving a logic of the aspects that universities must work on to get closer to the industry without the intervention of an intermediary. Then, it is necessary to conduct more in-depth analyses in this research area, where a large-scale survey will help to ultimately reveal the status and impact of innovation practices in the region, as well as among HEIs.

2.2. HEIs and Linkage Studies in Mexico

The forms of linkage are presented in three related groups: (a) Promotion of specific areas of science and technology, (b) construction of structures that facilitate long-term linkage, and, finally, (c) the development of linkage systems. Most of the available studies in Mexico about experiences on linkage between HEIs and the productive, public, and social sectors have been focused on analyzing the first form if there is linkage [31]. That is, they analyzed individual experiences of collaboration, documenting the main characteristics of the projects carried out as well as the attitudes that researchers demonstrate in these types of experiences. Based on a lesser extent, studies are available related to the characteristics of linkage schemes that emerged as initiatives implemented by HEIs and on the use of public programs to promote them [32–35]. Additionally, the issue of linkage has been frequently addressed as a case study, confirming the tendency to analyze the phenomenon of linkage from a bottom-up perspective [36]. The above indicates that it is not enough to provide generalizable information on inhibitory factors or promoters of establishing collaborative relationships between HEIs and the productive sector.

As an essential source of intellectual assets, the public higher education sector, as a centralized federal public administration, has a critical role in education and links the productive and the social areas. As a result, HEIs contribute to research, development, and innovation, but as a requirement and as a measurement to estimate the efforts of a country to move towards a knowledge-based economy. The participation of resources (administrative staff, research professors, infrastructure, and system) is scarce, and there are opportunities for improvement. This considers the operating mechanisms that do not allow greater cohesion among the participating sectors, where institutional and regulatory factors seem to be at the first level, by inhibiting an association that must exist between the academia, which is seen in its primary component, and the productive sector [37].

In the national context, Mexico's investment concerning Science and Technology is improving [38–40]: The federal government makes efforts along with legislators to increase budgets and encourage the increase of private investment, which is close to one-third of the total investment. Lags are dragged, as there are few researchers per capita compared to other countries and the number of patents, very precarious retirement systems, and increasing circulation of places. In the Special Program for Science, Technology, and Innovation, from five fundamental objectives, two are focused on strengthening regional development and integrating links in the productive sector. On the issue of local development, the most focused policy of distributing the federal entities into three large groups and supports has been adopted. It is not easy to utilize these relationships when coverage in higher education is not resolved. Institutional policies prioritize teaching activities within the university to serve as many students as possible. Specifically, bringing students to the industry involves smaller groups and specific planning of the projects in which they would be involved. These projects require specific supervision, which lacks coverage limits.

Moreover, Baja California is one of those entities that is close to building an ecosystem that allows sustaining a knowledge economy. In this entity, they contribute $1 for $1 to carry out a significant project. In the state innovation agendas, since 2014, a discussion was held during several meetings in each federative entity to define what the innovation agendas are and where that entity has possibilities where business, government, and scientific groups are interested, as well as local academics, with projects throughout the country. In order to strengthen the infrastructure issue, where much emphasis has been placed, investment has grown by more than 218%. A good part of the increases that have been made have been channeled to all universities, technological institutes, and research centers throughout the country, to strengthen their infrastructure and equipment. However, not all projects are supported, since the resources are limited. The infrastructure and equipment are items with opportunity, since they are part of real actions to make linkage possible in terms of technology transfer, literature review, and reality, which helps realize that there is an area of opportunity in this aspect [41–45]. In 2011, in [46], it was identified as an opportunity area for Mexico by establishing the linking with latecomer firms. In the case of some latecomer firms and modes of interaction, such as training, consulting, and hiring graduates, that are also relevant for their innovative or economic performance, this represents an attractive option for both parties.

2.3. The National Linking Survey (NLS)

Concerning to the NLS, the Ministry of Public Education, and the Center for Economic Research and Teaching (CERT), there is a focus on gathering information to analyze regional differences and design policies at an intermediate level. The same document indicates that one of the topics on which little information is available at a national level is the frequency where HEIs relate or initiate projects with the productive sector [10–14,47]. One of the objectives when designing the NLS was to identify those factors, from the perspective of HEIs, that could be inhibitors to establishing sustainable collaborative activities between HEIs and the productive sector. Regarding the question about: "What are the possible causes of not carrying out tasks for research, experimental development, or innovation by companies?", the officials surveyed in the HEIs identified at least four main factors to explain the absence of activities in this area: The lack of information of companies about the services offered by HEIs, the lack of resources to develop these projects, the low interest of companies, and, finally, the lack of researchers. To a lesser extent, other factors related to aspects of regulations or institutional capacity in HEIs and research costs were reported [47]. In addition, 25% of HEIs showed that their liaison offices lack organizational manuals and procedures to manage projects related to the provision of technological services. A total of 23% lack regulations for exercising funds to finance technical service projects, a modality in which legal or regulatory certainty, such as intellectual property rights, can be a determining factor in bringing the social, public, and productive Sectors closer together.

In general, the previous historical, contextual, governmental, business, and academic antecedents begin to provide the necessary tools to work on the construction of the model. The emphasis on the subsystems that integrate to form the Regional Innovation Ecosystem is highlighted, as well as how the interactions are conceived, the restrictions that have been detected from the system failures, limiting factors, and how data are used to define variables later. Tables 1 and 2 illustrate some factors according to their categories. As sources from Celaya and Barajas and the National Linking Survey (Mexico) conducted by the Ministry of Public Education suggest [10–13,43], Institutional Framework (IF), Teaching, Research and Technical Assistance (TRTA), Support and Management (SM), and Physical and Professional Support Infrastructure (PPSI) are the main factors that are explained in the section below.

2.3.1. Institutional Framework

The institutional framework refers to the existing legislation and regulations in HEIs that regulates different aspects of the university processes, including linkage: The Organic Law (which determines the purpose, personality, objectives, and attributions of universities). The norms, regulations, and guidelines should also encourage the interaction and generation of mechanisms for cooperation and collaboration with the productive sector. Therefore, its appropriate contribution to the proper functioning of the linkage is evaluated.

2.3.2. Teaching, Research, and Technical Assistance

As a matter of fact, among the extension and linking activities that teachers supervise, there are professional practices, professional residences, community social service, and industrial visits. They participate in bachelor, master, and doctorate programs, where it is essential to evaluate the coverage and relevance in the community; these are focused on technological development projects and basic and applied science. This instrument section assesses the collaboration of professors and researchers with other organizations from the business sector at the local, regional, and national levels, in technology transfer projects, technical assistance, and teaching in companies.

Table 1. Factors and indicators defined (Institutional Framework (IF) and Research and Technical Assistance (TRTA)).

Factor	Dimension	Indicators
Institutional Framework (IF)	Organic Law Statutes Regulations Satisfaction with IF	IF1. Organic Law. IF2. Statutes. IF3. Regulations. IF4. Satisfaction.
Teaching, Research, and Technical Assistance (TRTA)	Human resources training	Bachelor degrees. TRTA1. Offer on bachelor degrees. TRTA2. Satisfaction level in professional practices. TRTA3. Satisfaction level in professional projects with industry. TRTA4 Satisfaction level in Social Services. TRTA5. Satisfaction level in company visits. Master grades. TRTA6. Professional training. TRTA7. Academic training. PhD grades. TRTA8. Professional training. TRTA9. Academic training and technological projects with companies.
	Scientific research and technological development	Basic Research. TRTA10. Relevance. TRTA11. Satisfaction. Applied research. TRTA12. Relevance. TRTA13. Satisfaction. Technological Development. TRTA14. Satisfaction with project development other institutions. TRTA15. Satisfaction with project development (locally). TRTA16. Satisfaction with project development (national).
	Technical assistance	TRTA17. Technological transfer projects. TRTA18. Technological services. TRTA19. Business stays.

Source: [10–14,47].

2.3.3. Support and Management

The Support and Management factor includes the linking activities and incentives that promote direct economic benefits for teachers. These positively influence their professional careers, as well as the dissemination of the teachers' participation in research activities related to the National System of Researchers, university incubators, technology transfer offices, and collaborative research centers.

2.3.4. Physical and Professional Support Infrastructure

The necessary physical and human infrastructure in HEIs that promote extension and linking activities includes funds to attract and retain researchers, as well as technical and administrative support for personnel and laboratory equipment to encourage their integration, according to the vocation of the region, to carry out management and transfer activities.

Table 2. Factors and indicators defined (Support and Management (SM) and Physical and Professional Support Infrastructure (PPSI)).

Factor	Dimension	Indicators
Support and Management (SM)	Incentives to promote linkage	SM1. Institutional incentives through promotional scores. SM2. Economic incentives. SM3. Incentives for professional development.
	Academic development promotion	SM4. Promotion of the participation as a member in the National System of Researchers (NSR).
	Linking Instances	Linking department. SM5. Responsibilities. SM6. Satisfaction. SM7. Transparency and technology management department Linkage manager SM8.Responsabilities. SM9. Satisfaction
Physical and Professional Support Infrastructure (PPSI)	Research and development groups	Total number of members of a research group with a doctoral degree. PPSI1. Uptake expense. PPSI2. Expense to maintain. PPSI3. Creation of research groups. PPSI4. Creation and PPSI5. Maintenance of research groups according to regional vocations. PPSI6. Selecting and PPSI7. Maintaining technical personnel for vocational activities program. PPSI8. Selecting and PPSI9. Maintaining technical personnel for research activities.
	Physical and support infrastructure	Support staff with the necessary capacity to support specialized staff. PPSI10. Selecting and PPSI11. Maintaining technical personnel for technological transfer activities. PPSI12. Selecting and PPSI13. Maintaining administrative personnel for vocational activities. PPSI14. Selecting and PPSI15. Maintaining administrative personnel for research activities. PPSI16. Selecting and PPSI17. Maintaining administrative personnel for management and technological transfers.
		Infrastructure in conditions that allows carrying out the activities in an optimal way. PPSI18. Maintenance and PPSI19. Upgrade of physical infrastructure for vocational activities.PPSI20. Maintenance and PPSI21.Upgrade of physical infrastructure for research. PPSI22. Maintenance and PPSI23. Upgrade of physical infrastructure for technological transfers. PPSI24. Maintenance and PPSI25. Upgrade equipment's for vocational activities. PPSI26. Maintenance and PPSI27. Upgrade of equipment for research activities. PPSI28. Maintenance and PPSI29.Upgrade of equipment for management and technological transfers'.

Source: [10–14,47].

2.3.5. Hypothesis

The Institutional Framework (IF) supports the priority activities developed by the HEIs that regulate its relationship with the different social sectors. There are institutions that, although they do not have a legal framework that enables the linkage with different areas, have not established or developed regulations that explicitly consider the operating guidelines for linkage. However, they carry out linking activities with several sectors [11,12]. This factor involves indicators such as Organic Law, Norms, and Regulations. These observed variables influence the ability to link, which can define a part of the level of linkage. The Institutional Framework should be considered as an independent variable; what is being sought is to estimate it, which is an effective regulation. It is of interest to know the type of effect that this regulation has on the ability to link HEIs only if this effect is negative. Therefore, H1 is proposed.

Hypothesis 1 (H1). *IF has a direct and positive effect on TRTA.*

Hypothesis 2 (H2). *IF has direct and positive effect on PPSI.*

Hypothesis 3 (H3). *IF has a direct and positive effect on SM.*

The Teaching, Research, and Technical Assistance (TRTA) factor considers the training of human resources and research, as well as the development of activities. When technical assistance to the productive sector is carried out, human resources training activities and research activities enhance its impact. The indicators presented in Table 1 were grouped as a single factor, raised by Hypothesis 4.

Hypothesis 4 (H4). *SM has a direct and positive effect on the TRTA.*

The Support and Management (SM) factor refers to the support and reward of the personal effort to promote linkage. It can be the trigger to link HEIs and Scientific Centers with the business sector. The Physical, Professional, and Human Infrastructure factor is composed of scientific and technical groups, which are the most valuable capital that institutions have, which, supported by a physical infrastructure of appropriate laboratories and equipment, represents a solid response to support of the productive sector. In addition, their observed variables, presented in Table 2, are associated with these hypotheses:

Hypothesis 5 (H5). *PPSI has a direct and positive effect on TRTA.*

Hypothesis 6 (H6). *PPSI has a direct and positive effect on the SM.*

Figure 1 illustrates the relationships and the six hypotheses previously proposed. It contains the proposed initial model, which will be submitted for evaluation. Finally, from the proposal of this model, one more hypothesis can be mentioned:

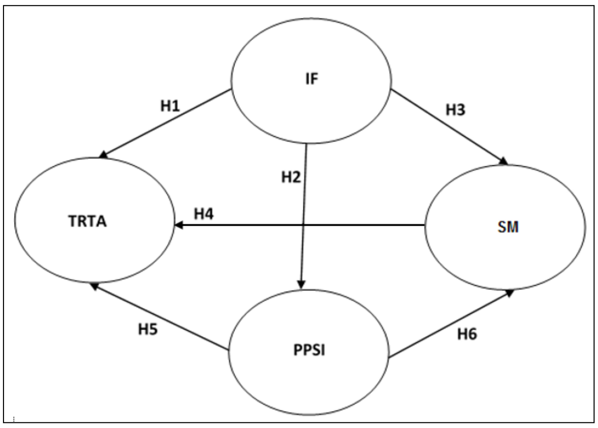

Figure 1. Proposed hypothesis. IF = Institutional Framework, TRTA = Teaching, Research, and Technical Assistance, SM = Support and Management and, PPSI = Physical and Professional Support Infrastructure.

Hypothesis 7 (H7). *The proposed model of structural equations can measure bonding capacity.*

3. Materials and Methods

This paper proposes a model that uses a quantitative approach based on Structural Equations Modeling (SEM), and data analysis is performed using the Partial Least Squares (PLS) method. According to the literature review, Structural Equations Modeling is a suitable technique for evaluating the relationships between variables as well as determining their effects [48]. The genuine aim at this phase was to recognize corresponding research, but no one presents the same approach. As was mentioned earlier, the instrument used was proposed based on [10–14] and grouped into four dimensions (IF, TRTA, SM, and PPSI), with 61 items, as can be seen in Tables 1 and 2. IF [3,49,50], SM [3,51,52], TRTA [3,53–55], and PPSI [52] are the observed variables included as a part of the strategic planning in HEIs, which have been identified as dimensions in linking activities and trust-based quality culture.

3.1. Limitations of the Study

This study represents an approach to the construction of a model for linking HEIs. It should be considered that a model including all of the variables and relationships that are presented is unfeasible due to the excessive time and costs that are necessary for data collection. Therefore, the identification of variables that will be adjusted to reality and that are relevant for decision-making in the national context was a restriction of the study. Regarding the availability of the data provided, the difficulty in the response rate of the participants increased, and the programming of the project activities did not make it possible to extend the time for data collection. Another restriction was the need to use as input the questionnaires previously developed in the context of Mexico, considering those validated by national experts.

3.2. Participants Description

The participant profile was determined, where experts in the area of linkage and extension were selected based on experience in this job position: In the time that they have been currently been working or previous experience. The intention was that they must be completely related with the terminology of the questionnaire and the implications of the HEI–industrial sector relationships. Employers who were no longer in charge of the Department of Extension and Linking were included as well, since that allowed their responses to be more neutral. Previously, surveys used question sections with only Yes or No answers, which did not adequately reflect the efforts of the institutions. A Likert-type scale was included that allowed: Measuring the relationships and effects between variables, but, more importantly, obtaining answers closer to reality by assessing the minor efforts that are aimed at improving the management of HEIs.

The subjects to whom the questionnaire was applied were key actors that have been defined as specialized and support staff in HEIs with a previous background, such as researchers, professors, postgraduate executives, and linkage instances. The HEIs where the instrument was applied are established in the Northwest of Mexico. It was chosen to use a self-administered questionnaire, which was delivered personally to the participants, who responded individually. Sampling was used for convenience, geographic location, availability, and willingness to participate. Furthermore, the instrument was personally delivered to 100 participants. In order to achieve this, massive events were attended where there were several institutional representatives of the HEIs. Local informants were interviewed personally, whereas those from other cities submitted it digitally; it was applied for a period of six months. At the closing date, 47 responses were received; therefore, the response value was 47%. The data were collected in 2017. The characteristics of the participants are presented in Table 3.

Table 3. Informant characteristics.

Gender	Average Age	Education Level	Training Area
Male: 32 (68.09%)	42	Master Degree: 11 (26%)	Business: 7 (16.66%) Engineering: 23 (54.76%) Chemical Sciences: 4 (9.52%)
Female: 15 (31.91%)		PhD: 31 (74%)	Economy: 4 (9.52%) Marketing: 2 (4.76%)

3.3. Study Design

The aim of the study was to collect data on HEI linkage with the industrial sector. For the present research work, the Likert scale (five points) was implemented, where 1 is equal to strongly disagree or highly unsatisfied, 2 = disagree or unsatisfied, 3 = neither agree nor disagree, neither satisfied nor unsatisfied, 4 = agree or satisfied, and 5 = totally agree or totally satisfied. This allowed the evaluation of partial fulfillments or advances. It was identified that responding yes or no did not really reflect the level of work in favor of the linkage that HEIs are doing.

In this study, data were collected considering that, in Mexico, there are 5343 HEIs with an enrollment of more than 3.6 million students. NAUHEI (National Association of Universities and Higher Education Institutions) comprises 197 of the HEIs in all of the country [56]. The Northwest of Mexico is one of the eight regions of the country, comprised of the states of Baja California, Baja California Sur, Chihuahua, Durango, Sinaloa, and Sonora, and is highlighted in green in Figure 2. There are 32 HEIs registered in NAUHEI belonging to the Northwest region. The Northwest region is where they are mostly sought to be linked (36.36%). Based on the previous information, it was decided to take the Northwest region of the country as a representative sample by applying the instrument to 47 participants (linkage department specialists) from the area of association belonging to the Northwest region, HEIs registered in NAUHEI, as is presented in Figure 2.

Figure 2. Northwest region in Mexico.

3.4. Data Registration and Questionnaire

SPSS 21® software was the statistics analysis tool for the data. The database was registered in a spreadsheet, and subsequently analyzed in the Warp PLS 7.0 software. In order to validate the methodology of this research, information was retrieved from 47 participants from the Northwest region of Mexico. Partial Least Squares (PLS) allows working with small samples. In the reliability analysis, standardized data were used, having results for interpretation. Reliability of the questionnaire was obtained with the total of samples [57]. The Cronbach's alpha statistic has a value of 0.938 for the 61 variables considered and 47 questionnaires. Then, the confirmatory factor analysis indicates that the validation of the instrument is appropriate. Cronbach's alpha suggests reliability in a group of criteria to measure an assessed construct. Values to understand reliability are: <0.60; 0.60 ≥ uncertain < 0.70; 0.70 ≥ acceptable < 0.80; 0.90 ≥ good < 0.90; y ≥ 0.90 excellent.

The Average Variance Extracted (AVE) was useful to rate the discriminant validity of the latent variables, where 0.50 is the minimum acceptable value. AVE was evaluated, as well as the correlations between the LV (Latent Variable), in terms of converge validity [58]. Regarding collinearity, Variance Inflation Factor (VIF) coefficient was registered in each LV to obtain the R^2, which is a statistical coefficient to measure the explained variance. Therefore, the variance of a dependent LV is explained by an independent LV. Lastly, the adjusted R^2 coefficient was registered [59].

3.5. Descriptive Analysis and SEM

The median value and the interquartile range (IQR) were estimated for each item as measurement of central tendency, as well as a measurement for data dispersion, respectively. High median values indicated a positive connotation associated with the support and management for the linkage process, while low values indicated a negative connotation in the linkage process, according to the Likert scale that was previously established. In addition, the seven-model fit and quality indexes suggested by Kock [60] were illustrated, as Table 4 illustrates.

Table 4. Model fit and quality indices.

Index	Yield
Average Path Coefficient (APC)	$p \leq 0.05$
Average R-Squared (ARS)	$p \leq 0.05$
Average Variance Extracted (AVE)	Admissible if ≥ 0.05
Variance Inflation Factor (VIF)	Admissible if ≤ 5, desirable if ≤ 3.3
Average Variance Inflation Factor (AVIF)	Admissible if ≤ 5, desirable if ≤ 3.3
Average Full Collinearity VIF (AFVIF)	Admissible if ≤ 5, desirable if ≤ 3.3
Tenenhaus GoF (The Goodness of Fit)	Desirable ≥ 0.36

Four indexes are estimated to measure the model fit quality: Average Path Coefficient (APC), Average R-Squared (ARS), Average Variance Inflation Factor (AVIF), and Average Full Collinearity VIF (AFVIF). APC registered with the absolute values of the path coefficients. Thus, APC and ARS counterweight each other and will only increase together if the LV increases the model's overall predictive and explanatory power. Otherwise, AVIF will grow if new LVs are added into the model and include vertical collinearity in the model's LV blocks. Finally, AFVIF will increase if new LVs are included in the model and added to the model's full collinearity [61–64]. The direct, indirect, and total effects are estimated to measure dependency between variables. In addition, their corresponding *p*-values, pondering the null hypothesis to establish statistical significance related to the effects ($\beta i = 0$, opposite alternative hypothesis, $\beta i \neq 0$), were estimated. In a similar way, the size effect (SE) is estimated for each dependent variable; an SE is the percentage of a variance included in a dependent LV and explained by an independent LV. The confirmatory factor analysis indicates that the validation of the instrument is adequate.

3.5.1. Questionnaire Validation

All latent variable components are over 0.831 for each Cronbach's alpha value. Table 5 presents results of the validation process for LV regarding the indicators considered in the methodology. Indexes of composite reliability for each of the LV are over 0.80, which evidences the internal validity. Finally, AVE results support the convergent validity of data, since they are over 0.50, and VIF does not show problems of collinearity in LV, as they are under 3.33.

3.5.2. Descriptive Analysis

According to Table 6, the variables with a higher estimation and less variability were considered, as well as the aspects in which there are fewer problems. For the Institutional Framework (IF) LV, the results suggest in the linkage process that the best variable is the Organic Law; this is logical, since the Organic Law represents the maximum rules or norms established by the higher authority in universities to regulate their activities. Therefore, it can be interpreted that HEIs have specific legal mechanisms for linkage; therefore, there are no obstacles for collaboration. In the Teaching, Research, and Technical Assistance (TRTA), the best elements are: TRTA1; diversity of the education that is offered at a bachelor's level, TRTA7; academic training and master degrees, TRTA10; relevance of basic research, TRTA11; satisfaction with basic research, TRTA13; satisfaction with applied sciences, TRTA15; satisfaction with project development (locally). In addition, participants consider linking department responsibilities and satisfaction (SM5 and SM6), the best elements of Support and Management linkage instances. Finally, PPSI5, Maintenance of research groups according to regional vocation, which is the most important variable in Physical and Professional Support Infrastructure (PPSI) factor.

Table 5. Validation process of latent variables.

Index	IF	TRTA	SM	PPSI
R-Squared		0.699	0.633	0.294
Adjusted R-Squared		0.678	0.616	0.279
Composite reliability	0.888	0.954	0.930	0.983
Cronbach's alpha	0.831	0.947	0.914	0.982
Average Variance Extracted	0.666	0.530	0.597	0.666
Full Collinearity VIFs	1.453	3.200	3.046	3.174
Q-Squared		0.706	0.634	0.290

Table 6. Descriptive analysis.

Latent Variables and Items	Percentiles			IR
	25	50	75	
INSTITUTIONAL FRAMEWORK				
IF1. Organic Law.	4	4	5	1
IF2. Statutes.	3	4	4	1
IF3. Regulations.	3	4	4	1
IF4. Satisfaction.	3	3	4	1
TEACHING, RESEARCH AND TECHNICAL ASSISTANCE				
TRTA1. Offer on bachelor degrees (BD).	4	4	5	1
TRTA2. Satisfaction level in professional practices (BD.	3	4	4	1
TRTA3. Satisfaction level in professional projects with industry (BD).	3	4	4	1
TRTA4 Satisfaction level in Social Services (BD).	3	4	4	1
TRTA5. Satisfaction level to company visits (BD).	2	4	4	2
TRTA6. Professional training, master grades.	2	4	4	2
TRTA7. Academic training, master grades.	2	4	4	2
TRTA8. Professional training, PhD grades.	3	3	4	1
TRTA9. Academic training and technological projects with companies.	3	3	4	1
TRTA10. Relevance of Basic Research	2	4	5	3
TRTA11. Satisfaction of Basic Research.	3	4	5	2
TRTA12. Relevance of Applied research.	3	4	4	1
TRTA13. Satisfaction of Applied research.	3	4	5	2
TRTA14. Satisfaction with project development other institutions (TD).	2	4	4	2
TRTA15. Satisfaction with project development (locally TD).	3	4	5	2
TRTA16. Satisfaction with project development (national TD).	3	4	4	1
TRTA17. Technological transfer projects.	3	4	5	2
TRTA18. Technological services.	2	4	4	2
TRTA19. Business stays.	2	4	4	2

Table 6. *Cont.*

Latent Variables and Items	Percentiles			IR
	25	50	75	
SUPPORT AND MANAGEMENT				
SM1. Institutional incentives through promotional scores.	2	3	4	2
SM2. Economic incentives.	2	3	4	2
SM3. Incentives for professional development.	2	3	4	2
SM4. Promotion of the National System of Researchers (NSR).	2	3	4	2
SM5. Linking department responsibilities.	3	4	5	2
SM6. Linking department satisfaction.	2	4	5	3
SM7. Transparency and technology management department	2	3	4	2
SM8. Linkage manager responsibilities	2	3	4	2
SM9. Linkage manager satisfaction.	2	4	4	2
PHYSICAL AND PROFESSIONAL SUPPORT INFRASTRUCTURE				
Total number of members of a research group with a doctoral degree.				
PPSI1. Uptake expense.	2	3	4	2
PPSI2. Expense to maintain.	2	3	4	2
PPSI3. Creation of research groups.	2	3	4	2
PPSI4. Creation and	3	4	4	1
PPSI5. Maintenance of research groups according to regional vocations.	3	4	5	2
PPSI6. Selecting and	3	4	4	1
PPSI7. Maintaining TP for vocational activity programs.	2	3	4	2
PPSI8. Selecting and	2	3	4	2
PPSI9. Maintaining TP for research activities.	2	3	4	2
Support staff with the necessary capacity to support specialized staff.				
PPSI10. Selecting and	2	3	4	2
PPSI11. Maintaining TP for technological transfers' activities.	2	3	4	2
PPSI12. Selecting and	2	3	4	2
PPSI13. Maintaining AP for vocational activities.	2	3	4	2
PPSI14. Selecting and	2	3	4	2
PPSI15. Maintaining AP for research activities.	2	3	4	2
PPSI16. Selecting and	2	3	4	2
PPSI17. Maintaining AP for management and technological transfer.	2	3	4	2
Infrastructure in conditions that allow carrying out the activities in an optimal way.				
PPSI18. Maintenance and	2	3	4	2
PPSI19. Upgrade of physical infrastructure for vocational activities.	2	3	4	2
PPSI20. Maintenance and	2	3	4	2
PPSI21.Upgrade of physical infrastructure for research.	2	3	4	2
PPSI22. Maintenance and	2	3	4	2
PPSI23. Upgrade of physical infrastructure for technological transfer.	2	3	4	2
PPSI24. Maintenance and	2	3	4	2
PPSI25. Upgrade of equipment for vocational activities.	2	4	4	2
PPSI26. Maintenance and	2	4	4	2
PPSI27. Upgrade of equipment for research activities.	2	4	4	2
PPSI28. Maintenance and	2	4	4	2
PPSI29. Upgrade of equipment for management and technological transfer.	2	3	4	2

IR = Interquartile Range, TD = Technological Development, TP = Technical Personnel, AP = Administrative Personnel.

3.5.3. SEM: Direct Effects

The results of the introduced model are presented in Figure 3. Each effect is represented by the β-value and its parallel *p*-value for the statistical hypothesis test. The values of R^2 are incorporated for each dependent LV; in this case, TRTA, SM, and PPSI. Specifically, for the model's index adjustments, the following results are presented in Table 7.

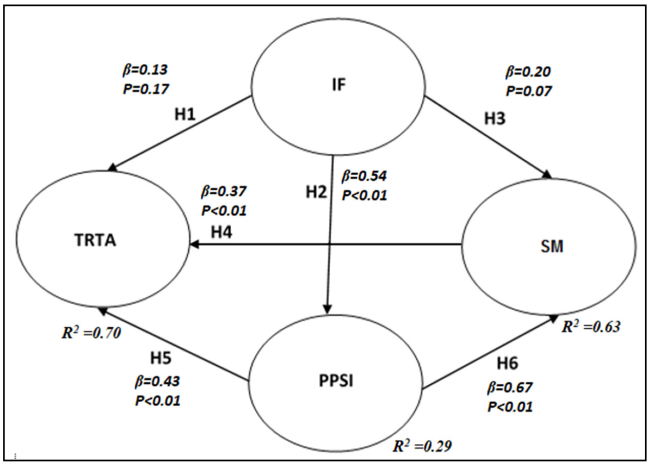

Figure 3. Model solved.

Table 7. Model fit and quality indices.

Index	Yield	Performance
Average Path Coefficient (APC)	$p \leq 0.05$	0.392, $p < 0.001$
Average R-Squared (ARS)	$p \leq 0.05$	0.542, $p < 0.001$
Average Adjusted R-squared (AARS)	Admissible if ≥ 0.05	0.524, $p < 0.001$
Average Variance Inflation Factor (AVIF)	Admissible if ≤ 5, desirable if ≤ 3.3	1.843
Average Full Collinearity VIF (AFVIF)	Admissible if ≤ 5, desirable if ≤ 3.3	2.718
Tenenhaus GoF (The Goodness of Fit)	small ≥ 0.1, medium ≥ 0.25, large ≥ 0.36, desirable ≥ 0.36	0.577

Table 8 presents conclusions regarding the six hypotheses. As it is shown, the Hypothesis 1 that associates the Institutional Framework with Teaching, Research, and Technical Assistance was rejected statistically, since the *p*-value was over 0.05 ($p = 0.17$); in the same way, Hypothesis 2, associating Institutional Framework with Support and Management, was statistically rejected ($p = 0.07$). However, even if there is statistical evidence to reject Hypotheses 1 and 2, from a theoretical perspective, it is not possible to dismiss these relationships [3,51]. According to Table 6, the quality indices to evaluate the model fit are appropriate to consider the hypothesis as accepted. Therefore, Hypotheses 1 and 2 were accepted.

Table 8. Hypothesis results.

H_i	From	To	p-Value	Conclusion
H_1	Institutional Framework	Teaching, Research, and Technical Assistance	0.16	Accepted
H_2	Institutional Framework	Physical and Professional Support Infrastructure	≤0.01	Accepted
H_3	Institutional Framework	Support and Management	0.17	Accepted
H_4	Teaching, Research, and Technical Assistance	Support and Management	≤0.01	Accepted
H_5	Physical and Professional Support Infrastructure	Teaching, Research, and Technical Assistance	≤0.01	Accepted
H_6	Physical and Professional Support Infrastructure	Support and Management	≤0.01	Accepted

Additionally, Table 9 displays the decomposition of R^2 values for dependent LVs, where it was established that Physical and Professional Support Infrastructure (PPSI) is explained in 52.2% by the Support and Management (SM) variability and by the R^2 with a high value. The IF variable has a positive and direct effect on TRTA, SM, and PSSI of 0.074, 0.111, and 0.294, respectively (which means that when IF increases its deviation in one unit, TRTA, SM, and PSSI increase in 0.074, 0.111, and 0.294, respectively).

Table 9. Effect size for direct effects.

From	IF	TRTA	PPSI	R^2
TRTA	0.074		0.341	0.70
SM	0.111	0.284	0.522	0.63
PSSI	0.294			0.29

IF = Institutional Framework, TRTA = Teaching, Research, and Technical Assistance, PPSI = Physical and Professional Support Infrastructure, SM = Support and Management.

3.5.4. Structural Equation Model: Indirect and Total Effects

Indirect effects take place between dimensions through other dimensions that appear as intermediaries. They can also be presented in some segments. Table 10 shows indirect and total effects that are set between LV and *p*-values; all indirect effects were significant. Accordingly, even if the IF direct effects on TRTA and SM were statistically rejected, the indirect and total effects were accepted, which confirms a high value. Consequently, IF indirectly explains 36.5% of SM and TRTA variability, since SE = 0.365. Total effects are determined as the sum of direct and indirect effects. Total effects can be translated in the same way as indirect effects. For instance, the total effect regarding PPSI and SM is 0.672; when the first LV increases in one standard deviation, the second LV increases in 0.672 standard deviations. It is recognized that the total effects are statistically significant and all *p*-values are under 0.05. In addition, it is necessary to highlight that PPSI had the highest effect in SM with β = 0.670.

Table 10. Indirect and total effects.

Indirect Effects				Total Effects			
	IF	IF *	PPSI		IF	TRTA	PPSI
TRTA	IE= 0.310 p < 0.001 SE = 0.129 ES = 0.172			TRTA	TE= 0.578 p < 0.001 SE = 0.116 ES = 0.320		TE = 0.683 p < 0.001 SE = 0.111 ES = 0.536
SM	IE = 0.365 p = 0.010 SE = 0.089 ES = 0.200	IE = 0.134 p = 0.049 SE = 0.080 ES = 0.074	IE = 0.248 p = 0.005 SE = 0.093 ES = 0.194	SM	TE = 0.566 p < 0.001 SE = 0.117 ES = 0.311	TE = 0.369 p = 0.003 SE = 0.126 ES = 0.284	TE = 0.672 p < 0.001 SE = 0.112 ES = 0.522
				PPSI	TE = 0.543 p < 0.001 SE = 0.118 ES = 0.294		

IE = Indirect Effect, SE = Standard Error, * = path with 3 segments, TE = Total Effect, ES = Effect Size.

4. Analysis

This section approaches the research questions that were presented in the theoretical perspective section: What specific activities or areas should be prioritized to have a greater impact on the linkage developed by academics? How do different items influence the academics' performance? Furthermore, the applicable legislation represented by the Institutional Framework (IF) is an independent latent variable, whose factorial charges are shown in Table 11. These have high values that confirm the importance of the Organic Law, norms, and regulations that are being aligned with the vision of industry–HEI linkage. In addition to being considered relevant, the participating academic community shows satisfaction with them, which is an indication that university legislation allows them to carry out linking activities and that the legal framework does not represent a problem in Mexican HEIs. It is of interest to know if there is a legal framework for linking activities, since these are mostly shown at a basic level.

Table 11. Institutional framework.

Item	Mean	Loading	p-Value
IF1. Organic Law.	4.04	0.720	<0.001
IF2. Statutes.	3.57	0.847	<0.001
IF3. Regulations.	3.53	0.838	<0.001
IF4. Satisfaction.	3.29	0.850	<0.001

In the proposed model, the direct effect of the Institutional Framework (IF) is low towards the Teaching, Research, and Technical Assistance (TRTA) factor. However, the greatest effect was identified towards the Physical and Professional Support Infrastructure. As is shown in Table 12, for this latent variable, the teacher's participation in human resources training for masters and doctorates, the development of applied research projects, technology transfer and technical assistance services to companies, professors' and researchers' lounges in companies, and academic and professional training (TRTA7–TRTA9, TRTA13–TRTA18) were the most relevant variables, which is reflected in the high factor load.

Table 12. Teaching, Research, and Technical Assistance.

Item	Mean	Loading	p-Value
TRTA1. Offer on bachelor degrees (BD).	4.25	0.425	<0.001
TRTA2. Satisfaction level in professional practices (BD).	3.78	0.586	<0.001
TRTA3. Satisfaction level in professional projects with industry (BD).	3.70	0.366	0.003
TRTA4 Satisfaction level in Social Services (BD).	3.48	0.694	<0.001
TRTA5. Satisfaction level in company visits (BD).	3.14	0.550	<0.001
TRTA6. Professional training, master grades.	3.36	0.686	<0.001
TRTA7. Academic training, master grades.	3.34	0.794	<0.001
TRTA8. Professional training, PhD grades.	3.51	0.813	<0.001
TRTA9. Academic training and technological projects with companies.	3.42	0.818	<0.001
TRTA10. Relevance of basic research	3.38	0.698	<0.001
TRTA11. Satisfaction of basic research.	3.76	0.683	<0.001
TRTA12. Relevance of applied research.	3.44	0.586	<0.001
TRTA13. Satisfaction of applied research.	3.74	0.847	<0.001
TRTA14. Satisfaction with project development in other institutions (TD).	3.42	0.799	<0.001
TRTA15. Satisfaction with project development (local TD).	3.59	0.867	<0.001
TRTA16. Satisfaction with project development (national TD).	3.48	0.869	<0.001
TRTA17. Technological transfer projects.	3.53	0.881	<0.001
TRTA18. Technological services.	3.31	0.827	<0.001
TRTA19. Business stays.	3.42	0.746	<0.001

TD = Technological Development.

Nevertheless, the rating is not concluded in terms of satisfaction in the fulfillment of these activities; the answers with a rating of three or less reflect that strategies have not been implemented to increase coverage and quality regarding these variables. It can be emphasized that there is greater satisfaction with the educational offer at a bachelor level, which is reasonable, since that is where the efforts of HEIs for the training of human resources are centered. However, in order to encourage higher levels of association, greater support must be devoted to education in postgraduate professionals, as well as to the participation of researchers in projects of the industry.

The latent Support and Management (SM) variable is related to the activities carried out by the institution to improve linking activities. The promotion and dissemination of the stimulus program of the National System of Researchers obtained the highest factor load, as it was considered a very important variable for the hiring and permanence of researchers in HEIs (see Table 13).

Table 13. Support and Management.

Item	Mean	Loading	p-Value
SM1. Institutional incentives through promotional scores.	2.96	0.727	<0.001
SM2. Economic incentives.	3.04	0.811	<0.001
SM3. Incentives for professional development.	2.87	0.879	<0.001
SM4. Promotion of the National System of Researchers (NSR).	3.04	0.896	<0.001
SM5. Linking department responsibilities.	3.68	0.678	<0.001
SM6. Linking department satisfaction.	3.49	0.764	<0.001
SM7. Transparency and technology management department	2.91	0.662	<0.001
SM8. Linkage manager responsibilities	3.06	0.719	<0.001
SM9. Linkage manager satisfaction.	3.45	0.785	<0.001

The following aspect was the opportunity to grow professionally in the institution and in the productive sector, as well as the economic incentives for participating in projects related to the industry. However, the average ratings were approximately three or less, which indicates that the participants are not very satisfied in the way in which these incentives are managed. From the perspective of the participants, the stimuli are towards linkage research and development of technological projects, but the greatest workload is in teaching at a bachelor's level. Therefore, the level of linkage is limited to basic application projects, with projects that are managed by the company and the students, where the researchers assume a passive function in the achievement of goals of projects.

Regarding the Physical and Professional Support Infrastructure (PPSI) latent variable, the activity of selecting and maintaining technical and administrative personnel for the management of vocational and research technological projects has the highest factor load according to Table 14. This factor has the highest median value causalities compared to the rest of the factors. There is no specialized staff dedicated to the previous mentioned activities. The critical mass of the staff is focused on teaching activities. Research groups are created, but there have not been enough investments according to the demand. Equipment is acquired but its maintenance is not performed on a regular basis. Improvement actions are initiated but the cycles are not closed to increase the level of linkage.

Moreover, other related questions regarding the hypothesis are addressed, as well as the hypotheses that were tested in the model illustrated in Figure 3.

a) How does the Institutional Framework (IF) influence the Support and Management (SM) and Teaching, Research, and Technical Assistance (TRTA)? Hypothesis 1: IF has a direct and positive effect on TRTA. There is not enough statistical evidence to conclude that IF has a direct and positive effect on TRTA. However, the p-value is 0.07; it is close to the acceptance region ($\leq$0.05); according to the theoretical perspective [46,47], IF has repercussions in SM; thus, this hypothesis is accepted. Hypothesis 3: IF has a positive direct effect on SM. There is not enough statistical evidence to conclude that IF has a positive and direct effect on SM. However, it is paralleled with Hypothesis 1, since the theoretical perspective evidence has an impact on these variables. Therefore, this hypothesis is accepted. The contribution was to measure this impact.
b) What is the relationship between the Teaching, Research, and Technical Assistance (TRTA) and the Support and Management (SM)? Hypothesis 4: SM has a positive and direct effect on TRTA. There is enough statistical evidence to conclude that TRTA has a positive and direct effect on SM, since when the first LV increases in one standard deviation, the second LV increases in 0.37 standard deviations. Therefore, this hypothesis is accepted.
c) What is the relationship between the Institutional Framework (IF) and the Physical and Professional Support Infrastructure (PPSI)? Hypothesis 2: IF has a positive and direct effect on PSSI. There is enough statistical evidence to conclude that IF has a positive and direct effect on PSSI, since

when the first LV increases in one standard deviation, the second LV increases in 0.54 standard deviations. Therefore, this hypothesis is accepted.

d) How does PPSI react towards TRTA and SM? Hypothesis 5: PSSI has a positive and direct effect on TRTA. Hypothesis 6: PSSI has a positive and direct effect on SM. There is enough statistical evidence to conclude that PSSI has a positive and direct effect on TRTA and on SM, since when PSSI increases in one standard deviation, TRTA increases in 0.78 standard deviations; when PSSI increases in one standard deviation, SM increases in 0.46 standard deviations. Therefore, Hypothesis 5 and Hypothesis 6 are accepted.

e) What type of knowledge does PPSI provide to SM? PPSI14 and PPSI5: Creation and maintenance of research groups according to regional vocations is the most important variable in the PPSI factor for SM.

Table 14. PPSI: Physical and Professional Support Infrastructure.

Item	Mean	Loading	p-Value
PPSI1. Uptake expense.	2.76	0.523	<0.001
PPSI2. Expense to maintain.	3.10	0.682	<0.001
PPSI3. Creation of research groups.	3.17	0.758	<0.001
PPSI4. Creation and	3.55	0.735	<0.001
PPSI5. Maintenance of research groups according to regional vocations.	3.61	0.792	<0.001
PPSI6. Selecting and	3.53	0.773	<0.001
PPSI7. Maintaining TP for vocational activities program.	3.00	0.808	<0.001
PPSI8. Selecting and	3.00	0.817	<0.001
PPSI9. Maintaining TP for research activities.	2.87	0.881	<0.001
Support staff with the necessary capacity to support specialized staff.			
PPSI10. Selecting and	2.93	0.877	<0.001
PPSI11. Maintaining TP for technological transfer activities.	3.00	0.855	<0.001
PPSI12. Selecting and	2.95	0.893	<0.001
PPSI13. Maintaining AP for vocational activities.	2.95	0.873	<0.001
PPSI14. Selecting and	2.93	0.859	<0.001
PPSI15. Maintaining AP for research activities.	2.78	0.864	<0.001
PPSI16. Selecting and	2.91	0.893	<0.001
PPSI17. Maintaining AP for management and technological transfers.	2.85	0.871	<0.001
Infrastructure in conditions that allow carrying out the activities in an optimal way.			
PPSI18. Maintenance and	2.78	00792	<0.001
PPSI19. Upgrade of physical infrastructure for vocational activities.	3.19	0.769	<0.001
PPSI20. Maintenance and	3.17	0.769	<0.001
PPSI21.Upgrade of physical infrastructure for research.	3.17	0.855	<0.001
PPSI22. Maintenance and	3.08	0.838	<0.001
PPSI23. Upgrade of physical infrastructure for technological transfers.	3.10	0.843	<0.001
PPSI24. Maintenance and	3.23	0.863	<0.001
PPSI25. Upgrade equipment for vocational activities.	3.36	0.710	<0.001
PPSI26. Maintenance and	3.27	0.827	<0.001
PPSI27. Upgrade equipment for research activities.	3.14	0.819	<0.001
PPSI28. Maintenance and	3.12	0.856	<0.001
PPSI29. Upgrade equipment for management and technological transfers.	3.12	0.826	<0.001

TD = Technological Development, TP = Technical Personnel, AP = Administrative Personnel.

5. Discussion

HEIs have a strong influence on the regional innovation in collaboration with society, civil, government, and private initiatives [2]. A study conducted in developing countries (Algeria, Indonesia, Malaysia, and India) argues that a healthy balance of several types of higher education institutions (HEIs) at regional and national levels in a country may be necessary for a better performance of national innovation [65]. Latin America requires strategic planning that allows it to achieve its sustainability objectives, among the pending activities to consolidate this linkage [3], which is a dynamic system that requires a conscious and specific design process for its optimization. This will be attractive to participants if the benefits of this interaction are highlighted and mutually exchanged, where collaborations are systematically facilitated, as highlighted in the cases of Albania and Kosovo [1].

In addition, Mexico has several types of HEIs that perform specific activities at different levels of linkage. However, the number of researchers is still not enough, according to the demand for the services of the productive sector in industrialized cities. The retention of researchers has become more complicated due to personnel hiring policies and changes due to labor reforms. The benefits of a more advanced level of linkage are not yet clear to the productive sector, because the service has not been offered in most cases. There are plenty of consulting companies that are successful, since they do not have a real competition from HEIs.

Nowadays, with the budget cuts in Mexico, HEIs begin to feel the pressure to seek external financing for the development of their activities, which, in the United States, has been a phenomenon for more than 20 years [48], which means that Mexico has been living with an educational model with more than 20 years of lag. All of the strategies that can be proposed require institutional leadership and awareness from researchers to leave their laboratories and actively participate in innovation projects by promoting academic engagement [29].

The model reflects the importance of the Institutional Framework dimension from HEIs to have a Legal Framework (Organizational Law and Creation Decree) that allows developing and maintaining relationships with the environment, as well as having a structure and norms that facilitate government and management, and having regulations that determine the relationships in the best way for linkage. Regarding Teaching, Research, and Technical Assistance, it involves having human resources training and carrying out scientific research and technological development activities that facilitate interaction between HEIs and companies to provide technological services. Likewise, the PPSI included the observed variables of research and development groups, the administrative infrastructure, the laboratories, and equipment. These effects had already been empirically identified in other studies, but a mathematical validation is proposed here [30,33,36].

In fact, one important finding is the estimation of the impact from the Support and Management on the criteria that contribute to the ability to link through the Teaching, Research, and Technical Assistance latent variable. A positive effect was identified, which implies that, as the opinion increases on the training of human resources, the carrying out of scientific research, technological development activities that facilitate the interaction between HEIs and companies, and providing technological services and consulting, relationships will be intensified due to the incentives of linkage, the promotion of academic development, and the functioning of the linkage instances. It is highlighted that the effect of the Physical and Professional Support Infrastructure latent variable that included the observed variables of research and development groups, the technical–administrative infrastructure, and laboratory and equipment on the TRTA and the SM is significant; on the first variable and on the second variable, the highest values of β are shown, and the effects received from the Institutional Framework are precisely the third highest value of β. In addition, the direct and positive effect of the Institutional Framework on Support and Management was discarded because of the high p-value of 0.20; however, the indirect effects are given through Teaching, Research, and Technical Assistance, as well as through Physical and Professional Support Infrastructure. This value was found even by eliminating observed variables with high levels that were not considered in the preliminary model and model A, where no significant change was presented.

6. Conclusions

Based on the accomplishment of this research, it was possible to design a model of complexity of the linkage capacity of HEIs and the productive sector. The model is useful in terms of its conceptual model. The promotion of ways of linkage in specific areas in science and technology is presented as agreements with more short-term objectives, such as technical support and service provision by the university, training programs, cooperation in the creation of human resources, continuing education courses, and specialized consulting, among others [30]. These links and services are characterized, because they are less long-lasting and more restricted in terms of agreements, and their impact on both the science and technology sector and the productive sector is minimum. However, this type of linkage is part of the path to start efforts focused on achieving closer relationships between the university and the industry. In addition, the idea is to maximize the linkage based on the variables and efforts. The aspects defined in the variables and restrictions can be points of action for institutional work. Specifically, for designing policies and the strengthening of ways of linkage in specific areas of science and technology with longer-term objectives, it is intended to continue strengthening all other variables, maximizing the function objective of linkage, towards more advanced ways and the development of linkage systems as well. Although other models on industry–university relations, such as [66], based on a holistic approach have been proposed, the difference is that the model proposed in this research is the whole-institution approach.

The institutional framework is considered adequate based on the outreach and extension activities at a basic level. Nevertheless, to effectively promote science and technology, that will have a positive impact at a higher level, university structures are needed to allow outreach and extension activities. These systems structures will only work if institutional leadership recognizes their potential and backs them up financially: Administrative and technical staff, researchers, infrastructure, procurement and equipment, and infrastructure maintenance. Indeed, creating a sound base structure will allow the university to offer scientific and technical services with the aim of innovating and developing new technologies. The generation, application, transfer, and commercialization of knowledge is a strategic issue in most Mexican universities. Mexican universities, in terms of this crucial issue, lag compared to other developing countries.

There is still work to be done at the basic education level; moreover, there is also social and state pressure to offer more enrollment seats at the higher education level nationwide that competes with knowledge creation for funding. Yet, not all is lost; universities are starting to shift towards self-financing, at least partially, through outreach towards the private sector, following similar models that have been successful in more developed countries. They are using university Technology Transfer Offices to spearhead privately financed projects, providing services to the government, the private sector, and the general public.

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