SOCIOECONOMIC IMPACTS OF UNIVERSITY-INDUSTRY COLLABORATIONS: SCALE DEVELOPMENT AND PRETEST

ABSTRACT

University-industry collaborations result in generation of significant socioeconomic impact. Although these collaborations are recognized as drivers of socioeconomic development, there is a lack of metrics for assessing these impacts. Considering this gap, this study developed a scale to measure the socioeconomic impacts of university-company collaborations according to the companies' perspective. From a theoretical standpoint, this work contributes to the structuring of a measure model to evaluate the socioeconomic impacts of university - industry collaborations. The findings also have managerial implications enabling improvement, planning and performing of necessary actions to generate greater socioeconomic impacts from university-industry collaborations.

INTRODUCTION

To survive in a dynamic, global context, firms must constantly adapt and evolve. Firms drive markets by exploiting and strategically managing knowledge, despite the constant change. Universities are critical within the science and technology ecosystem as an inexhaustible source of information and technological capabilities, given the growing awareness of knowledge as a possible source of competitive advantage (Berbegal-Mirabent *et al.*, 2015).

Academics and policymakers have recognized universities as potential drivers of regional economic growth (Fischer *et al*., 2018). The acknowledgement of universities as proactive entrepreneurial institutions was marked by the triple helix model (Budyldina, 2018).

The triple helix depicts a new configuration of institutional forces in innovation systems, as well as an interactive (non-linear) model of innovation and a trilateral adjustment of collaboration between academics, government, and business that contrasts the traditional concept in which firms alone are responsible for economic production, universities are solely responsible for knowledge generation and transmission, and the government serves as a facilitator, regulator, and co-investor. The triple helix model

acknowledged that the demarcation lines of between the three institutions became less clear (Etzkowitz, 2008).

The entrepreneurial university attempts to stimulate socioeconomic development by promoting the transfer of academic knowledge to firms (Etzkowitz, 2008). The university has gained reputation as a potential resource for enhancing innovation and establishing a science-based economic development environment. Entrepreneurial activities are conducted with the goal of enhancing regional or national economic performance and producing revenue for the university and its faculty (Etzkowitz *et al*., 2000).

The growth of entrepreneurial activity at higher education institutions is largely due to an underlying need for economic development as well as a greater focus on social responsibility. Higher education institutions have a critical role in developing human resource capacity and efficiency (Alessandrini *et al.*, 2013).

Academic entrepreneurship operates within the limitations of various scientific and professional contexts in the economy knowledge, requiring the need for supportive help to overcome these limitations. The entrepreneurial university is deemed as a key accelerator for regional economic and social growth, because it develops and investigates knowledge as entrepreneurial potential (Urbano and Guerrero, 2013). In the face of the old trinity of land, labor, and capital (traditional sources of richness), science has arisen as an alternative engine of economic expansion. Scientists and engineers became founders of new enterprises, and science and technology became a more important element of capital (Etzkowitz, 2013).

Although the university and its collaborations with the industry are recognized for promoting socioeconomic development, several authors point out the need to create metrics to assess the socioeconomic impact of these collaborations.

An increasingly important global goal is a university that develops and translates knowledge and discovery into social and economic progress. However, the most widely used measures were created when research and teaching were the main academic goals. (Etzkowitz *et al*., 2018).

According to Etzkowitz *et al*. (2018) despite the growing interest in finding solutions to help academics promote entrepreneurial behavior and practices, universities lack precise information and tools to track and evaluate overall entrepreneurial performance and processes.

It is commonly acknowledged that existing technology transfer output statistics are not only inadequately defined, but also fail to account for the national impact of technology transfer personnel's efforts. Instead of focusing solely on metrics such as the number of registered patents and revenue from license agreements, the efficacy of the technology transfer function could be measured in terms of social impact on communities, job creation and poverty reduction, all of which can be translated into long-term financial benefits for the country (Alessandrini *et al.*, 2013).

Academic entrepreneurship requires a comprehensive assessment that goes beyond specific criteria like financial returns on an intellectual property portfolio or individual performance, it must be taken into account broader social and economic benefits such as knowledge dissemination, production of intangible assets behind new venture process, and the contribution to employment for social, cultural, and economic reasons (Etzkowitz *et al*., 2018).

Consequently, in this work, a scale was developed to measure the socioeconomic impact of university-industry collaborations on the business perspective. This article is part of a doctoral research in the area of innovation and technology management on the socioeconomic impacts of university-industry collaborations. The doctoral research was divided into 3 articles, the first one is the systematic bibliographic review and construction of the conceptual model (Lima *et al*., 2021), the second is the article on the development of the scale (this study), and the third article that will be about data analysis with (a) statistical software to evaluate and simplify the model created (the next step).

The article is structured as (it) follows: the second section presents the literature review, the third section describes the research method (and) the fourth section refers to results, with the research development followed by conclusions, recommendations and future researches possibilities in last section.

LITERATURE REVIEW

For the construction of the theoretical model that served as a basis for the development of the scale, a systematic review of the literature was carried out with 94 scientific articles. The steps of the systematic literature review are described in detail in Lima *et al*. (2021). In this topic the results of the literature review and the model created will be presented.

The socioeconomic impacts of university-industry collaborations found in the literature were categorized into (1) economic, (2) social and (3) financial. The dimensions were divided into (1) economic: infrastructure, production and processes, and scientific development; (2) social: jobs, skills, and qualification; and (3) financial: purchases, taxes, investments, and income generation (Lima *et al*., 2021). Figure 1 presents the model developed for measuring the economic impact of university–industry collaborations.

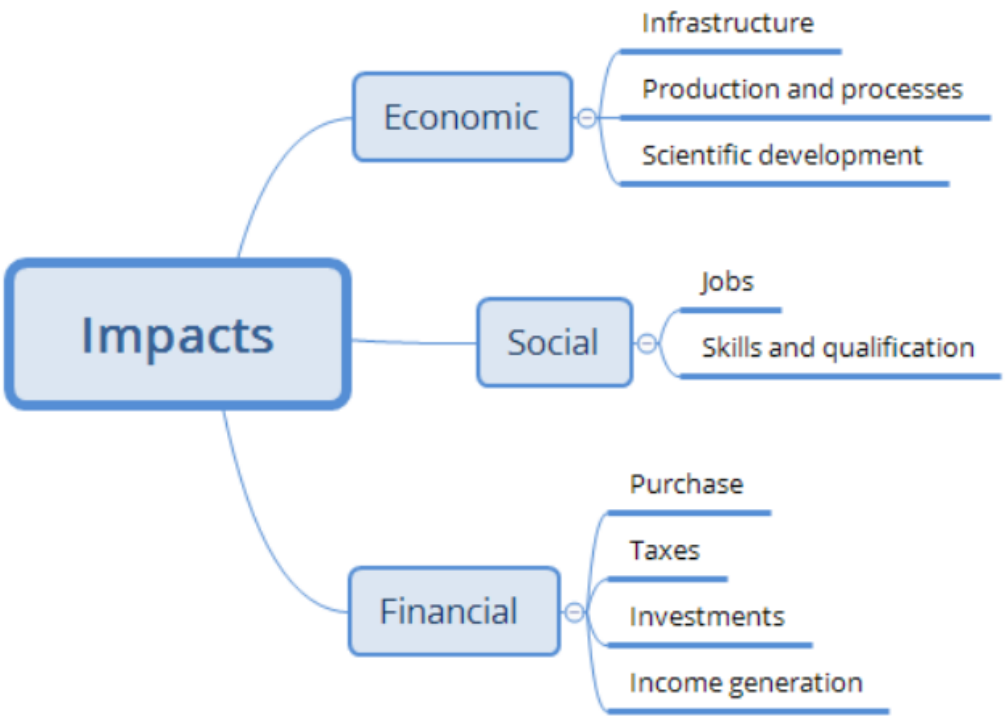

Figure 1. Evaluation model for the socioeconomic impact of university–industry collaborations

Source: Lima *et al.* (2021)

Based on the key benefits from the actors in the triple helix, we developed a conceptual model of socioeconomic impact of the university-industry collaborations. The institutional realms are put into perspective using the triple helix paradigm. Understanding the most significant consequences and the stakeholders who benefit from them contributes to the discussion between constituents and allows for the development of policies aimed

at improving socioeconomic impacts based on interests and objectives (Lima *et al.*, 2021). Figure 2 illustrates the Socioeconomic Triple Helix Conceptual Model.

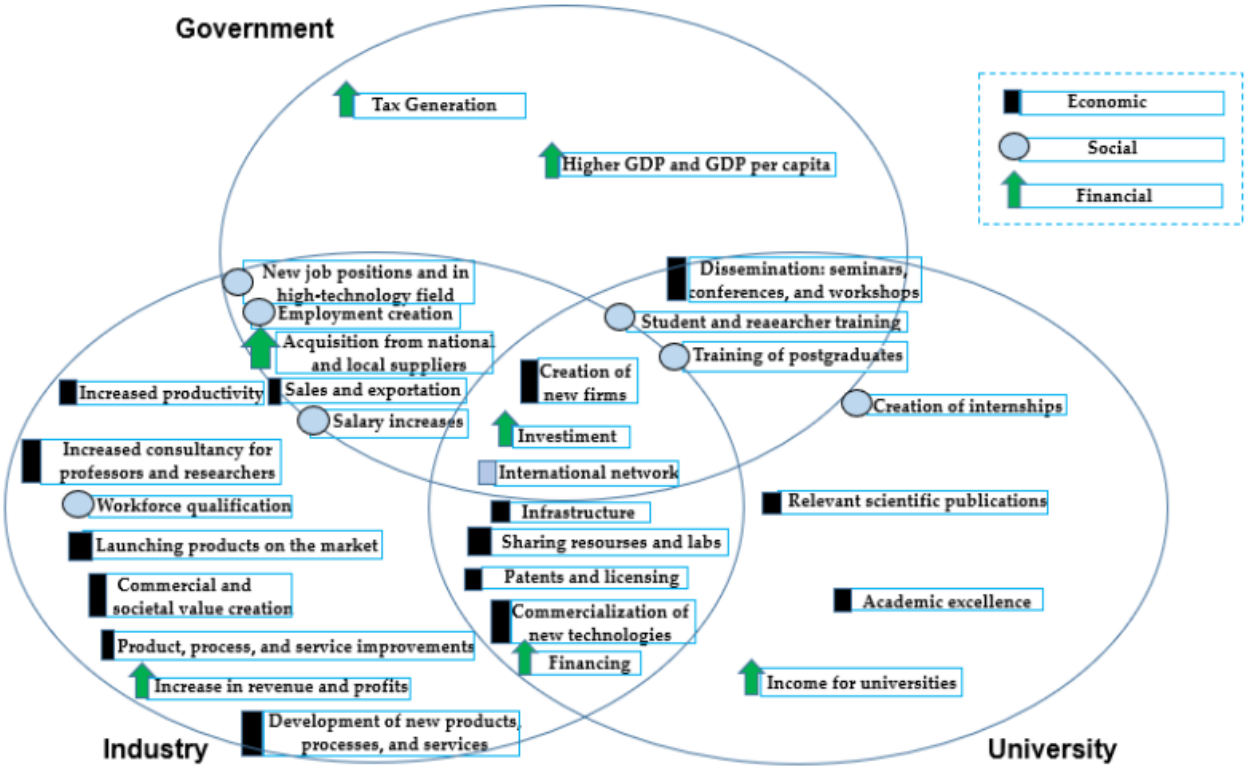

Figure 2. Socioeconomic Triple Helix

Source: Lima *et al.* (2021)

As the objective of this study being to develop a scale to assess the socioeconomic impacts of university-industry collaborations on the perspective of companies, a model was cut accordingly to the research's area of interest.

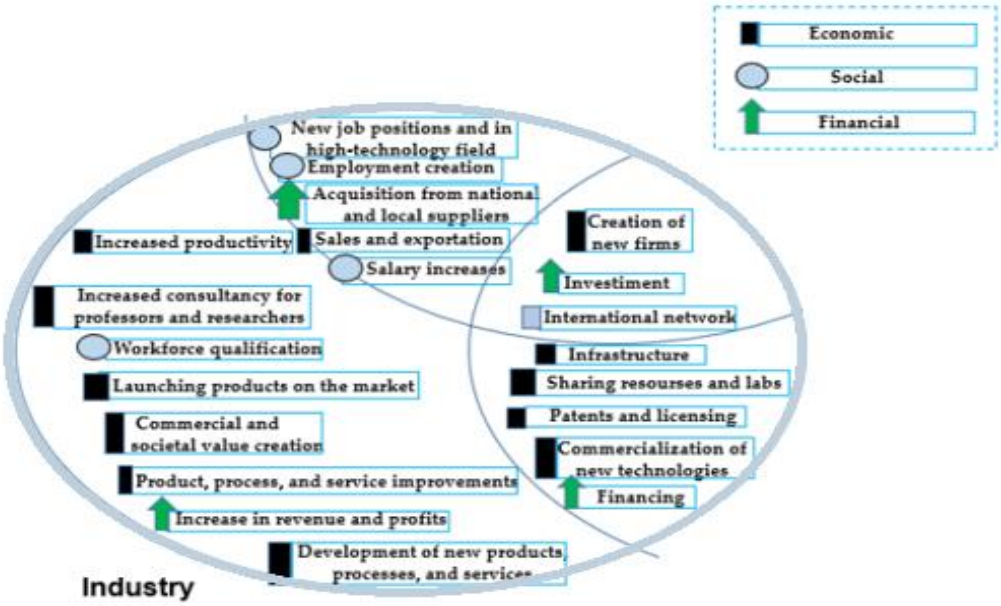

Figure 3. Socioeconomic Impacts to Industry

Source: Based in Lima *et al.* (2021)

For the scale development, the guidelines of DeVellis (2017) were followed.

RESEARCH METHOD

In a wide variety of social science contexts, measurement is very important (DeVellis, 2017).

When we try to quantify processes that we think it exists based on our scientific view of the universe but can't determine it directly, we develop scales. Scales are measurement instruments that consist of a series of items combined into a composite score and are used to reveal levels of theoretical variables that are not easily measurable by direct means (DeVellis, 2017).

The scale has been developed according to the recommended procedures and steps by DeVellis (2017): (1) determine clearly what is it that you want to measure and generate an item pool; (2) determine the format for measurement and have the initial item pool reviewed by experts; (3) consider the inclusion of validation items and administer items to a development sample; and (4) evaluate the items and optimize scale length.

Determine clearly what it is you want to measure and generate an item pool

Authors like DeVellis (2017) claim that the initial poll must be greater than the final scale.

Write items that are logically related to the survey purpose, use multiple items to tap into a construct, but avoid repetition of items and items that crossover to a related construct, write items to be concrete and precise, and keep them objective (Jonhson and Morgan, 2016).

Determine the format for measurement and have (the) initial item pool reviewed by experts

There are several different types of question formats. Early on in the study process, the researcher should understand the format. This move should take place at the same time as item creation to ensure that the two are compatible (DeVellis, 2017).

According to DeVellis (2017) identification of the target stimulus is followed by a list of adjective pairs. Each pair represents opposite ends of a continuum, defined by adjectives (e.g., disagree and totally agree). In essence, the individual lines represent points along the continuum defined by the adjectives. The respondent places a mark on one of the lines to indicate the point along the continuum that characterizes his or her evaluation of the stimulus.

In addition, you might invite your experts to comment on individual items as they see fit. This makes their job a bit more difficult but can yield excellent information. A few insightful comments about why certain items are ambiguous, for example, might give you a new perspective on how you have tried to measure the construct previously. (DeVellis, 2017).

Consider inclusion of validation items and administer items to a development sample

Many of the issues associated with shift score unreliability are avoided by using the initial state as a control variable (DeVellis, 2017).

It may be feasible and practical to include some additional items in the same questionnaire that will aid in assessing the final scale's validity (DeVellis, 2017).

Evaluate the items and optimize scale length

According to DeVellis (2017) The ultimate quality we look for in a product is a high correlation with the latent variable's true score. The higher the correlations between items, the higher the reliabilities of individual items (i.e., the more intimately they are related to the true score).

The more reliable the items are, the more reliable the scale they form would be (assuming that they share a common latent variable). As a result, the first characteristic we look for in a group of scale objects is that they are highly intercorrelated (DeVellis, 2017).

The investigator has a pool of products that show acceptable reliability at this point in the scale creation stage. A scale's alpha is influenced by two characteristics: the extent of covariation among the items and the number of items in the scale. For items that have item-scale correlations about equal to the average inter-item correlation (i.e., items that are fairly typical), adding more items will increase alpha and removing more will lower it. Generally, the shorter the scales, the better for respondents, who can respond more easily. Longer scales, on the other hand, tend to be more reliable (DeVellis, 2017).

Alpha coefficient is useful for estimating reliability in a particular case: when item-specific variance in a unidimensional test is of interest. If a test has a large alpha, then it can be concluded that a large portion of the variance in the test is attributable to general and group factors. This is an important information because it implies that there is very little item-specific variance (Cortina, 1993).

RESULTS

The results are presented and according to the guidelines of DeVellis (2017).

Determine clearly what it is you want to measure and generate an item pool

The first step was to understand the concepts related to the socioeconomic impacts of university-business collaborations with an exploratory analysis of the literature. Thus, it was found that the main socioeconomic impacts of these collaborations comprise three fundamental groups: (1) economic, (2) social, and (3) financial.

The systematic bibliographic review was used to map the state of the art of the socioeconomic impacts of university-industry collaborations in the dimensions identified, which also made possible the establishment of subdimensions of each construct. Figure 1 shows the conceptual model used for the development of the scale.

33 socioeconomic impacts were identified from the systematic bibliographic review to be measured on the scale.

The 33 socioeconomic impacts identified were rewritten in the format of statements in order to provide a clear language for respondents according to guidance of Jonhson and Morgan (2016) presented in section 3 of the research method.

Determine the format for measurement and have initial item pool reviewed by experts

The format for measurement used is the semantic differential scale.

Obtaining item significance assessments normally entails presenting the expert panel with the understanding work of the construct. They are then asked to rate each object in terms of its importance to the construct as described by the researcher.

The content validation of each practice was carried out by three groups of experts. The first group consists of internal academic research specialists, the second group of external academic research specialists and the third group of management specialists.

The review by internal specialists indicated the separation of impacts according to stakeholders, selecting only the direct impacts on companies for the scale, which resulted in 23 items.

The external experts suggested the inclusion of more items for the assessment of the people construct which resulted in a total of 24 items. The review by management specialists was used to assess the clarity of the questionnaire and the understanding of all items by the respondents.

Chart 1 – Questionnaire (third version of the scale)

Dimension	Subdimension	Socioeconomic impacts of university–industry collaborations	Code
Economic	Infrastructure	The partnership of our company with university(ies) results in greater amounts of investments in the company infrastructure	A1
		The partnership of our company with university(ies) results in resources sharing and/or universities laboratories.	A2
	Production and Processes	The partnership of our company with university(ies) results in products, processes and/or services improvement.	A3
		The partnership of our company with university(ies) results in the development of new technologies	A4
		The partnership of our company with university(ies) results in new technologies commercialization.	A5
		The partnership of our company with university(ies) results in the development of new products, processes and services.	A6
		The partnership of our company with university(ies) results in the release of new products	A7
		The partnership of our company with university(ies) results in the creation of new companies	A8
		The partnership of our company with university(ies) results in the generation of intellectual property (deposit of patent application, trademark registration, software registration or any other kind of intellectual property protection)	A9
		The partnership of our company with university(ies) results in patent licensing	A10
		The partnership of our company with university(ies) results in the increasing of our sales	A11
		The partnership of our company with university(ies) results in the increasing of our exportations	A12

		The partnership of our company with university(ies) results in the creation of commercial and corporate/shareholder value of our company.	A13
Social	Scientific Development	The partnership of our company with university(ies) results in the creation of network with other institutions and/or international associations	A14
	Employment	The partnership of our company with university(ies) results in employment generation	A15
		The partnership of our company with university(ies) results in the creation of new high technology workstations	A16
		The partnership of our company with university(ies) results in salary increase of employees who participated in the university-company collaboration	A17
	Skills and Training	The partnership of our company with university(ies) results in the professional qualification of our workforce	A18
Financial	Purchases	The partnership of our company with university(ies) results in the purchase of goods and services of local suppliers.	A19
		The partnership of our company with university(ies) results in the purchase of goods and services of national suppliers.	A20
	Investment	The partnership of our company with university(ies) results in the increasing of external investment on the company.	A21
		The partnership of our company with university(ies) results in the increasing of public or private financing of our company.	A22
	Revenue Generation	The partnership of our company with university(ies) results in the increase of company's revenue	A23
		The partnership of our company with university(ies) results in the increase of company's profit.	A24

Consider inclusion of validation items and administer items to a development sample

In our study we verified if the interest is in the data of the companies that conduct formal collaborations with universities and, for this reason, a verification question was created to identify how companies conduct this type of collaboration. In case of a positive answer, the respondent is sent to a questionnaire, if there is a negative response, then the respondent is sent to a different screen thanking the him for his participation. He is not included in the research since he does not collaborate with universities.

Evaluate the items and optimize scale length

The created questionnaire, based on the literature review, was sent to companies that collaborate with universities via e-mail and LinkedIn® to the scale pretest, in which 10 Brazilian firms, that have formalized collaboration projects answered the questionnaires. We analyzed the Cronbach Alpha with the SPSS® *software*. The data obtained is shown in Table 1.

Table 1 – Cronbach alpha

Cronbach's Alpha	Cronbach's Alpha based in standardized items	N of items
,931	,932	24

According to Almeida *et al.* (2010) Cronbach's Alpha is a statistical tool that measures the reliability of a questionnaire on a scale of 0 to 1. For a reliable questionnaire, 0.7 is the minimum appropriate value. As the value obtained in Cronbach's Alpha (0.931) was much higher than the minimum value (0.7) described by Almeida *et al*. (2010) the Cronbach's Alpha value (0.931) was accepted.

Another important issue is that when checking the improvement of Cronbach's Alpha when it comes to removing the variables, there is minimal variation (almost null), considering that the only possibility of obtaining a greater Cronbach's Alpha would be with the removal of variable 15 and the Alpha obtained would be 0.932 (a practically insignificant difference from 0.931).

Therefore, all variables were maintained, since the removal of none of them would considerably increase the value of Cronbach's Alpha, in addition, the value was already well above the minimum accepted value (0,7) proposed by Almeida *et al.* (2010).

Scientific Contributions to Knowledge and Teaching

This work provides scientific contributions of high value to knowledge because it fills a gap present in the literature and presented by several authors, hence the lack of comprehensive metrics to measure the socioeconomic impact of university-company collaborations. In this way, it provides a powerful tool capable of analyzing the socioeconomic impacts on the companies' perspective. The described method can be replicated for the construction of scales to evaluate the socioeconomic impact from the perspective of both government and universities.

Regarding the contributions to education, it can be highlighted that the tool developed can be applied by students to assess the socioeconomic impact of their universities' collaborations with companies, the strategic information obtained can be used to strengthen collaborations and focus on the areas of greatest importance and interest of the stakeholders present. Additionally, the inclusion of practical activities in the teaching and education processes is widely recognized to be beneficial, contributive and capable to the formation of better qualified professionals, with practical experience of strategic analysis in the area of innovation and technology management.

CONCLUSIONS

Although university-industry collaborations are recognized as capable of generating socioeconomic development, a literature gap is perceived in the area of comprehensive metrics to measure the socioeconomic impacts of these collaborations. This work achieved its objective of developing a scale to assess the socioeconomic impacts on the perspective of the firms and the scale pretest. This article of methodological applications, includes both theory and practice aspects.

Theoretical, Knowledge and Teaching Contributions

Several authors like Alessandrini *et al*. (2013), Etzkowitz *et al.* (2018) and Audretsch *et al*. (2019) agree that traditional measurements and indicators are incapable of capturing the socioeconomic benefits of university–industry relationships. Our work created a powerful tool for deeper analyzing the socioeconomic impacts of university-industry collaborations. The scale developed will contribute to the creation of new knowledge of great value and interest from academics, firms and the government. This study contributes to professional education and teaching with a new tool for analyzing important impacts of university-company collaborations.

Managerial Contributions

The developed scale is a tool of fundamental importance for firms that carry collaborations with universities, which measures the socioeconomic impacts of their collaboration projects and guide their entire innovation strategy towards the main aspects of interest, in this way, a tool enables a thorough analysis of the socioeconomic impacts aspects of these collaborations, enabling companies to implement improvements and actions necessary to achieve better results in collaborative projects of research and development (R&D), and technological innovation. Scales can also be constructed according to the perspective of universities and the government to assess the socioeconomic impacts of university-company collaborations, with greater strategic information according to the aspects of interest of these other actors.

Research Limitations

The research limitation is that the model is generic. It is necessary to understand the major interests of firms in order to verify which are the indicators of greatest importance according to their reality and expectations with the university collaborations.

Recommendations and Future Research

According to the results obtained in the research, it is recommended to apply the tool to assess the socioeconomic impact on the perspective of companies that will serve as a support for strategic decision making to improve the results in innovation and research.

As a future research, it is suggested the creation of scales to assess socioeconomic impacts from the perspective of universities and the government. The data and information generated from the analyzes can be compared and the collaborations with better performance can serve as an example, allowing other collaborations to learn from it and be inspired by, so they can generate significant socioeconomic impacts as well.

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