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Digital platform for shared solutions and open innovations: proposal of a structured theoretical model

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Abstract

Objective: This article aims to present a collaborative digital platform model, structured to promote the improvement of communications, integration, and cooperation between the agents of the Triple Helix (TH), in the construction of shared solutions and open innovations activities.
Project / method / approach: The e-Delphi method applied in this research is directed to identify levels of consensus and dissent among respondents, when asked about the validation of the proposed platform model.
Main results: The main results show that the Content Validity Index, the Coefficient of Variation, and the Interquartile Range, were consistent with the recommended standard (Okoli & Pawlowski, 2004; Polit & Beck, 2006; Alexandre & Coluci, 2011 and Miguel, 2012).
Research limitations / implications: The insertion of facilitating instruments in endogenous communication and integration processes can contribute to the effectiveness of the TH model. The model is proposed in its theoretical form, as an academic contribution, and the requirements for construction are provided in this document.
Originality / value: The relevance of this article is corroborated by the unprecedented application of the calculation of three statistical indicators (CVI-CV-IR) in research using the e-Delphi method, and for the unprecedented proposition of a digital platform model for shared solutions and open innovations.
Social / management contributions: As a scientific contribution, the platform can contribute to improving cooperation between institutions of the Triple Helix model, especially in activities involving shared solutions and open innovations. The proposed model can be replicated, safeguarding the necessary adaptations to different regional realities.

Keywords: open innovation, triple helix model, digital platforms, shared solutions, e-Delphi method

Plataforma digital para soluções compartilhadas e inovações abertas: proposta de um modelo teórico estruturado

Resumo

Objetivo: Este artigo tem como objetivo apresentar um modelo de plataforma digital colaborativa, estruturada para promover a melhoria da comunicação, integração e cooperação entre os agentes da Tríplice Hélice (TH), na construção de soluções compartilhadas e atividades de inovações abertas.
Projeto / método / abordagem: O método e-Delphi aplicado nesta pesquisa é direcionado para identificar níveis de consenso e dissenso entre os respondentes, quando questionados sobre a validação do modelo de plataforma proposto.
Principais resultados: Os principais resultados mostram que o Índice de Validade de Conteúdo, o Coeficiente de Variação e o Intervalo Interquartil foram consistentes com o padrão recomendado (Okoli & Pawlowski, 2004; Polit & Beck, 2006; Alexandre & Coluci, 2011 e Miguel, 2012).
Limitações/implicações da pesquisa: A inserção de instrumentos facilitadores nos processos endógenos de comunicação e integração pode contribuir para a eficácia do modelo TH. O modelo é proposto em sua forma teórica, como uma contribuição acadêmica, e os requisitos para a construção são fornecidos neste documento.

Originalidade/valor: A relevância deste artigo é corroborada pelo ineditismo da aplicação do cálculo de três indicadores estatísticos (CVI-CV-IR) em pesquisa utilizando o método e-Delphi, e pelo ineditismo da proposição de um modelo de plataforma digital para soluções compartilhadas e inovações abertas.
Contribuições sociais/gerenciais: Como contribuição científica, a plataforma pode contribuir para melhorar a cooperação entre as instituições no modelo da Tríplice Hélice, especialmente em atividades que envolvam soluções compartilhadas e inovações abertas. O modelo proposto pode ser replicado, resguardadas as adaptações necessárias às diferentes realidades regionais.

Palavras-chave: inovação aberta, modelo da tríplice hélice, plataformas digitais, soluções compartilhadas, método e-Delphi

Plataforma digital para soluciones compartidas e innovaciones abiertas: propuesta de un modelo teórico estructurado

Resumen

Objetivo: Este artículo tiene como objetivo presentar un modelo de plataforma digital colaborativa, estructurada para promover la mejora de las comunicaciones, la integración y la cooperación entre los agentes de la Triple Hélice (TH), en la construcción de soluciones compartidas y actividades de innovación abierta.
Proyecto / metodología / enfoque: El método e-Delphi aplicado en esta investigación está dirigido a identificar los niveles de consenso y disidencia entre los encuestados, cuando se les pregunta sobre la validación del modelo de plataforma propuesto.
Principales resultados: Los principales resultados muestran que el Índice de Validez de Contenido, el Coeficiente de Variación y el Rango Intercuartil fueron consistentes con el estándar recomendado (Okoli & Pawlowski, 2004; Polit & Beck, 2006; Alexandre & Coluci, 2011 y Miguel, 2012).
Limitaciones/implicaciones de la investigación:- La inserción de instrumentos facilitadores en los procesos endógenos de comunicación e integración puede contribuir a la efectividad del modelo TH. El modelo se propone en su forma teórica, como aporte académico, y los requisitos para su construcción se brindan en este documento.
Originalidad / valor: La relevancia de este artículo es corroborada por la aplicación sin precedentes del cálculo de tres indicadores estadísticos (CVI-CV-IR) en investigaciones con el método e-Delphi, y por la propuesta sin precedentes de un modelo de plataforma digital para compartir soluciones e innovaciones abiertas.
Contribuciones sociales / de gestión: Como aporte científico, la plataforma puede contribuir a mejorar la cooperación entre instituciones del modelo Triple Hélice, especialmente en actividades de soluciones compartidas e innovaciones abiertas. El modelo propuesto puede ser replicado, salvaguardando las adaptaciones necesarias a las diferentes realidades regionales.

Palabras clave: innovación abierta, modelo de triple hélice, plataformas digitales, soluciones compartidas, método e-Delphi

Introduction

Academic research in the field of university-government-industry interactions has focused mainly on describing the roles assigned to each, generally considering the existence of these three institutions in a region as a final condition, and not as a means, to establish a place of innovation.

Anchored in the approaches of (Vilarinho, T. *et. Al*, 2018) and (Crupi, 2021); this work has as part of its purpose, to instigate the communities about the importance of systematic communication, practice, and integration between its citizens and institutions, as the essence for its functioning and effectiveness, aimed at building a creative and innovative environment.

In this context, perceived by the findings of (Cantú, Corsaro & Snehota, 2012; Dutta, Lanvin & Wunsch-Vincent, 2018) the need for a closer relationship between University-Industry-Government and society in general in search of suitable solutions for local development, this article proposes a collaborative digital platform model, as a means of communication, integration and relationship of citizens and institutions focused on building innovative solutions.

The proposed model aims to build a basis for the convergence of the perceptions and ideas of citizens living in society, in the search for the construction of intelligent spaces, organized based on individual, and collective contributions, similar to examples developed in smart cities, which are still scarce at the level worldwide.

Considering that collective actions should prevail over isolated initiatives when seeking the alignment of forces to build social and economic development, it was chosen as a research question: How improve the communication processes between the agents of the Triple Helix model aiming at the construction of enabling solutions applied to shared innovations?

However, the models of Brazilian state universities are hindered by laws and guidelines that hinder the creative process by the academic community, hindering the transfer of technology, the registration of patents and contracts with industries, contributing to the Brazilian position midway between the success and failure in implementing a robust system aimed at innovation (Kaniak & Takahasshi, 2018).

Among other measures, this trend indicates the need to enable solutions at the local and regional levels, aiming at a minimum base of self-sufficiency, based on initiatives for local problems, especially in the areas of education, health, security, infrastructure, and economic development (Manzini, 2014).

Realizing the scarcity of academic constructs based on the aspects of distortion, non-consolidation, disarticulation, and poor communication between citizens and institutions, this work aims to present a contribution to the gradual closure of this research gap.

In this context, the importance of creating means that enable the convergence of the eyes, initiatives, and contributions of citizens, individually or collectively, united in the search for enabling solutions directed to the construction of new ways to improve, create and ensure the existence and social and economic development of communities.

When perceiving the superficiality of community relations as one of the problems that hinder the self-development and progress of communities, collaborative platforms are seen as instruments capable of contributing to the convergence of opinions, generating debates, and implementing public-private actions, in the construction of more intelligent inhabited spaces.

It was noticed, in the works consulted in the Scopus, Web of Science, and Science Direct databases, the lack of proposals on an instrument capable of converging initiatives, guidelines, and policies among the TH model institutions, in the sense of seeking cooperative solutions aimed at the implementation of enabling solutions and shared innovations.

Theoretical reference framework

Open innovation

Activities to create or improve products and services can rely on valuable ideas shared by individuals from inside or outside the company through the application of Open Innovation (OI) mechanisms. In general terms, companies that practice Open Innovation use, among other ways, the practice of focus groups. To do so, they invite customers to the innovation process as a partner and co-producer. (ITU-T, 2015).

It should be noted that Open Innovation companies need to combine internal research with external ideas in order to implement these ideas in their own businesses and/or in partnership with other companies for the joint development of innovations. Open Innovation activities require an architecture capable of integrating internal and external technologies.

Monitoring startups closely is a fundamental practice associated with open innovation initiatives. Studying and learning from the experience of startups is a virtue of companies that launch themselves into the world of Open Innovation.

For Chesbrough (2003) "Open Innovation will allow knowledge and ideas to find greater use, in a wider variety of possibilities and configurations, than was previously possible." (Chesbrough, 2003, p.191).

(Pigola, Costa, Mazieri & Scafuto, 2022) state: “Collaborative technological innovation is considered essential to promote the flow of resources, knowledge and technology among the entities, considering that innovation is no longer a closed and isolated system”. These authors highlight “The main premise is that technologies do not exist in isolation. Only by exchanging inputs and information with the environment can the innovation system can be renewed and developed” (Pigola, et. al. 2022, p.207).

In line with the principles of the Triple Helix model, the change in the location of basic research will imply that the government must provide funding, not implying that research necessarily needs to be conducted by government scientists, but instead can be carried out in university laboratories.

It should be noted that in a growing and irreversible way, the university system is increasingly consolidating itself as an indispensable environment for fundamental discoveries.

For this, industry must align itself with universities in order to promote the absorption of knowledge applicable to innovative products.

In a world of open innovation, the practice of monopoly is not conceived. Chesbrough (2003) asserts: "The economies of scale that may have existed in R&D a generation ago (when Closed Innovation thinking accepted monopolies as a necessary price for discovery-oriented industrial research) are weaker now." (Chesbrough, 2003, p.194)

Companies that adhere to the open innovation model are exposed to a world of opportunities by taking advantage of ideas from the environment around them, which can enrich their own ideas applied in the current and future moments.

The growth in the number of companies practicing the principles of open innovation may contribute to a greater stock of shared knowledge, to the improvement of professionals' skills and to the strengthening of the TH model, which should not do without instruments that facilitate communication and cooperation of the institutions involved, namely: The University, the Government and the Industries, excelling among other possibilities, through the use of digital platforms, through which it becomes possible to approach with a view to the practice of joint work

and support for the exchange of knowledge, thus being able to provide a promising future for communities and their citizens. (Vanhaverbeke, 2006).

When questioning the possibility of measuring synergies in different innovation systems, Leydesdorff and Ivanova (2016) assert that "Both OI and TH models programmatically invite us to examine the processes of exchange of information and knowledge between partners with different perspectives and other institutional roles." And they add: "In addition to opening up the innovation process to third parties, the Triple Helix provides an innovation model in which the three parties are specified in terms of selection environments and the processes of interaction between them."

The Triple Helix Model

Observing the results of the more developed world economies it is identified that the integration and cooperation between the members of the TH model, aligned with the common objective of economic development and strengthening and guided by efficient leadership, has been a major factor in the growth and hegemony of the select group of more developed countries.

In this aspect, (Etzkowitz, 2017) reinforces that the approach, integration, and cooperation between university, industry, and government are contributing factors for innovation and growth in a knowledge-based economy.

The transformations provided by the interaction between academy-government-enterprise are of fundamental importance because they demand shared knowledge, cooperation, and actions aimed at the growth and development of a particular region or even a country (D'Ávila, Bilessimo, Esteves & Vargas, 2015).

According to (Lee & Kim, 2016), this triple alliance consists, among other things, of the provision of human capital by the university, the regulatory role assumed by the government, and the application of new technologies in the production of goods and services by industry.

In this sense, (Verlinde & Macharis, 2016) warn that the triple helix model requires reciprocity between its members, and when properly performed, it gives universities the importance that is not highlighted in previous development models.

Concerning the observations of (Meza & Bastos, 2018), it is clear that the establishment of relationships in search of shared solutions is characterized as a fundamental step toward the

creation of a homogeneous innovation system to which technological demands flow naturally and from it, enabling solutions can emerge.

(Klafke, 2014) emphasizes that the expressiveness of technology-intensive production requires coverage in communications and the alignment between the guidelines of agents from both governments, universities, and industry.

From the approach of (Eberhart & Pascuci, 2014), it can be inferred that an integration model designed according to a triple helix involves cooperation processes, in particular enabling the integration of government and companies in a process whose presence of universities is configured as essential for social and economic development.

Related to online communication Kobza & Mutlucan (2016, p.291) emphasized that [...] social networks can provide not only resources and support, but also new and holistic perspectives, thanks to different perspectives and contributions from members. And they add [...] Today, the entrepreneurial mindset is often derived from young professionals and students. In addition, this mindset can be multiplied by the impact of your social networks.

It is identified through the work of (Kapetaniou & Lee, 2017) that the current role of universities in the knowledge-based economy can be analyzed using the TH model. This approach, which emphasizes the critical role of interactions between universities and other actors, conceptualizes and highlights the current role of universities in the innovation process.

It is noteworthy that urban and regional developments demand look, initiatives, and solutions that contribute to improving the associations of individuals while providing these conditions for social and intellectual development and better standards of quality of life.

When referring to the TH movement as a hybrid model that emphasizes the construction of overlapping and relatively interdependent relationships among its members, (Sarpong et al., 2017) highlight its similarity with a network that encourages movement around mutual collaborative relationships and bonds, taking for itself the innovation policy based on the result of their interactions and not on the exclusive dependence on a recipe provided by the government.

Devoid of effective communication mechanisms, the government and the university cannot act to face the problems of industry and society, involving them in a common environment to provide resources for the generation of knowledge and the provision of funding for the application of new technologies.

Concerning Brazil, (Pellin, & Engelmann, 2018) emphasize that the distance from government-industry-university institutions leads to a condition of low systemic maturity mainly due to the imposition of traditionalist bases on its historical-cultural process, perceived as lethargic in response to the competitiveness of the world economic scenario given the attachment to state institutionalism that distances the country from modernity.

In an investigative study on cooperative relationships between universities and companies, Kindt (2022) asserted that "in regions with fewer large companies, universities connect a significant number of small companies in collaborative networks and simultaneously function as connectors for actors outside the region." (KINDT, et al. 2022, p.1290).

According to Pigola, Costa, Mazieri & Scafuto (2022), "The extension of activities in technology transfer has taken companies from the early stage of development, to later stages ranging from property management to commercial support and network development". For these authors, "An activity that appears as common sense is the substantial extension in internal and external networking with the objective of supporting the commercialization of technology." (PIGOLA et. al. 2022, July).

When considering competitors, government organizations and citizens in general, at different times, sometimes as customers, sometimes as suppliers, it becomes imperative to understand the importance of their involvement as potential collaborators, which through their ideas, criticisms and suggestions can influence the inventive processes of companies. In this sense, the use of collaborative digital platforms becomes a useful instrument in shared solutions and co-creation initiatives.

Digital platforms

The digital platforms require, among other elements, electronic participation (Saebo; Flak & Sein, 2011; Wimmer et al., 2012) to enable citizens to connect with the constituted public authorities (Fedotova; Teixeira & Alveolos, 2012). In this way, electronic participation meets the needs of citizens and governments, provides reinforced tools for access to information, and thus meets the basic demands of the democratic process.

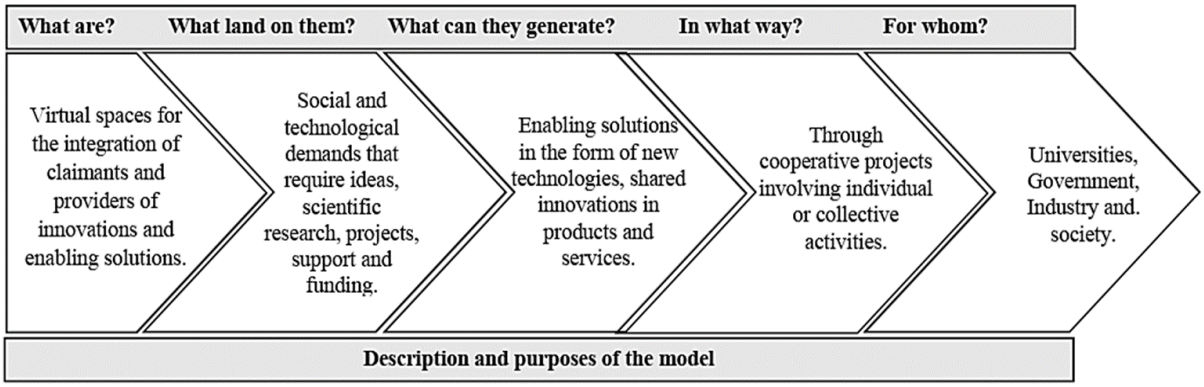
(Pearce et al.,2012) when suggesting a database in the form of a system for knowledge exchange, among other aspects, conditions its success to the intensity of its ability to support simplified collaborative exchanges between users.

In this sense, the insertion of content storage instruments in the collaborative platforms is foreseen, accessible to those dedicated to research aimed at the search for enabling solutions to problems in different segments of society.

Figure 1 show details about the features of an integrative platform for e-participation.

Figura 1

The sequential 5w's of the proposed model



Source: Elaborated by the authors

(Dameri, 2013) tells us that the vision of the future indicates the need for interaction, sharing good practices and initiatives capable of improving the connected world, where people relate to the intensive use of information technologies.

The constant technological advancement of the Internet, according to Schmidt, (2016), has enabled the sharing of ideas for a creative process that provides innovations in a short space of time, by allowing co-creation activities between individuals and institutions.

For this, referring to the work of (Scuotto, Ferraris, & Bresciani, 2016), it is observed that digital media and, among them, collaborative digital platforms are perceived as part of the apparatuses of open innovations, which can contribute to the approach, planning, and coordination of services demanded by urban sectors.

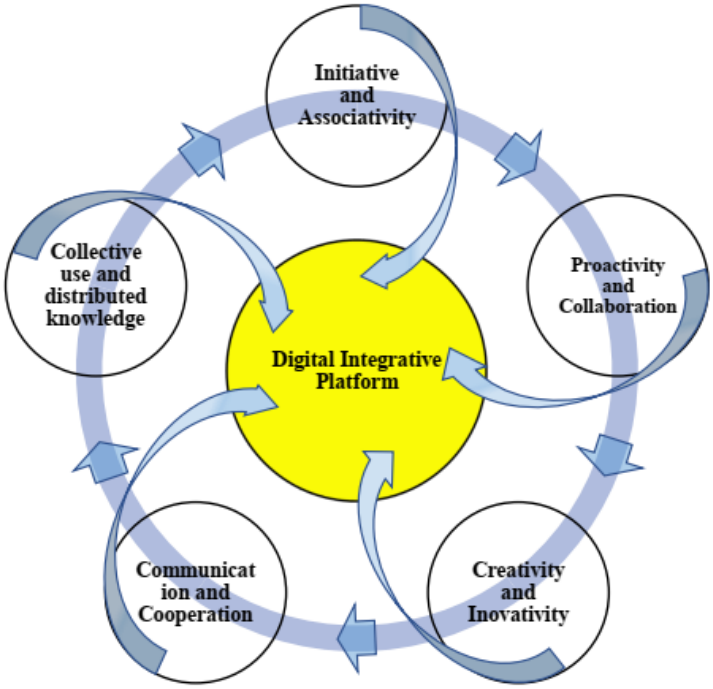
Referring to the importance of integrative platforms, Grillitsch & Sotarauta (2018, p.14) assert that [...] the establishment and promotion of platforms or organizations involving social sectors promote interconnection within diverse systems such as youth associations, entrepreneurs, or business leaders.

From the aforementioned authors, it is deduced the viability of the creation and implementation of collaborative digital platforms for enabling solutions, as instruments for the convergence of citizens' contributions, to build inhabited spaces where collective decisions predominate as a means of insertion of the individual in pluralistic societies.

It is suggested that, for the good functioning of a community, a collaborative digital platform considers a set of actions sequenced in a circular orbit (see Figure 2), generating initiatives aimed at a central base where its protagonists, through integrated activities can build, through synergistic efforts, a set of contributions that enable solutions to collective social demands.

Figura 2

Creation, maturity and perpetuity cycle of Integrative Digital Platforms



Source: Elaborated by the authors

The basis for the creation of an integrative digital platform requires, among other things, the initiative of an individual or a group in search of the associativity of those who wish to dedicate themselves to reinventing the forms of coexistence, creativity, and cooperation in the spaces inhabited by people.

From the point of view of (Praharaj; Han & Hawken, 2017), for social transformation to occur, individuals must be willing to be associative and to go through stages of evolution whose

phases will require proactivity and collaboration, in a continuous exercise focused on creativity and innovation.

When referring to networks to promote collaboration in innovation, (Ferreira & Dannyela, 2022) identified elements that influence a collaborative network, such as the cultural and material structure of the region and the relationships established in the network, especially individual predispositions and the strength of ties

In this sense, it is emphasized that this transformation, in turn, will require efficient communication and cooperation, guiding them to learn that the distribution of knowledge, sharing, and collective use of things can lead them to a more participatory, inclusive, and self-managed society.

It follows that integrative digital platforms can be considered as virtual habitats, where people are dedicated to collaboratively and continuously thinking about new ways of doing things and new uses for things already created.

Method

This chapter aims to describe the methodological guidelines that guided this research and the techniques and procedures for collecting and analyzing the data obtained to achieve the proposed objectives.

The e-Delphi method applied in this research is directed to identify levels of consensus and dissent among respondents, when asked about the validation of the proposed platform model.

Originally, Linstone & Turoff, (1975, p.3) considered that "Delphi may be characterized as a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem."

Delphi is a method used to examine a complex problem through a group of experts. Experts generate a data source because of their knowledge and experience regarding the subject under investigation.

This method was developed in the USA by RAND Corporation and involves an expert group that responds anonymously to questionnaires and subsequently receives feedback in the form of a statistical representation of the group response (Landeta, Barrutia, & Lertxundi, 2011).

Some types of Delphi designs were presented by (Hasson & Keeney, 2011), to know: Classical, to obtain opinions and identify consensus; Modified: which varies according to the

design of the project, from forecasting future events to reaching consensus; Decision: which aims to structure decision-making and create the future from reality, instead of predicting; Real-time conference: to obtain the opinion and obtain consensus with simultaneous participation; e-Delphi: the structure may vary depending on the nature of the research that is carried out electronically; Argument: to develop relevant arguments and to expose reasons underlying different opinions on a specific issue; Disruptor: used in the construction of future scenarios.

During the process of applying the Delphi, method data are collected through questionnaires during the application of successive rounds interspersed by various iterations between researcher and respondents (Strasser, 2017).

For (Cortez & Johnston, 2017), the Delphi Method is an iterative and structured process used to elicit, collect and aggregate opinions and judgments in a context of collective decision-making. The method can be used when there is incomplete knowledge about the phenomena.

Lund (2020, p.2) thus refers to the publication on the Delphi method (Linstone & Turoff, 1975): “this book was an important step in legitimizing Delphi as an academic research method. he outlined the philosophy, purpose and steps of the Delphi method.”

It is noteworthy that it is a work whose citation should not be overlooked, especially in scientific research, which does not allow itself to dispense with relevant constructs underlying the Delphi method.

When applying the Delphi method, the researchers can count on the contributions of specialists with vast experience and opinions based on the field of the chosen theme.

They may also have expanded their experimental observations on which their initial theories were based, thus expanding their theoretical basis, and generating a greater probability that the result of their work will contribute to multiple contexts and discoveries (Reguant & Torrado, 2016).

The application of the Delphi method in its electronic version, called e-Delphi, to send questionnaires and realize rounds, is characterized as a way to obtain the survey data more quickly. In the booming era of cloud computing, researchers must strongly consider the important security and access benefits that research efforts like e-Delphi allow.

It was identified that among several authors, there is agreement on the four fundamental pillars of the technique, namely: anonymity, the use of experts, the application of interactive and feedback rounds, and the search for consensus or dissent.

During the development of the research using the e-Delphi method, the facilitator also accumulates, as a fundamental activity, the establishment of periodic contacts with the interviewees, to seek their commitment to the deadlines necessary to complete the research according to the established schedule.

In this work, the inductive method of basic research was applied, adding a qualitative approach through bibliographic and documentary procedures and a quantitative approach with the development of a survey, as described in Figure 3. Using the e-Delphi technique, it was applied a combined approach, applying qualitative and quantitative approaches.

According to (Ameyaw et al., 2016) "Compared with traditional Delphi studies, quantitative Delphi studies require careful research design and consequently, several statistical data analysis approaches."

Figura 3

Research classification

Regarding the method	→ Inductive	Regarding procedures
As for nature	→ Applied	↓
Regarding approaches	→ Combined	Survey and e-Delphi method
Objective	→ Exploratory and Descriptive	Bibliographic, documental and field researches
Applied tools		Questionnaire, SPSS and Stat Plus Softwares

Source: Elaborated by the authors

As shown in Figure 3, regarding the type, the research was classified as exploratory and descriptive, considering the development of field research to know the structure, configuration, and *modus agendi* of the local TH.

The main actions required were presented in the graphical representation of the research method and the methodological flow, and these actions, together, will lead to the fulfillment of the general objective of this article.

Describing, detailing, and sequencing these steps is especially helpful for readers who want to know how the methodology used has influenced the results, or for readers who are interested in replicating or extending the work described. A set of information collection and data analysis tools was used to fulfill the specific research objectives. (see Figure 4).

Figure 4

Methodological tools for data and information collection and analysis

Specific objectives	Collection tools	Analysis Tools
Search databases of academic constructs on the topics: Open Innovation, Triple Helix and Collaborative platforms.	Bibliographical and documentary research	Literature review
Identify and describe the existing TH agents in the research region.	Field, exploratory, descriptive, bibliographical and documentary research	Content analysis
Create and propose to respondents to evaluate a platform model for enabling solutions.	Searches: Bibliographic, Documentary, e-Delphi and Survey	Parametric and Nonparametric Statistics SPSS Software
Review the content of the article spelling and grammatically.		https://www.deepl.com/ https://app.grammarly.com/

Source: Elaborated by the authors

(Creswell, 2014) suggests that quantitative methods are suitable for deductive approaches, where a theory or hypothesis justifies variables, states purposes, and indicates narrowly defined research questions.

According to the author, researchers of mixed methods, usually organize the report of procedures in the collection of quantitative data and the analysis of the content of qualitative information. The author adds, "[...] then, in the conclusions or the interpretation phase of the study, the researcher measures how the qualitative information helped to elaborate or expand the quantitative results" Creswell, (2014, p.220).

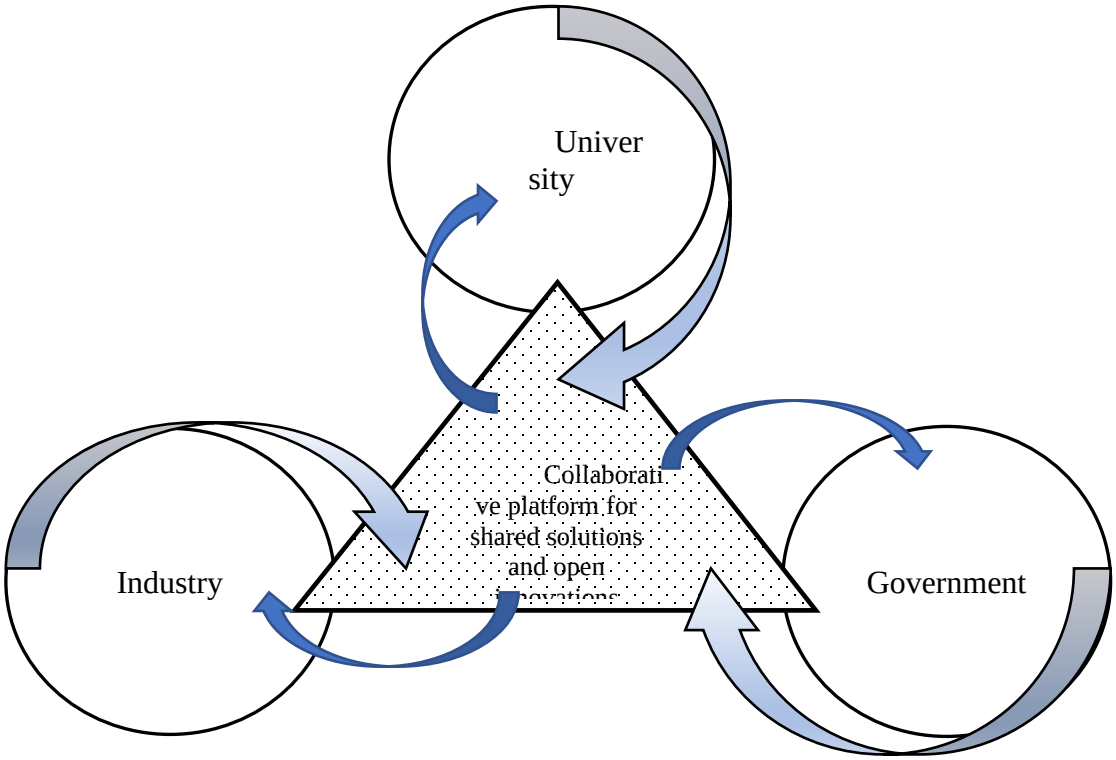
Proposed model for shared solutions and open innovations

After identifying the theoretical contributions in the consulted literature, the process of idealization and construction of the platform model began, as shown in Figures 5 and 6.

Taking as a basis that an integrative platform must contemplate a form of operation that allows the actors involved in mechanisms of approximation, to seek reciprocally complementarity for their contributions and continuous learning through frequent contact with their peers.

Figura 5

Cyclic integration in the proposed platform model



Source: Elaborated by the author

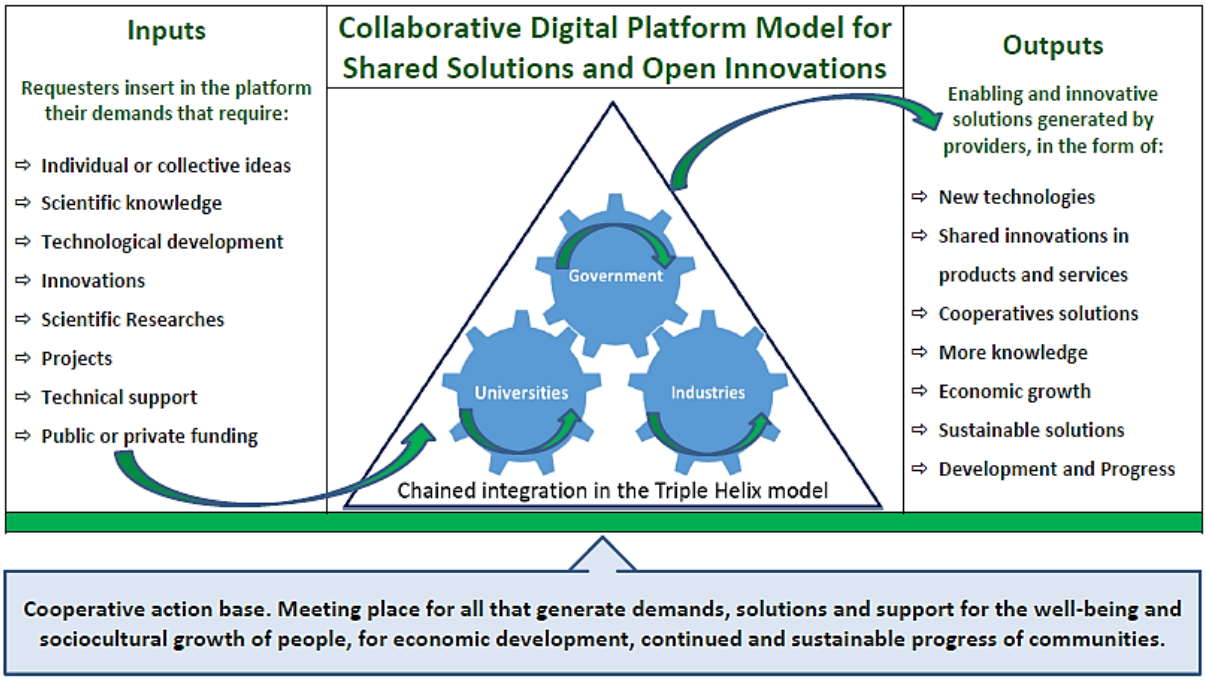
It was established as a purpose that the suggested platform model consolidates itself as an integration space, receiving the diverse social and technological demands, which require ideas that instigate scientific research, transformed into projects dependent on support and financing.

The proposed platform model can be used as an effective external impulse complement to the TH internal modus operandi. With the increasing pace of development of science and technology, as well as the demand for innovation, the external impulse is perceived as a driving force for internal collaborative activities in the TH model.

In addressing technology transfer organizations as a source of exogenous motivation for TH members, (Xu et al., 2017) state that, in the virtual environment of the platform, each participant, through reciprocal contributions, forms an interactive and reflective relationship, acting in the role of requesters and providers of enabling solutions.

Figura 6

Proposed platform model



Source: Elaborated by the author

Conceptually, the theoretical model assumes that your feed process is composed of social and technological demands that require individual or collective ideas, scientific research, projects, technical support, and funding.

It is expected that once these inputs are processed, outputs such as: enabling solutions and shared innovations, new technologies, innovations in terms of products and services, cooperative solutions that provide more knowledge, economic growth, sustainability, economic development, and continued progress in communities where the triple helix model operates.

Established this virtual integration space in the form of a collaborative digital platform for shared solutions and open innovations, through the cooperation process between universities, government, and industry, greater intensity is expected in the generation and sharing of enabling solutions for diverse demands.

It is emphasized that the synergistic effect of this sharing can contribute to the discovery of new ideas and the creation of technologies that enable innovations in products and services, which, in the form of facilitating solutions, generate more knowledge for citizens, transforming common places in creative and more developed communities.

The proposed model consists of an unrestricted public platform, administered by research and development sectors or institutions duly recognized and regulated by applicable legislation, with the main objective of meeting the people who generate demands and challenges, whose participation requires the application of technical knowledge and scientific research.

The basic objective of the platform is to manage, based on the TH model (Leydesdorff & Zawdie, 2010), the relations between the three socio-productive and educational agents, namely Universities, Government, and Industry, in the commitment, search, and generation of innovative solutions for problems involving the three sectors.

Added to these purposes, with the creation of this common virtual environment, improvements are expected in the convergence of involvement and efforts from TH communities, in terms of effective members' participation to implement agility in the discovery and application of scientific solutions for current and future problems.

This is expected by using an environment of mutual support in the field of interactive social cooperation, entrepreneurship, and technological innovation as a means of access to development and collective well-being and consolidation to a competitive economy.

In this way, it seeks to bring the three agents of TH closer together, acting as a binding factor of synergies, as well as to fill possible existing communication gaps, thus implementing the role of each of the agents as builders of a collaborative and complementary society, active in the search for solutions that rationalize the use of natural and economic resources.

Additionally, the aim is to provide the technical schools and universities with a locus of opportunities for their teachers and students to put into practice a set of knowledge and skills created and developed in the classroom, to develop and present solutions to the demands and challenges posed by thus fulfilling an important requirement of active teaching / learning methodologies.

In the proposed platform people, institutions, companies, and government agencies can insert their needs, problems, demands and challenges, social, infrastructure, management, education, knowledge, health, security, technologies, and innovation among others to find potential solution providers.

Through contracts, with or without profit, established between applicants and proponents, educational institutions and companies can offer solutions of a scientific / technological nature, to

meet the demands and challenges proposed, building partnerships that promote increased competitiveness, and technological and economic development.

Some of the main demands and challenges of the proposed platform correspond to the potential individual or collective needs whose solution suits the concept of the project and depends on the use of skills acquired or developed in educational institutions, as well as the professional experience of the bidders.

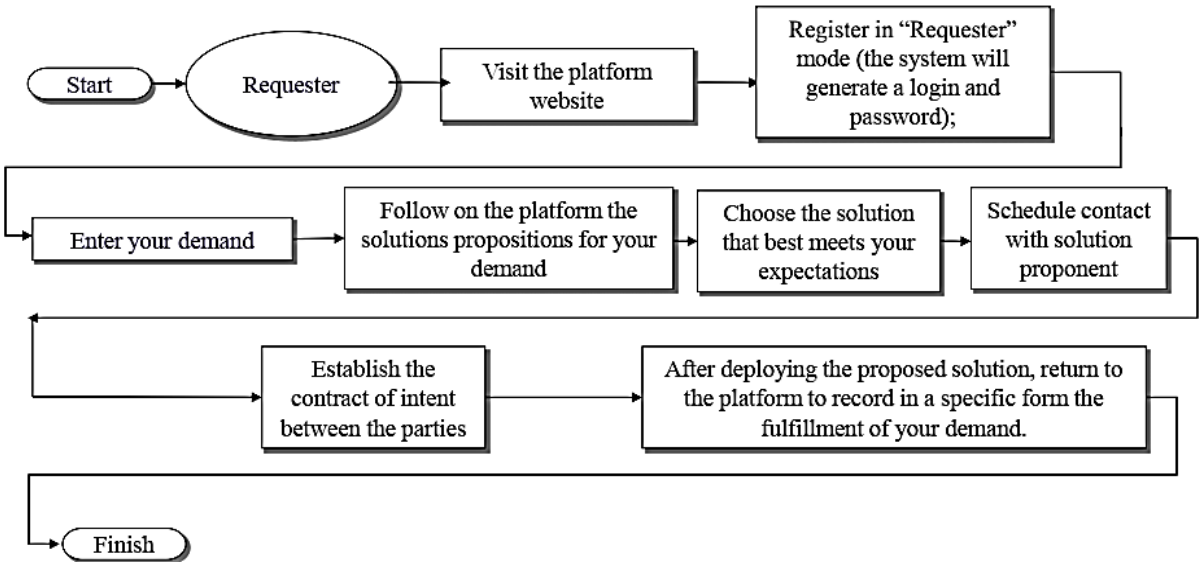
All citizens, through one of the representative entities of TH, can act as plaintiffs or as proponents inserting their needs, challenges, or solutions into the platform, following the guidelines. (Figures 7 and 8).

Following are the instructions that make up the operating flowchart of the proposed model:

For requesters;

Figura 7

Flowchart for requesters of solutions in the platform

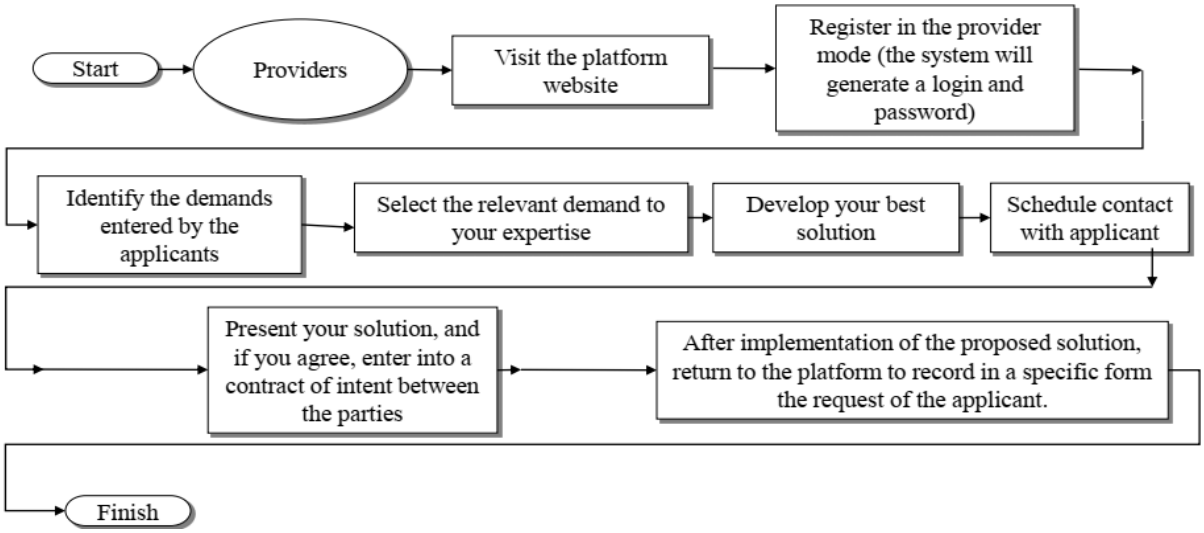


Source: Elaborated by the author

a) For providers

Figura 8

Flowchart for providers of solutions in the platform



Source: Elaborated by the author

It is noteworthy that one of the purposes of the platform is to bring people interested in sharing ideas, needs and enabling solutions, by acting integrated into a cooperative process, capable of generating results for individual or collective achievements.

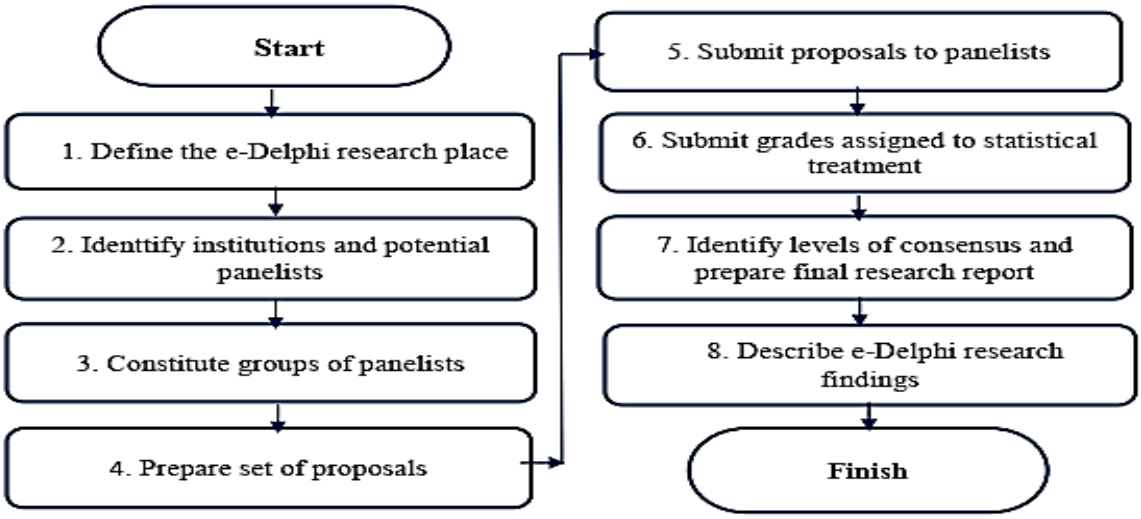
Concluding the presentation of a theoretical model, we proceed to describe the validation step performed.

Validation of the theoretical proposed model

To search for evidence on the assertiveness of the proposed theoretical model and to identify possible problems in its future development, a round of research was carried out with the application of the e-Delphi method steps (see Figure 9).

Figura 9

Flowchart for e-Delphi research



Source: Elaborated by the author

Describing, detailing, and sequencing these steps is especially helpful for readers who want to know how the methodology used has influenced the results, or for readers who are interested in replicating or extending the work described.

To this end, a group of fifteen panelists (respondents) was selected, representing the three sectors that belong to a model of TH established in Brazilian Electronic Valley. located in the Southeast Region of Brazil.

Participants were emphasized that the main objective of the research was to know the degree of agreement or disagreement between them in terms of the adequacy of the theoretical model proposed for the collaborative digital platform, with a view to future development and implementation.

Panelists were informed that the main objective of the platform is to establish itself as a basis for cooperative action, a meeting place for all who generate demands, solutions, and support for social and economic, continuous and sustainable development, intensively focused, in the generation of innovations based on enabling solutions.

On the platform, the user can act as a solicitor or provider of the individual or collective demands that require the application of technical and scientific research, uniting to promote socio-economic self-development and the progress of the communities where they are established.

In this sense, concerning the proposed theoretical model, the participants of the e-Delphi panel were asked to assign a response according to the options illustrated (see Figure), in terms of the intensity of agreement or disagreement about the adequacy of the theoretical model proposed. Panel participants were emphasized that adding comments would be optional.

It is emphasized that personal data as well as the institutions originating from the panelists are kept strictly confidential, according to the guidelines of the Delphi method.

Figura 10

Likert scale used to validate the proposed platform.

Total disagreement	1	2	3	4	Total agreement
	( )	( )	( )	( )	
Respondent Comments:					

Source: Elaborated by the author

The questionnaire was made available to the fifteen panelists in word text, via email and the answers were inserted in the same document, and later transferred to an electronic spreadsheet suitable for data tabulation.

The evaluation of the responses presented by the panelists on the Likert Scale used in this research in the 4-point format (Figure 10), was carried out by applying the statistical calculations of the Average (1), the Median (2), the Variance (3), the Sample Standard Variation (4), Content Validity Index (5), the Coefficient of Variation (6) and the Interquartile Range (7), whose formulas are shown in Figure 7.

In this sense, it is emphasized according to (Beatty, W., 2018) that "Statistical calculations do not make decisions. The role of all statistics (of any kind) is limited to supporting the analysis that the decision maker needs to make, to decide as to what to do in the face of a problem or situation."

Figura 11

Statistical calculations applied to data processing

Calculations	Formulas	What measures or determines	
Average	$\overline{x} = \frac{1}{n}\sum_{i-1}^{n} x_i$	The ratio of the sum of all elements in a data set.	(1)
Median	$Med = x_{\frac{n+1}{2}}$	The value that occupies the central position of the series of observations of a variable, in a roll, diving the set in two equal parts.	(2)
Variance	$S^2 = \frac{\sum(x - \overline{x})}{n-1}$	Shows the variation around the measure.	(3)
Sample standard deviation	$S = \sqrt{\sum_{i=1}^{N} \frac{(x_1+\overline{x})^2}{n-1}}$	Shows the distance of each value in the data set in relation to the central mean value. The smaller, the closer the value is to the average.	(4)
Content Validity Index	$CVI = \frac{\bar{X}[\sum(ga \geq 3)]}{k}$	The degree of consensus about a proposition measured using a 4-point adapted Likert scale. (Note: *ga = grades assigned*)	(5)
Coefficient of Variation	$CV = \frac{S}{\overline{x}} \times 100$	The variability between data set measures on scales. Measures the variation relative to the average.	(6)
Interquartile Range	$IR = (Q_3 - Q_1) / Q_1$	The degree of a spread of data around the centrality measure. A measure of data dispersion around the population average.	(7)

Source: Adapted from Polit and Beck (2006); Miguel (2012) and Beatty, W. (2018)

Quantitative research data were processed using Stat Plus LE software (https://www.analystsoft.com/br/products/statplusmacle/), SPSS (https://www.ibm.com/br-pt/analytics / spss-trials). It is reiterated that the Delphi Method uses scientific techniques that allow the analysis of qualitative and quantitative data. It is a research tool that allows discovering the opinions of specialists called panelists, on complex issues.

However, opinions may prove to be congruent or divergent, since they are exposed to the panelists' perceptions, and may generate a coefficient of agreement or disagreement below expectations.

The results were submitted to a statistical treatment through the Software SPSS., which are summarized in Table 1.

Table 1

Research results for validation of the proposed model

		GROUP 1		GROUP 2		GROUP 3	
		GOVENMENT RESPONDENTS	GRADE ASSIGNED	UNIVERSITY RESPONDENTS	GRADE ASSIGNED	INDUSTRY RESPONDENTS	GRADE ASSIGNED
ROUND FOR VALIDATION OF THE PROPOSED PLATFORM MODEL		1	3,0	4	4,0	2	4,0
		5	4,0	6	4,0	3	3,0
		7	4,0	8	4,0	9	3,0
		13	4,0	11	4,0	10	4,0
		14	4,0	12	4,0	15	4,0
CVI	CONTENT VALIDITY INDEX ≥0.7		0,76		0,80		0,72
CVR	GENERAL CONTENT VALIDITY INDEX ≥0.7	**0,76**					
	SUM OF INDIVIDUALS GRADE	19,0		20,0		18,0	
STATISTICAL DATA PROCESSING	VARIÂNCIA	0,20		0,00		0,30	
	AVERAGE	3,80		4,00		3,60	
	MEDIAN	4,00		4,00		4,00	
	STANDARD DEVIATION	0,40		0,00		0,49	
	COEFFICIENT OF VARIATION <30%	10,53%		0,00%		13,61%	
	1st QUARTILE	4,00		4,00		3,00	
	3rd QUARTILE	4,00		4,00		4,00	
	Distance between quartiles <50%	0,00%		0,00%		33,33%	

Source: Elaborated by the author

The final result in terms of the degree of dissent / consensus, by indicators and by groups of panelists are presented in the Table 2.

Table 2

Compilation of research results for validation of the proposed model

GROUPS	INDICATORS	DEGREE OF DISSENSE / CONSENSUS VALIDATION OF THE PROPOSED MODEL
1	CONTENT VALIDITY INDEX ≥0,7	0,76
2		0,82
3		0,72
1	COEFFICIENT OF VARIATION ≤30%	11,77%
2		0%
3		16,11%
1	INTERQUARTILE RANGE ≤50%	0,00%
2		0,00%
3		33,33%

Source: Elaborated by the author

After analyzing the research results, it was found that the Content Validity Index (0,76; 0,82; 0,72), the Coefficient of Variation (maximum = 16,11%), and the Interquartile Range (maximum = 33,33%), were consistent with the recommended standard (Okoli & Pawlowski, 2004; Polit & Beck, 2006; Alexandre & Coluci, 2011 and Miguel, 2012) to characterize the consensus condition established by panelists' responses. to the questions. Hence, the panelists recognized the adequacy of the proposed theoretical model for the collaborative digital platform.

It is inferred, from the analysis of the results displayed in the Tables 1 and 2, that the intensity of agreement among the interviewees, indicates that the theoretical model proposed for the Collaborative Digital Platform model was approved.

Conclusions

It is understood that the proposed general objective was achieved, as the work consisted of creating a theoretical model of a collaborative digital platform in the form of an integrating base for the members of the TH model, so that, through cooperative actions, they can promote convergence from individual or collective demands for a common digital locus, for knowledge, analysis, and propositions of enabling solutions aimed at shared innovations.

To achieve the proposed objective, a theoretical basis was sought, based on bibliometric analysis, and bibliographic and documentary research. Through the documents accessed, the theoretical aspects of Open Innovation, TH Model, Digital Platforms and the Delphi Method were studied.

It is noteworthy that for the successful creation of an integrative digital platform for enabling solutions in a given region, some basic premises must be considered by its proponents:

a) the model must be interactive;
b) the model cannot do without a systemic community willing to share information and knowledge through a representative network composed of a significant number of institutions and people;
c) TH members must be protagonists and responsible for the process (which must be emergent, horizontal, customized, and endogenous);
d) requesters and providers must take into account individual accountability for the action and assigned / assumed power, as well as the establishment of relationships of synergy and trust.

In addition to the highlighted assumptions, another important conclusion is that to achieve the best results from using the platform in a given region, some criteria must be considered in the process, namely:

a) ready structures should not be copied, as they were not designed or adapted to the particularities of the region;
b) a central platform management body with functional availability and representativeness to the target community should be established.
c) process ownership should be facilitated and promoted so that users can quickly identify feature functionality and benefits. Appropriation of the process means the self-responsibility of each of the actors for their development and for the common good.
d) it is understood that the network is the basis of the strategy for the successful operation of the platform. Its dissemination through social networks and media is crucial for the successful application of the model.

e) the role of social networks is the great differential added in this proposed model and serves as its basis of support.

For those who appropriate the proposed model, some qualitative and / or quantitative indicators to measure post-implementation effectiveness are suggested, such as:

a) Scope (number of people and entities involved);
b) Number of enabling solutions generated for the target audience, companies, government, and society at large;
c) Quantity and quality of innovative solutions generated;
d) Mobilization and retention of plaintiffs and providers.

For those willing to implement the proposed theoretical model, persistence, energy, and resilience are recommended because it takes time, overcoming personal and cultural challenges so that, among other things, the breaking of paradigms can be accomplished.

The following are the conclusions of the work developed, as well as the associated contributions to both theory and practice in the context of the theme.

The research presented here points to the relevance of the topic and the importance of understanding, as well as the benefits that the integration of individuals and organizations to which they belong can bring to the socio-economic development and the progress of communities.

The results in terms of the validation of the model indicated a considerable level of assertiveness of the developed idea and the structure of the theoretical model presented.

The epistemological framework pointed to the existence of material abundance in the theory of the TH model, however, it was found that works focused on instruments for improving communication and integration between agents of the TH model when applied in a region were absent. This finding added motivation to the construct of this research.

Given the scarcity of scientific work in this direction, the present work sought to bring benefits to academia, educators, government agencies, and social organizations by developing and proposing an integrative platform model for enabling solutions applicable to TH models deployed in any region.

In this sense, the research conducted during this work showed that it is possible to construct and operationalize instruments focused on the advancement of forms, collective thinking, and effective actions directed to the progress of inhabited geographical spaces.

The general objective was to create and submit to the evaluation of a group of panelists who are part of an established TH, a theoretical model of a collaborative digital platform for shared solutions and open innovations.

After the analysis of the results, it could be inferred that, despite the respondents being familiar with the proper way of functioning of the TH, actions still under structuring and dispersed prevail in the locus studied, lacking an instrument capable of uniting the three spheres of the model, in search of synergistic actions, whose sum of the results surpasses individual achievements.

By immersing itself in the theoretical constructs about TH, the lack of an instrument capable of providing convergence and virtual integration of the members of the three propeller blades - university - government - industry was identified.

To fill this identified gap, an instrument was developed to improve the interaction between the members of TH and to find shared facilitating solutions that can contribute regionally to technological, economic, and social development.

In this sense, in response to the research question, a collaborative digital platform model for shared solutions and open innovations, was developed and its validation through the e-Delphi method was proposed to a group of fifteen respondents from the areas of government, industry and universities in the Brazilian Electronics Valley.

It is reiterated that the theoretical model was developed to provide TH members with an online tool capable of contributing to the approximation and convergence of TH members' initiatives, to contribute to the smooth functioning and consolidation of relations between them.

After sending the proposed platform model, the interviewees were invited to evaluate and comment on the adequacy of the proposed objective. The analysis of the results showed the predominant consensus among the interviewees as to the results of the three indicators: Content Validity Index, Coefficient of Variation, and Interquartile Range, thus inferring the approval of the model in its presented form.

The implications of this work for the theory can be considered, mainly, concerning the unprecedented application of the calculation of three statistical indicators (Content Validity Index, Coefficient of Variation, and Interquartile Range) for data from research in the e-Delphi Method.

The proposed model can also be characterized as an innovation proposed to improve the inter-member relations of TH, in the search for its consolidation as a model directed to economic development.

In terms of practical implications of the work, the main accumulated contributions are:

a) the establishment of the necessary parameters for the development of a digital platform model that allows the systematization of relationships in the TH community.

In this sense, the possibility of replicating this model stands out, with due openness to the inclusion of particularities, in any inhabited geographic space. It is understood that the theoretical model of an integrative platform represents a potential by-product of this academic contribution under development, but whose minimum requirements for its construction are established here.

In this sense, it is understood that this work contributes both to the scientific research and production environment and to the advancement of democratic inter-social relations. The characterization of its relevance and originality was mainly due to the elaboration of an integrative platform model to enable solutions applicable to the TH model.

The creation and detailed description of an integrating instrument, namely, through the adoption / adaptation of already established dimensions and theories, can also be perceived as a contribution to this work.

In addition, it is proposed for future work the possibility of new inclusions and restructuring, given the possibilities for improvement and customization of the proposed model.

Search Limitations

When considering the research method itself, which has the natural characteristic of the little basis for the generalization of the conclusions obtained, caution and consideration should be given to the conclusions of this work, which must be seen in the foreground in the context in which they emerged: creation of a theoretical model of a collaborative digital platform.

Finally, the conclusions presented here may not even reflect the reality of other initiatives focused on mechanisms, which support the TH model in other contexts that will use the same or similar dynamics.

It is hoped that the development of this work can contribute to the realization of academic constructs focused on research for the creation and development of virtual communication networks aimed at regional development programs.

The possibility of the proposed model being applied to any inhabited geographic space is asserted, safeguarding adaptations to the specificities of each location.

The road to mass involvement and awareness is often long, entangled with challenges, sometimes blocked by paradigms, but rich in learning.

The efforts made in this work lead us to suggest, among others, the following works:

- Development and implementation of the proposed theoretical model;
- Research on the perception of the results of the implementation and operation of the post-development model;
- Identification of opportunities to improve the model through the creation of applicable tools, including analysis of what is fundamental and what can be suppressed or customized.
- Development of an awareness and engagement plan for the TH community, locus of implementation;
- The scientific community is encouraged for future research that can improve the model presented in its theoretical form in this work, and that contributes to the evolution of knowledge related to the use of virtual communication tools.

Finally, it can be said that the platform model suggested, proved to be viable in the context of the contributions and intensity of consensus presented by the panelists, being able to generate results, as long as it was developed and applied in line with the actions and premises defined.

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