

Statistical representation of university management as a means for sustainable development in connection with the productive sector

Representación estadística de la gestión universitaria como medio para el desarrollo sustentable en vinculación con el sector productivo

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Abstract

Resumen

Statistical representation of university management as a means for sustainable development in connection with the productive sector.

Representación estadística de la gestión universitaria como medio para el Desarrollo sustentable en vinculación con el sector productivo.

Objectives	Methodology	Contributions
The objective of this study is the use of statistical tools that estimate the effects of the link made by the HEIs with the productive sector, on the impact on sustainable development.	methodological process 	With the analysis of results it allowed the argument of scenarios Knowledge of AST industrial advisors and competency model. Lack of knowledge of the AST industrial advisors and the competency model

Objetivos	Metodología	Contribuciones
El presente estudio tiene como objetivo la utilización de herramientas estadísticas que estimen los efectos de la vinculación realizada por las IES con el sector productivo, en el impacto para el Desarrollo sustentable.	Proceso metodológico 	Con el análisis de resultados permitió el argumento de escenarios Conocimiento de los asesores industriales del AST y modelo por competencias. Desconocimiento de los asesores industriales del AST y modelo por competencias

Sustainability, MSMEs, Linkage, AST, Logit model

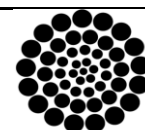
Sustentabilidad, MIPyME's, Vinculación, AST, Modelo Logit

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Introduction

Organisations are constituted with a specific purpose or aim, however, in their productive action, collaborative work has been perceived in isolation, so that the lack of knowledge in the forms of interaction with Higher Education Institutions (HEIs) with MSMEs, limit, based on their advantages and particular characteristics, the generation of a proposal that provides them with the basis for proper management in their processes and linkage with HEIs, Therefore, the academy should consider strengthening through a model that allows HEIs to generate interaction and participation in AST for the strengthening of academic activities as well as help in the management of MSMEs' processes.

Similarly, it is based on the General Law of Higher Education (2021), which establishes the coordination, promotion, linkage, social participation, evaluation and continuous improvement of higher education in the country, being part of the analysis the intervention of the Government for the linkage of HEIs with the productive sector.

The research is in the process of generating strategies for the design of the proposal of the Linkage Model, having as background the tests carried out with the industrial advisors during the periods 2016 and 2017, in such a way that with both theoretical and statistical elements, support the hypothesis and with it the generation of the model, for this the proposal of the triple helix model is taken up, in which the actions to be carried out by each of the subjects involved in the linkage are evaluated, according to Figure 1.

Considering the Triple Helix model supported by Etzkowitz, H., & Leydesdorff, L. (1997), cited by Antonio & Treviño (2018) in the trilateral analysis and its linkage to meet social, academic and political needs, which allows for this study the adoption of the sustainability approach as a construct in the linkage and the perception of the productive sector for its participation in the AST and its impact on the training of graduates when considered in the curriculum design, the above is supported by statistical representation.

Box 1

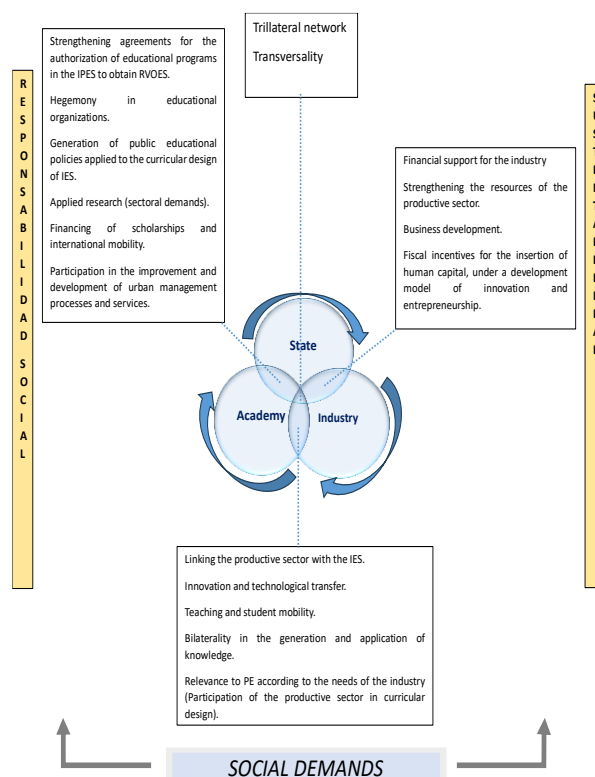


Figure 1

Triple Helix Model

Source: Antonio & Treviño (2018), Based On Etzkowitz, H., & Leydesdorff, L. (1997).

Literature Review

There are organizational models, which according to the needs of the company, it is necessary to use and can be modified, considering for its adaptation to its own system.

The knowledge that its staff brings, as well as key elements that allow a successful implementation, in this regard Velasquez C. (2005), considers the situational analysis, intervention and organizational learning, which establishes a dynamic of organizational change, considering learning as one of the factors.

This is why micro and macro environmental phenomena influence and demand changes in already existing systems, models or processes, so that the participation of different disciplines is necessary to promote an articulation of knowledge that allows the generation of complex models.

García (2000) establishes how models of enormous heuristic utility can be generated for the description and simulation of the relationship between micro social and macro social processes, applying his study to the interaction of MSMEs with HEIs through the use of statistical tools.

A sustainable model focuses on the objective of satisfying the needs of the present generation without compromising the ability of future generations to compensate for their own needs.

Bernal (2010) indicates that individuals, organizations and nations that do not invest in education and research will be left behind, dependent and marginalized, and education will cease to fulfill its social mission.

Society requires research professionals to solve the problems that arise in the interconnected and digital world, to work collaboratively and to take care of our environment (Osorio, 2022).

In the conceptualization of AST, Hanel del Valle (2004), states that it is a method that leads to the application of the most appropriate procedure to analyze the situation of an organization, either to identify a problem, risk or area for improvement, (González, 2016) states that a Situational Analysis of Work consists of conducting a workshop with academics, entrepreneurs and experts to determine the competencies, knowledge and attitudes that a professional must possess to perform successfully in the labor field and for the purposes of this article its scope will be in the interaction of MSME's with academia, CGUT (2017), establishes that to initiate the design and curriculum development by professional competencies, the AST is applied, to the productive sector with which the Technological Universities are linked.

Technological Universities, as part of their competency-based model, assume the importance of training students and promoting interaction with companies, depending on the line of business and size, they consider as a strategy the practical schools and internships according to each educational program, having the first approach with the participation for the development of the AST.

Nuñez (2011), considers that there must be a mutual collaboration between the company and the academy, favoring the satisfaction of the needs of both.

According to Escalante (2020) who cites Sarabia (2016) and García et al., (2017) consider that collaboration between universities and companies benefit the development of countries, the exchange of knowledge favoring the generation of technologies and innovations that favor both parties and society.

In this regard Yáñez (2015) mentions that macro and micro environmental aspects should be considered for the Situational Analysis of the company in his argument focuses on decision making and application to adapt the factors in your organization, in a very general way, likewise they consider the key element: Human capital as part of the analysis to be part of the company. Likewise, Cañas (1999) argues the need to use technologies to build knowledge, intertwining map design with technology.

For students as Reyes (2016), a cognitive structure must be generated in the concepts to be used, since only from this will not be found arbitrary relationships with the new concepts. Therefore, in the AST design, it is aided by areas such as administration, pedagogy, computer science and statistics, developing a brainstorming to subsequently develop the feasibility analysis, with the help of matrices to form each element or construct that covers not only knowledge but also skills, abilities, skills, attitudes and aptitudes, as Ortiz, et al. (2015) considers the use of tools such as portfolios that show the skills of a person, being useful for the collection of information in the development of the AST.

With respect to the Higher University Technician (TSU), it is integrated to the Technological University system in Mexico since its opening in 1991, by filling an existing gap in the industrial and service sector with middle management that involves operational processes with aspects of its training 70% practical and 30% theoretical, besides being consistent in being, knowing and knowing how to do, integrating to ICT enables to be a versatile, dynamic professional who responds to the needs of the environment, by developing sustainable schemes implies consistency in the formation of competencies and using resources efficiently.

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This involves redefining the teaching-learning processes, as well as global perspectives to promote changes in future professionals and the application of knowledge in an environment of innovative transformation (Martínez, 2023).

The paradigm of sustainable development must become an unavoidable guideline for technological development, not to prevent or discourage it, but to accompany it, setting quality standards (Ferrer et al., 2023).

In the technological aspect, Tamayo (2022) comments that social networks have been a platform for sharing links and have motivated higher education institutions to implement networking and monitoring strategies in institutional communication due to the ease of reaching an infinite audience.

In addition, García-Arce et al. (2021) mentions that Higher Education Institutions (HEI) have a fundamental role as forgers of human beings committed to the environment, and interested in improving their quality of life, through the precepts of sustainability.

Methodology

It is of utmost importance that a company that provides a service must think customer-oriented if it wants to ensure its success.

That is why the purpose of this work is to obtain direct information from industrial consultants regarding ASTs and to analyze such information with basic and multivariate statistical techniques that allow identifying possible relationships between non-metric variables through the application of logistic regression. The challenge is focused on establishing strategies through which industrial advisors and ASTs are more efficient for the benefit of students considering the new demands of digital environments and their application in the generation of sustainable projects.

Logistic regression is a special form of regression in which the dependent variable is a dichotomous (binary) non-metric variable, also known as logit analysis Hair Joseph & Anderson Rolph (1999), where qualitative variable models are used.

This variable will reflect the choice made by an individual, which in this case will be each industrial consultant, according to a series of explanatory variables, hence it can be said that this type of model seeks to analyze, as far as possible, the answers given by each specific individual.

The dependent variable is dichotomous and will therefore follow a binomial probability distribution and its variance will not be constant. As a consequence, the regression errors will also be distributed as a binomial (not normally) and heteroscedasticity will be present, so logistic regression was developed as an alternative to linear regression applicable to these circumstances. For the purposes of this research, a quantitative research was applied, STATA 12 software was used as technological resources, and 465 surveys were applied in the different states to industrial advisors, who are the representatives of each company of the productive sector (MSME's) in which stays of UTCV's educational programs were carried out, performing 1 pilot test and after that the survey to be applied in its final version 2017 was validated, considering the variables of linkage, productive sector, IES, AST and public policies.

Results

For the analysis of the results, applying statistical analysis, each one is presented with the corresponding support: Specification of the Logistic Regression Model: According to the association results of the survey of Industrial Advisors, the following logistic regression model was found

$$P_i = (Y_i = 1 | X_1, X_2, X_3, X_4) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4)}} \quad (1)$$

The model explains the probability that a person: Where $Y_i = anasit$: es the binary response variable that assumes the following values:

$$Y_i = \begin{cases} 1 = \text{If the industrial consultant has heard of the situational analysis of the job;} \\ 0 = \text{If the industrial consultant has not heard of the situational analysis of the job.} \end{cases}$$

The following are the set of independent variables that explain the likelihood that the company where the student stays is aware of the situational analysis of the job

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Article

$X_1 = Buy$: is a binary variable that assumes the following values:

$$X_1 = \begin{cases} 1 = \text{If the industrial advisor is aware of the educational programs offered by UTCV;} \\ 0 = \text{If the industrial consultant does not know them.} \end{cases}$$

$X_2 = modcomp$: is a nominal binary variable that assumes the following values:

$$X_2 = \begin{cases} 1 = \text{Whether the industrial consultant is familiar with the competency-based educational model;} \\ 0 = \text{If the industrial consultant does not know} \end{cases}$$

$X_3 = caroies$: is a polychotomous variable on an ordinal scale that answers the question: How expensive is it for the company to collaborate with the Institute of Higher Education?

$$X_3 = \begin{cases} 5 = \text{Strongly agree;} \\ 4 = \text{Agree;} \\ 3 = \text{Disagree;} \\ 2 = \text{Indifferent;} \\ 1 = \text{Don't know.} \end{cases}$$

$X_4 = polpub$: is an ordinal scale polychotomous variable that describes the industrial consultant's perception of whether public policies should be generated to propose mechanisms and tools to ensure pertinence, relevance, efficiency and equity..

$$X_4 = \begin{cases} 5 = \text{Strongly agree;} \\ 4 = \text{Agree;} \\ 3 = \text{Disagree;} \\ 2 = \text{Indifferent;} \\ 1 = \text{Don't know.} \end{cases}$$

Non-parametric tests of association between the response variable and the independent variables, as part of the process for choosing the variables and specifying the model.

The following table shows the results of applying the Chi-square test of the response variable with each of the independent variables, as well as the value of the contingency coefficient to observe the degree of association between the variables.

Results of association of the response variable anasit and the nominal independent variables.

Box 1**Table 1**

Results of association of the anasit response variable and the nominal independent variables

	Chi-square	Degrees of freedom	P-value $\alpha=5\%$	H0: Independence	Cramer's V contingency coefficient
Buy	17.116	1	0	Rejected	0.1919
Modco mp	23.783	1	0	Rejected	0.2262
Caroies	13.917	4	0.008	Rejected	0.173
Polpub	11.667	4	0.02	Rejected	0.1584

According to Table 1, the following statements can be deduced: There is statistically significant evidence according to the Chi-Square test what; the knowledge that industrial advisors have about job situational analysis -whether they have heard of the topic or not- is associated with the knowledge that advisors have about the educational programs offered by UTCV along with whether they know something about the competency-based educational model or if they know about it;

On the other hand, industrial advisors' knowledge about job situational analysis is also associated with industrial advisors' perception of how expensive it is for the company to collaborate with a higher education institution, as well as the latter's perception of whether public policies should be generated to propose mechanisms and tools to ensure pertinence, relevance, efficiency and equity. According to Cramer's V contingency coefficient, the variables are in a weak degree of association as both are close to 0.2, however, this does not prevent the variables from being associated as the tests show, in the case of caroies and polpub the association is even lower. The following image shows the results of the logistic regression model obtained in STATA 12.

Box 2**Table 2**

Results of the model in STATA12

Logistic regression		Number of obs=465				
Log likelihood=-235.80236		LR chi2(4)=48.60				
		Prob > chi2=0.0000				
		Pseudo R2=0.0934				
	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
anasist						
Buy	0.7255	0.22903	3.17	0.002	0.27657	1.174339
modcomp	0.9899	0.2611	3.79	0.000	0.4782	1.501676
caroies	0.3604	0.14802	2.44	0.015	0.07034	0.6505519
polpub	0.3774	0.1632	2.31	0.021	0.05756	0.6972862
_cons	-4.7586	0.85238	0.02	0.000	-6.4291	-3.088031

As can be seen in Table 2, the overall significance test from the Chi-Square test is significant, with a p-value equal to 0.000, which implies that the set of independent variables does exert a simultaneous overall effect on the response variable. According to the signs of the coefficients, each of the variables is positively associated with the probability that the assessor has knowledge about the situational analysis of the job, so the model is specified as follows:

$$P_i = (Y_i = 1 | X_1, X_2, X_3, X_4) = \frac{1}{1 + e^{-(-4.7585 + 0.7254X_1 + 0.9899X_2 + 0.3604X_3 + 0.3774X_4)}} \quad (2)$$

The greater the industrial counselors' knowledge about the educational programs offered by UTCV, the greater the probability that the industrial counselor knows about situational analysis;

If the advisor knows about the competency-based educational model, the higher the probability that he/she knows about situational analysis of the job.

The higher the perception of how expensive it is for the company to collaborate with a higher education institute, the more likely it is that he/she knows about job analysis;

The greater the perception of the industrial consultant about whether public policies should be generated to propose mechanisms and tools to ensure pertinence, relevance, efficiency and equity, the greater the probability that he/she will have knowledge about situational job analysis.

Box 3

Table 3

Results of the Wald test for individual significance

	Chi-cuadrado	Degrees of freedom	P-value $\alpha=5\%$	H0: Independence
<i>compro</i>	10.03	1	0.0015	Rejected
<i>modcomp</i>	14.38	1	0.0001	Rejected
<i>caroies</i>	5.93	1	0.0149	Rejected
<i>polpub</i>	5.35	1	0.0207	Rejected

According to the Wald tests of individual significance, all variables exert a partial and positive effect on the probability of response, as shown in Table 3.

Box 4

Table 4

Marginal Effects - Scenario 1-scenario 1-

Marginal effects after logit $y = \text{Pr}(\text{anasit})$ (predict) $= 0.65614998$							
Variable	dy/dx	Std. Err.	z	P> z	[95 %]	C.I.	X
<i>Buy*</i>	0.175957	0.05539	3.18	0.001	0.067	0.285	1
<i>modcomp*</i>	0.241252	0.06292	3.83	0.000	0.118	0.365	1
<i>caroies</i>	0.081323	0.02554	3.18	0.001	0.031	0.131	5
<i>polpub</i>	0.085153	0.03583	2.38	0.017	0.015	0.155	5

Table 4 shows the results of carrying out the calculation of the probability that an industrial advisor knows about job situational analysis when:

The industrial assessor knows about the curricula offered by UTCV;

The industrial assessor knows about competency-based educational programs;

The advisor is of the opinion that it is too expensive to collaborate with an institute of higher education and;

When the advisor fully agrees that public policies should be generated to propose mechanisms and tools to ensure pertinence, relevance, efficiency and equity.

According to the pre-established conditions the probability is approximately equal to 0.7, which can be considered as a very favorable probability.

According to the values resulting from the partial derivatives of the model, the variable that has the greatest impact on the probability of response is: if the industrial consultant knows the competency-based education model, this increases the probability by almost 24%.

Discussion

The General Coordination of Technological Universities regulates the use of the AST as an instrument to determine the elements that, according to the competency-based model, contribute to the curricular design of the proposed educational program, in addition to generating, by its nature, the interaction between HEIs and companies.

However, with the statistical analysis, it was shown that for synergy to exist, both in the company and in the IES, the industrial advisor must have knowledge of the competency-based model and the AST. Therefore, it will be important to establish communication channels to generate actions for the participation of subjects that strengthen the Situational Analysis of Work and relevance in educational programs.

In this regard Bautista (2014) emphasizes the quadruple helix with the additional participation of the social sector to strengthen the linkage, although more subjects are being considered to promote the interrelationship, the ideal is to work with the communication channels that allow to generate and strengthen according to the role of the participants and how they could intervene for the design of the curriculum considering their own strengths.

Although the use of AST does not consider relevant aspects such as the knowledge of the participants in the competency-based model, as well as its applicability in the particular higher education institutions, it does have an impact on the contributions that are particularly limited to the knowledge, however, the participation of the productive sector in coordination with the authorities is necessary for the HEIs to carry out their processes in order to obtain the requirements for the official recognition and validity of their study programs, being a problem for the HEIs the assistance and participation in the elaboration of the AST's, due to the process involved in their development.

The use of statistical tools has been used as a means for the generation of models that allow the optimization of resources, quality, processes and decision making, however, in the interaction of research, academia, government and the productive sector as a whole, there is a lack of statistical models that strengthen their processes in this interaction. It is worth mentioning that AST focuses on human "capital", being the future graduate who at the end of his studies will achieve the objective of his educational program according to its curricular design and the discourse given by Pariente (2010), in which he alludes not only to the participation of the teacher as a key piece in the construction of a hidden curriculum, but also to the educational situation in Mexico and the participation of the Government in the generation of public policies.

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However, there is a gap in the interaction of the productive sector with Higher Education Institutions, as well as of tools and processes that help in strengthening the academic activities to be developed between both subjects, because although, according to Taípe (2015) establishes the elements to consider for a situational analysis of the company, they are not applied from a situational view of work and its application for the curricular design of educational plans and programs.

Conclusions

It was determined that through the use of statistical methods, in addition to the validation tests used in the survey, there is a correlation not only in the interaction of industrial consultants, but also in the knowledge of the competency model, the participation in the AST of MSMEs and the need to create public policies that allow interaction between the two.

In the results of the survey applied, it is perceived that the industrial consultants, not knowing the educational programs that the Educational Institution has, break with the interaction because there is no motivation of the company to generate a link with the academy, therefore, there is no participation in the AST, but it does consider necessary the intervention of the government to generate the linkage.

Therefore, by statistically testing all the elements that affect both external and internal, this allows strengthening the AST Model in such a way that the interaction of subject variables is demonstrated in the validation of the items and the probabilities that are favorable for the generation of the proposal.

Finally, actions will be developed to strengthen the Situational Analysis of Work, not only for the creation of educational programs and feasibility studies, but also to consider the phenomena that have repercussions for its pertinence and relevance in the decision making of organizations, as well as in the sustainable strategies that higher education institutions work with academic projects in conjunction with companies to comply with regulations that must be respected in the care of the environment, generation of sustainable projects, innovation and jointly achieve sustainable development in its different dimensions.

Declarations

Conflict of interest

The authors declare that they have no conflict of interest. Neither have any financial interest, nor personal relationships that could have seemed to influence the development of this article.

Authors' contributions

Hernández-Peralta, Alejandro De Jesús: Methodology, analysis of results, and discussions.

Antonio-Vidaña, Paula Rosalinda: Title of the article, context, state of the art, methodology, analysis, development, conclusions, references, final review for acceptance.

Alcudia-Chagala, Lorena: Participated in the development of the state of the art, technological support and video for the virtual paper.

Rojas-Patiño, Nancy: Participated in the development of the state of the art, analysis of results and references.

Availability of data and materials

Files are shared in an attached folder for review.

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Abbreviations

HEI (Higher Education Institutions).

AST (Situational Analysis of Work)

MSME's (Micro, small and medium-sized enterprises).

CGUT (General Coordination of Technological Universities).

UTCV (Universidad Tecnológica del Centro de Veracruz).

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