

## Trends of higher education institutions with the productive sector in the formation of human capital and the generation of innovation and development: challenges and challenges in the face of COVID-19

### Tendencias de las instituciones de educación superior con el sector productivo en la formación del capital humano y la generación de innovación y desarrollo: retos y desafíos ante el COVID-19

ANTONIO-VIDAÑA, Paula Rosalinda†\*, AGUILAR-HERRERA, Doris, HERNÁNDEZ-PERALTA, Alejandro de Jesús and MARTÍNEZ-NAVARRETE, Daniel

*Universidad Tecnológica del Centro de Veracruz, Mexico.*

ID 1<sup>st</sup> Author: *Paula Rosalinda, Antonio-Vidaña* / ORC ID: 0000-0002-1175-0611, CVU CONACYT ID: 673436

ID 1<sup>st</sup> Co-author: *Doris, Aguilar-Herrera* / ORC ID: 0000-0001-5660-0150, CVU CONACYT ID: 909724

ID 2<sup>nd</sup> Co-author: *Alejandro de Jesús, Hernández-Peralta* / ORC ID: 0000-0003-1624-7529, CVU CONACYT ID: 498020

ID 3<sup>rd</sup> Co-author: *Daniel, Martínez-Navarrete* / ORC ID: 0000-0003-2072-9598, CVU CONACYT ID: 223155

DOI: 10.35429/JHRT.2021.20.7.29.35

Received: July 30, 2021; Accepted: December 30, 2021

#### Abstract

This article aims to distinguish the interaction that exists between higher education institutions with the productive sector and the results of its linkage as a fundamental pillar of the formation of human capital, knowledge transfer and the impact for economic and social development . A quantitative research was carried out applying 465 surveys to companies of commercial, industrial and service lines, the STATA12 Software and for the analysis of results and their validation As part of the results of the Factorial Analysis of Correspondences (CFA) they allowed to identify the groups related, which share in common a set of characteristics of the relationship between higher education institutions (HEIs) and the productive sector that makes them interdependent and that at the same time represents a profile for the subjects that are being analyzed, based on of the coordinates of the categories of variables in relation to axes or dimensions represented in a two-dimensional graph (Lizasoain, L., & Joaristi, L., 2012). With the help of the STATA12 software, the simple factorial correspondence analysis was performed, as well as the obtaining of graphs. In this sense, the related groups between HEIs, companies and their forms of interaction, given the impact of COVID-19.

**Higher education, Productive sector, Human capital, Innovation and development**

#### Resumen

El presente artículo, tiene como objetivo distinguir la interacción que existe entre las instituciones de educación superior con el sector productivo y los resultados de su vinculación como pilar fundamental de la formación de capital humano, transferencia de conocimiento y el impacto para el desarrollo económico y social. Se llevó a cabo una investigación cuantitativa aplicando 465 encuestas a empresas de giro comercial, industrial y de servicios, el Software STATA12 y para el análisis de resultados y su validación Como parte de los resultados del Análisis Factorial de Correspondencias (AFC) permitieron identificar los grupos afines, los cuales comparten en común un conjunto de características de la relación existente entre las instituciones de educación superior (IES) y el sector productivo que los hace interdependientes y que al mismo tiempo representa un perfil para los sujetos que se están analizando, a partir de las coordenadas de las categorías de variables en relación a ejes o dimensiones representadas en gráfico bidimensional (Lizasoain, L., & Joaristi, L., 2012). Con ayuda del software STATA12 se realizó el análisis factorial de correspondencias simple, así como la obtención de gráficos. En este sentido, los grupos afines entre IES, las empresas y sus formas de interacción, ante el impacto del COVID-19.

**Educación superior, Sector productivo, Capital humano, Innovación y desarrollo**

**Citation:** ANTONIO-VIDAÑA, Paula Rosalinda, AGUILAR-HERRERA, Doris, HERNÁNDEZ-PERALTA, Alejandro de Jesús and MARTÍNEZ-NAVARRETE, Daniel. Trends of higher education institutions with the productive sector in the formation of human capital and the generation of innovation and development: challenges and challenges in the face of COVID-19. Journal of Human Resources Training. 2021. 7-20:29-35.

\*Correspondence to Author (Email: paula.antonio@utcv.edu.mx)

†Researcher contributing first Author

## Introduction

Higher Education Institutions generate their educational proposals which are supported by their educational model and the pretension with the formation of the student, in addition they satisfy a social need, so considering their nature and processes they must identify the subjects that are immersed in their proposal, in such a way that in interacting with them, they establish the bases that will form their curricular proposal and with it the forms of interaction, However, the proposals are designed under a normative process in which the productive sector is left isolated, with the understanding that the trend in the 21<sup>st</sup> century will be to interact with them and to insert innovation and development in a broad context as part of the proposal.

The objective of this paper is to distinguish the interaction between higher education institutions and the productive sector and the results of their linkage as a fundamental pillar of human capital formation, knowledge transfer and the impact for economic and social development, being important to consider the impact of COVID-19 for the linkage and therefore of the activities derived from such interaction.

## Theoretical framework

Education today must adapt to changes not only in technology as a determining factor in the 21<sup>st</sup> century, but also to the requirements of labor markets and the productive structure; the governance of the system has increased its complexity due to the greater number of actors and functions required of higher education institutions SEP (2010). The participation of new actors as part of the linkage between Higher Education Institutions (HEI) and the productive sector derived from the new approaches and social requirements allow interacting in this hegemonic struggle of educational proposals both for the formation of human capital and in the requested programs that have an impact on the new challenges of innovation and technology. It is through education that the foundations for the economic development of a society are laid. It is largely responsible for the possibility of countries to increase their innovation, productivity and economic growth rates, allowing them to reduce poverty and inequality levels (Mosquera, 2011).

Under a sphere of globalization in which the productive sector is impacted as established by Ochoa Silva & Wendlandt Amexaga (2016) present results in situations of companies regarding variables among some of them improvement in the quality of the product or service, improvement in the image of the company which gave us a reference in the results obtained to contextualize according to the needs of company or productive sector as is the focus of this article, shows its participation, that is to say, it considers a gap of analysis of what are the pretensions of the businessman and based on it will be then the way of interacting with the IES in its contribution for the formation of students according to its industrial, commercial or service line of business.

Therefore, it is necessary for the IES to have a pertinent educational offer that takes into account the needs of the context. To achieve this, it is essential that institutional management in educational communities is carried out in a collaborative manner, in order to establish training projects aimed at mobilizing the knowledge of educational actors, including teachers, managers or students, to contribute to the solution of existing problems in society, as well as to enable the change of educational practices focused only on the teaching of content dislocated from the action.

However, the pandemic that occurred before the COVID-19 put into question the link that existed between HEIs and the productive sector. Schmelkes S. (2020) establishes that three major impacts were produced as a result of the pandemic in higher education in Mexico: economic, technological and organizational-pedagogical.

## Methodology used

Quantitative research was carried out by applying 465 surveys to commercial, industrial and service companies, using STATA12 software, in addition to using data reduction techniques such as factor analysis, as well as Chi-square statistics, in order to establish hypotheses on the relationship between the productive sector and Higher Education Institutions (HEI) and the formation of human capital.

A practical way of establishing this relationship is through the probability value -p value-, which represents the lowest probability at which the null hypothesis can be rejected (Gujarati, N., & Porter, D., 2010), Table 2 describes the result of the test using the probability value as a decision criterion to establish association.

Correspondence factor analysis (CFA) allows studying the interrelation between a set of row and column variables, for the simplest case of only two variables the interrelation can be identified from the coordinates of the categories of the variables in relation to the axes or dimensions represented in a two-dimensional graph (Lizasoain & Joaristi, 2012). With the help of the STATA12 econometrics software, the simple correspondence factor analysis was performed, as well as obtaining its graphs.

## Results

Table 1 shows a contingency table for the study of the relationship between educational institutions and the business line of the business sector based on the opinion of industrial consultants.

IES	Tum	Commercial	Service	Industrial	Educational	Don't know or don't answer	Totals
Universities	86	112	65	12	12		287
Technological institutes	41	33	46	3	4		127
Private schools	20	56	6	1	1		84
Other public schools	25	31	14	5	1		76
Don't know or don't answer	2	6	3	1	1		13
Totals	174	238	134	22	19		587

**Table 1** Contingency table describing the association between the productive sector and the educational institutions

The test statistic calculated from the Chi-square contingency table is shown in equation 1, which allows us to reject or not the null hypothesis of independence between the variables.

$$\chi^2 = \frac{\sum_{i=1}^n \sum_{j=1}^n (n_{ij} - e_{ij})^2}{e_{ij}} \quad (1)$$

With a calculated Chi-Square value equal to 51.1307 greater than the table Chi-Square value  $\chi_{(\alpha, gl)}^2$  with a confidence level  $\alpha=5\%$  and with degrees of freedom  $gl=(r-1)(c-1)=16$  (where r is the number of rows in the table and c is the number of columns) equal to 28.84 for a bilateral test, the null hypothesis of independence is rejected and it is confirmed that there is an association between the variables.

Chi-square	Degrees of Freedom	P-value	Cramer's V
9.7174	1	0.002	0.4323

**Table 2** Chi-Square Test -Higher Education Institutions and Business Sector Line of Business-with a confidence level  $\alpha=5\%$

Since the p-value=0.002 is less than the  $\alpha=5\%$  confidence level, the null hypothesis of independence between the variables can be rejected. A contingency coefficient that helps to establish the degree of association between the variables is defined in equation 2 by means of the Cramer's V coefficient

$$V = \sqrt{\frac{\chi^2/n}{\min(r-1) \text{ o } (c-1)}} \quad (2)$$

Cramer's V coefficient can assume values between 0 and 1 ( $V \in [0,1]$ ), which according to Malhotra (2008), a large value of V only indicates a high degree of association and not the way in which the variables are related, in this sense being equal to 0.4323, it makes clear the existence of a moderate association between the variables, which not being defined in ordinal scale the sense of the relationship cannot be observed.

### Correspondence Factor Analysis (CFA) between Higher Education Institutions and the Productive Sector

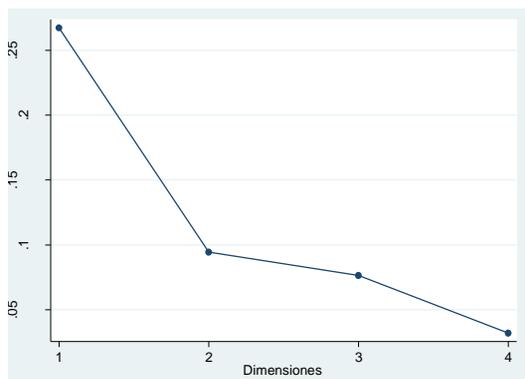
#### Total inertia and contribution of the factorial axes to inertia

$$IT = \frac{\chi^2}{N} \quad (3)$$

Equation 3 measures the contribution to inertia of each of the dimensions or axes, defined as the percentage by which they help to explain the relationship between the row and column variables (Santesmases Mestre, 2001), the numerator of equation 3 is the Chi-Square statistic and the denominator the total number of observations in the sample, so that table 3 and figure 1 show the inertia of each of the calculated axes, which by default are equal to the number of categories of the column variable minus 1.

Axes	Eigenvalues	Inertia	Chi2	(%)	(%) cumulative
1	0.2670298	.0713	41.86	81.86	81.86
2	0.0944449	.0089	5.24	10.24	92.10
3	0.0764661	.0058	3.43	6.71	98.81
4	0.0321453	.0010	0.61	1.19	100.00
Total		.0871	51.13	100	

**Table 3** Characteristics of the factorial axes



Graphic 1 Singular values of dimensions

The contribution of the axes to the explanation of inertia is decreasing given the singular values resulting from the application of the principal component analysis as can be seen in Figure 1 (Santesmases Mestre, 2001). According to Table 3, the first and second axis together contribute 92% of the inertia or association between the variables, with the first axis being the most important contributing 81.86% of the inertia.

**Interdependence between Higher Education Institutions and the Productive Sector**

Table 4 shows the coordinates of each category of the column variable with the axes obtained from the roots and characteristic vectors, as well as their correlation with each of these and the percentage contribution to the inertia of each category.

It is observed that the service and industrial categories are the most important to explain their interrelation with the productive sector, since they are highly correlated with the first dimension and together contribute 95% of the inertia.

	Dimension 1			Dimension 2		
	Coordinate	Correlation	Contribution to inertia	Coordinate	Correlation	Contribution to inertia
Commercial	0.161	0.494	0.029	0.035	0.008	0.004
Services	-0.572	0.988	0.497	-0.080	0.007	0.027
Industrial	0.728	0.964	0.453	-0.202	0.026	0.099
Educational	0.141	0.026	0.003	1.415	0.940	0.794
Don't know	0.392	0.220	0.019	0.470	0.112	0.076

Table 4 Study of the columns by simple CFA

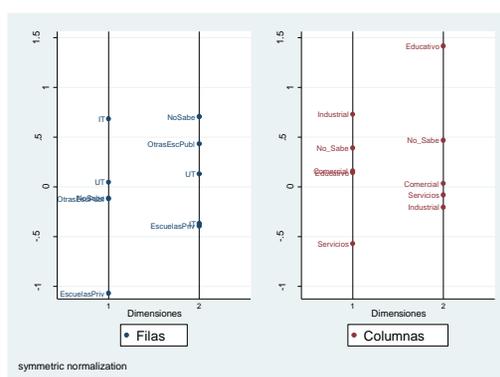
Table 5 shows now in the same way the analysis of the row variable through its coordinates with the axes, its correlation with each one and its contribution to the inertia in each factorial axis.

	Dimension 1			Dimension 2		
	Coordinate	Correlation	Contribution to inertia	Coordinate	Correlation	Contribution to inertia
Technological universities	0.046	0.144	0.004	0.130	0.410	0.087
Technological institutes	0.684	0.904	0.379	-0.366	0.091	0.307
Private schools	-1.066	0.954	0.609	-0.391	0.046	0.232
Other public schools	-0.119	0.084	0.007	0.433	0.394	0.257
Don't know	-0.113	0.019	0.001	0.708	0.264	0.117

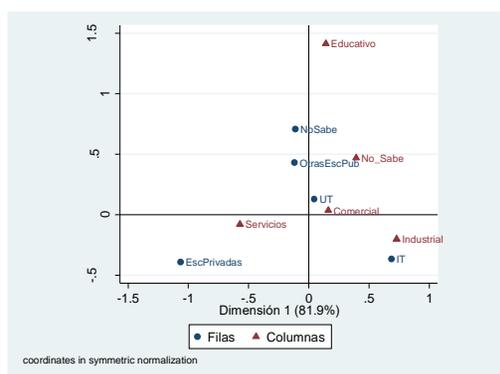
Table 5 Study of the rows by the simple CFA

According to the study of the rows in Table 5, the most important categories are private schools and technological institutes, both contribute 98% of the inertia that explains the first axis and are highly correlated with it.

Graphic 2 shows a graphical representation of the coordinates for each of the categories of the row and column variables in the axes or dimensions of tables 4 and 5, those that appear aligned or at the same height on the same axis show a relationship or dependence, as is the case of technological institutes and industrial companies, technological universities and commercial companies, the service sector and private schools.



Graphic 2 Coordinates of the row and column categories on axes 1 and 2 of the CFA.



Graphic 3 Simple Correspondence Analysis between the Productive Sector and Higher Education Institutions

According to the coordinates of the row and column categories resulting from the correspondence factor analysis, Graph 3 shows an interdependence between technological institutes and industrial companies, private schools and service companies, and finally between technological universities and commercial companies.

**Correspondence Factor Analysis (CFA) between forms of interaction, HEIs and the Productive Sector**

Table 6 shows the categories corresponding to the projects that have been carried out in the companies as a result of the linkage with higher education institutions (HEIs) according to the opinions of the industrial consultants.

Projects	
	Basic or applied research
	Product or service innovation
	Process innovation
	Organizational innovation
	Innovation/marketing
	Other

**Table 6** Definition of the forms of interaction through which HEIs and the Productive Sector are linked

The analysis of the interdependence between the forms of interaction, the educational institutions (HEI) and the commercial line of business of the companies is now carried out on the basis of a contingency table.

IES	Turn					
	Commercial	Service	Industrial	Educational	Don't know or don't answer	
Technological universities	86	112	65	12		12
Technological institutes	41	33	46	3		4
Private schools	20	56	6	1		1
Other public schools	25	31	14	5		1
Don't know about IES	2	6	3	1		1
Basic or applied research	44	57	36	10		6
Product or service innovation	29	57	19	7		5
Process innovation	47	49	34	7		9
Organizational innovation	14	25	16	0		1
Innovation/marketing	14	27	6	1		5
Other forms of interaction	28	26	17	2		2
Do not know the forms of interaction	2	4	4	1		0

**Table 7** Contingency table between the forms of interaction and the commercial line of business

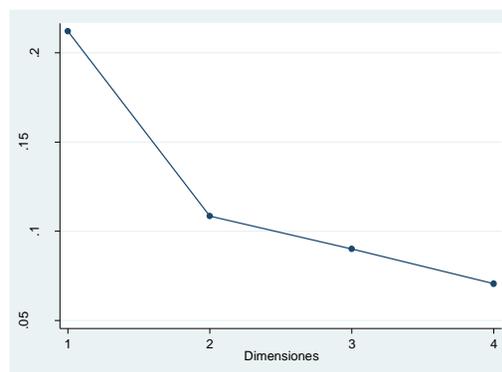
According to the results of the correspondence factor analysis (CFA) performed in STATA 12, the value of the Ji-Square  $\chi^2$  statistic is equal to 83.60 with 44 degrees of freedom and a significance level  $\alpha$  equal to 5%, so the null hypothesis of independence between the three variables can be rejected and is confirmed with a probability value  $p$  equal to 0.0003 and less than  $\alpha$ .

Table 8 shows the contribution to inertia of each of the axes or dimensions, taking into account that their contribution to inertia is decreasing, the first two axes concentrate 81.24%.

Axes	Eigenvalues	Inertia	Chi2	(%)	(%) cumulative
1	0.2119769	0.0449342	53.83	64.39	64.39
2	0.108413	0.0117534	14.08	16.84	81.24
3	0.0900949	0.0081171	9.72	11.63	92.87
4	0.0705482	0.0049771	5.96	7.13	100.00
Total		0.069781	83.60	100	

**Table 8** Characteristics of the factorial axes

The eigenvalues resulting from applying the principal components method to the contingency table can be visually represented by means of graph 4, where it can be observed that the contribution to the inertia of the axes is decreasing, as well as in these eigenvalues.



**Graphic 4** Singular values of dimensions

Analysis of the interdependence between forms of interaction, HEIs and the business line of the companies.

	Dimension 1			Dimension 2		
	Coordinate	Correlation	Contribution to inertia	Coordinate	Correlation	Contribution to inertia
Commercial	0.177	0.371	0.044	0.005	0.000	0.000
Services	-0.510	0.965	0.495	-0.109	0.022	0.044
Industrial	0.661	0.905	0.458	-0.203	0.044	0.084
Educational	0.136	0.015	0.003	1.076	0.551	0.445
Don't Know	0.035	0.001	0.000	1.085	0.544	0.426

**Table 9** Study of the simple CFA columns

	Dimension 1			Dimension 2		
	Coordinate	Correlation	Contribution to inertia	Coordinate	Correlation	Contribution to inertia
Technological universities	0.050	0.680	0.003	0.032	0.137	0.002
Technological institutes	0.794	0.882	0.316	-0.374	0.100	0.137
Private schools	-1.173	0.896	0.455	-0.555	0.103	0.199
Other public schools	-0.090	0.041	0.002	0.045	0.005	0.001
Don't know about IES	-0.203	0.062	0.002	0.645	0.319	0.042
Basic or applied research	0.124	0.196	0.009	0.240	0.375	0.068
Product or service innovation	-0.415	0.748	0.079	0.240	0.137	0.052
Process innovation	0.227	0.387	0.030	0.335	0.430	0.126
Organizational innovation	0.030	0.002	0.000	-0.793	0.823	0.271
Innovation/marketing	-0.625	0.475	0.081	0.420	0.110	0.072
Other forms of interaction	0.206	0.231	0.013	0.420	0.139	0.029
Do not know the forms of interaction	0.466	0.197	0.009	-0.135	0.008	0.002

**Table 10** Study of the rows of the simple CFA

From the study of the columns in Table 9, the commercial services and industrial sectors are identified as those productive sectors that contribute in a greater proportion to the interdependence between the forms of interaction that higher education institutions and the productive sector have carried out by contributing 95% of the inertia. Next in order of importance are the commercial and educational sectors. The CFA makes it possible to reduce the dimensionality of the categorical variables in the most important ones that account for the highest percentage of inertia.



**Conclusions**

Undoubtedly, this is a topic that allows us to reflect on two dimensions, the link between the productive sector and the HEIs and the forms of interaction in which it occurs, thus identifying the degree of impact it has on the company, in addition to visualizing that according to the type of company and the type of HEI is the elaboration of proposals to be developed, generating tendencies towards proposals that according to the type of company and the participation of the institution impact the level reached, as was observed in Table 7.

As for the realization of applied projects with the productive sector, it was diminished due to the sanitary regulations, the non-permissibility regarding the number of people who perform activities within the company, causing that the companies did not accept students for the realization of their practical training, social service and internships.

As a consequence, strategies were sought in which the students who were left without the opportunity to carry out their internships, carried out projects in accordance with the lines of research of the Business Development educational program, thus increasing research projects in the service sector with a focus on marketing innovation, considering that the greatest demand of the projects requested by the productive sector are focused on marketing innovation as well as product or service innovation.

**Acknowledgement**

We are grateful to the Universidad Tecnológica del Centro de Veracruz for conducting the research, to the students who applied the surveys during their stays, as well as to the businessmen who participated in providing the information.

**References**

Gujarati, N., & Porter, D. (2010). *Econometría*. McGrawHill.

Lizasoain, L., & Joaristi, L. (2012). Las nuevas tecnologías y la investigación educativa. El análisis de datos de variables categóricas. *Revista española de pedagogía.*, 111-129.

Malhotra N. (2008). *Investigación de Mercados*. Pearson Educación.

Mosquera, A. B. (2011). La educación y su efecto en la formación del capital humano y en el desarrollo económico de los países. *Apuntes del CENES*, 45 - 59.

Ochoa S., & Wendlandt A. (2016). Expectativas de las Microempresas en México. Dirección General de Difusión y Vinculación de la Universidad Autónoma de Aguascalientes.

Santesmases M. (2001). *Diseño y Análisis de Encuestas en Investigación Social y de Mercados*. Pirámide.

Schmelkes S. (2020). La educación superior ante la pandemia de la COVID-19: el caso de México. *DOSSIER*, 74-87. doi:<https://doi.org/10.36888/udual.universidade.s.2020.86.407>

SEP. (2010). *Instituciones Públicas de Educación Superior*. Miguel Angel Porrúa.