ISSN: 2683-1597

Project Design and Management

PDM
PROJECT DESIGN AND MANAGEMENT

January - June, 2023

VOL. 5 NUM. 1

https://www.mlsjournals.com/Project-Design-Management

PROJECT, DESIGN & MANAGEMENT

Vol. 5 ● Núm. 1 ● Junio – June - Junho 2023

https://www.mlsjournals.com/Project-Design-Management

EQUIPO EDITORIAL / EDITORIAL TEAM / EQUIPA EDITORIAL

SUMARIO ● SUMMARY ● RESUMO

Editorial

This issue of MLS Project Design & Management emphasizes the importance of joint participation that connects with the diverse scientific disciplines of our collaborators. Innovation in scientific-technological development is a fundamental feature that demonstrates the main objectives of the journal in research and dissemination. This edition presents 10 selected articles, divided into three sections. The first section corresponds to the discipline of business management implemented in micro and small enterprises (MSEs) through design and innovation using an international guide for project management. The second section corresponds to the technical development, presenting the design of a tool that evaluates quality, environment and safety in automotive companies. In addition, for the agribusiness sector, two relevant research studies are presented, the first corresponds to the analysis of the factors that affect innovation in agricultural MSMEs and the second is oriented to entrepreneurship in agriculture in Puerto Rico. Finally, the teaching section presents a spatial analysis of co-research in collaborative spaces and a proposal for systemic improvement of distance education project management tools validated in a state university as a case study.

The first article exposes applicable strategies for companies that need to improve the chances of success in their projects through the intervention of Argentina's national culture and its impact on project management, implemented by project managers certified in the Project Management Fundamentals Guide (PMBOK® Guide). In addition, the second article, through a correlative analysis, constitutes a contribution to the development of management theories adapted to the realities in the operations of micro and small enterprises of a country, applying a model of formulation of organizational management projects among theoretical and conceptual tools of an entrepreneur in his Organizational Management Projects, demonstrating a greater development of his Determining Factors of Entrepreneurial Survival for the first years of life of the company.

The importance of Service Design in Internal Audit units is demonstrated through an exploratory research conducted in the third article, designing services as the facilitators of co-creation of value for users and reflecting its importance in the development of strategic actions, new processes, tools and methods under an iterative approach.

Through a multi-criteria analysis, the fourth article establishes a standardized parameter that operates based on geographic information and the principles of co-research, offering the possibility of managing the processes and products derived from collaborative work to achieve excellence in educational centers.

The description of the fifth article details the matrix design as a quality, environment and safety evaluation tool for an automotive company in Reynosa Tamaulipas, Mexico, implementing a matrix design with the help of the Ishikawa diagram, which is optimal in the efficiency of the management of the organization, eliminates the duplication of documents and processes, allowing to minimize the workload and efforts, avoiding non-compliance in the lack of standardization and customer and regulatory requirements.

According to the results of the sixth article, the incorporation and use of Information and Communication Technologies is necessary in different productive sectors, due to the modification and adaptation to the new technologies and changes present in the market so necessary for subsistence, such incorporation was analyzed in bakery companies in the Municipality of Campeche, Mexico.

Through a direct and significant correlational research in agricultural MSMEs between the lack of competence of managers and the lack of articulation with the public sector as factors that affect innovation in MSMEs, the seventh article shows the lack of technology transfer and knowledge management as determinants of low innovation in Norte de Santander. Meanwhile,

the eighth article presents the agricultural entrepreneurship applying changes and development in Communication and Information Technologies in agribusiness in Puerto Rico, based on the theory of planned behavior (TCP) in determining the production of cannabis for medicinal use and driven by students of the University of Puerto Rico in Utuado and Mayagüez.

The ninth article demonstrates the relationship between managerial leadership and the productive development of the automotive sector in Guayaquil, stating that the confidence shown by a leader who directs and supports the team with confidence, generates a high degree of commitment to the team for the achievement of results expected from the manager with the ability to transmit vision and assign responsibilities for the fulfillment of goals and the development of each individual.

The last article, on the other hand, proposes an integrative matrix of concepts, containing information on the practical applications of high impact articles within the academic knowledge between Building Information Modeling together with Thermal Performance, Energy Efficiency and Sustainability, summarizing the most impactful applications in an integrated matrix, which allows BIM professionals and academics to use these results to find new applications, authors, debates and data in a more efficient way.

Before concluding this editorial, it is important for all of us who collaborate in this new project to thank the team of collaborators, IT and technical, as well as the Ibero-American University Foundation (FUNIBER) and the Universities that have provided all the material support so that this issue can be carried out, with the conviction that we are on the right path towards international recognition.

Dr. Luis A. Dzul López
Dr. Roberto M. Alvarez
Editors in chief

PROJECT, DESIGN AND MANAGEMENT

https://www.mlsjournals.com/Project-Design-Management

ISSN: 2683-1597

How to cite this article:
Flouret, C. G. (2023). El impacto de la cultura nacional en la gestión de proyectos en la Argentina. *Project, Design and Management, 5*(1), 7-26. doi: 10.35992/pdm.5vi1.1136.

THE IMPACT OF THE NATIONAL CULTURE ON PROJECT MANAGEMENT IN ARGENTINA

C. Gustavo Flouret
Aden University Panama (Argentina)
gflouret@aden.org - https://orcid.org/0000-0002-3076-3944

Abstract. Organizations implement their strategies by executing initiatives called projects. To manage them, they use good practices or methodologies from different sources. The person in charge of directing the projects is the Project Manager, who, through his experience and the guides' help, carries out the necessary actions to obtain the project objectives. One of the most popular guides is the "A Guide to the Project Management Body of Knowledge (PMBOK® Guide)". Because of the globalization that has taken place in the last 30 years, the national culture has begun to be taken into account in project management, but the incorporation of this topic in the PMBOK® has been slowly carried out. There are numerous papers that study the relationship between national culture and project management, but there are very few that includes Argentina in its research. Based on the hypothesis "National culture impacts the management of projects, which are managed by PMP® certified argentine Project Managers, in Argentina", this work aims to fill that void. To this end, a review of the existing literature was carried out, and from it, forty six statements were developed, which, opportunely, were presented to 10 Argentine PMs, with PMP® certification, within the boundaries of a qualitative research. After the analysis of their answers, the research hypothesis was confirmed. In addition, forty-two cultural considerations of practical application for project management in Argentina were identified, including aspects such as organization, leadership, relationships and communication with stakeholders, and interaction with the project team, among others. It is expected that these results may be applied in professional practice, to improve the chances of success in projects.

Keywords: National culture, project management, Argentina, Hofstede.

EL IMPACTO DE LA CULTURA NACIONAL EN LA GESTIÓN DE PROYECTOS EN LA ARGENTINA

Resumen. Las organizaciones implementan sus estrategias ejecutando iniciativas llamadas proyectos. Para gestionarlos, utilizan buenas prácticas o metodologías de distintos orígenes. El encargado de dirigir los proyectos es el Director de Proyecto (DP), que por medio de su experiencia y del auxilio que le brindan estas guías lleva a cabo las acciones necesarias para obtener el objetivo. Una de las más difundidas es la Guía de los Fundamentos para la Dirección de Proyectos (Guía del PMBOK®). Como consecuencia de la globalización ocurrida en los últimos 30 años, la cultura nacional ha comenzado a ser tomada en cuenta en la gestión de proyectos, pero la incorporación de este tema en el PMBOK® se ha realizado lentamente. Existen numerosos trabajos que estudian la relación entre cultura nacional y la gestión de proyectos, pero hay muy escasa literatura que incluya a la Argentina en sus investigaciones. A partir de la hipótesis “La cultura nacional impacta la gestión de proyectos, que sean dirigidos por Directores de Proyectos argentinos certificados PMP®, en la Argentina", este trabajo tiene el objetivo de llenar ese vacío. A tal efecto, se realizó una revisión de la literatura existente y a partir de ella, se

efectuó una investigación cualitativa, utilizando 46 afirmaciones, desarrolladas a partir de la base teórica, que fueron presentadas a 10 DP argentinos, con certificación PMP®. Como resultado del análisis de las respuestas, se confirmó la hipótesis de investigación. Además, se identificaron cuarenta y dos consideraciones culturales de aplicación práctica para la gestión de proyectos en la República Argentina, incluyendo aspectos tales como la organización, liderazgo, relaciones y comunicación con los interesados e interacción con el equipo de proyecto, entre otros. Se espera que estos resultados puedan ser aplicados en la práctica profesional, para mejorar las oportunidades de obtener el éxito en los proyectos.

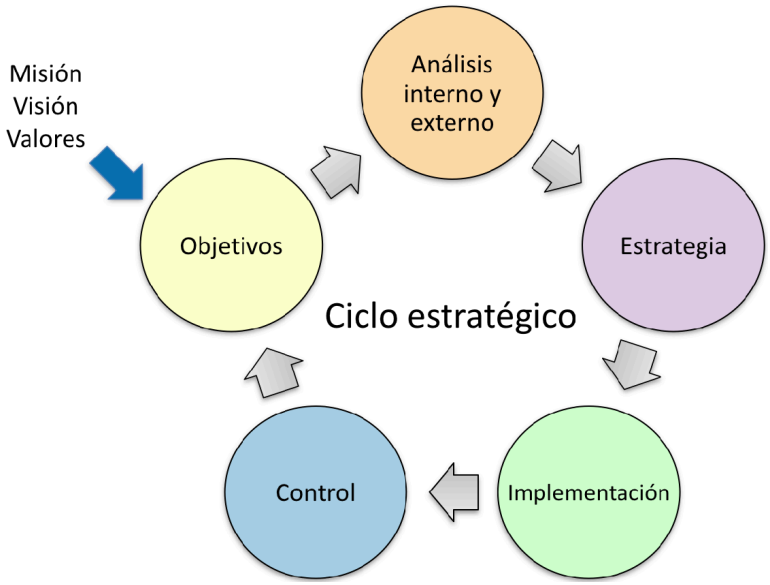
Palabras clave: *Cultura nacional, gestión de proyectos, Argentina, Hofstede.*

Introduction

Within the strategic planning cycle of organizations (see Figure 1), there is a stage called "Implementation", where the initiatives that respond to the organization's strategies are carried out (Project Management Institute, 2014). These initiatives are called projects.

Figure 1

Strategic cycle



Projects are temporary efforts that are undertaken to achieve a unique product, outcome or service (Project Management Institute, 2017, p. 3) and are intended to bring about the strategic change required by organizations (Project Management Institute, 2014). The most widely known and used project management standard in the world is the Project Management Fundamentals Guide (PMBOK® Guide), which incorporates predictive and agile methodologies (Alwaly and Alawi, 2020; Project Management Institute, 2017)which incorporates predictive and agile methodologies.

The skills and experience of the Project Manager (PM) together with the best practices described in the PMBOK® improve the initiative's chances of success, which is measured by the achievement of objectives and customer satisfaction.

Given the ease of working from anywhere in the world where there is an internet connection, projects, whether local or international, involve people from different cultures involved in them, so it would be expected that the PMBOK® would make some reference to the effects of national culture on the project. However, the PMI has developed this concept very slowly since in versions 5 and 6 of the PMBOK®, it introduced the concept of culture, but more oriented to organizational culture. In version 7, it outlined the concept of national culture, within the section on the external environment, without going into the subject in depth (Project Management Institute, 2021, p. 18)without going into the subject in depth. This forces the PD to understand and manage the impact of the national culture, both of the organization and of the country or countries where the project is carried out, without PMBOK® support.

National culture has no single definition so for the purposes of this paper, culture will be defined as "the collective programming of the mind that distinguishes the members of one group or category of people from others." (G. H. Hofstede et al., 2010).

For the purposes of this research, the choice of Geert Hofstede's model (2003; 2010) is based on the fact that its citations in scientific and popularization works outnumber other models by a wide margin (Beugelsdijk et al., 2017; Bing, 2004; Kirkman et al., 2006). In addition, Nakata (2009) indicates that the popularity of this work stems from the following reasons:

- The population surveyed is huge and the data collected is of such magnitude that statistically supported conclusions can be drawn.
- The dimensions identified by Hofstede, initially four, with the addition of a fifth later[1], are capable of describing all national cultures and not just a subset. In addition, the framework is flexible enough to be adapted to different research needs.
- The theory underpinning Hosftede's work is supported by previous anthropological, sociological and psychological studies.
- The availability of the questionnaire used in the research and the standardized values of the different dimensions facilitate its use in quantitative research.

This model consists of six bipolar dimensions:

- Power Distance Index (PDI). The degree to which less powerful members of institutions, organizations and family structures expect and accept that power is unequally distributed.
- Uncertainty Avoidance Index (UAI). The degree to which members of a culture feel threatened by ambiguous or unfamiliar situations.
- *Individualism vs. Collectivism* or individualism vs. collectivism (IDV). Individualism corresponds to societies in which the ties between individuals are weak and each person is expected to take care of himself and his immediate family. Collectivism corresponds to societies where people, from birth onwards, are integrated into cohesive and strong groups that take care of them throughout their lives, in exchange for unquestionable loyalty.
- *Masculinity vs. Femininity* or masculinity vs. femininity (MAS). A society is called masculine when the emotional gender roles are clearly different: men are assumed to be assertive, tough and focused on material success while women are assumed to be more modest, tender and concerned with quality of life. A society is feminine when emotional gender roles overlap: both men and women are supposed to be modest, tender and concerned with quality of life.

[1] This work does not take into account the sixth dimension, as identified by Minkov (2007).

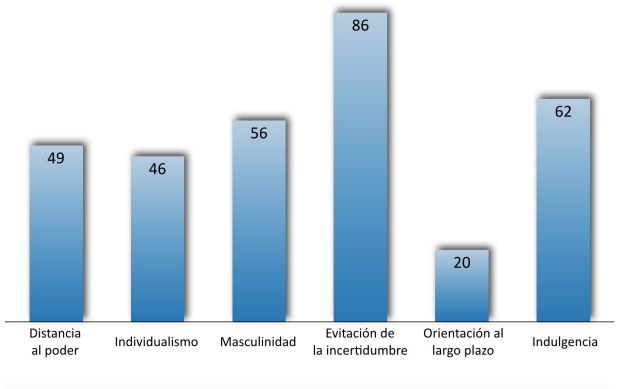
- Long Term Orientation (LTO). Long-term orientation is based on promoting virtues oriented to future rewards, perseverance and savings. The opposite, short-term orientation, is based on promoting virtues related to the past and present, in particular, respect for tradition, preservation of image or reputation and the fulfillment of social obligations.
- *Indulgence vs. Restrain* or indulgence vs. containment (IVR). Indulgence represents the tendency to allow free gratification of basic and natural human desires, related to enjoying life and having fun. Restraint reflects the conviction that such gratifications need to be curbed and regulated by strict social norms.

The aforementioned dimensions are used to explain the behavior of cultural groups in different settings. Each one of them has an associated scale with values ranging from 0 (low) to 120 (high) ⊣, placing each country according to a value obtained from the statistical analysis of the respective data. Values of 50-60 are considered average values, while below 50 are low and above 60 are high.

The data for Argentina are as follows:

Figure 2

Values of the dimensions for Argentina



Note. Source: Hofstede (2018)

As can be seen in Figure 2, Argentina has slightly low values in PDI (distance to power) and IDV (individualism), medium-high in MAS (masculinity vs. femininity), very high in UAI (uncertainty avoidance), very low in LTO (long-term orientation) and high in IVR (leniency vs. restraint).

There are numerous works that explore the impact of national culture on the projects, such as, for example, (Avison and Myers, 1995; Baumann, 2013; Binder, 2007; Bredillet et al., 2010; Chen and Partington, 2004; Chin Mei Yen and Pulatov, 2008; Eberlein, 2008; Esteves and Bohórquez, 2007; Friday and Stella, 2019; G. Hofstede, 1983b, 1983a; G. Hofstede and Bond, 1988; Loosemore and Muslmani, 1999; Maruping et al., 2019; Milosevic, 2002; Müller and Turner, 2004; Newman and Nollen, 1996; Pheng and Leong, 2000; Rees-Caldwell, 2010; Rodrigues et al., 2014; Shore and Cross, 2005; Tata, 1999; Winch et al., 1997)among others, but those that do so with reference to Argentina are extremely scarce.

Method

The purpose of this work, represented by its general objective, is:

To establish whether there is an impact of the national culture on project management in Argentina from the PMBOK® point of view.

In turn, the specific objectives are:

- Identify the impact that the dimensions of the national culture have on project management in Argentina from the PMBOK® point of view.
- Develop cultural suggestions for project management in Argentina.

To conduct the research, the following hypothesis is developed:

- H1: The national culture impacts project management, which is led by PMP® certified Argentinean Project Managers in Argentina.

To carry out this work, an instrument was developed consisting of forty-six statements, mentioned in Table 1, which were submitted to the opinion of each of the interviewees in interviews conducted virtually.

Table 1
Affirmations

Number	Affirmation
1	Project management requires assertiveness, performance and clear objectives.
2	Projects require very detailed planning and clear rules of the game to be successful.
3	Executing the project means obtaining concrete results in the short term and completing the project. Everything else is management's problem.
4	Innovations within the project work undermine the performance and objectives of the project.
5	I feel better working on a project when I am interested in the objective of the project.
6	Project roles must be clear and autonomy must be limited.
7	Either in meetings or in personal interviews, a team member may express his or her opinion or disagreement with the Project Manager or the Sponsor.
8	A planned allocation of team members' work is preferable to changes in the assignment of activities.
9	From the beginning of the project, it is important to demonstrate to suppliers who is in charge.
10	Even if the project is innovative and uncertain, it is important to have a well-defined organization chart to carry it out.
11	I am responsible for my daily work. When I finish I go home.
12	Rules and standards only serve to limit the freedom of action in a project.
13	In the project, it is preferable to focus on what can go wrong, in order to be prepared for that moment.
14	The project sponsor is always open to chat and have a beer with the team, contributing to a good working atmosphere.
15	It is important to focus on the project. Any personal gratification or celebration, even at the end of the project, is a waste of time and resources.

16	The quality of the project has to do with top management. User requirements will be considered if directed by my managers.
17	The important thing within the project is to be disciplined and focus on the project work, putting it before personal considerations.
18	I generally find it easy to put together high-performing project teams.
19	I prefer an assertive and firm leadership style to manage the project.
20	Generally, organizational norms make it difficult to assemble project teams.
21	Help from one team member to another should be acknowledged in a relatively short period of time.
22	I don't care what decision they make because I will never be consulted.
23	The autonomy I have is sufficient to modify the activities, if necessary.
24	As a Project Manager I am not comfortable when I have to make risky decisions.
25	Costs must be very detailed to meet long-term project objectives.
26	The relationship with stakeholders requires authority, firmness and control.
27	Input from the project team is essential to determine the work to be performed on the project.
28	Lower level employees should not be considered for stakeholder identification. Their contribution to the project is limited.
29	The important thing is perseverance. Results will be obtained when appropriate, but not before.
30	Project decisions are made at a higher level than mine and that is what I prefer.
31	Contracts with suppliers are essential to avoid project risks.
32	If I have a problem on a project, I prefer to consult an expert rather than a friend.
33	Status meetings and project reports are a waste of time, so I prefer to communicate one-on-one with team members
34	Project decisions should be made at the project team level.
35	The reward for a well-performed activity should be exclusively for the individual who performed it.
36	Project quality requires well-defined standards and constant monitoring to avoid problems in the future.
37	The description of the tasks to be performed is specified and there is no room for personal discretion.
38	Communication in the project is extensive and at all levels.
39	It is important to have a clearly established project team organization chart in order to manage it.
40	It is essential to have all stakeholders identified before starting project implementation.
41	Project risks should be defined as precisely as possible, leaving aside ambiguities.
42	The activities in a work package can change and that's fine.
43	The workload should be reasonably balanced among team members regardless of their individual capabilities.
44	Out-of-office activities with the project team are rewarding and help to consolidate the group.
45	Rest and freedom to choose tasks within the project are totally secondary.
46	Project cost planning should be provided in great detail.

These statements were developed on the basis of the literature surveyed, which details the relationships between Hofstede's dimensions and the different behaviors or attitudes of the individuals or groups studied. The aim is not only to provide a starting point for the

interviewees' comments, but also to use them as behavioral triggers for a more authentic response.

The statements were presented to ten active project managers, who obtained their PMP® (Project Management Professional) certification in different geographical areas of Argentina. To determine the total number of respondents, we took into account the recommendations of Hernández Sampieri et al. (2014, p. 384) that consider the operational capacity of collection and analysis, the phenomenon under study and what they call the "saturation of categories". The latter occurs when, when new answers are added, no new elements or data are provided. During the course of the research, it was observed that there was a repetition of responses between the fifth and ninth interviews, so it was decided to conduct ten of them.

Among his activities we can mention the management of projects of different sizes and scopes, national and international consulting, academic experience in university classrooms and companies, coaching and project auditing, among others. His field of action is both private and public, in companies, consulting firms and industrial and service organizations.

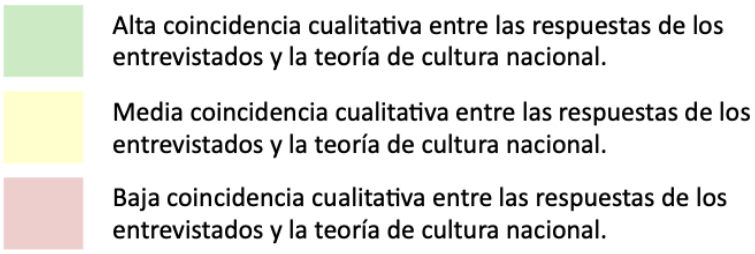
In addition, several of them are professors at prestigious universities in Argentina and, in particular, two of them are directors or members of academic committees that influence the contents of the university courses under their responsibility.

All of them are or were involved with PMI in Argentina, leading or being part of projects of the local chapters and the Educational Foundation. One of them has won an award of relevance from PMI.

Each of the 460 responses to the different statements was analyzed for agreement with the national culture theory, classifying them as high, medium or low agreement (see Figure 3), with an associated color. Thus, if the response reflected behavior that coincided with the theory, it was classified as high. On the other hand, if the response had a limited degree of agreement, but aspects of the theory were recognized in it, it was classified as medium agreement. Finally, if the response reflected behavior different from the theory, it was classified as a low match.

Figure 3

Classification of responses



The result of all statements can be seen in Figure 4. Each of the squares contains a number representing the statement under consideration and a color, which represents, according to Figure 3, the coincidence of the responses with the theory of national culture (TCN). Then, for example, the green square, with the number 1 inside, should be read as meaning that the respondents, when proposing statement 1, made comments that have high agreement with what is expected according to the NCT.

Of all of them, 34 responses showed high qualitative agreement between respondents' answers and the national culture theory, 6 responses showed medium agreement and 6 responses showed low agreement. This means that the responses of the project managers interviewed, in some cases, deviate from what is expected, according to the theory and the literature surveyed.

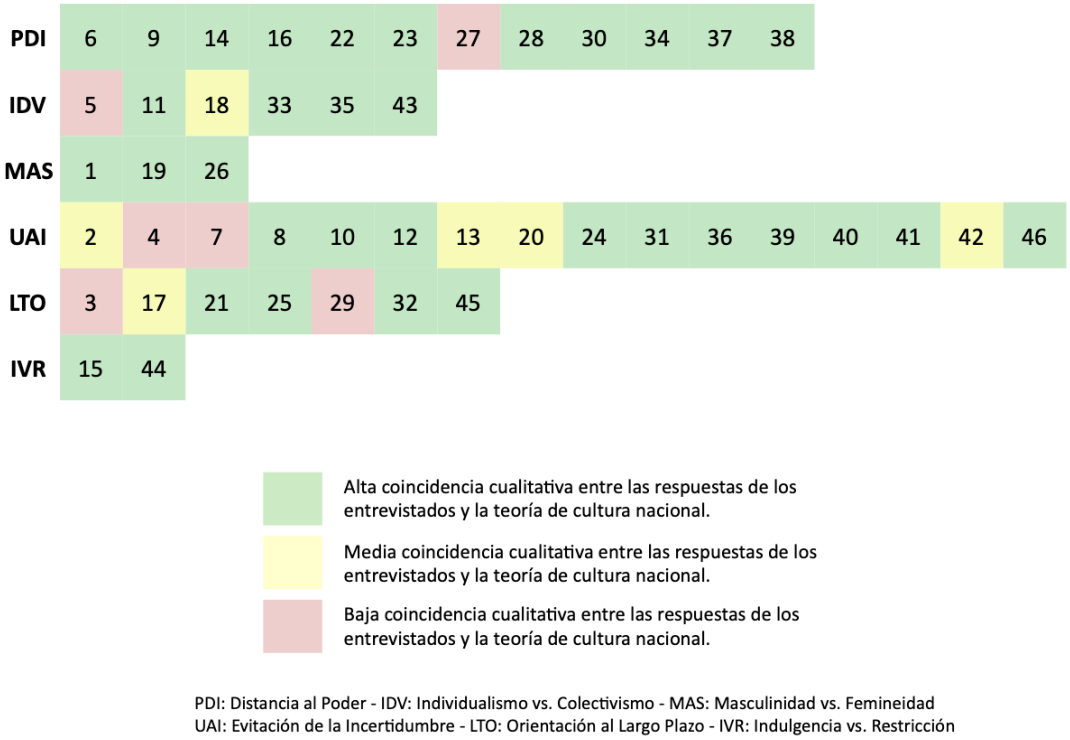
Figure 4

Results showing the coincidence of the answers with the TCN

Figure 5 shows the distribution of responses according to Hofstede's dimensions.

Figure 5

Results showing the coincidence of the responses with the TCN distributed by dimension



Results

As a result of the literature review and the data analysis carried out, it is observed that the national culture influences the behavior and opinions of the interviewees and, therefore, it is verified that it has an effective impact on project management in Argentina, within the limitations specified for the work.

The effects can be seen on multiple aspects, among them:

- Organization, hierarchical structure and leadership.
- Autonomy and decision making.
- Planning and management.
- Stakeholder relations.
- Relationship with the project team.
- Communications within and outside the project.
- Risk management.
- Behavior of the Project Director (PD).

As mentioned above, there are cultural impacts that coincide with the theory of national culture. With respect to project management, these are:

- The masculine behavior of the Argentine culture supports the consideration that the PD should have an assertive behavior, with clear objectives, which, as a consequence, reduces uncertainty. It is the opposite of doubt, indecision. He/she must be firm, understanding firmness as empathy, with solid convictions, with self-discipline, motivator, with clarity of objectives, willing to listen, and with a freer style of collaboration, order and organization, where there is room for dissent and exchange of ideas. Therefore, he rejects authoritarianism, represented by imposition, excessive order, excessive regulations and rules, being strict, not recognizing mistakes and not being grateful, among other things.
- The high UAI of the Argentine culture is represented by the PD's need for clear rules of the game, understanding by this term all those actions that tend to clarify the project and reduce uncertainty. These should involve all stakeholders, especially the sponsor and the team, and should be shared by all of them. The results of not having enough clarity on the project are confusion, miscommunication, and, eventually, failure.
- According to an average distance to power, it is indicated that, when the project is underway, daily decisions are the responsibility of the PD, implying the necessary autonomy to carry them out. Given the characteristics of management, there is a need to make decisions and apply discretion to project activities and management. Those that modify the previously agreed plan may be consulted through the agreed channels, but, during the project work, with the approved plan being executed, consultations are not necessary. In any case, organizational structures are recognized, where the sponsor occupies the most hierarchical level and makes those decisions that go beyond the plan. In this context, the PD's autonomy will be limited by the project's objective.
- Continuing with the distance to the middle power, it is important to highlight that the autonomy already developed above applies to the determination of the activities to be executed. Within the context of the project, team members can innovate, adding value to their activities. This implies that it is possible to perform technical tasks in different ways and to find new ways to obtain the expected results. On the other hand, there is the impossibility of reaching 100% specifications and it is emphasized that the activities have to do with technical aspects about which the PD may not have all the knowledge. Therefore, it is necessary to rely on the common sense of the person performing the activity and give him/her a certain amount of discretion. In addition, good communication within the team and with the PD is essential, as well as a clear strategic vision, communicated in a timely manner, so as not to restrict the contribution of team members.
- The uncertainty of the project is avoided by means of rules and norms that help its management, without confusing them with restrictions to freedom of action, a subject already discussed in previous paragraphs. These help to:
    - ◊ Define acceptable behaviors.
    - ◊ Establish behaviors that enhance the dynamics and possibilities of the project.
    - ◊ Increase security and confidence in execution.
    - ◊ Contain and channel freedom of action.
    - ◊ To provide a reference framework for management.
    - ◊ Keep chaos away.
    - ◊ Make the limits clear.
    - ◊ Order, organize and increase the probability of success of the project.

- ◊ Define the role of people and focus energy.

- Finally, even in uncertain and innovative projects, they are considered to maintain a neat environment within the project.
- In a culture whose individualism is average, the person responsible for the project is the PD and, as such, must lead, develop and take into account the planning of the project. This responsibility includes concern for stakeholders in general and team members in particular. Included in this commitment is the generation of team spirit, not only for those involved in technical issues, but for all stakeholders.
- Coinciding with a low LTO value, the DPs consider that consultations for technical issues should be made to experts. Although it is possible to obtain valuable feedback for an introspective view of interpersonal behaviors from consultations with friends, expert consultations are prioritized.

With respect to human resources, these are:

- The project organization can be impacted by cultural behaviors corresponding to several dimensions. In the case of the organization chart and the roles and responsibilities, on the one hand, we have the PDI dimension and on the other, the UAI. For the former, clarity of roles and responsibilities in the project management structure is fundamental. It clarifies power and authority relationships and allows to deduce the levels of autonomy available for work management and decision making. Autonomy is valued, but is limited by roles and responsibilities, scope, type of project, uncertainty of objective, structure of both the project and the organization carrying it out, and type of team work.

For the second, the organization chart is an important tool for its help in organizing the work, avoiding problems due to lack of knowledge of roles and responsibilities and allowing decisions to be escalated to the correct level, thus reducing uncertainty. It helps to understand, at a glance, the structure of an organization, whether permanent, such as an established company, or temporary, typical of project management. It represents the resources involved and allows for their proper management.

- Consistent with the medium level of distance to power, there is a hierarchical distance between the sponsor and the project team. He values his guiding role, his support for the initiative, and the greater communication and clarity that his involvement brings. However, it is indicated that their constant presence is not necessary for the work to be performed. In fact, it can cause inconveniences due to overlapping roles with the PD and the confusion in reporting that can occur, increasing the risk in the project.
- In a culture with a strong tendency toward personal enjoyment, celebration and gratification are important. The pressures on a project are considerable and one way to reduce them is to have moments of relaxation. These create an environment that reduces tensions, empowers, cohesionizes and provides feedback to the team, creates a climate of collaboration and communication and, fundamentally, allows people to be thanked for their work.
- Activities can be carried out inside or outside the office, either celebrating stages, milestones and events (birthdays, births and personal achievements, among others), or carrying out actions that emphasize team building, improvement, consolidation and gratification and highlight the relationship that is built outside the technical activities of the project.

- One of the dangers lurking for the PD and project team members is physical exhaustion from the demands they face. In a culture with a short-term vision that seeks immediate results, this danger is clear and present. Therefore, rest and freedom to choose tasks are not considered to be secondary issues. Both generate commitment and motivation and should be taken into account.

Excess work may exist, for reasons related to the project situation, but it must be totally cyclical. If it becomes a habit, the work team will suffer the consequences with a corresponding increase in project risk and consequent demotivation.

- Help among team members should be recognized. In a culture that expects everything to happen immediately, this recognition must be made as soon as possible. This helps to further integration and team building.
- The definition and implementation of recognition and rewards are part of the PD's responsibility. The slightly collectivist aspect of the national culture influences in the sense that group rewards are preferred, despite the fact that it is a member of the team that has developed the activity that provokes the recognition. This comment is based on the fact that it is not possible to obtain achievements without the help of the team.
- The way in which decisions are made is closely related to the distance to power. With a medium value, the PDs consider consensus desirable and emphasize that there are different alternatives for achieving it, but agree that the ultimate responsible party is the PD.
- According to mild collectivism, it is considered that the workload should take into account individual capabilities, but this should not be used as an excuse to overload a team member, since this would generate exhaustion, demotivation and increased project risks.

With respect to the interested parties, these are:

- Early identification of stakeholders is considered very important or critical because of its impact on reducing project uncertainty and risk. For a culture that pursues both objectives, this activity requires sufficient dedication in both initiation and planning. The advantages are the verification of the impact of project decisions on them, avoidance of redoing activities already completed, and mitigation of risks and changes that could originate from unidentified stakeholders.
- It is important to bear in mind that there are projects in which stakeholders may be very difficult to identify or form part of a very large group of people where individualization of each one of them is virtually impossible. In these cases, it is important not to consider large conglomerates of stakeholders as uniform and to look for mechanisms to separate them into smaller, manageable groups.
- According to an average distance to power, it is considered that all employees of the organization, regardless of their level, should be taken into account as stakeholders. As reasons, they indicate the proximity to the operation and to the client, the impact on the project if their requirements are not met, the unsuspected stakeholders that are detected by avoiding using the organization chart as a filter, the contribution they may have to the project, and the reduced risk of boycott.
- Consistent with an average value of MAS, it is considered that the relationship with stakeholders should take into account firmness in protecting the scope of the project, in communication, without hesitation or hesitation, and in the timing and location of

stakeholder involvement. It is also important to know how to discern the moment to be flexible in order to adapt to their requirements or demands.

- Authoritarian leadership is not accepted by a culture with an average POI. In this regard, it is commented that, with respect to suppliers, clear rules of the game are sought and it is emphasized that collaboration is very important.

With respect to costs, these are:

- From LTO's point of view, it is considered that costs should be detailed according to the duration of the project and the control to be carried out. A possible guideline is found in the CAPEX[2] of the same, which will determine the discrimination of costs.
- However, from the point of view of uncertainty, the greatest possible detail is sought, which generates clarity, understanding that the information may be impacted by the time frame, size and uncertainty of the project.

With respect to quality, these are:

- Quality in a project implies customer satisfaction. In a culture with a medium power distance, it is considered that this objective should involve all stakeholders, listening to the users, surveying their needs and requirements, prioritizing according to the parameters established by the project strategy and the comments of the sponsor and key stakeholders, and agreeing on the final scope. Requirements build the value of the project, so it is essential to manage them.
- Reducing uncertainty in quality management is reflected in the need to define standards and perform quality planning. This will provide the project with a guide and the necessary mechanisms to monitor it.

With respect to communication, these are:

- With an average POI, communication is considered a relevant topic. Communications must be specific, precise and clear, with established responsible parties and identified recipients. A communications plan should be developed to manage the dissemination of project data and information based on stakeholder needs.
- For a culture with average individualism, both project meetings and status reports are important. The former must be planned and managed to avoid falling into unproductive sessions. The agenda and inviting the right people are important. The advantages that can be cited are:
    - ◊ The exchange of opinions of the participants, after the presentation of the topic.
    - ◊ The counterpoint between team members.
    - ◊ The appearance of hidden problems.
    - ◊ Different points of view on the same situation.
    - ◊ The participation of all team members.
    - ◊ Interactions that do not occur on a day-to-day basis.

[2] Capital Expenditure - Capital Investment

Consequently, with respect to reports, and taking into account the comments in the previous item, it is suggested that the PD develop and implement a process for creating and distributing information in reports, the content of which is agreed upon with the stakeholders who will receive them.

- Regarding meetings, it is suggested that the PD develop and implement a protocol for meetings, containing, among others, the following points:
    - ◊ Develop and send the agenda in advance of the meeting.
    - ◊ Invitation to the corresponding interested parties.
    - ◊ Development and application of rules of conduct, including punctuality.
    - ◊ Identification of those responsible for the actions, with date of compliance.
    - ◊ Preparation and distribution of the minutes.
    - ◊ In addition, it is suggested to manage and conduct the meeting and the use of the "parking lot"[3] technique to record off-agenda items that should be considered at another time.
- It is considered uncomfortable to make risky decisions in the project. While inevitable and part of the profession, it is still a matter of concern. The PD must be prepared to deal with these situations and the sponsor must build a supportive environment.
- It is important to unambiguously identify and define project risks. This implies that they must be specifically defined, leaving aside generalities (Project Management Institute, 2019). For example, it is not the same to declare a "risk of disease", where a disease can range from a cold to a very serious health condition, as it is to declare "There is a risk of a flu epidemic due to the weather conditions expected during the course of the project". This reduces the uncertainty of the project.
- Contracts should serve to reduce risk exposure in a business relationship. To do this, they must set a clear framework within which the contractor will carry out its activity, including its responsibility, the scope of the task, the deadline and the deliverables. In addition, good contract and supplier management is required to aid in the success of the project.

The results reflected behaviors that do not coincide with the national culture theory. With respect to project management, these are:

- Contrary to expectations, taking into account a slight collectivism reported by Hofstede's IDV dimension, DPs analyze the possibility of not participating in the project if the objectives do not coincide with their particular interests. Therefore, from the point of view of the organization, sponsor or client, it is advisable to seek an alignment between the PD's personal objectives and the project's objectives. The results indicate that given this coincidence, there is a greater sense of well-being, greater commitment and greater interest.
- In contradiction with the need to avoid uncertainty and have all aspects of the project under control, the DPs, within the general framework of the initiative, consider innovation as an element to be encouraged. They believe that this choice boosts performance, adds

[3] A technique developed to note important issues that arise in a meeting, but are not included in the agenda. These can be dealt with later in ad-hoc meetings.

richness to the project, provides creative ideas for problem solving and helps to adapt and converge towards changing objectives. They recommend taking into consideration planning, team training, risk assessment, support for innovation activities, the stage of the project at which it occurs and the methodology used. In general, agile methodologies and the early stages of a project are considered to be the most prone to innovate.

With respect to planning, these are:

- As opposed to the need to control and plan in detail to avoid uncertainty, the general preference is to work with less detailed, higher-level planning, with greater flexibility. However, this decision depends on the objective and type of project. The factors that have an impact are the methodology to be used, the scope, the resources available, the dynamism of the organization and the context of the initiative.
- Stakeholder pressures for immediate or short-term results, behavior that coincides with the LTO dimension, are counterproductive. The DPs emphasize that they must be obtained based on planning, whether in the short, medium or long term, and the responsibility for achieving them lies with the DP. It is important that there is a congruence between them and the final objective of the project. A fundamental aspect is perseverance, understanding that objectives must be achieved at the appropriate time.
- Although Argentine culture values predictability and avoids uncertainty, the modifications to the project are accepted, with some considerations. The DPs understand that there are elements that may affect the project and, as a consequence, impact the project activities. In general, the uncertainty of the project's objective, the external environment and issues internal to the organization that affect the project's development are mentioned. However, they add that changes cannot be anarchic, but must follow a process of control and justification and must contribute to improving the project's objective, reducing risks, satisfying the user and the sponsor, and lowering deadlines and costs.

With respect to resources, these are:

- Although strict processes are preferred in cultures with a high UAI, such as Argentina's, in general, the DPs indicate that teams are formed by the people and the leader. They accept that standards can help since they generate a standard of the links between people, but that the construction of the teams depends on the people who lead and compose them.
- Despite being a culture with a certain degree of collectivism, which favors team building, the DPs agree that there is great difficulty in putting together high performance teams. The causes are varied and they comment that, to achieve this, it requires time, sacrifice, communication, patience, persistence, finding the right people and achieving synergy between them.
- In spite of being a culture where there is a distance to medium power, the DPs agree that the participation of the project team is fundamental to determine the work to be done. This is due not only to technical issues such as technical knowledge, better technical estimation of the duration of activities and better risk management, but because of the team's greater commitment to something they helped define, better communication between members and better management of the project team.
- In a culture with a high UAI, tolerance of differing opinions is low. However, most DPs agree that freedom of expression to the sponsor or the DP is critical to reaching agreements, getting better ideas and making better decisions, and avoiding both groupthink and keeping quiet about what the bosses dislike. They explain that the

responsibility for achieving this freedom lies with the PD. Some propose that there should be some limitations, although it is important to be able to express oneself freely, bearing in mind that feedback is very important. They propose that the personal interview is the best tool to achieve this and that the target should be the PD, matching an average POI. In any case, the way in which this opinion is expressed is important in order to enrich teamwork and not generate conflict.

With respect to risks, these are:

- The focus on what can go wrong with the project is part of the characteristics of a high UAI culture. However, the DPs agree that a positive vision must be taken by focusing on achieving the objectives and protecting the value of the project to achieve success, without neglecting, through risk management, what can go wrong.

Discussion and conclusions

From the interviews conducted and the results obtained, it is verified that the national culture has an impact on projects in Argentina from the PMBOK® point of view, in accordance with the national culture theory.

In addition, H1 is tested: The national culture impacts the management of projects, which are led by PMP® certified Argentinean Project Managers, in Argentina, within the limits specified for the job.

From this validation, it is observed that the results of the analysis of the responses of 36 statements coincide with what was expected, in accordance with the theory of national culture. This means that the behaviors of the DPs respond to those described in the literature consulted.

For the rest of the statements, the answers show a different picture. In fact, 6 of them have medium coincidence and another 6 have low coincidence with the TCN. This means that the behaviors of the DPs do not coincide with those indicated by the literature consulted. The reasons for this divergence have not been investigated and may be the subject of future research.

It is important to note that the results highlight certain specific aspects of project management, such as the organization and hierarchical structure of the project, the type of leadership that is feasible to use, including autonomy and decision making, stakeholder relations from various points of view, project team management, communications, both internal and external, risk management, quality and costs, and PD behavior.

The application of these results can be immediately applied to ongoing projects and can be used for post-mortem analysis of projects to incorporate the findings into lessons learned. It is also possible to incorporate, within the project planning, aspects of the national culture that can be taken into account for each of the PMBOK® knowledge areas. For example, taking into account the low LTO of the Argentinean culture, it is to be expected that stakeholders will want to obtain results in the shortest possible time, even leaving aside planning. The PD, knowing this trend, can prepare strategies to respond to these requirements without increasing the pressure on the work team. In addition, the work team may be motivated by observing the protection that the PD provides to its members.

On the other hand, the limitations identified are as follows:

- The research focused on PMI PMP certified project managers. Although there is no such profession as Project Manager, there are numerous professionals who, with greater or

lesser adherence to PMI best practices or other methodologies, manage projects in Argentina. These were not considered and may produce different results in this study.

- The PMI indicates that there are more than 1800 certified professionals in Argentina, so the number of interviewees is very limited, which opens the possibility of expanding this research to confirm or modify the results of this work.
- Because the interview is a tool that requires contact between the interviewer and the interviewee, there is a possibility that the response will be influenced by this interaction.

Finally, it is hoped that these results can be applied in professional practice, both for Argentine PDs and for foreign PDs who must develop projects in Argentina, to improve the chances of success in the initiatives to be carried out. The more successful they are, the greater the possibility of building a better future for Argentina.

References

Alwaly, K. A. & Alawi, N. A. (2020). Factors Affecting the Application of Project Management Knowledge Guide (PMBOK® GUIDE) in Construction Projects in Yemen. *International Journal of Construction Engineering and Management*, *9*(3), 81-91. https://doi.org/10.5923/j.ijcem.20200903.01

Avison, D. E. & Myers, M. D. (1995). Information systems and anthropology: And anthropological perspective on IT and organizational culture. *Information Technology & People*, *8*(3), 43-56. https://doi.org/10.1108/09593849510098262

Baumann, L. (2013). *The impact of national culture on project management in the Middle East* [Tesis doctoral, Loughborough University]. https://dspace.lboro.ac.uk/dspace-jspui/handle/2134/12274

Beugelsdijk, S., Kostova, T., & Roth, K. (2017). An overview of Hofstede-inspired country-level culture research in international business since 2006. *Journal of International Business Studies*, *48*(1), 30-47. https://doi.org/10.1057/s41267-016-0038-8

Binder, J. (2007). *Global project management: Communication, collaboration and management across borders*. Gower Publishing Limited.

Bing, J. W. (2004). Hofstede's consequences: The impact of his work on consulting and business practices. *Academy of Management Executive*, *18*(1), 80-87. https://doi.org/10.5465/AME.2004.12689609

Bredillet, C., Yatim, F., & Ruiz, P. (2010). Project management deployment: The role of cultural factors. *International Journal of Project Management*, *28*(2), 183-193. https://doi.org/10.1016/j.ijproman.2009.10.007

Chen, P. & Partington, D. (2004). An interpretive comparison of Chinese and Western conceptions of relationships in construction project management work. *International Journal of Project Management*, *22*(5), 397-406. https://doi.org/10.1016/j.ijproman.2003.09.005

Chin Mei Yen, A. & Pulatov, B. (2008). *International differences in project planning and organizational project planning support in Sweden, Japan, Israel, and Malaysia* [Tesis de Maestría, Handelshögskolan vid Umeå universitet]. https://www.diva-portal.org/smash/get/diva2:141241/FULLTEXT01.pdf

Eberlein, M. (2008). Culture as a critical success factor for successful global project management in multi-national it service projects. *Journal of Information Technology Management*, *XIX*(3), 27-42.

Esteves, J. & Bohórquez, V. (2007). El impacto de la cultura nacional en la implantación de sistemas ERP. *Revista de Empresa*, *21*, 46-64.

Friday, P. & Stella, M. (2019). Culture and management philosophy practice in Nigeria. *Online Journal of Arts, Management and Social Sciences (OJAMSS)*, *4*(1), 139-149.

Hofstede, G. (1983a). Cultural dimensions for project management. *International Journal of Project Management*, *1*(1), 41-48. https://doi.org/10.1016/0263-7863(83)90038-8

Hofstede, G. (1983b). National cultures in four dimensions: A research-based theory of cultural differences among nations. *International Studies of Management & Organization*, *13*(1-2), 46-74.

Hofstede, G. (2003). *Culture's consequences* (2.ª ed.). Sage Publications, Inc.

Hofstede, G. (2018). Country Comparison—Argentina. *Hofstede Insights*. https://www.hofstede-insights.com/country-comparison/

Hofstede, G. & Bond, M. H. (1988). The Confucius connection: From cultural roots to economic growth. *Organizational Dynamics*, *16*(4), 5-21. https://doi.org/10.1016/0090-2616(88)90009-5

Hofstede, G. H., Hofstede, G. J., & Minkov, M. (2010). *Cultures and organizations: Software of the mind* (3.ª ed.). McGraw-Hill.

Kirkman, B. L., Lowe, K. B., & Gibson, C. B. (2006). A quarter century of Culture's Consequences: A review of empirical research incorporating Hofstede's cultural values framework. *Journal of International Business Studies*, *37*(3), 285-320. https://doi.org/10.1057/palgrave.jibs.8400202

Kroeber, A. L. & Kluckchohn, C. (1952). Culture—A critical review of concepts and definitions. *Papers of the Peabody Museum of American Archeology and Ethnology*, *XLVII*(1), 223.

Loosemore, M. & Muslmani, H. S. Al. (1999). Construction project management in the Persian Gulf: Inter-cultural communication. *International Journal of Project Management*, *17*(2), 95-100. https://doi.org/10.1016/S0263-7863(98)00030-1

Maruping, L. M., Venkatesh, V., Thong, J. Y. L. & Zhang, X. (2019). A Risk Mitigation Framework for Information Technology Projects: A Cultural Contingency Perspective. *Journal of Management Information Systems*, *36*(1), 120-157. https://doi.org/10.1080/07421222.2018.1550555

Milosevic, D. Z. (2002). Selecting a culturally responsive project management strategy. *Technovation*, *22*(8), 493-508. https://doi.org/10.1016/S0166-4972(01)00054-2

Minkov, M. (2007). *What makes us different and similar: A new interpretation of the world values and other cross-cultural data*. Klasika i Stil Publishing House.

Müller, R. & Turner, J. (2004). *Cultural Differences Project Owner Manager Communication*. PMI® Research Conference: Innovations, London, England. https://www.pmi.org/learning/library/cultural-differences-project-owner-manager-communication-8329

Nakata, C. (2009). *Beyond Hofstede: Culture frameworks for global marketing and management* (1.ª ed.). Palgrave Macmillan.

Newman, K. L. & Nollen, S. D. (1996). Culture and Congruence: The Fit between Management Practices and National Culture. *Journal of International Business Studies*, *27*(4), 753-779.

Pheng, L. S. & Leong, C. H. Y. (2000). Cross-cultural project management for international construction in China. *International Journal of Project Management*, *18*(5), 307-316. https://doi.org/10.1016/S0263-7863(99)00027-7

Project Management Institute. (2014). *El alto costo de un bajo desempeño*. Project Management Institute. https://www.pmi.org/-/media/pmi/documents/public/pdf/learning/thought-leadership/pulse/pulse-of-the-profession-2014.pdf?sc_lang_temp=es-ES

Project Management Institute. (2017). *Guía de los Fundamentos para la Dirección de Proyectos (Guía del PMBOK®)* (6ta ed.). Project Management Institute.

Project Management Institute. (2019). *The Standard for Risk Management in Portfolios, Programs and Projects*. Project Management Institute.

Project Management Institute. (2021). *Guía de los Fundamentos para la Dirección de Proyectos (Guía del PMBOK®)* (7.ª ed.). Project Management Institute.

Rees-Caldwell, K. (2010). *Project Management and National Culture: Arab and British Project Planning* [Master, British University in Dubia]. http://bspace.buid.ac.ae/handle/1234/327

Rodrigues, J. S., Costa, A. R., & Gestoso, C. G. (2014). Project Planning and Control: Does National Culture Influence Project Success? *Procedia Technology*, *16*, 1047-1056. https://doi.org/10.1016/j.protcy.2014.10.059

Shore, B. & Cross, B. J. (2005). Exploring the role of national culture in the management of large-scale international science projects. *International Journal of Project Management*, *23*(1), 55-64. https://doi.org/10.1016/j.ijproman.2004.05.009

Tata, J. (1999). The cultural context of teams: An integrative model of national culture, work team characteristics, and team effectiveness. *Academy of Management Proceedings*, *1999*, I1-I5.

Winch, G., Millar, C., and Clifton, N. (1997). Culture and Organization: The Case of Transmanche-Link. *British Journal of Management*, *8*(3), 237-249. https://doi.org/10.1111/1467-8551.00063

Date received: 24/02/2022
Revision date: 07/06/2022
Date of acceptance: 06/09/2022

PROJECT, DESIGN AND MANAGEMENT

https://www.mlsjournals.com/Project-Design-Management

ISSN: 2683-1597

How to cite this article:
Muñoz Bonilla, H. A. & Soriano Flores, E. (2023). Formulación de proyectos en Mypes: evidencia empírica de la ausencia de un modelo práctico. *Project, Design and Management, 5*(1), 27-43. doi: 10.35992/pdm.5vi1.1152.

FORMULATION OF PROJECTS IN MYPES: EMPIRICAL EVIDENCE OF THE ABSENCE OF A PRACTICAL MODEL

Hugo Alejandro Muñoz Bonilla
Lumen Gentium catholic university foundation (Colombia)
hugoamunoz@unicatolica.edu.co - https://orcid.org/0000-0001-8757-3909
Emanuel Soriano Flores
Universidad Internacional Iberoamericana (Puerto Rico)
emmanuel.soriano@unini.org - https://orcid.org/0000-0002-8747-5679

Abstract. This is an investigation that addresses the activity of formulating organizational management projects (PGO) in micro and small enterprises (Mypes), with a quantitative, correlational and cross-sectional investigative exercise, within a case study, to test the hypothesis that: The greater the number of theoretical elements used by a microentrepreneur in the formulation of their projects, the greater the development of the determining factors of business survival, a process that allows determining the existence or not of a model adopted to the operational particularities of this type of business. , using an ad hoc instrument validated by expert judgment, in two stages (design and calibration), with CVC of 0.98, Fleiss de Kappa for construct and objectivity of 0.95, with a Pearson temporal stability coefficient of 0.95 and alpha of Cronbach of 0.81. The result indicates that in the case of the population under study, there is no model adapted and used mostly by Mypes, in addition, with a Spearman's Rho of 0.617, a strong correlation between the variables studied is evidenced, which allows to contribute the concept to incorporate the Operational Distinctive Features (RDO) of the Mypes to the development of management theories adapted to their operational realities for the formulation of PGO.

Keywords: projects, micro and small companies, SMEs, business management.

FORMULACIÓN DE PROYECTOS EN MYPES: EVIDENCIA EMPÍRICA DE LA AUSENCIA DE UN MODELO PRÁCTICO

Resumen. Esta es una investigación que aborda la actividad de la formulación de proyectos de gestión organizacional (PGO) en micro y pequeñas empresas (Mypes), con un ejercicio investigativo de enfoque cuantitativo, correlacional y transversal, dentro de un estudio de caso, para probar la hipótesis que: A mayor cantidad de elementos teóricos utilice un microempresario en la formulación de sus proyectos, mayor desarrollo de los factores determinantes de supervivencia empresarial logra, proceso que permite determinar la existencia o no de un modelo adoptado a las particularidades operativas de este tipo empresarial, utilizando para ello un instrumento Ad hoc validado por juicio de expertos, en dos etapas (diseño y calibración), con CVC de 0.98, Fleiss de Kappa para constructo y objetividad de 0.95, con coeficiente de estabilidad temporal de Pearson de 0.95 y alfa de Cronbach de 0.81. El resultado indica que en el caso de la población objeto del estudio, no existe un modelo adaptado y usado mayoritariamente por las Mypes, además con un Rho de Spearman de 0.617 se evidencia una correlación fuerte entre las variables estudiadas, lo que permite aportar el concepto de incorporar los Rasgos

Distintivos Operacionales (RDO) de las Mypes al desarrollo de teorías gerenciales adaptadas a sus realidades operativas para la formulación de PGO.

Palabras clave: proyectos, micro y pequeñas empresas, pymes, gestión empresarial.

Introduction

Organizational management projects (OMP) are the instruments used by entrepreneurs and businessmen to modernize their structures and processes in order to maintain or improve business competitiveness indexes, seeking to achieve operational survival in the participating market. Such a process has the same objective in different types of companies, and yet, although they pursue the same type of purpose, the operating conditions and availability of resources constitute a particular reality that in many cases can be considered too adverse for the project and therefore for the entrepreneur who formulates and develops it.

Within such a nature of heterogeneous and particular conditions, business managers resort to the various theoretical approaches to management, either implementing them as a single model for their administrative management or harmonizing elements and principles of different approaches, thus originating hybrid models appropriate to the particularities of both the organization and the style of leadership and management applied therein.

In such a scenario of formulation of the OMPs, it is inferred that the size of the company in which the administrative management exercise is intended to be carried out is one of the real limitations for the adoption of a structured model of project formulation, especially for micro and small enterprises (MSEs) where the capacity of their resources is more limited (Rey Campero, 2016), since the larger the size of the company that is the object of the administrative intervention, the more analysis and understanding of the intervening variables is required in proportion to the complexity of the organizational and operational structure that is being intervened, hence the project model used will require the same proportional amount of resources for its application (Gallego & Cáceres, 2015).

Now, given the recognized importance of the Mypes in the economies of the countries (Campos, 2013; Cajigas Romero, Haro, & Ramírez, 2017; Vera Muñoz, Vera Muñoz, & Martínez Méndez, 2020) and its low level of business survival in a country like Colombia where the rate of operational continuity reaches 60% for the first year of existence (Confecámaras, 2018) where one of the causes of operational failure is linked to the scarcity of economic resources and lack of financing opportunities, 2017) and others have their origin from the project structure itself in which they originate as entrepreneurial processes, as pointed out by the Asociación Colombiana de Pequeños Industriales - ACOPY (2018) when referring to a business failure rate of 45% of those constituted with the financial support of the national government and its support funds for Colombian entrepreneurs.

This coincides with the findings of Jiménez (2014), Serrano Montiel, Borgucci García, Vera Colina (2013), Fracica Naranjo, Matíz B., Hernández and Mogollón (2011), in that although the economic structure of MSMEs (which are included in the analysis of MSMEs) has deficiencies, new financing modalities for microenterprises are also identified, with public and private programs, which allows us to assume that the cause of low survival is not only financial. And in the understanding that it is natural in the development of a company's operations to present difficulties and situations that require administrative management to overcome them, this gives rise to the need to formulate and design successful PGOs that optimize the scarcity

of resources, since no matter how much money is available for an improvement plan, if the plan is poorly formulated or if there is no detailed plan, it is destined to be a failure and a waste of resources for the company.

The above is evidenced by the report of (2018) who indicate that micro-enterprises carried out PGO, have an intervention tendency in personnel training close to 24%, machinery and equipment 22% and new technologies 22%, coinciding in their project actions with small companies that on average invested 29% of the PGO in machinery and equipment, and also 19% in personnel training, but even so the failure rate of this sector remained high.

Therefore, it could be thought that the microentrepreneur's difficulties are in the formulation and design of the PGO, in this regard Cajigas Romero et al. (2017) points out that in the profile of the support provided by financing entities to microentrepreneurs, an average of 30% of them have an undergraduate degree in progress and 40% have a completed undergraduate degree, with a failure rate of 42% in both cases, which indicates that the cause is not entirely linked to the entrepreneur's level of academic training, this indicates that the cause is not entirely linked to the entrepreneur's level of academic training, thus leading us to look at the lack of project management capacity of microentrepreneurs, as Saavedra (2007) indicated when presenting the phenomenon as a social debt of management schools and a constant request of the business community.

However, the above could be read out of context in view of the existence of project formulation methodologies, widely disseminated from academic environments, such as the logical framework methodology (Ortegón et al., 2005), the GIDPI model (Velásquez Restrepo et al., 2017), the modeling of projects by objectives with a focus on the Determining Factors of Business Survival (FDSE) (Angelelli & Prats, 2005), the formulation of entrepreneurship and investment projects from the perspective of business feasibility and its articulation to productivity clusters Arboleda (2001, 2013), Meixuerio and Pérez (2008), Méndez (2012), Padilla (2016) who take elements of the Logical Framework (LF) for the origin of the formulation of projects with the purpose of business creation.

Also in the academy there are contributions from the *Project Management Institute* through the different versions of its *PMBOK* (2013; 2017) model which, although it addresses with great breadth and precision the project formulation in large companies, it also lays the general foundations of the activity at all business operational levels. Thus, Ortega Zarza (2015) explains the application of the PMBOK for auditing project execution in small and medium-sized companies.

However, the evidence of the existence of theoretical models for project formulation does not imply that they are being fully used in MSMEs, and at the same time, the contextual evidence mentioned so far allows considering that, if there are successful results obtained at the level of micro and small enterprises in their OMPs, these should be related to the use of a widely disseminated and applied project model in the MSME sector or, failing that, to the use of theoretical and conceptual tools that seek to explain the particularities of the enterprises in order to facilitate their intervention and development.

Such particularities are their Operational Distinctive Features (ODR) that can be identified from the nature of the SMEs' business model (Osterwalder, 2016), the competitive advantage developed (Porter, 1990), the structural way in which they make their value proposition operational (Porter, 2009), the strengths and weaknesses presented by the company (Serna Gómez, 2008), the way in which it plans the control and follow-up of its projects (Kaplan & Norton, 2004), since in any of the cases it is evident that it is positively impacting its FDSE (Mas Verdú et al., 2015; Talebi et al., 2015; Confecámaras, 2017; Parra Alviz et al., 2017).

Therefore, by identifying a gap in the current knowledge regarding the identification of successful methodologies applied by MSMEs in the formulation of their PGO oriented to develop better business survival rates, it is necessary to prove that the more theoretical and conceptual tools an entrepreneur applies in his PGO, the greater the development of his FDSE for the first years of the company's life.

The proposed research is relevant because it can contribute to the identification of a design model fully adjusted to the operational particularities of the business sector studied, or, failing that, it can indicate from its findings the theoretical bases on which the development of a model adjusted to the characteristics of small and medium-sized enterprises should be based.

Method

For the development of the present research, a quantitative approach is adopted, within a non-experimental exercise of correlational and transversal character, which is supported by the principles of the post-positivist research paradigm, in the understanding that due to the characteristics of the studied phenomenon, a relative truth can be found and susceptible to be falsified in the future, but which in turn validates the formulation of the specific qualitative-descriptive objectives, which leads to a research design of empirical character which begins with a documentary research and then addresses an observational process of evidence of the behavior of the formulation of projects, to subsequently perform a validation of hypotheses from the information obtained from the observational process, in a representative sample of the phenomenon that finally allows to rationalize the results in a contribution to the current state of the art (Cruz et al., 2017; Universidad de las Américas & Ramos, 2015).

Based on the above, assuming that a structured model of formulation and design of a PGO is in synthesis a unique and determined sequence of actions and activities, usually non-repetitive, that propose the coordination of multiple resources in a company to achieve a defined objective, in a determined time and cost (Instituto Vasco de cualificaciones y formación profesional et al., 2010), the existence of an independence between the variable FDSE with respect to the variable Distinctive Operational Traits (RDO) that are taken into account by an entrepreneur when formulating and designing his PGO will be sought, for this purpose the following alternative hypothesis is proposed:

- Hi: The more distinctive operational features a microentrepreneur includes in the formulation of his or her PGO, the higher the indices of determinants of business survival he or she develops.

For the above, a case study is used with a non-probabilistic sample of typical cases for quantitative-deductive purposes (Hernández Sampieri et al., 2014) and for which the following design is proposed:

- Population: Micro and small enterprises (MSEs) operating commercial activities in economic sectors II and II of the municipality of Yumbo Valle del Cauca, Colombia, a region with a high rate of business creation in the country (Confecámaras, 2017), a municipality included in the territory with the highest business survival rates and close to 44% (Confecámaras, 2017; 2021).
- Sample size: Non-probabilistic for ease of access, with a minimum acceptance of 18 business units, with a minimum proportion of six observational units for each business activity (services, commerce and manufacturing).

- Sampling frame: active registration of Mypes in the Chamber of Commerce of Cali Yumbo section published by Informa Colombia (2019).
- Sampling unit: The person in charge of the formulation of the company's OGP, who may be the legal representative, the owner or the administrator, or an academic intern who has formulated the OGP during his or her business practice; the foregoing is based on knowledge or access to the information requested.
- Inclusion criteria: Company with an OGP formulated and applied up to 18 months prior to sampling.

An ad hoc instrument designed for the research exercise was used, which underwent a validation process by seven experts in two stages (design and calibration), achieving a CVC of 0.98 with Fleiss Kappa for construct of 0.95 and Fleiss Kappa for objectivity of 0.95, with Pearson's temporal stability coefficient of 0.95 and a final Cronbach's alpha of 0.81.

The instrument is made up of a total of 37 items, where the first 13 are intended for the qualitative identification of the sample subject, the company that is the object of the PGO, the nature and type of theoretical and practical tool used and its results. The following 24 items refer to the variables under investigation; the instrument presents a distribution of nominal qualitative response scales for the characterization questions, an ordinal response scale to inquire about the effect of the PGO on the FDSE (negative impact, no change and positive impact) and a nominal qualitative response scale to identify the theoretical components used in the formulation of the project.

The data treatment is dual, with descriptive statistics procedures for the identification of the predominant type of OGP formulation model and the understanding of the type of sample achieved, and inferential statistics treatment for hypothesis testing.

The research approach is based on the consideration that a project formulation model is a mediating variable in a process of theoretical interpretation of the RDOs of a MSME that are intervened through the execution of the PGO in order to develop its FDSE, given that there is no independence between the variables, giving rise to a relationship (R) of dependence. As illustrated in Figure 1.

Figure 1

Research approach

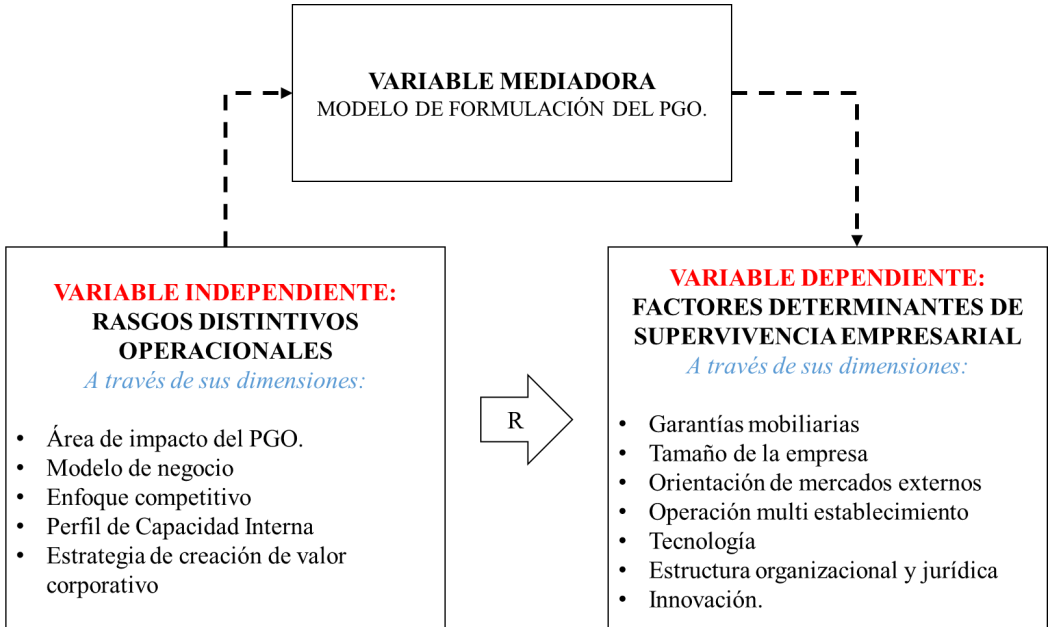


Figure 1 shows the way in which the dimensions in which the variables are observed can be visualized from the theoretical framework investigated, which allows understanding the systematization developed for them, starting with the mediating variable, as shown in Table 1.

Table 1

Operationalization of the mediating variable OMP Formulation Model

Dimension	Indicators	Interpretation scale	Calculation
Methodological Model	a) It was formulated and designed using a theoretical-academic model b) It was formulated and designed by applying an empirical model, not structured, but written. c) It was formulated and designed using the PRADO model d) No model	Qualitative Nominal	Frequency of use
Structured technique	a) Theoretical-academic tools b) Empirical tools and without a written project. c) None of the above b) Structured empirical formulation c) Casual formulation of the project	Qualitative Nominal	Frequency of use

Note. The selected indicators are not presented in any pre-established order.

Table 1 illustrates how the mediating variable will be observed in two dimensions, where the first one allows to identify the use of a structured model and the second dimension the

existence of a specific and structured technique for the formulation of the OMPs. The following is the operationalization of the independent variable.

Table 2

Operationalization of the independent variable of Operational Distinctive Traits

Dimensions	Indicators	Interpretation scale	Calculation
Business Model	Level of use of the constituent elements of the Canvas Canvas tool. Osterwalder Business Model (2010).	Discrete quantitative	Level of use = (∑ of elements used in the formulation of the PGO/ Total constituent elements of the tool) x 100%
Operational structure	a. Level of use of the constituent elements of the tool Value chain [a]. Porter (1990)	Discrete quantitative	Level of use = (∑ of elements used in the formulation of the PGO/ Total constituent elements of the tool) x 100%
	b. Level of use of the constituent elements of the Internal Capabilities Profile (ICP) tool. Serna Gómez (2008)		Level of use = (∑ of elements used in the formulation of the PGO/ Total constituent elements of the tool) x 100%
Business strategies	a. Level of use of any of the constituent concepts of the Competitive Focus Strategy (Porter, 1990)	Discrete quantitative	Evidence of use = 100% In the absence of evidence of use = 0%
	b. Level of use of the constituent elements of the Corporate Value Creation Strategy tool. Norton and Kaplan [b] (2004b; 2009)		Level of use = (∑ of elements used in the formulation of the PGO/ Total constituent elements of the tool) x 100%

Note. The selected indicators are not presented in any pre-established order.
[a] The value chain proposed by Michael Porter (1990) presents two typologies of elements, supporting activities and primary activities, with at least one element of one typology present, 50% evidence of use of the tool will be considered. One of each will be 100%.
[B] The Corporate Value Creation Strategy tool is linked to the authors' Balanced Scorecard proposal, consisting of four elements.

Table 2 shows that the ODR are observed in three dimensions and with a total of five indicators, and finally the FDSE variable is operationalized in Table 3.

Table 3

Operationalization of the dependent variable (FDSE)

Dimensions	Indicators	Interpretation scale	Calculation
STRATEGIC (Organizational Resources)	a) Movable guarantees (assets)	Ordinal scale.	Interpretation of the type of impact perceived in the company under the scale: Positive impact= 1 Negative impact= -1 No change=0
	b) Company size (By hiring level)	Ordinal scale.	Interpretation of the type of impact perceived in the company under the scale: Positive impact= 1 Negative impact= -1 No change=0
	c) Technology.	Ordinal scale.	Interpretation of the type of impact perceived in the company under the scale: Positive impact= 1 Negative impact= -1 No change=0
	d) Innovation	Ordinal scale.	Interpretation of the type of impact perceived in the company under the scale: Positive impact= 1 Negative impact= -1 No change=0
TACTICAL-OPERATIVE (Operational conditions)	e) External market orientation	Ordinal scale.	Interpretation of the type of impact perceived in the company under the scale: Positive impact= 1 Negative impact= -1 No change=0
	f) Multi-plant operation	Ordinal scale.	Interpretation of the type of impact perceived in the company under the scale: Positive impact= 1 Negative impact= -1 No change=0
	g) Organizational and legal structure	Ordinal scale.	Interpretation of the type of impact perceived in the company under the scale: Positive impact= 1 Negative impact= -1 No change=0

Note. The two FDSE Dimensions adopted for the research cover the factors specific to an organization, according to Confecámaras (2017).

Table 3 shows that the FDSE are observed in two typologies, strategic and operational, under an ordinal scale that allows understanding the type of impact achieved with the implementation of the PGO. Finally, it is necessary to establish some calculated variables that will allow the analysis of the data obtained. Table 4.

Table 4

Calculated variables

Coding	Meaning	Calculation
% of value chain usage	Percentage level of use of the "*Value Chain* " theory at a rate of 1/11 % per element used	(Number of elements used) x (1/11)% (Number of elements used) x (1/11)% (Number of elements used) x (1/11)%
% PCI usage	Percentage level of use of the theoretical tool internal competency profile matrix PCI, at a rate of 1/5 % per element used	(Number of elements used) x (1/5)% (Number of elements used) x (1/5)% (Number of elements used) x (1/5)%
% of Canvas Canvas usage	Percentage level of use of the theoretical tool CANVAS Canvas at a rate of 1/9% per element used	(Number of elements used) x (1/9)% (Number of elements used) x (1/9)% (1/9)%)
% use of competitive strategies	Identifies the use of Michael Porter's (1990) concept of competitiveness	100%= Uses the concept 0%= Do not use
balanced Scoredcard usage rate	Percentage level of use of the Balanced Scorecard (BSC) theoretical tool at a rate of ¼% per item used	(Number of elements used) x 25% (Number of elements used) x 25% (Number of elements used) x 25% (Number of elements used) x 25%
IMPACT	Identifies the type of final impact achieved on business survival factors, based on the difference in quantity between positive and negative impacts after project implementation.	Impact= (total factors impacted positively) - (total factors impacted negatively)
Sum of use of theoretical concepts	Number of elements and theoretical concepts used.	∑ theoretical elements used
FESE	Level of strategic business survival factors impacted with the implementation of the PGO	∑ p4 + p5 + p5 + p8 + p10
FTSE	Level of tactical-operational factors of business survival impacted by the implementation of the PGO	∑ p6 +p7 +p9
Strategy_emp	Level of use of business strategy concepts	∑sumap14 + sumap15
Elements_EO	Level of use of the PCI matrix and the Value Chain model	∑sumap11 + sumap12

Note. P 4 to p 15 are the research instrument questions with a value of 1 if the item was used.

Results

A total of 60 valid samples with the following characteristics were obtained:

- Sector II of the economy: Total 15 companies, of which six are microenterprises and nine are small companies.
- Sector III of the economy: A total of 45 companies, nine of which are small companies and 36 are microenterprises.
- 23 samples are from product commercialization establishments, 15 from manufacturing and 22 from services.
- 52 samples were taken from owners and 8 were filled out by persons in the position or functions of managers.

Given that the number of samples in some types of companies is less than 50, the variables are tested for normality using Kolmogorov-Smirnov statistics for samples greater than

50 and Shapiro-Wilk for samples less than 50, obtaining that some variables do not have a normal distribution when a p-value of less than 0.5 is obtained, which allows us to assume the Rho Spearman as a nonparametric test for correlation estimation. See table 5.

Table 5

Normality test

Variable	Type of company	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistician	gl	Sig.	Statistician	gl	Sig.
% of value chain	Microenterprise	,222	42	,000	,885	42	,001
usage	Small business	,160	18	,200*	,889	18	,037
% PCI usage	Microenterprise	,268	42	,000	,725	42	,000
	Small business	,287	18	,000	,765	18	,001
% of Canvas Canvas	Microenterprise	,395	42	,000	,603	42	,000
usage	Small business	,247	18	,005	,816	18	,003
% use of competitive	Microenterprise	,514	42	,000	,417	42	,000
strategies	Small business	,523	18	,000	,373	18	,000
balanced Scoredcard	Microenterprise	,321	42	,000	,805	42	,000
usage rate	Small business	,229	18	,014	,836	18	,005
IMPACT	Microenterprise	,163	42	,007	,938	42	,024
	Small business	,144	18	,200*	,966	18	,724
Sum of use of	Microenterprise	,201	42	,000	,912	42	,003
theoretical concepts	Small business	,163	18	,200*	,925	18	,160
FESE	Microenterprise	,206	42	,000	,925	42	,009
	Small business	,221	18	,020	,890	18	,038
FTSE	Microenterprise	,205	42	,000	,932	42	,015
	Small business	,195	18	,067	,934	18	,232

Note. *. This is a lower limit of true significance.

a. Lilliefors significance correction

Hypothesis testing

On the understanding that the variables are observed within several dimensions and the aim is to falsify the independence of the variables, six specific supporting hypotheses (He) are formulated that correlate the variables from their dimensions, as illustrated in Figure 2.

Figure 2

Specific auxiliary hypotheses

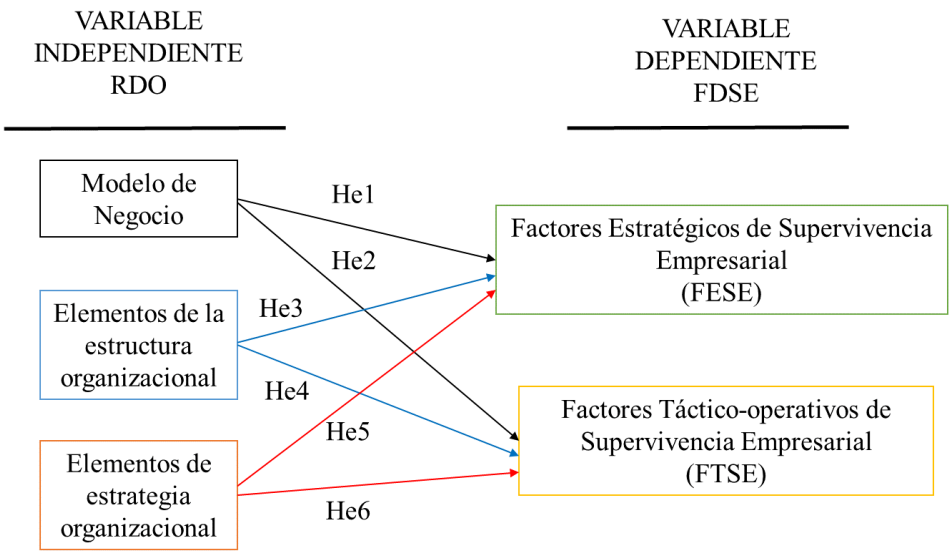


Figure 2 provides a comprehensive understanding of the phenomenon by validating the specific hypotheses, therefore, it is generally adopted that:

- Ho: The variables analyzed are independent and their behavior is not correlated
- Hi: The variables analyzed are not independent; therefore, their behavior is correlated
- With P-value = Sig < 0.05, Ho is rejected and Hi is accepted
- With P-value = Sig >0.05, Ho is accepted and Hi is rejected
- Rho Sperman statistical test

The results of the six tests applied reveal the existence of an inter-variable relationship in five of the six cases, as illustrated in the table below

Table 6

Results of the Rho Spearman statistical test between the dimensions of the variables

	FESE	FTSE
Business Model (% use of canvas)	Rho Spearman: 0.379 Sig 0.003	Rho Spearman: 0.313 Sig 0.015
Elements of the organizational structure (∑sumap14 + sumap15)	Rho Spearman: 0.426 Sig 0.001	Rho Spearman: 0.354 Sig 0.006
Elements of organizational strategy (∑sumap11 + sumap12)	Rho Spearman: 0.372 Sig 0.003	Rho Spearman: 0.178 Sig 0.172

Note. sumap11, sumap12, sumap13, sumap14 represent the sum of the research instrument questions with a value of 1 if the item was used.

Table 6 shows that there is no evidence of a relationship between the use of organizational strategy elements and the development of tactical business survival factors, since the Rho of 0.172 is interpreted as a very low relationship (Hernández Sampieri et al., 2014;

Ramírez Rios, 2016). The above leads to test the general working hypothesis, based on the calculated variables "IMPACT" and "Sum of use of theoretical concepts", for which the following is assumed:

- Ho: The variables "IMPACT" and "Sum of use of theoretical concepts" are independent
- Hi: The variables "IMPACT" and "Sum of use of theoretical concepts" are not independent, so there is correlation.
- With P-value = Sig < 0.05, Ho is rejected and Hi is accepted
- With P-value = Sig >0.05, Ho is accepted and Hi is rejected.
- Rho Sperman statistical test

The SPSS 25 software shows that Spearman's Rho value is 0.617 with a sig (bilateral) of 0.001, which indicates the existence of a high (strong) correlation between the variables analyzed, in accordance with Hernández Sampieri et al. (2014) and Ramírez Ríos (2016), this result is confirmatory of the specific hypothesis testing process previously carried out.

Descriptive analysis

The results analyzed with descriptive statistics for the categorical questions implemented, allow us to point out that:

- 100% of the micro and small enterprises in the sample do not use structured theoretical models for the formulation of their OMP.
- 11.6% acknowledge using academically unstructured models and 88.4% do not use any type of model.
- The unstructured models make use of the SWOT matrix in a proportion of 6.7%, while the formulation of projects with empirical tools such as basic calculations, quotations and informal budgets reaches 38.3%, closing with the absence of the use of academic theoretical tools with 55% that represents the planning and execution of the PGO in a totally improvised manner.
- Despite the fact that there is no prevalent use of academic models or tools for the project formulation process, it is evident that 65% of the micro and small enterprises perceive that they obtain positive results, 20% consider that there were no changes in their enterprises and 15% feel that the project was adverse to their planned interests and purposes.
- Regarding the formulation of the OGP through the use of theoretical and academic tools, it is observed that 51.5% of those who do not use any tool and project based on the internal knowledge of their company achieve positive results; those who use some empirical tools but do not make a formal written project obtain positive results in 78.3% of the cases; and those who use at least one empirical tool and showed evidence of having carried out a written exercise, in 100% of the cases their results were positive.
- Simultaneously, by means of the cross-table analysis, it was identified that 69% of the positive results occurred in microenterprises and the highest rate of negative results was found in small enterprises, reaching 55.6%.
- Likewise, 85.7% of those who used an unstructured model obtained positive results, approximately 23% higher than the 62.3% rate for those who achieved success in their projects by totally improvising their planning and execution.

Discussion and conclusions

Despite the fact that for the initial dates when the sample was scheduled to be taken, it could not be taken due to the effects of confinement as a result of the Covid-19 pandemic, finally with the progressive return to mobility and opening of commerce, it was observed that

many micro and small businesses had ceased operations and others had implemented PGO as a contingency measure in the search for business survival, in this way the social situation that initially was a limitation for the development of the research, finally contributed with a greater number of accessible sample subjects.

From the above situation, it is impossible for the researcher to determine whether the results obtained are due to the administrative situation in times of pandemic that prevented entrepreneurs from seeking advice for their projects or are the reflection of a constant administrative behavior, even so, the results allow inferring that at least from the autonomous project management exercised by entrepreneurs and owners of MSEs, this coincides with Elizundia Cisneros (2012), Liao and Gartner (2008), Dyer and Ross (2008) and Hamilton (2003) in that in the MSME sector there is a high tendency not to plan under defined medium or long term strategies, although they do make a mental planning for their decision making (Elizundia Cisneros, 2015).

Now, in the understanding that the RDOs are approached from academically accepted theoretical concepts, such as the value chain of (Porter, 2009), the Canvas canvas as a tool for approaching and understanding the business model (Osterwalder & Pigneur, 2009; Osterwalder, 2016), the understanding of the internal capabilities profile (ICP) (Serna Gómez, 2008) and management through the creation of strategies with control indicators (Kaplan & Norton, 2004), it should be noted that the evidence of the correlation between the use of the concepts or principles that integrate them and the development of the FDSE in MSMEs coincides with the findings of Pantoja Burbano, Arciniegas, Álvarez Hernández and Enríquez Chuga (2019) that indicate how the success of micro and small entrepreneurs is related to the management of internal factors of their business model and external factors, among which are competition, technological regulation and the political-social situation.

In the same sense, the results of the evidence of correlation found between the variable *elements of the organizational structure* and the FESE variable coincide with what was pointed out by Londoño Patiño (2020) in terms of the fact that decisions in SMEs are related not only to the business environment, but also to the knowledge of their labor productivity variables to guide decision-making in the search for comprehensive productivity, a matter already identified as a need for knowledge management orientation in the sector of small and medium-sized enterprises that contributes to significantly increase their business performance (Pinzón Castro et al., 2019).

Regarding the FTSE, among which is the multi-establishment and multi-market operation, and its correlation with the use of theoretical elements shows a Spearman's Rho of 0.172 in a positive sense, which when interpreted from a post-positivist posture reveals that there is no absolute independence between the variables, however, with a p-value greater than 0.05 there is no certainty that the evidence represents a causal tendency, since on the interpretation scale it is identified as a very low relationship. However, taking into account the historical moment when the sample was taken, where companies (including SMEs) adopted remote or home-based work as a contingent measure (Bargados, 2021), and many others in the commerce and services sector were forced to close physical spaces and implement home-based operations and home service (Acosta Fonseca, 2020), it is not possible to determine whether the weakness of the relational evidence is related to the model of formulation of the OGP or to the moment of operational contingency in which it is generated.

The 87.5% of positive results in projects formulated without a structured model are a result that confirms the importance of strengthening the management capacity of the micro-entrepreneur (Rey Campero, 2016) to improve business survival rates in the sector as part of an entrepreneurial ecosystem (Arboleda Vélez, 2013).

In conclusion, having falsified the hypothesis of independence between the variables, it has been possible to prove that in this case, the more theoretical and conceptual tools an entrepreneur applies in his PGO, the greater the development of his FDSE for the first years of the company's life, which provides a starting point to advance in the development of a proposed model for the formulation of organizational management projects for small and medium-sized enterprises, by identifying that the RDOs articulated so far are relevant to the thinking and strategic planning processes of MSE entrepreneurs, which constitutes a contribution of this research exercise to the development of management theories adapted to the operational realities of micro and small enterprises in a country.

References

Acosta Fonseca, Va. (2020). En medio de la pandemia por covid-19, cerraron 509.370 micronegocios en Colombia. *La República*. https://www.larepublica.co/economia/en-medio-de-la-pandemia-por-covid-19-cerraron-509370-micronegocios-en-colombia-3130382

Angelelli, P., & Prats, J. (2005). *Fomento de la actividad emprendedora en América Latina y el Caribe: Sugerencias para la formulación de proyectos* [Technical Notes]. Inter-American Development Bank. http://publications.iadb.org/handle/11319/6178

Arboleda Vélez, G. (2001). *Proyectos, Formulación, evaluación y control* (Cuarta Ed.). AC Editores.

Arboleda Vélez, G. (2013). *PROYECTOS, Identificación, Formulación, evaluación y gerencia* (2ª Ed.). Alfaomega.

Asociación Colombiana de pequeños industriales [ACOPI]. (2018). *Encuesta de desempeño empresarial*. Acopi. https://acopi.org.co/encuesta-de-desempe%C3%B1o-empresarial-acopi-2do-trimestre-de-2018.pdf

Asociación Colombiana de pequeños y medianos industriales. (2018). *Encuesta de desempeño empresarial acopi 2do trimestre de 2018*. https://acopi.org.co/encuesta-de-desempe%C3%B1o-empresarial-acopi-2do-trimestre-de-2018.pdf

Bargados, A. (2021). Impacto del Covid-19 en las Pymes argentinas: Actividad, empleo y condiciones de trabajo. *Trabajo y Sociedad*, *21*(36), 123-145.

Cajigas Romero, M., Haro, M. D. C., & Ramírez, E. (2017). El Estado Colombiano y El Emprendimiento Empresarial: Éxito o fracaso de su programa clave, *Criterio Libre*. *15*(26), 106-130.

Campos, L. J. Q. (2013). Características de la innovación en pymes de Colombia que han utilizado recursos públicos. *Revista Mutis*, *3*(1).

Comfecámaras - Red de Cámaras de Comercio. (2021). *Resultados Encuesta de las Cámaras de Comercio de Seguimiento y Monitoreo del Impacto de la COVID-19 en el Sector Empresarial*. https://www.confecamaras.org.co/phocadownload/2020/VF_Encuesta_Empresarios_Covid-19_Febrero_2021.pdf

Confecámaras - Red de Cámaras de Comercio. (2017). *Determinantes de supervivencia empresarial en Colombia* (N.º 14; Cuaderno Económico, p. 24). http://www.confecamaras.org.co/phocadownload/Cuadernos_de_analisis_economico/Cuaderno_de_An%D0%B0lisis_Economico_N_14.pdf

Confecámaras - Red de cámaras de comercio de Colombia. (2017). *Cuaderno de Análisis Económico N°14* (N.º 14; Cuaderno de análisis económico, p. 28). http://www.confecamaras.org.co/phocadownload/Cuadernos_de_analisis_economico/Cuaderno_de_An%D0%B0lisis_Economico_N_14.pdf

Confecámaras - Red de cámaras de comercio de Colombia. (2018). *Nuevos hallazgos de la supervivencia y crecimiento de las empresas en Colombia*. http://www.confecamaras.org.co/phocadownload/2018/Cuadernos_An%C3%A1lisis_Econ%C3%B3mico/Cuaderno_demografia_empresarial/Cartilla17.pdf

Cruz, L. E., Álvarez Velázquez, E., Flores Barrios, L., & Hidalgo Barrios, B. V. (2017). Beneficios de las prácticas de sustentabilidad aplicadas en las Pymes De Tuxpan, Ver. *Revista de la Alta Tecnología y Sociedad*, *9*(2), 23-30.

Elizundia Cisneros, M. E. (2015). Factores de emprendimiento que influyen en el desempeño de la micro y pequeña empresa. *Universidad Anahuac del Sur,* 53-75.

Fracica Naranjo, G., Matíz B., F. J., Hernández, G., & Mogollón, C. Y. (2011). Capital semilla para la financiación de Start Ups con alto potencial de crecimiento en Colombia. *Revista EAN*, *71*, 126-146. aph.

Gallego, M. G., & Cáceres, J. H. (2015). Identificación de factores que permitan potencializar el éxito de proyectos de desarrollo de software. *Scientia et Technica*, *20*(1), 70-81.

Hernández Sampieri, R., Fernandez Collado, C., & Baptista Lucio, M. del P. (2014). *Metodología de la investigación* (Sexta Ed.). MCGRAW-HILL.

Informa Colombia. (2019). *Listado de empresas en YUMBO*. Directorio de Empresas - Directorio de empresas en Colombia. https://www.informacolombia.com/directorio-empresas/localidad_yumbo

Instituto de dirección de proyectos. (2013). *Guía de los Fundamentos para la dirección de proyectos (Guía del PMBOK)* (Quinta ed.). https://www.gob.mx/cms/uploads/attachment/file/79535/PMBOK_5ta_Edicion_Espanol__1_.pdf

Instituto Vasco de cualificaciones y formación profesional (2010). *Guía de elaboración de proyectos*. Koalifikazioen Eta Lanbide Heziketaren Euskal Institutoa. https://www.pluralismoyconvivencia.es/upload/19/71/guia_elaboracion_proyectos_c.pdf

Jiménez Sánchez, J. I. (2014). Nuevas modalidades de financiación para microempresas. *Puente: Revista Científica*, *8*. http://unicatolica.basesdedatosezproxy.com:2070/ehost/detail/detail?vid=0&sid=60ff0bf0-86ab-464f-b7da-c2b88689ecee%40sessionmgr104&bdata=Jmxhbmc9ZXMmc2l0ZT1laG9zdC1saXZl#db=aph&AN=102022339

Kaplan, R. S., & Norton, D. P. (2004). *Mapas Estratégicos, Convirtiendo los activos intangibles en resultados tangibles* (Primera). Gestión 2000.

Londoño-Patiño, J. A. (2020). Toma de decisiones basada en la productividad en Pymes manufactureras: Aproximación desde la Lógica Difusa. *Revista CEA*, *6*(12), 181-207.

Mas Verdú, F., Ribeiro Soriano, D., & Roig Tierno, N. (2015). Firm survival: The role of incubators and business characteristics. *Journal of Business Research*, *68*(4), 793-796. https://doi.org/10.1016/j.jbusres.2014.11.030

Meixuerio Garmendia, J., & Peréz Cruz, M. A. (2008). *Metodología general para la evaluación de proyectos*. http://www.cepep.gob.mx/work/models/CEPEP/metodologias/documentos/metodologia_general.pdf

Méndez Lozano, R. (2012). *Formulación y Evaluación de Proyectos. Enfoque para emprendedores* (Séptima). Rafael Méndez Lozano.

Ortega Zarza, M. (2015). *Sistema basado en PMBOK para la Auditoría en la Gestión de Proyectos, en Pymes: Caso de una empresa comercializadora de diversos servicios;* http://ri.uaemex.mx/handle/20.500.11799/66439

Ortegón, E., Pacheco, J. F., Prieto, A., & Latin American and Caribbean Institute for Economic and Social Planning. Projects and Investment Programming Division. (2005). *Metodología del marco lógico para la planificación, el seguimiento y la evaluación de proyectos y programas*. Naciones Unidas, CEPAL, ILPES, Área de proyectos y programación de inversiones.

Osterwalder, A. (2016). *Generación de modelos de negocio: Un manual para visionarios, revolucionarios y retadores Título original. Bussines model generation* . Deusto, Grupo Planeta.

Osterwalder, A., & Pigneur, Y. (2009). *Business model generation.* (Primere Ed.). Wiley.

Padilla, M. C. (2016). *Formulación y evaluación de proyectos*. Ecoe Ediciones.

Pantoja Burbano, M. J., Arciniegas, G., Rocío Álvarez Hernández, S. del, & Enríquez Chuga, J. F. (2019). Factores que influyen en los emprendimientos de los artesanos de San Antonio de Ibarra. *Investigación Operacional*, *40*(2), 242-248.

Parra Alviz, M., Rubio Guerrero, G., & López Posada, L. M. (2017). Factores distintivos de emprendimiento que propiciaron el éxito: Casos de estudio en empresarios de Ibagué, Tolima. *Distinctive factors of entrepreneurship that led to success: case studies in entrepreneurs from Ibagué, Tolima.*, *43*, 89-127. https://doi.org/10.14482/pege.43.10583

Pinzón Castro, S. Y., Maldonado Guzmán, G., & Marín Aguilar, J. T. (2019). Orientación de la gestión del conocimiento y rendimiento en las pequeñas y medianas empresas mexicanas. *Revista de Ciencias Sociales*, *25*(1), 21-34. https://doi.org/10.31876/rcs.v25i1.27284

Porter, M. E. (1990). *La ventaja competitiva de las naciones*. Vergara.

Porter, M. E. (2009). *Estrategia Competitiva: Técnicas para analizar Industrias y Competidores* (Tercera). Piramide.

Project Management Institute. (2017). *Guía de los Fundamentos Para la Dirección de Proyectos (Guía del Pmbok)* (6 Ed.). Project Management Institute.

Ramírez Rios, A. (2016, junio 29). *Prueba de hipotesis con RHO de Spearman para variable cualitativa y variable cuantitativa*. https://www.youtube.com/watch?v=LEBIOkhaoIg

Rey Campero, C. R. (2016). La formulación y evaluación de proyectos de inversión: Una nueva visión para las PYMES de servicio. *Sotavento M.B.A.*, *5*(27), 22-48. https://doi.org/10.18601/01233734.n27.03

Saavedra Mayorga, J. J. (2007). Una aproximación a las demandas sociales de las escuelas de administracion en Colombia. *Revista Universidad y Empresa - Universidad Del Rosario*, *16*, 74.

Serna Gómez, H. (2008). *Gerencia estrategica. Teoría-Metodología- Alineamiento, Implementación y Mapas Estratégicos. Indices de gestión.* (10ª Ed.). 3R.

Serrano Montiel, M. I., Borgucci García, E. V., & Vera Colina, M. A. (2013). Estrategias de microfinanciamiento por la banca privada en Venezuela y Colombia. *Microfinance strategies developed by prívate banks in Venezuela and Colombia.*, *34*(2), 115-129.

Talebi, K., Rezazadeh, A., & Nobari, N. (2015). *Business model innovation: A remedy for SMEs' survival and growth*.

Universidad de las Américas, & Ramos, C. A. (2015). Los paradigmas de la investigación científica. *Avances en Psicología*, *23*(1), 9-17. https://doi.org/10.33539/avpsicol.2015.v23n1.167

Velásquez Restrepo, S. M., Londoño Gallego, J. A., López Romero, C., & Vahos, J. D. (2017). Desarrollo de una plataforma web multimedial para la elaboración de proyect.os bajo la metodología del marco lógico. *Lámpsakos*, *18*, 12-20. http://dx.doi.org/10.21501/21454086.2601

Vera Muñoz, G., Vera Muñoz, M., & Martí-nez Méndez, R. (2020). PYMES y Desarrollo Sustentable. *Management Review*, *3*(1). https://doi.org/10.18583/umr.v3i1.108

Date received: 09/03/2023
Revision date: 10/05/2023
Date of acceptance: 29/06/2023

PROJECT, DESIGN AND MANAGEMENT

https://www.mlsjournals.com/Project-Design-Management

ISSN: 2683-1597

How to cite this article:
Fahl, R. F. & Tahara Amaral, C. S. (2023). Design service como abordagem de inovação em auditoria interna de instituições financeiras. *Project, Design and Management, 5*(1), 44-56. doi: 10.35992/pdm.5vi1.1134.

DESIGN SERVICE AS AN INNOVATION APPROACH IN INTERNAL AUDIT OF FINANCIAL INSTITUTIONS

Ricardo Alexandre Fahl
Univerdidade de Araraqua (Brazil)
ricardoafahl@ig.com.br · https://orcid.org/0000-0003-2947-8684
Creusa Sayuri Tahara Amaral
Univerdidade de Araraqua (Brazil)
c.sayuri.tahara@gmail.com · https://orcid.org/0000-0003-4959-2636

Abstract. This article aims to analyze the applicability of Design Service techniques in Internal Audit (AI) units of Financial Institutions (FI). The work is based on the premise that AI units are service providers, occupying a relevant strategic position in organizations, adding knowledge to the processes of the audited areas. Companies operating in the financial sector, in addition to the challenge of seeking to achieve levels of efficiency equal to or higher than those of their traditional competitors, live with new market players, technology companies, whose business model is based on innovation. The work methodology is based on a bibliographical research, with a literature review on the subject, for the technical basis and systematization of information. For the data collection, an exploratory research was conducted on the ScienceDirect platform, publications in conferences and complementary information from portals of companies specialized in the Internal Audit activity. The information was analyzed considering the framework of design theories in services and their adherence to AI processes. As a result, the importance of Design Service was verified, as an iterative approach, in the development of AI strategic actions, development of new processes, tools and methods, as well as to design new services as facilitators of co-creation of value to users of AI services.

Palavras chave: Design Service; Internal Audit; Innovation; Product Development.

DESIGN SERVICE COMO ABORDAGEM DE INOVAÇÃO EM AUDITORIA INTERNA DE INSTITUIÇÕES FINANCEIRAS

Resumo. O presente artigo visa analisar a aplicabilidade das técnicas de Design Service em unidades de Auditoria Interna (AI) de Instituições Financeiras (IF). O trabalho parte da premissa de que unidades de AI são prestadoras de serviço, ocupam posição estratégica relevante nas organizações, agregando conhecimentos aos processos das áreas auditadas. As empresas que atuam no segmento financeiro, além do desafio da busca por alcançar níveis de eficiência iguais ou superiores aos de seus tradicionais concorrentes, convivem com novos players de mercado, empresas de tecnologia, que tem na inovação, a essência de seu modelo de negócio. A metodologia do trabalho fundamenta-se em uma pesquisa bibliográfica, com uma revisão da literatura sobre o tema, para o embasamento técnico e sistematização das informações. Para o levantamento de dados foi conduzida uma pesquisa exploratória na plataforma ScienceDirect, publicações em congressos e complementarmente informações de portais de empresas especializadas na atividade de Auditoria Interna. As informações foram analisadas considerando o arcabouço das teorias de design em serviços e de sua aderências aos processos da AI. Como resultado verificou-

se a importância do Design Service, como uma abordagem iterativa, no desenvolvimento de ações estratégicas da AI, desenvolvimento de novos processos, de ferramentas e métodos, bem como para projetar novos serviços como facilitadores de co-criação de valor aos usuários dos serviços de AI.

Palavras chave: Design Service; Auditoria Interna; Inovação; Desenvolvimento de Produto.

SERVICIO DE DISEÑO COMO ENFOQUE DE INNOVACIÓN EN AUDITORÍA INTERNA DE ENTIDADES FINANCIERAS

Resumen. Este artículo tiene como objetivo analizar la aplicabilidad de las técnicas del Servicio de Diseño en las unidades de Auditoría Interna (AI) de las Instituciones Financieras (IF). El trabajo parte de la premisa de que las unidades de IA son proveedores de servicios, ocupando una posición estratégica relevante en las organizaciones, sumando conocimiento a los procesos de las áreas auditadas. Las empresas que operan en el sector financiero, además del desafío de buscar alcanzar niveles de eficiencia iguales o superiores a los de sus competidores tradicionales, conviven con nuevos actores del mercado, las empresas tecnológicas, cuyo modelo de negocio se basa en la innovación. . La metodología de trabajo se basa en una investigación bibliográfica, con una revisión bibliográfica sobre el tema, para la fundamentación técnica y sistematización de la información. Para la recolección de datos se realizó una investigación exploratoria en la plataforma ScienceDirect, publicaciones en congresos e información complementaria de portales de empresas especializadas en la actividad de Auditoría Interna. La información fue analizada considerando el marco de las teorías de diseño en servicios y su adherencia a los procesos de IA. Como resultado, se verificó la importancia del Design Service, como enfoque iterativo, en el desarrollo de acciones estratégicas de IA, desarrollo de nuevos procesos, herramientas y métodos, así como para diseñar nuevos servicios como facilitadores de co-creación de valor para usuarios de servicios de IA.

Palavras chave: Servicio de Diseño; Auditoría interna; Innovación; Desarrollo de productos.

Introduction

The world of the internet of things, artificial intelligence has increasingly interconnected people, services, machines leading to continuous and profound transformations within and between service systems (Koskela-Huotari et al., 2021). Contemporary theoretical developments and global economic trends highlight the importance of services and provide new theories and research related to the role of organizations and employees in the *design* and delivery and development of services (Pugh & Mahesh; 2016). Services are actions, processes and performances (Zeithaml & Bitner, 2003) co-produced by one entity or people, for another entity or person (Zeithaml, Bitner & Gremler, 2011).

The development of new services is essential for organizations to survive and am, as seen by the necessary changes in business stemming from the 2019 Sars-Covi2 pandemic. Still, many service providers are hampered by the fact that their current strategy and processes are not designed well enough to develop and deliver services efficiently (Imran, Haeberle & Husen, 2017). However, the process of change can be complex, time consuming, expensive, and often unsuccessful (Smith, Fischbacher & Wilson, 2007).

In this context, innovation is decisive for service companies. The development of new methods and technologies provide opportunities for the development and improvement of new services (Smith, Fischbacher & Wilson, 2007). From this perspective, as the service sector has gained momentum and recognition for its economic importance, research on innovation in the area has expanded and diversified (Carvalho & Goodyear, 2017).

Knowledge and innovation are intrinsically connected elements; there is no innovation without knowledge. It is from knowledge that new ideas are generated, because together with the organization's competencies, knowledge promotes assimilations that guide innovation

(Silva et al., 2018). Companies achieve competitive advantage through innovative initiatives. These initiatives should occur in a systematized way from processes established by the organization (Tajra, 2020).

Audit service is the process of reviewing the financial information prepared by a company's management (Stuart, 2014). Internal Auditing is an independent evaluation and advisory activity to management, focused on the adequacy, efficiency, and effectiveness of control systems (IIA, 1991). Audit firms and Internal Audit Units are providers of services in the area of auditing, tax, and consulting. As a rule, auditors provide a diversity of auditing, consulting, and assurance services (Stuart, 2014), which also need to keep up with the innovations offered for the field while maintaining their quality and efficiency. Thus, the continuous generation of value, having with one of the sources, innovation in auditing services, is of crucial importance for the survival of the auditing activity, since it is about arguments to justify its existence and maintenance (Imoniana, Matheus & Perera, 2014).

Service *design* is a human-centered, iterative approach, focusing on understanding human experiences to design better customer journeys by developing methods and tools to improve specific touchpoints and enhance the service experience. More recently service *design* has strengthened its role by focusing on the dynamics of organizational and social change to design services as facilitators of value co-creation (Koskela-Huotari et al., 2021). Service *design* shows itself as a means of improving the process of generating innovations in the service area and in particular in the internal audit area.

Considering this context, the objective of this article is, based on a literature survey, with a review of the literature on the subject, to present an analysis of how to improve service innovation management in IA services in FI, through the *Design Service* approach.

Design Service

Innovation can be defined as the process of implementing new ideas to create value for an organization, which can mean the creation of a new service, system, process, or the improvement of some of these elements (Silva et al., 2018). Innovation is important for all organizations, as it is a requirement for their longevity. To truly reap the benefits offered by innovation, organizations must understand that innovation is an outcome, a process, and a mindset (kahn, 2018). Thus, innovations are not the result of spontaneous generation, nor created in a vacuum, they are first and foremost the result of deliberate intentions and generated in a conducive environment where ideas can thrive (Scherer, 2016). Broadly speaking, innovation is not just about designing products and services - it is also about designing an organization or system capable of disseminating solutions.

Innovation research originally focused on technological innovation, having historical roots in the manufacturing sector. As the service sector has gained momentum and recognition for its economic importance and its relevance to economic development and growth research on service innovation has seen an expansion and diversification (Carvalho & Goodyear, 2017).

According to Buehring and Bishop (2020), the role of *design* in the first half of the 20th century was closely linked to the ideas of aesthetics and style, craftsmanship and mass production. The second half of the 20th century witnessed a shift toward intentionality and human-centered practices. In response to market forces, the focus was on designing products that people would find useful, that would be usable, and that would arouse the desire to buy.

Service Design (SD) or Service *Design* (DS) - emerged in the 1990s and is the activity of planning and organizing people, infrastructure, communication, and material components of a service in order to improve its quality and the interaction between the company providing the service and consumers (Batista, 2017).

Rosa et al. (2019) state that SD is a constantly evolving concept, as well as the service context to which it relates, and has at its base the user and his interaction, with the different stages of relationship with an organization. For Brouwer (2017), *Service Design* is one of the keys to improving the way we approach today's complex problems, especially since the predominant view of service systems is mechanistic and linear. Also, SD is a multidisciplinary area that helps innovate services (Lim & Kim, 2018).

According to Batista (2017), in *DS* three issues are very important:

Table 1
Service Design Requirements

Requirements:	Description:
Customer Focus	The way you think about and plan your services puts your customers at the center of the process.
Co-creation	In the planning phase *stakeholders* are encouraged to participate in the creation of the services, test sessions, and provide *feedback* regarding these services.
Holistic	In the holistic approach, the whole and each of the parts are connected with constant interactions.

Grade. Source: Adapted Batista (2017)

Candi (2016), conceptualizes SD as a combination of aesthetic *design* and experiential *design* . For the author, aesthetic *design* is simple to understand, because it is related to aspects that can be perceived with the human senses. Experiential *design* is a more elusive one, and is related to the quality perceived by customers. Thus, the theoretical consideration of *design* principles and methods is not only associated with improving the appearance and functionality of material products. *Design* practices have spread to comprise different areas of business, management, and innovation (Carvalho & Goodyear, 2017).

Design methods are seen as a means of engaging problems, exploring customer needs and corporate objectives in new ways. Recently, *design* methods are accepted as a means of understanding knowledge; designers can apply the *design* approach to find service ideas (Lee, Zhao & Lee, 2019), proposing innovative product and service solutions by analyzing, creating, developing and optimizing, as well as understanding the needs of everyone who interacts with these products and services (Rosa et al., 2019). If deep user insights are seen as fundamental to an innovation process, then it becomes relevant to explore how these types of insights can contribute to designing service systems (Brouwer, 2017). Innovation takes design to a systems level.

However, managers of companies know little about modern techniques and *design* tools for creating innovation and also about the possibility of their effective use for management and the decision-making process in the area (Lendel, Hittimar & Siantova, 2015). DS can present itself as an important solution in this context.

Internal Audit

Internal Auditing (IA) is an independent evaluation and advisory activity to management, aimed at examining and evaluating the adequacy, efficiency and effectiveness of the control systems, as well as the quality of the performance of the areas in relation to the duties and the plans, goals, objectives and policies defined for them (Instituto dos Auditores Internos do Brasil, 1991). In broad terms, internal audit is the process of examining, monitoring, and analyzing organizational activities to review what the company is doing, identify potential

threats, and advise on ways to mitigate the different mapped risks-technological, emerging, strategic, etc.-that may compromise the company's sustainability (Wittayapoom, 2014). As a function, IA is a relatively recent occurrence, localized, according to some authors, during the 1929 economic crisis in the US (Munteanu & Zaharia, 2014).

IA plays a vital role in corporate governance as it provides objective assessment and offers insights into the effectiveness and efficiency of risk management, internal control, and governance processes (Instituto dos Auditores Internos do Brasil, 2018). Internal audit's *insights* into governance, risk and control trigger positive change and innovation within the organization.

It is recognized that IA is a management aid tool, enabling an entity's decision makers to better manage its activities; it evaluates all management resolutions aimed at ensuring its normal and efficient operation and, not lastly, it creates value on an ongoing basis (Petrascu & Tamas, 2013).

In this sense, internal auditors must have a good knowledge of the audited business in order to be able to monitor the situation and assess the changes that the entity itself is subject to. They should be aware of the changes, help identify new risks that managers may face, although managers are still responsible for identifying them (Zaharia, Lazar & Tilea, 2014).

Improving the management processes of audited companies, in all its complexity, requires the knowledge and application of more modern principles that aim to ensure the functioning of entities, at the level of performance and competitiveness (Zaharia, Lazar & Tilea, 2014), by adapting its functions to current challenges, IA will increase security of corporate governance as a whole (Caratas & Spatariu, 2014).

IA is an important aspect to the process innovation program, which is critical to improving business performance programs. Process analysis, used in the context of internal audit, focuses on continuous improvement programs that focus on optimizing the mix and allocation of resources and strategies designed to minimize waste and reduce non-value added activities in the organization (Sisaye, 1999). According to the works of Wong and Cheung (2008) and Martins and Terblanche (2003) audit innovation is defined as the ability to seek and create new audit techniques and different method to achieve audit goals and audit service (apud Hannimitkulchai & Ussahawanitchakit, 2016

Doyle et al. (2019) pointed out that with numerous innovation models and little or no integration between projects, a lack of consistency in innovation activities is identified contributing to poor performance tracking and limited decision making in innovation silos and frameworks. Internal Auditing has integrated processes and the work is conducted as projects, thus, the innovation inserted in its processes provides continuous improvement in its deliveries.

In the organization, auditing, when acting in innovation processes, goes beyond measurement, which is based on identifying the gaps between current and required performance, and can identify where the problems and needs are, provide information that can be used in action plans, to assist in the development of performance improvements (Pellegrini et al., 2014).

Thus, all entities need internal auditing for business efficiency towards good asset management, cost reduction (in an organized way) profit maximization, and achievement of medium and long term goals. In addition, this activity should be evaluated from the perspective of the benefits it brings in increasing future value added (Petrascu & Tieanu, 2014).

Although the role of internal auditing in companies is increasingly considered relevant and necessary, the practice of internal auditing has received relatively little academic attention (Christ et al., 2020). Thus, on the landscape of academic research on internal audit published in national journals and congresses, Souza (2017) reported that academic production on internal audit is low when compared to other bibliometric research in the accounting field and constitutes a field that still needs to be better explored by researchers.

Methodology

A literature search was conducted to analyze the applicability of *Design Service* techniques in Internal Audit units. To gather the information, an exploratory research was conducted, since scientific work should start by knowing all the relevant aspects of the theme, in order to build a current scenario, the identification of gaps and the proposition of assumptions (Andrade, 1999). Exploratory research is also conducted in areas and on problems where there is little or no accumulated and systematized knowledge, and by its nature, there are no hypotheses (Dias, 2011). Thus, the Work used data from secondary sources. As information sources, the *Science Direct*database was consulted, considering as search strategy the *strings* described in table 1. The fields considered in the search form the title and abstract. A filter was also applied to publications in the areas of business, management, and accounting, which include Financial Institutions. The number of papers found in the searches are described in Table 2. Also used were additionally publications in congresses, national and international specialized magazines, and complementarily information from portals of companies specialized in the IA activity.

After analyzing the title and abstract, the articles were selected according to the focus of the study. A set of 57 articles were selected, analyzed and compiled for the development of the overview on the topic and discussion about *Design Service* and innovation in IA units.

Table 2
Search process - search tips: Title, abstract or Keywords

Database	Password	No. of articles	No. of articles (after abstract filter)
Science Direct	Audit innovation	33	15
Science Direct	Internal audit innovation	5	2
Science Direct	"Service Design and Methodology	62	15
Science Direct	"Service Design and audit	8	0
Science Direct	"Service Design and process	34	3
Science Direct	"Service Design	87	22

Results and discussion

IA is considered a profession that has been evolving over the years, always seeking to meet the new needs of its organizations, in the early days focused on accounting problems, but now it has become a powerful tool to detect the main risks of organizations (Munteanu & Zaharia, 2014).

An organization's innovation capability includes the ability to understand and respond to changing conditions in its context, seek new opportunities, and leverage the knowledge and creativity of people within the organization, and in collaboration with external stakeholders (Associação Brasileira de Normas Técnicas, 2020). Until recently, the internal auditing profession has not faced the need to innovate, let alone reinvent itself. However, without applying new approaches, the role of internal audit would lag behind strategic and technological developments, be unable to meet stakeholder needs, and ill-equipped to address emerging risks (Deloitte, 2018).

It is clear that internal audit work has been changing over the years and as companies grow and modernize with new systems and technologies, develop new ways and controls, they also need constant monitoring and updates (Imoniana, Matheus & Perera; 2014). In the age of *big data*, internal audit functions must innovate to incorporate new techniques to add value to their organizations (Rakipi, Santis & D'onza, 2021).

Although Sisaye (1999) already pointed out that internal audit could be the key to the innovation process in organizations, considering that audit not only identifies the quality of processes in organizations, it also identifies gaps between current and desired performance, IA departments are not used to investing in innovation, needing to be persuaded to invest in this area (Alles, Kogan & Vasarhelyi, 2013).

In recent decades, large retail commercial banks have brought a lot of innovation to the financial system, transforming the way we relate to money and banking (Carvalho, 2019). Banks have innovated and innovate to increase the efficiency of financial services production, as well as the quality and variety of their products and services (Bos, Kolari & Lamoen, 2013). However, if previously the development of new technological standards was centered on the banking and financial institutions themselves, as they were the inducers for the development of new technologies, the current scenario is configured differently. New companies have appeared on the market competing with banks in niches and products previously only dominated by them. These companies are the so-called *fintechs, startups* that offer financial products and services ("fin" for financial) and have a high level of technology (Barbosa, 2018).

Against this backdrop, for Internal Audit of Financial Institutions, adopting innovative approaches assists in keeping the audit function up to date with new models of developments, positioning the unit to anticipate and then effectively respond and meet stakeholder needs, and equipping the internal auditors themselves to address risks in an effective and impactful manner (Deloitte, 2018).

The research methodology used did not identify any academic production on *Design Service* in Internal Audit units. Notably, Candi (2016) points out that the value of *design* as an element of product innovation is widely recognized, although *design* in the context of service innovation is less understood. For the author, technology-based service companies are a particularly interesting context to study the value of *design* for service innovation.

Koskela-Huotari et al (2021) points out that service *design* has strengthened its role with a focus on the dynamics of organizational change, to promote institutional change, or to design services as facilitators of value co-creation.

Caratas and Spatariu (2014) pointed out that IA in adapting its functions to the current challenges of organizations must change its current *status* from a control and assurance function to service providers. For Ahmi, Saidin and Abdullah (2014) one of the main subjects of the auditor's performance is the auditee or client. In turn, Daniela and Attilab (2013) point out that IA must constantly redefine itself, with the claim of meeting the changing needs of entities. Therefore, for these authors, besides the constant need for updating, for an IA unit, different players are considered as clients, such as the audited areas, the company's top management, and inspection and regulatory agencies,

Thus, SD can be strategic in the IA innovation process, noting Smith, Fischbacher and Wilson's (2007) understanding that when designing a new innovative service, specific implications for staff, customers and the environment can arise.

Another relevant aspect, pointed out by Selva and Pinto (2019), is with the constant development of companies and the diversification of their economic activities, internal audit has become an indispensable resource to - in a changing and innovative scenario - contribute to the improvement of governance, as well as the management of risks and controls of companies, in this vein, Buehring and Bishop (2020) point to the evolution of SD in understanding the potential of *design* to support the improvement, management and change of organizations, turning designers into facilitators and co-creators of new systems and services.

Designing change, and the *design*process, has been the subject of study for many decades (Valtonen, 2020). Developments in SD demonstrate that organizations that treat *design* as a corporate resource and core competency now apply it to organizational activities-including management, strategy, and leadership-to generate sustained innovation and competitiveness (Buehring & Bishop, 2020).

IA has become a function that ensures security for management and facilitates the conditions necessary to achieve global performance and a competitive and sustainable business environment (Danescu, Prozan & Prozan, 2015). Similarly, the focus on the human being is one of the main characteristics of *design*, widely adopted outside the traditional *design* field through SD thinking and *design* innovation (Brouwer, 2017). Customization is evaluated as a DS goal to increase customer satisfaction. Personalized services are delivered with implicit knowledge and their quality depends on the skills of each service provider (Kaneko, Kishita & Umeda, 2017). Audit resources applied in its services, including audit knowledge, are strategic for IA to build its competitive advantage (hannimitkulchai & Ussahawanitchakit, 2016), and its customization to the audited areas is desirable.

Mukhtar, Ismail, and Yahya (2012, point out that in SD, customers' roles from passive users to collaborators in the creation and extraction of business value have given rise to customer co-creation techniques and value co-creation models. As a consequence, it can assist in designing appropriate encounter processes as a basis for engaging customers and subsequently provides innovation for organizations, including IA units.

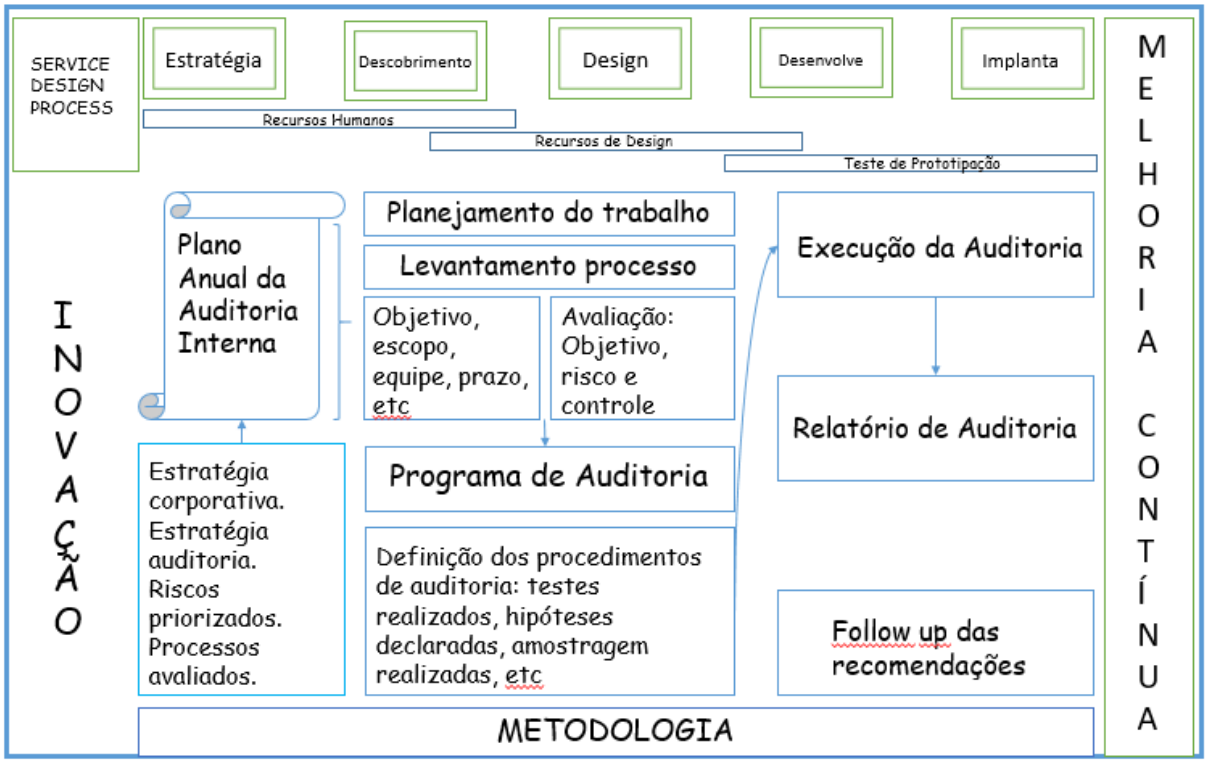
Research proves that service innovation has become a critical issue in academia in the context of the service economy. It is crucial for any service organization to analyze and assess existing contradictions and points of failure in processes to respond to constant challenges and maintain and improve customer satisfaction (Lee, Zhao & Lee, 2019), a scenario no different for Internal Audit units.

Thus, SD methods are seen as a means of understanding problems, exploring customer needs and corporate objectives in new ways. More recently, design methods have been taken as a means of reasoning knowledge; where designers apply the design approach to find service ideas (Lee, Zhao & Lee, 2019), a continuing need for IA, especially from Financial Institutions.

From the integration of SD with innovation and auditing processes (figure 1), the active inclusion of users and providers in service design and delivery is enabled, allowing for the co-creation of associated value (Colledani et al., 2016).

Figure 1

Integration of SD with Innovation and Auditing processes



Conclusion

This work presented a brief literature review that propitiated the analysis of some elements of *Service Design*, to allow the understanding of its applicability in innovation in organizations and to identify its adherence to an IA unit.

It has been found that organizations pioneering SD have devoted effort to systematically leverage human-centered *design* as innovation practices and tools to create new value (Buehring & Bishop, 2020). The authors also highlight new trends in SD to integrate forecasting and *design* as critical processes to anticipate internal change coming from the external environment and identify opportunities to influence the future through external action, paramount for IA units that need to add value for their customers in anticipating risks.

As a relevant point, SD enables service providers to build an understanding of customer perceptions and customer goals in service enhancement and development (Struwe & Slepniov, 2021). Measuring the results of the IA department in its main focus has the pure and simple intention of knowing whether it is effective in generating value (Imoniana, Matheus & Perera, 2014).

The case for evaluating SD, as an approach in innovation programs in IA units, can be verified as feasible, strategic, and aligned to audit service enhancements and developments. Because it is a customer-centric perspective, it enables the co-creation of associated value from the possibility of the active inclusion of users and *design* providers in the delivery of products and services (Colledani et al., 2016). The result that is expected from an innovation process is

the commitment of people and the generation of knowledge with added value, contributing to the achievement of the organization's results (Selva & Pinto, 2019).

The material gathered on the topic contributes to the application of SD as a tool for innovation and integration, focused on service quality, which seeks to fill the gaps in the SD literature. This preliminary study on the innovation process in IA units, should gain diffusion, given its importance to the context of innovation management in companies, paving the way for future discussions, which present results of success, difficulties and identification of the need for improvement, besides inserting the SD in the context of innovation studies in IA units.

The work was limited by the search restricted to the Science Direct platform, with a focus on publications in the areas of business, management, and accounting. It is hoped that this study, among others cited in this paper, can contribute to research in the area and to those interested in future studies of SD application in IA, and that they will strengthen the diffusion of research.

References

Ahmi, A., Saidin, S. Z., & Abdullah, A. (2014). Adoption by Internal Auditors in Public Sector: A Conceptual Study. *Procedia - Social and Behavioral Sciences, 164*, 591-599.

Alles, M. G., Kogan, A., & Vasarhelyi, M. A. (2013). Collaborative Design Research: Lessons From Continuous Auditing. *International Journal of Accounting Information Systems*, *14*, 104-112.

Associação Brasileira De Normas Técnicas (2020). *NBR ISO 56002:2020: Gestão da inovação – Sistema de gestão da inovação – Diretrizes*. Rio de Janeiro.

Andrade, M. A. (1999). *Introdução à Metodologia do Trabalho Científico*. Atlas.

Instituto dos Auditores Internos do Brasil (2018). *Auditoria Interna.* https://iiabrasil.org.br.

Barbosa, R. R. (2018). *A Atuação das Empresas de Tecnologia de Serviço no Setor Bancário e Financeiro Brasileiro*. Dissertação (Mestrado em Administração) – Universidade Federal do Rio Grande do Sul. Porto Alegre, RS, Brazil, 129p.

Batista, R. Você sabe o que é *Service Design?* https://administradores.com.br/artigos/voce-sabe-o-que-e-service-design.

Bos, J., Kolari, J. W., & Lamoen, R. C. R. V. (2013). Competition and innovation: evidence from financial services. *Journal of Banking & Finance*, *37*, 1590-1601.

Brouwer, M. V. D. B. (2017). Designing for social infrastructures in complex service systems: a human-centered and social systems perspective on service design. *Journal of Design Economics and Innovation*, *3*(3), 183-197. https://doi.org/10.1016/j.sheji.2017.11.002

Buehring, J. & Bishop, P. C. (2020). Foresight and design: new support for strategic decision making. *Journal of Design Economics and Innovation*, *6*(3), 408-432. https://doi.org/10.1016/j.sheji.2020.07.002

Candi, M. (2016). Contributions of design emphasis, design resources and design excellence to Market performance in technology-based service innovation. *Technovation*, 3-41.

Caratas, M. A., & Spatariu, E. C. (2014). Contemporary approaches in internal audit. *Procedia Economics and Finance*, *15*, 530-537.

Carvalho, L. & Goodyear, P. (2017). *Design, learning networks and service innovation. Design Studies*, *55*, 25-53. https://doi.org/10.1016/j.destud.2017.09.003

Carvalho, R. C. (2019) *Inovação no sistema financeiro: estudo de caso de banco de varejo brasileiro*. Fundação Instituto de Administração.

Colledani, M., Silipo, L., Yemane, A., Lanza, G., Bürgin, J. Hochdörffer, J., Georgoulias, K., Mourtzis, D., Bitte, F., Bernard, A., & Belkadi, F. (2016). Technology-based product-services for supporting frugal innovation. *Procedia CIRP*, *47*, 126-131.

Christ, M. H., Eulerich, M., Krane, R., & Wood, D. (2020). A new frontiers for internal audit research. *Appc, 20*(4), 449-475. https://doi.org/10.1111/1911-3838.12272

Danescu, T., Prozan, M., & Prozan, R. D. (2015). The valances of the internal audit in relationship with the internal control - Corporate Governance. *Procedia Economics and Finance*. *26*, 960-966.

Daniela, P. & Attila, T. (2013). Internal audit versus internal control and coaching. *Procedia Economics and Finance*, *6*, 694-702.

Deloitte. *Auditoria Interna 3.0.* https://www2.deloitte.com/br/pt/pages/risk/articles/internal-audit-3-0.html.

Doyle, E., Mcgovern, D., Mccarthy, S., & Alaniz, M. P. (2018). Compliance-innovation: a quality-based route to sustainability. *Journal of Cleaner Production*, *210*, 266-275. https://doi.org/10.1016/j.jclepro.2018.10.307

Hannimitkulchai, K. & Ussahawanitchakit, P. (2016). Continuous audit development and audit survival: evidence from tax auditors in Thailand. *The Business and Management Review*, *7*, 487-498.

Imoniana, J. O., Matheus, C. P., & Perera, L. C. J. (2014). Medição de desempenho de auditoria interna: um estudo empírico. *Revista Universo Contábil*, *10*, 65–93.

Imran, S., Haeberle, D., & Husen, C. V. (2017). Governance: A new perspective to service design process. *Procedia CIRP*, *64*, 318-323.

Instituto Dos Auditores Internos Do Brasil (1991). *Procedimentos de Auditoria Interna Organização Básica*. São Paulo.

Kahn, K. B. (2018). Understanding innovation. *Business Horizons*, *61*, 453-460.

Kaneko, K., Kishita, Y., & Umeda, Y. (2017). In Pursuit of Personalization Design. *Proceedings CIRP*, *61*, 93-97.

Koskela-Huotari, K., Patrício, L., Zhang, J., Karpen, I. O., Sangiorgi, D., Anderson, L., & Bogicevic, V. (2021). Service system transformation through service design: Linking analytical dimensions and service design approaches. *Journal of Business Research*, *136*, 343-355. https://doi.org/10.1016/j.jbusres.2021.07.034

Lee, C. H., Zhao, X., & Lee, Y. C. (2019). Service quality driven approach for innovative retail service system design and evaluation: A case study. *Computers & Industrial Engineering*, *135*, 275-285. https://doi.org/10.1016/j.cie.2019.06.001

Lendel, V., Hittmar, S., & Siantova, E. (2015). Management of innovation processes in company. *Procedia Economics and Finance*, *23*, 861-866.

Lim, C. & Kim, K. J. (2018). Experience design board: A tool for visualizing and designing experiencecentric service delivery processes. *Journal of Retailing and Consumer Services*, *45,* 142-151.

Munteanu, V. & Zaharia, D. L. (2014). Current trends in internal audit. *Procedia - Social and Behavioral Sciences*, *16*, 2239-2242.

Mukhtar, M., Ismail, M. N., & Yahya, Y. (2012). A hierarchical classification of co-creation models and techniques to aid in product or service design. *Computers in Industry*, *63*, 289-297.

Pellegrini, V. L. B., Barbosa, J. G. P., Pitassi, C., & Oliveira, M. A. (2014). Auditoria de processos de inovação: um estudo de caso no inmetro. *Sociedade, Contabilidade e Gestão*, *9,* 124–141.

Petrascu, D.; Tieanu, A. (2014). The role of internal audit in fraud prevention and detection. *Procedia Economics and Finance*, 16, 489-497.

Petrascu, D. & Tamas, A. (2013). Internal audit versus internal control and coaching. *Procedia Economics and Finance*, 6, 694 - 702.

Pugh, S. D. & Mahesh, S. (2016). Taking services seriously: new directions in services management theory and research. *Human Resource Management Review*, 26(1), 1-3. https://doi. org/10.1016/j.hrmr.2015.09.001

Rakipi, R., Santis, F., & D'onza, G. (2021). Correlates of the internal audit function's use of data analytics in the big data era: global evidence. *Journal of International Accounting, Auditing and Taxation*, *42*, 2 - 39. https://doi.org/10.1016/j.intaccaudtax.2020.100357

Rosa, G. S., Faria, B. G., Guimarães, T. B. C., & Godinho, L. A. C. (2019). Da gestão da inovação ao design de serviços: articulações e conexões. *Administração de Empresas em Revista*, *11*, 24415 – 24438.

Scherer, F. O. (2016). *Gestão da Inovação na Prática: Como Aplicar Conceitos e Ferramentas Para Alavancar a Inovação*. Atlas.

Selva, C. R. G. & Pinto, L. S.; (2019) *Auditoria Interna: Colaboradores São Líderes da Inovação.* IPEA.

Silva, F. P., Lima, A. P. L., Alves, A., Junior, R. S. C., Dias, I.A. M., & Duarte, M. F. (2018). *Gestão da Inovação*. SAGAH.

Sisaye, S. (1999). An organizational approach for the study of the diffusion of process innovation strategies in internal auditing and control systems. International *Journal of Applied Quality Management*, *2*, 279-293.

Smith, A. M., Fischbacher, M., & Wilson, F. A. (2007). New Service Development: From Panoramas to Precision. *European Management Journal*, *25*, 370-383.

Struwe, S. & Slepniov, D. (2021). Conflict by design and why institutions matter in service design: a case of a german creative agency in China. *Journal of Business Research*, 130, 124-136. https://doi.org/10.1016/j.jbusres.2021.03.035

Stuart, I. C**.** (2014). *Serviços de auditoria e asseguração na prática***.** AMGH Editora Ltda.

Souza, R. G. (2017). *Auditoria interna: um panorama das pesquisas acadêmicas publicadas em periódicos e congressos nacionais*. Goiânia.

Tjara, S. F. (2020). *Inovação na pratica: design thinking e ferramentas aplicadas a startups*. Alta Books.

Traldi, M. C. & Dias, R. (2011). *Monografia Passo a Passo*. Subparagraph.

Valtonen, A. (2020). Approaching change with and in design. *Journal of Design Economics and Innovation*, 6(4), 505-528. https://doi.org/10.1016/j.sheji.2020.08.004

Wittayapoom, K. (2014). New product development, accounting information, and internal audits: a proposed integrative framework. *Procedia - Social and Behavioral Sciences*, *148*, 307-314.

Zeithaml, V. A. &Bitner, M. J. (2003). *Marketing de serviços: a empresa com foco no cliente*. Bookman.

Zaharia, D. L., Lazar, A., & Tilea, D. M. (2014). The role of internal audit regarding the corporate governance and the current crisis. *Procedia - Social and Behavioral Sciences*, *116*, 4819-4823.

Zeithaml, V. A., Bitner, M. J., & Gremler, D. D. (2003). *Marketing de serviços: a empresa com foco no cliente*. Bookman.

Date received: 24/02/2020
Review Date: 10/05/2022
Date of acceptance: 08/07/2022

PROJECT, DESIGN AND MANAGEMENT

https://www.mlsjournals.com/Project-Design-Management

ISSN: 2683-1597

How to cite this article:
Avila Jimenez, F.G. & Anaya Hernández, A. (2023). Análisis espacial: herramienta estratégica para la gestión de la co-investigación y docencia en espacios colaborativos. *Project, Design and Management, 5*(1), 57-78. doi: 10.35992/pdm.5vi1.1181

THE MULTICRETRY SPATIAL ANALYSIS FOR THE MANAGEMENT OF CO-RESEARCH IN COLLABORATIVE SPACES

Felipe Gerardo Avila Jimenez
Universidad Autónoma Metropolitana Unidad Xochimilco (Mexico)
fgavila@correo.xoc.uam.mx - https://orcid.org/0000-0001-5590-5577
Armando Anaya Hernández
Autonomous University of Campeche (Mexico)
armannaya@uacam.mx · https://orcid.org/0000-0003-3229-0930

Summary. In this paper we present a methodological proposal, based on the fundamental principles of multicriteria analysis that were adapted to the management of co-investigation, to be implemented in collaborative spaces that work with geospatial information. By combining multi-criteria methods with Geographic Information Systems, very powerful spatial analysis methodological guides are obtained, which make possible the integration, analysis, synthesis and dissemination of knowledge. In this case, said conjunction is considered as a support tool for the management of research projects in Higher Education Institutions. To apply and describe this proposal, we worked with two primary sources: 1. Opinions of professors, students and directors of the Universidad Autónoma Metropolitana Unidad Azcapotzalco (UAM-A), -data compiled for the preparation of a thesis for the Doctorate in Projects, UNINI-FUNIBER–. 2. Main challenges faced by urban laboratories, -opinions expressed at the 2021 Seminar, Urban Laboratories in the face of the Pandemic, UAM-A–. As part of the results, the method adapted to the reality of the Urban Form Laboratory of the UAM-A and the description of nine processes, which are based on the Hierarchical Analysis, are presented. From this exercise, a very useful standardized parameter is obtained, so that those responsible for research, teachers, technical teams and collaborators; improve their organizational processes and take advantage of the products derived from collaborative work.

Keywords: Spatial Analysis, Hierarchical Analysis, co-investigation, space and collaborative work.

EL ANÁLISIS ESPACIAL MULTICRETRIO PARA LA GESTIÓN DE LA CO-INVESTIGACIÓN EN ESPACIOS COLABORATIVOS

Resumen. En este trabajo se presenta una propuesta metodológica, basada en los principios fundamentales del análisis multicriterio que fueron adaptados a la gestión de la co-investigación, para instrumentarse en espacios colaborativos que trabajan con información geoespacial. Mediante la combinación de los métodos multicriterio, con los Sistemas de Información Geográfica, se obtienen guías metodológicas de análisis espacial muy poderosas, que hacen posible la integración, análisis, síntesis y difusión de conocimiento. Para este caso, dicha conjunción, es considerada como una herramienta de apoyo para la gestión en proyectos de investigación en Instituciones de Educación Superior. Para aplicar y describir esta propuesta, se trabajó con dos fuentes primarias: 1. Opiniones de profesores, estudiantes y directivos de la Universidad Autónoma Metropolitana Unidad Azcapotzalco (UAM-A),

–datos recopilados para la elaboración de una tesis para el Doctorado en Proyectos, UNINI-FUNIBER–. 2. Principales retos que enfrentan los laboratorios urbanos, –opiniones vertidas en el Seminario 2021, Laboratorios Urbanos ante la Pandemia, UAM-A–. Como parte de los resultados, se presenta el método adaptado a la realidad del Laboratorio de la Forma Urbana de la UAM-A y la descripción de nueve procesos, que están cimentados en el Análisis Jerárquico. De este ejercicio, se obtiene un parámetro estandarizado de gran utilidad, para que los responsables de investigaciones, docentes, equipos técnicos y colaboradores; mejoren sus procesos organizacionales y aprovechen los productos derivados del trabajo colaborativo.

Palabras clave: Análisis Jerárquico, co-investigación, espacio y trabajo colaborativo.

Introduction

In these times characterized by great uncertainty and dynamics derived from the Covid-19 pandemic, it is necessary to rethink the role of socio-urban laboratories installed in Higher Education Institutions (HEI) as information-producing entities, but also as collaborative spaces that today must be considered cross-border –disciplinary– for the generation of knowledge.

In view of this situation, laboratories related to social and urban research activities should provide a transit and openness to realities that lead to collaborative spaces; where "critical thinking, academic development and knowledge management" are developed in terms of achieving an "understanding of the morphological processes of cities in the XXI century" (Avila et al, 2021, p. 4).

To this end, they will have to redefine their lines of action and promote the development of research and educational processes under new forms that will allow them to reorient their objectives and work agendas. Both the forms of research production and teaching have been affected by the pandemic. This situation has accelerated processes in the two aforementioned dimensions, with manifestations that have increased the use of Information and Communication Technologies (ICT), promoted distance education, teleworking, data flows, information, the movement of scientific variables, as well as conceptual redefinitions and technological applications have been incorporated in a forceful and rapid manner in everyday life.

This context makes it possible to approach the reconfiguration of socio-urban laboratories based on the identification of those training and information needs that guarantee success in the quality fulfillment of the guiding ideas and strategic objectives to be considered for the design of a strategy that promotes collaborative work through multi-criteria analysis methodologies based on the principle of co-research (Núñez, 2008). This suggests strengthening the link between research and teaching, both fundamental elements of the work of HEIs. The concept of co-research forces to rethink the teaching-learning processes in an integral logic; however, there is evidence of some factors that slow down the approach of organizations to the approaches of knowledge production and organizational learning, such as: Top management, which is besieged or cornered by constant operability and the short term; the neglect of continuous training, both technical and project management; the working environment of low trust –fear of sharing knowledge due to individual competence–; and the lack of adequate spaces that encourage group or team work (Cuesta, 2001 in Núñez, 2004, p. 5).

To address these and other problems, there are several approaches, among which we identify those that deal with issues related to organizational studies and that have also been dynamic. So far, at least two clearly identified theoretical bodies prevail: the systemic school and the scientific school. The first, according to Rendón and Montaño (2004), is based on organizational theory, which focuses on human relations, while the second is based on management theory. The latter arises from the works of Taylor (1911) and Fayol (1916), which

represent the main theoretical support; although for organizational studies it only represents its material basis (Ibarra and Montaño, 1986 in Ramírez Martínez; Vargas Larios and De la Rosa Alburquerque, 2011). This materiality is permeated by a technological approach, which aims, through ICTs, to provide tools to efficiently carry out management activities and information and knowledge processes.

The vision of organizational studies considers knowledge as the result obtained from co-research processes, through the use of tools and methods in collaborative spaces. In this paper, the discussion focuses on the description of methodological tools that increase capacity, create value, and promote functional and operational organizational innovations considering their pre-existing capabilities. The aim is to comply with the foundational objectives of the IES and to adapt to current dynamics through medium and long-term organizational development strategies. These should focus on the management of the knowledge produced and consider it as a strategic factor for the solution of specific problems.

Regarding the key elements for developing a model of collaborative spaces, it can be pointed out that not only is it necessary to develop high technology, but it also requires increasing the capabilities of people and institutions in the acquisition, generation, dissemination and use of knowledge, in order to produce significant effects on learning. It is evident that the organization open to the production of knowledge represents a paradigm shift with respect to traditional organizations. We are witnessing the emergence of a new management perspective on how organizations should function and how they should deal with change (Pérez and Cortés, 2007).

This article proposes a methodological strategy based on multi-criteria analysis, to establish a standardized work parameter, aimed at research and teaching units, based on co-research in collaborative spaces.

Teamwork and collaborative work

In the Mexican case, a state policy seeks to promote research, which, due to its intrinsic importance, is a way to have a strong innovation and technological development system. Which suggests having a vigorous science dissemination and communication policy (UNAM, 2018).

To this end, the National Association of Universities and Higher Education Institutions[1] (ANUIES) has set as one of its many objectives the creation of scientific and technological collaboration networks. "This implies carrying out the functions of teaching, research, dissemination of culture, extension of services and institutional management with a vision of change, with a renewed perspective of the future to enhance the social function of IES" (ANUIES, 2018, p.17). The transition must take place towards the construction of knowledge societies and is recognized as a complex, unstable and turbulent process, in which HEIs must adapt to the conditions of the environment based on creativity. Collaborative work is a central axis of his discourse.

Within its lines of action, ANUIES foresees the generation of learning environments, through academic and knowledge networks[2]; promoting the use of ICT in most educational programs and; articulating and providing feedback on training, research, dissemination and university extension (ANUIES, 2018). In order to carry out these actions, the HEIs must

[1] Non-governmental organization that groups the 191 most important public and private higher education institutions in Mexico. These institutions, located in the 32 states, together serve almost 60% of the national enrollment and conduct 90% of scientific research.

[2] According to the Program for the Professional Development of Teachers (PRODEP), and in particular in its Rules of Operation 2020, the Academic Bodies are networks and "groups of full-time professors who share one or more lines of knowledge generation, applied research or technological development and innovation in disciplinary or multidisciplinary topics and a set of academic objectives and goals" (DOF, 2021, p. 4).

generate conditions conducive to collaborative research work and the participation of the academic communities. This is: "purposeful collaboration to create knowledge, that is, to create new ways of doing things, which guides the formation of working groups in knowledge society organizations" (Nonaka et al. 2001, in Santizo, 2016, p. 155).

For its part, the National Council for Science and Technology (CONACyT) in its 2019 General Report, reports a sustained increase in the number of researchers, which went from 18,555 to 30,548 in the period 2012-2019 (CONACyT, 2019). This group is made up of researchers from IES and other educational and research centers that are registered in the National System of Researchers (SNI). In this system, one of the elements to be considered is the generation of research groups and networks. In addition to this, the document Towards the Consolidation and Development of Public Policies in Science, Technology and Innovation, published by UNAM in 2018, states that the growth of Science, Technology and Innovation (STI) has increased the number of research lines and products; however, it specifies that scientific activity has been performed, "promoting development individually, rather than collaborative work that stimulates the formation of solid and interdisciplinary teams". Situation originated in part, because "there has been little stimulus to the application of disruptive approaches, in an innovative sense" (UNAM, 2018, p. 26).

For this reason, the creation of research teams represents a challenge for the national STI policy, as well as for the HEIs themselves. Although the benefits obtained from collaborative work are varied, we must not lose sight of the fact that in "joint work [...] its results, [...] are not integrated by the simple sum of individual contributions; there are additional benefits derived from collaboration" (Santizo, 2016, p. 161).

A fundamental element that influences collaboration is the trust existing among the members of a group (Luhmann, 2000, in Santizo, 2016). Another element to consider in collaborative work is the condition of complementarity. The latter, determines that teamwork is more effective than individual work and can counteract problems derived from the diffuse, which sometimes affects the allocation of tasks and responsibilities among members (Baker, 2002 and Fryer, 2013, in Santizo, 2016). The complementary knowledge and skills of researchers can encourage collaboration among them, as long as similarities, preferences and interests are considered and aligned with group objectives.

Co-research

In practice, collaboration represents an important element in strategies aimed at solving problems that, due to their complexity, are impossible to address individually. In research practice, it is convenient to adopt collaborative work strategies and to consider co-research as an approach that assumes that the members of a research group decide together the possibilities of cognitive self-determination in their various fields of expertise. Co-research, in Hartley and Benington's (2000) view, "establishes a dialectical process of inquiry drawing on complementary perspectives, interests, skills, and knowledge bases of scholars and practitioners" (p. 463). The authors recognize stakeholder perspectives and ways of producing knowledge and identify the academic as an actor who is responsible for and leads the research team. Both authors argue that knowledge is not only transferred between stakeholders, but is created jointly through dialectical research processes.

Co-research does not limit the participation of diverse actors and stakeholders in this productive process; therefore, it can be considered in the context of HEI, that students can and should be actively integrated. But also, co-research can be implemented in the classroom, to study the various objects of study, so that both the production and the transfer of knowledge support the teaching-learning process. Thus, the incorporation of the student sector in research will be vital to counteract the difficulties of students to achieve the curricularly prescribed

objectives and those present in HEIs to assume strong educational projects (Boavida and Da Ponte, 2011).

Collaboration, as an element of co-research, starts from an individual motivation and not from an external demand or imposition. Collaboration suggests that the individuals involved are considered as a member within a system, who, through their actions, manage to influence the structure and/or functioning of the same system (organization, event and/or process). The practical part of research is nourished by the previous definition and positions it as an intellectual process. A process based on a set of activities and methods applied in a systemic manner, with the objective of deepening the understanding and/or solution of a specific topic or problem; in addition, it allows for the expansion and development of knowledge and scientific interest.

However, Wagner 1997, cited by Boavida and Da Ponte, 2011, points out that collaboration constitutes a particular form of cooperation. Wagner uses the concept of cooperation "to designate all educational research that is conducted in schools, and even that in which researchers limit themselves to using teachers and students as data sources"; that is, cooperation is inherent in all research (p. 128).

In short, co-research suggests collaborative ways of working where roles are discussed and agreed upon within the team. It does not depend only on the existence of a common objective; it must be accompanied by much more horizontal forms of work and relationships, in order to trigger communication processes in all directions and scales, without losing sight of the responsibilities and commitments acquired as a group. "Co-research is a type of co-production methodology" (Hartley and Benington, 2000, p. 464).

Collaborative spaces

The ways of working, teaching and research influenced by the current dynamics and from the emerging perspective of HEIs, has triggered increasingly strong initiatives on the design of spaces that allow more stable interconnections, both face-to-face and at a distance. Professional training should direct its efforts to the promotion of teaching and research based on collaborative learning -networked, accelerated by the pandemic-. To this end, it is necessary to move towards spaces of collective construction between teachers-researchers-students, grouped on the basis of a common interest. This type of space allows the exchange of different points of view, experiences, problems, ideas and resources associated with research and teaching in the educational sector (Ollarves and Chivico, 2008).

In the task of HEIs to achieve a fusion or balance between teaching and research, the role of the researcher-teacher is of utmost importance. The latter is considered an agent of change and socio-educational transformations. This requires a dynamic role that manages to interconnect the knowledge of scientific knowledge through interactivity between peers –teachers, researchers and students–. The aim is to involve students in the research process and furthermore, to motivate collective interest through the transmission of the main findings obtained from the research activity and clear methods of collaboration.

Physical space is important, as it allows the creation of mechanisms that promote group interactions and interconnected ways of working; but it represents only the material basis. In this paper, the mechanisms and tools are discussed in depth, and only some recommendations of the minimum elements that this type of spaces should have are mentioned in a general way (these are indicative and not limiting). Collaborative spaces according to Duart and Sangrà, 2000 cited by Rodríguez, D., Bertone, R. and García-Martínez, R., 2009 are spaces which, given their physical characteristics, should have a specialized newspaper library and library, as well as well-equipped classrooms where workshops or seminars can be held.

Although this contribution lays the groundwork for defining the minimum operating requirements for this type of space, it is also necessary to clarify some elements. First, the newspaper library today can be part of the repository, where you have a collection of digital publications organized in: 1. Scientific production documents -regularly refers to internal production derived from research and teaching-; 2. Papers from other research groups related to the lines of research; and 3. Publication of journals, memoirs, proceedings and periodicals. To make its management possible, the generation of metadata[3] should be considered in order to implement digital consultation platforms or a basic Spatial Data Infrastructure (SDI)[4]. These conditions do not suggest that a collaborative space -considered in this analysis as equivalent to a laboratory- should become a documentary center; rather, it is a matter of consolidating a data and information bank that responds to the requirements of internal users (including research and teaching groups).

These recommendations should be considered as a starting point. The equipment and technological tools to be implemented will depend on the topics, disciplines and activities of the working groups. In addition, computational capacity, connectivity and space distribution, both physical and virtual, must be taken into account, as well as their relationship with organizational objectives.

The classroom space, according to Duart and Sangrà, 2000 in Rodríguez, et al. 2009 has evolved, thanks to technological advances in terms of communication infrastructure and computer equipment. This requires the provision of terminals, with intranet and internet connections, as well as adequate *software* to enable access, analysis, production, exchange and dissemination of value-added information. Any strengthening strategy must consider the use of available technological means and increase them in a sustained manner to generate material conditions that support the training of students and researchers. The aim is to support the researcher in training in his or her learning process, as well as the trained researcher, so that he or she can become a true facilitator of learning and transmitter of research skills (Rodríguez, et al. 2009). The above approach, contrasts with the opinion of Gamboa, Rodriguez F. (2016) who points out, that "Several authors note how little the educational environment has changed" (p. 202). State explained in part, because the educational relationship remains in the verticality and academic unidirectionality reduced to three units: time, place and action; that is, "all in the same place, at the same time, performing the same learning activities" (Moreno, 2007 cited by Gamboa, 2016, p. 202).

Moving from a static state to a dynamic educational environment suggests recognizing that communication mechanisms and methods become relevant over infrastructure and technological equipment. These mechanisms make possible the functioning and give life to the relationships established in the research and teaching-learning processes. This is why rethinking this type of spaces requires putting people (researchers, professors and students) at the center, so that they can be self-managers of their training process.

Methodological tools

As we have seen, collaborative work involves intentional participation to create knowledge through the formation of groups based on novel forms of interdisciplinary

[3] A metadata describes the attributes of a bibliographic, archival, geospatial, etc. resource, whose main purpose is to describe, identify and define a resource in order to retrieve, filter, report on conditions of use, authentication and evaluation, preservation and interoperability. See Ercegovac (1999), in Senso, José A. and De la Rosa, Piñero A. (2003).

[4] Spatial Data Infrastructure (SDI) is a relevant core collection of technologies, policies and institutional arrangements that facilitate the availability of and access to spatial data. This includes geographic data and attributes, metadata, catalogs and web mapping, and some method of providing access to geographic data.

grouping[5]. This makes it possible to design and implement clear and flexible ways of working, based on the principle of complementarity, which serve as a means to achieve the collective objectives. It suggests that working groups and collaborative spaces implement methods and use technological tools to guarantee the necessary conditions for the production of knowledge and collective learning. what methodological mechanisms can working groups use to trigger productive processes based on the principles of co-research in collaborative spaces of HEIs?

As a first approach to this question, we propose the application of a multi-criteria model, which is compatible and contributes methodological elements to co-research and supports the teaching-learning processes, from a collaborative work approach. Multi-criteria analyses are methodological tools that facilitate the understanding of the complexity of a problem, or the uncertainty of a situation or decision, where there are a variety of actors and interests. They operate by contrasting the different valuations assigned by the parties involved in decision making, problem solving or research processes.

There are several multicriteria models (see Rendón, Escamilla, Montaño, & Navarro, 2018), but for this work, the Hierarchical Analysis method of Saaty, (1980) AHP for its acronym in English (*Analytic Hierarchy Process*) has been selected, considering two criteria: 1. It is a method that is compatible with Geographic Information Systems (GIS) and 2. It allows the development of personal contributions -evaluations- to the collective work throughout the research and/or teaching process.

The AHP consists of formalizing the intuitive understanding of complex problems through the construction of a hierarchical model. The purpose of the method is to allow the decision-maker to structure a multi-criteria problem in a visual form, through the construction of a hierarchical model that basically contains three levels: goal or objective, criteria and alternatives (Avila, 2002).

Among its various benefits are the following: It is mathematically based; it allows the incorporation of qualitative and quantitative criteria, by means of a common scale; it includes the participation of various people or groups and generates consensus; it also allows verification of consistency and corrections; it is easy to use and allows the solution to be expressed in various media (tables, graphs, maps, etc.) (Toskano, 2005).

Toskano (2005), points out three elements to be considered by the team in charge of the AHP application: 1. Identification of participants according to their capabilities, skills, knowledge of the problem and interests. 2. Information required. In this case, the focus is on geographic information, although it also includes scientific, technical and tacit information. 3. Time and resources: resources associated with the process, design of a work plan that defines dates, agenda, logistics and participatory techniques.

AHP is complementary to GIS, through spatial analysis. This type of analysis responds to the need to analyze geographic phenomena in a systemic and efficient manner. It enhances the relationship between computer science, cartography and statistical methods (Siabato, 2018). A fundamental element in this type of method is undoubtedly Geographic Information (GI). It is analyzed in terms of its usefulness for the development of research, teaching and decision-making processes. From its construction to its use, GI is based on basic principles derived from

[5] Conceptually speaking, interdisciplinary grouping can be understood from the following concepts: "The word 'discipline', in the sense used in the word 'interdisciplinarity' [...], means a branch of knowledge, instruction, learning, teaching or education. So, 'discipline' is a set of knowledge or skills that can be taught and learned." Seen as action, it "refers to an activity that exists between existing disciplines or in a reciprocal relationship between them", without denying its independence. It is recognized that the "convergence of two sciences [...] requires an operational material continuity [...], and implies the establishment of common material principles. (such as the principles of mechanics or thermodynamics)"; avoiding as much as possible to fall into "a reductionist monism (of a formal nature)". As a process, "Teaching and learning are moments of scientific activity, but they are not necessarily the moment of constitution of scientific theorems but the moment of their transmission"; that is, this type of grouping can affect both research and teaching in IES, through communicative acts (Alvargonzález, D. 2011, p. 387, 388, 389 and 394).

spatial cognition, which is linked to the way in which we structure space and how we relate to it. Its material expression –digital or printed cartography– is nothing other than spatial or geographic information and is the result of the codification of the consequences of everyday activities (Gutiérrez, 2019). It represents one of the main materials used in spatial analysis.

Finally, Siabato (2018) points out that students, researchers and educators at all levels of education, already have massive access to this type of information, with which, it does not represent an impediment to use it.

Method

The methodological strategy based on spatial analysis serves to establish a structured parameter for collaborative work aimed at research and teaching units within the framework of HEIs. To this end, the schematic proposal incorporates initial aspects of the researcher based on the corpus of knowledge of organizational and technological studies, in addition to the experiences applied in both research and teaching processes.

The methodological approach focuses on the opportunities provided by the AHP model; considered in this vision as a catalyst for collaborative processes and facilitates the planning and definition of stages, actions, relationships, mechanisms and support tools. This is an operational research (descriptive-relational), cross-sectional, in which the methodological process is described and an analysis of the possible interactions between the components of the AHP model and the organizational activities and actions is carried out. It is based on a mixed data analysis method: 1. In the quantitative dimension, information derived from two questionnaires applied to internal users of the Urban Form Laboratory of the UAM-Azcapotzalco was used. This was used to identify, segment and diagnose the internal communication system; analysis expressed by means of contingency tables. 2. In the qualitative part, a documentary analysis was carried out to obtain strengths and opportunities in the institutional environment and the opinions expressed by the participants in the Seminar 2021, Urban Laboratories Facing the Pandemic[6], were analyzed to identify the main challenges. This set of empirical elements was used to identify information and training needs, which are part of the definition of an operational problem -in terms of collaborative work- and to materialize organizational opportunities, by incorporating them into the methodological proposal in a structured manner.

Results

Main needs

The starting point is the identification of internal users based on the analysis of their main activities, which are presented in Table 1. In this process, two major segments of interest were identified: 1. Teachers representing 45% and 2. Students equivalent to 55%. Within the first group, 56% stated that they carry out teaching and thesis advising tasks; while 33% of professors diversify their activities even more (teaching, thesis advising, research and

[6] The Urban Form Laboratory, the Urban Studies Area and the Postgraduate Program in Design and Urban Studies, with the support of the Department of Design Evaluation in Time and the CyAD Division of the Universidad Autónoma Metropolitana Unidad Azcapotzalco, organized the Seminar 2021, Urban Laboratories before the Pandemic".

participation in academic committees), and only 11% are engaged in management and/or coordination tasks.

Table 1
Percentage distribution of teachers and students according to their main activity.

Main activity	General segments	
	Teachers (%)	Students (%)
Coordination	11	--
Teaching and thesis advising	56	--
Teaching, thesis advising, research and academic committees	33	--
Student	--	73
Student involved in a research project	--	27
Total	**45**	**55**

Based on this case study, a need is identified to increase the number of teachers involved in research processes.

To identify the availabilities (capabilities, skills and interests) of the users, we used their membership in groups organized according to their line and area of research (categorical variable of membership, which was crossed with the topics of expertise declared by each participant).

Figure 1
Word map according to specialty topics

Note. Prepared by the authors, with information on the percentage distribution of professors and students by line and area of research in relation to the topics of expertise. Processed with TagCrowd.com

According to Figure 1, the topics of specialization of the segments grouped by lines and areas of research suggest that most users consider that geographic, statistical and documentary information are useful in studies on urban issues, as shown in Figure 2.

Figure 2
Word map of the main types of information used

Note. Prepared by the authors, with information on the most useful type of information by line and area of research. Processed with TagCrowd.com

In relation to Table 2, the use of physical spaces available in the HEI facilities, it is interesting to note that the classroom and the laboratory are most frequently used for teaching activities and thesis advising, according to the opinions of the professors. Most of the students make use of these spaces, in addition to the computer room. It is understandable that these spaces are frequently used by the student sector, since their main activity is academic. It is noteworthy that the teachers who stated that they participate in research projects mostly use their cubicles, classrooms and libraries to carry out their activities. This situation suggests that research is carried out in private places and is possibly caused by the lack of collective spaces and/or consolidated laboratories or by the absence of a collaborative method.

Table 2
Percentage distribution of space occupancy by type of main activity

Physical space	Main activity (%)					
	Coordination	Teaching and thesis advising	Teaching, thesis advising, research and academic committees	Student	Student involved in a research project	Total
Classroom	--	14	14	71	--	35
Classroom, Laboratory	--	50	--	25	25	20
Classroom, Cubicle, Library	25	25	50	--	--	20
Classroom, Laboratory, Computer Room	--	20	--	40	40	25

With regard to the strengths and opportunities currently available to the LFU, the following strengths stand out: It has physical, organizational and institutional support capabilities, as well as intellectual capacities, available institutional mechanisms and tools for aligning objectives through affinity and complementarity with similar organizations.

In parallel, the 2021 Seminar participants expressed the opportunities they identified in their laboratories, which were documented as follows:

1. Horizontality at the time of working, being inclusive, encouraging space to enter into research;
2. Interdisciplinary process, interaction with different stakeholders and credit to the information generator;
3. Research agenda as a collaborative tool, use of scientific networks;
4. Knowledge as a central element of collaborative work with a real impact on the collective;

5. Guarantee stability to the work teams in the laboratories;
6. Use of free *software* and sharing mechanisms;
7. It positions scientific work as open science and citizen science;
8. Intellectual co-ownership as a public good;
9. Laboratories as productive units of knowledge.

The results obtained from this organizational characterization are the inputs that nourish the necessary elements to design and apply the AHP according to Toskano's (2005) approach.

Description of the proposal

In response to the needs detected and the challenges identified, the methodological strategy based on the AHP is described as a model for structuring the research-teaching work in collaborative spaces.

The model proposed and described under the LFU reality -for demonstration purposes-, complies with the three elements necessary for initial planning according to Toskano (2005).

1. Identification of participants (teachers and students). In a second level of segmentation, five subgroups selected according to their main activity within the IES were defined: a) coordination, b) teaching and thesis advising, c) teaching, thesis advising, research and academic committee, d) student, and e) student involved in research. The segmentation can go into more detail, if those areas of specialty and/or interest are considered; if and when required. In other HEIs and entities, the number of groups and subgroups may vary, as well as the variables that define the activities, specialization and interests, among others.
2. Information required. Considered as a fundamental element to evaluate and make decisions. It was found that for the segments identified, cartographic, statistical and documentary information was indicated as the main types of information required and used, according to their activities and defined affinities, based on their lines and areas of research, as shown in Figure 2.
3. Time and resources. It considers those resources associated with the process, in addition to the design of a work plan that defines: dates, agenda, logistics and, very importantly, participatory techniques. In this process, only part of the logistics and some suggestions on participatory techniques are developed, as part of a descriptive exercise and not strictly applied.

To address the issue of participatory techniques, the general diagram of the strategic proposal for collaborative work is presented at[7].

[7] Collaborative work is not exclusively to be implemented in groups focused on research projects; it is worth remembering that during the teaching-learning process, students continuously form teams, investigate and analyze objects of study, topics or even territories and spaces. In this sense, the proposed method shows its goodness, since it allows the teacher-researcher to provide methodological elements to the students, so that they can develop it and participate actively, either to identify problems and/or solutions, or to have sufficient criteria to enable them to make a decision. In this way, the methodological tool contributes positively to teaching.

Figure 3

Process diagram for the application of multi-criteria analysis, in collaborative work groups

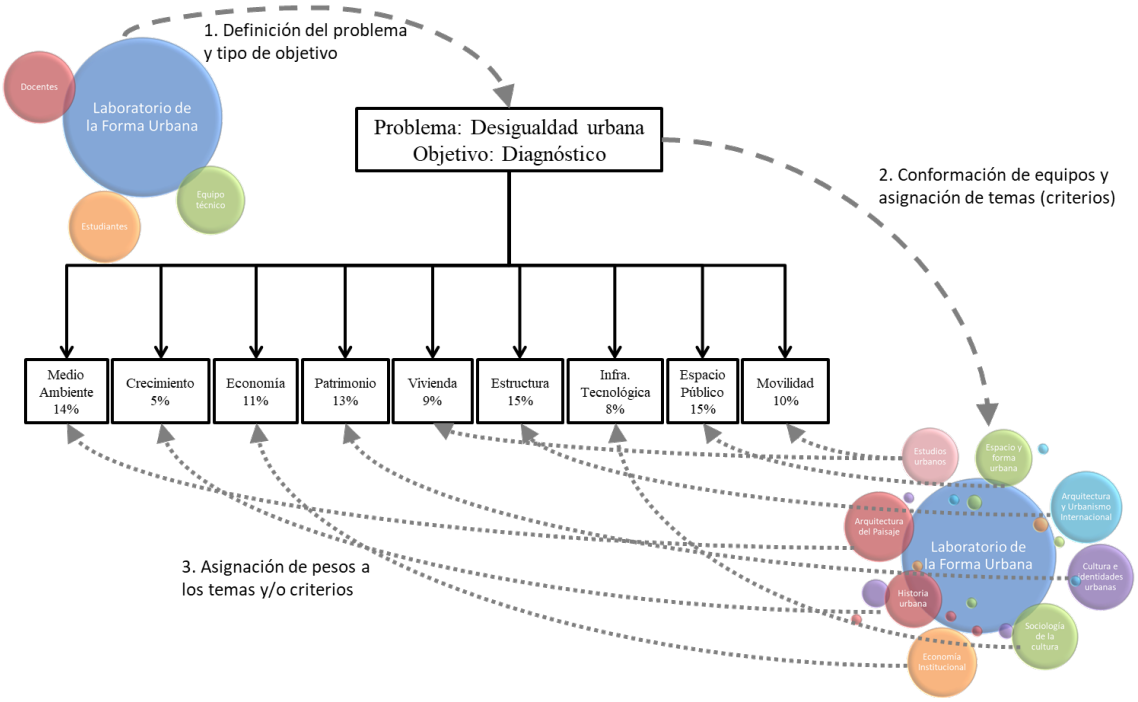
Note. Own elaboration. Between each process, the main activities to be carried out before starting the next one are indicated.

The following processes that can be integrally applied in the research-teaching-learning processes are defined below:

1. Definition of the problem and type of objectives. Based on the register of collaborators and considering their qualities (capabilities, skills and interests), the problem and the objective pursued by the model are defined together. Two types of objectives or goals are usually defined: 1. Diagnostics and 2. Strategic or proposals. In this process, brainstorming is often used based on the analysis of data and information available in print and/or digital media.
2. Formation of teams and assignment of topics (criteria). Based on the definition of the problem, relevant topics are identified and, through their analysis, a better understanding is obtained, allowing the creation or identification of working groups for their analysis and assignment of the topic by group. The register of collaborators from process 1 should be taken up again, considering their respective skills and interests.
3. Assignment of weights to topics and/or criteria. Once the teams have been formed and their topics assigned, weights are assigned. The groups hierarchically order the list of issues identified in the previous process; evaluating their importance or causality, in relation to the objective: to define the problem or design solutions. The weighting or weight assignment techniques may be selected by the thematic teams and defined by them, or they may use the technique in which the technical team has the most experience. It is also possible to use those techniques that adapt to the work methods and the number of participants. The important thing is to collectively define the weight of each topic.

Figure 4

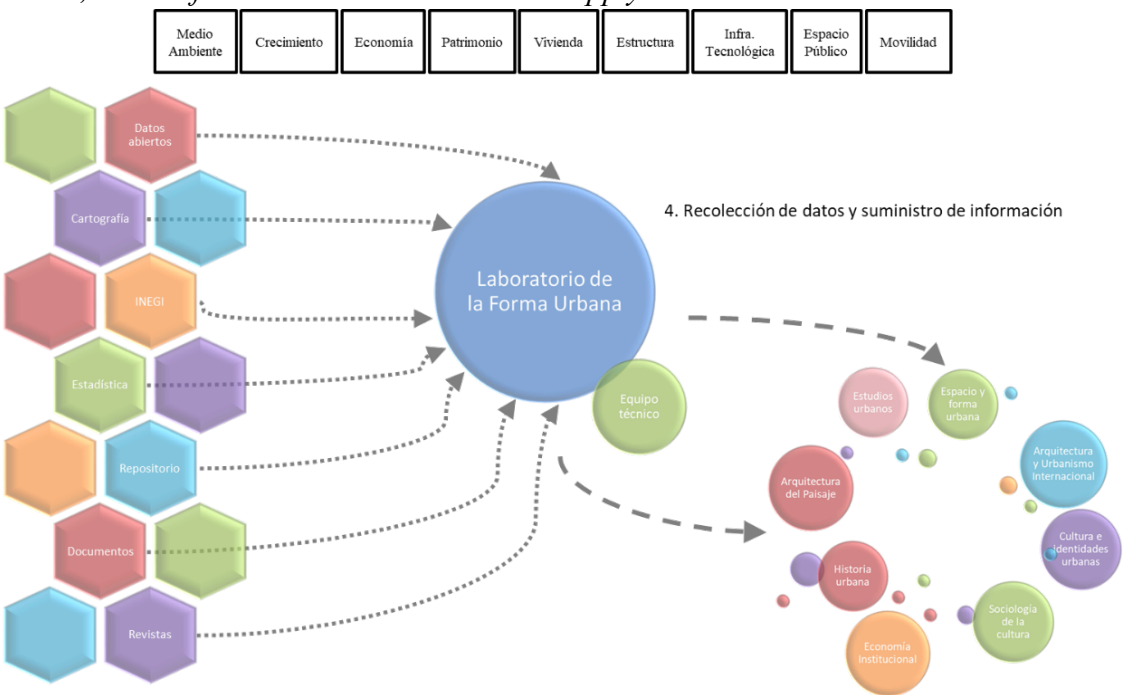
Processes 1, 2 and 3 of the AHP conceptual scheme applied to teamwork in collaborative spaces



4. Data collection and information provision. Data and information (documentary, cartographic and statistical) are collected by the technical team and made available to the thematic teams through shared repositories and data banks. The technical team must guarantee distribution based on criteria of usefulness, timeliness and reliability.

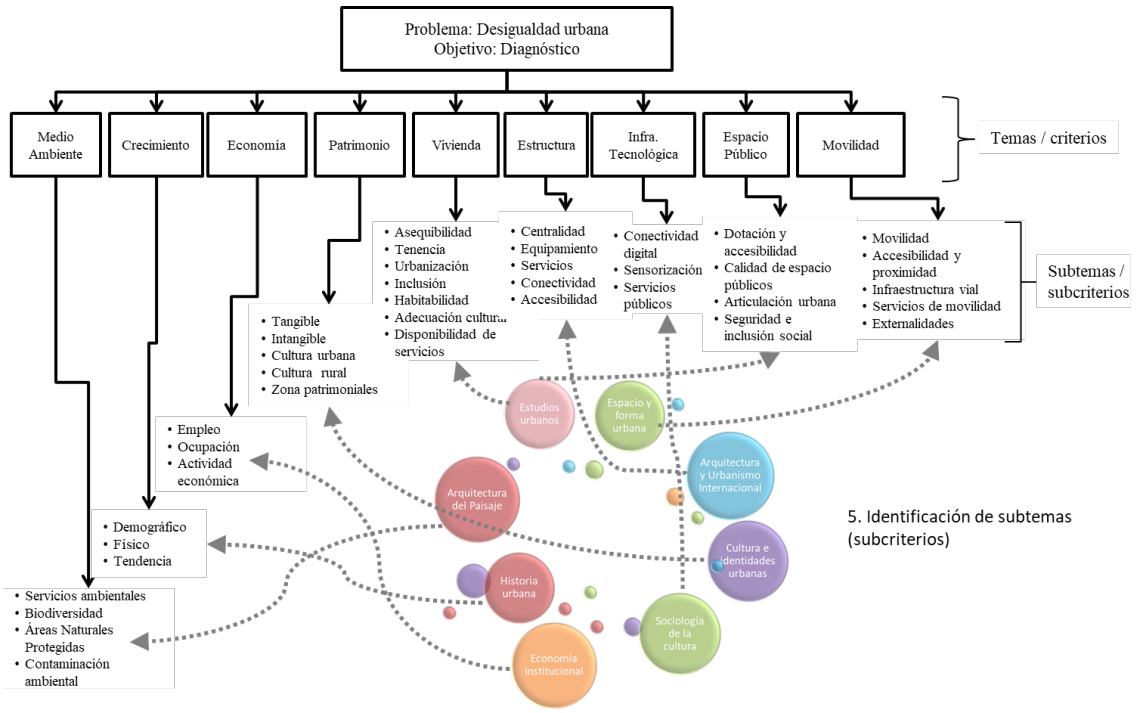
Figure 5

Process 4, outline for data collection and data supply



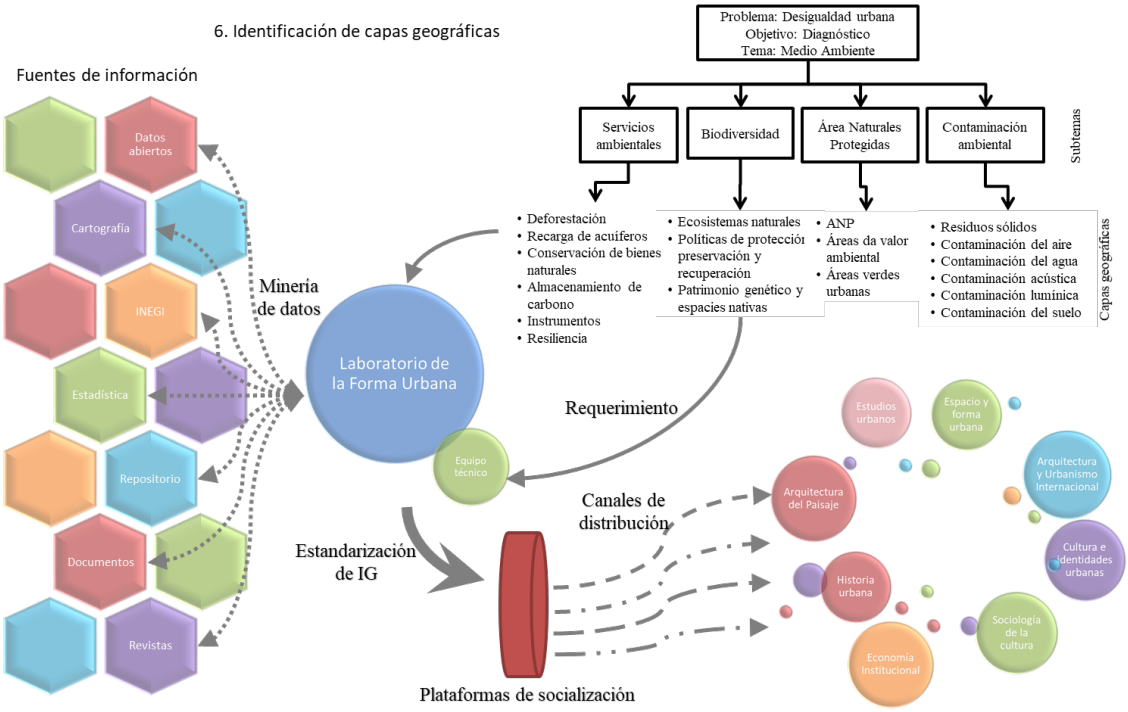
5. Identification of sub-themes (sub-criteria). The work in thematic teams should reanalyze their topic (process 3) to identify relevant subtopics. In other words, it is a matter of disaggregating the problem into topics and the topics into subtopics.

Figure 6
Definition of subtopics



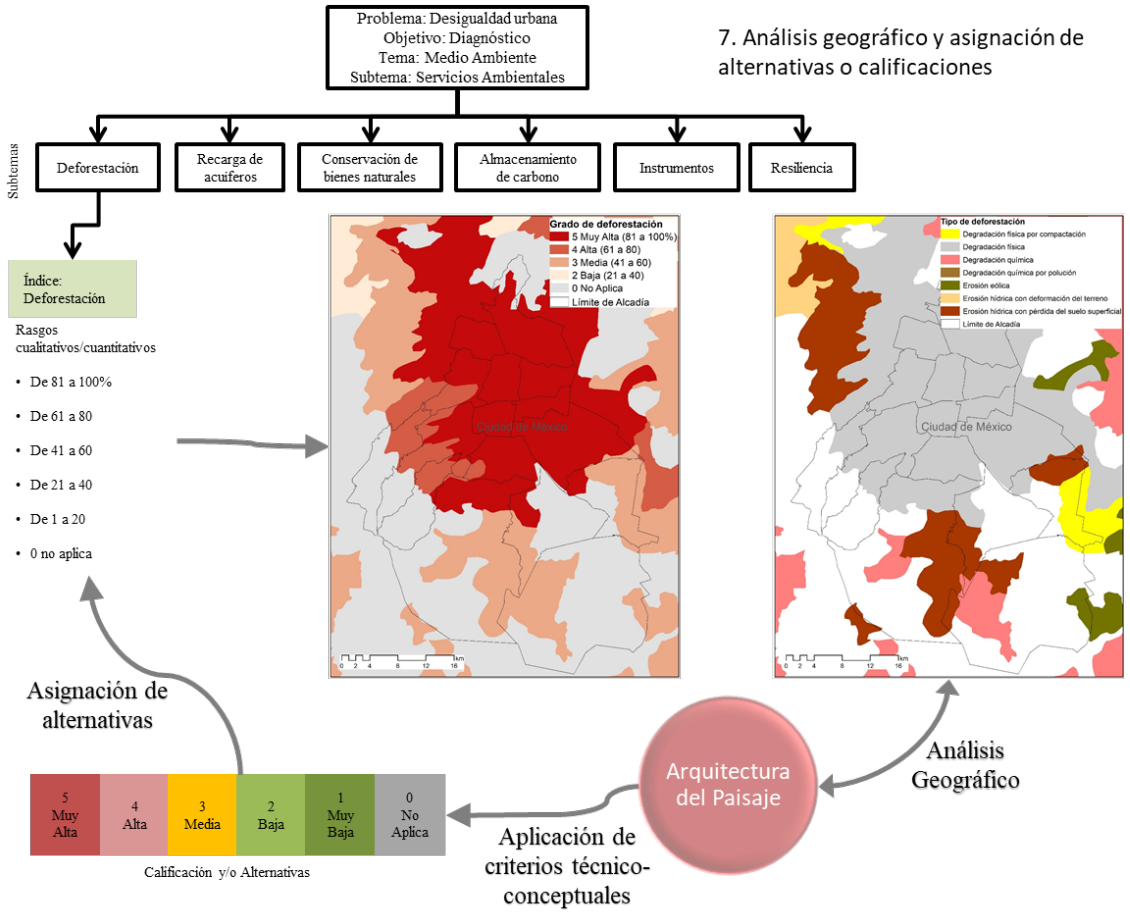
6. Identification of geographic layers. The geographic layers that are relevant to the approach and analysis of each subtopic are identified and selected. The technical team must take care and guarantee that the geographic information is standardized and relevant -updated and interoperable-.

Figure 7
Process for the identification of geographic layers



7. Geographic analysis and assignment of alternatives or ratings. For each subtopic, more than one geographic layer can be identified and used. To this end, each thematic team must have at least one person who can handle cartographic tools. Each geographic layer defines its attributes, understood as categorical or numerical features specific to each geographic element (it is suggested that these be units of analysis in polygons to facilitate the integration of layers). This process consists of assigning alternatives or qualifications to each geographical element, based on its particular features or attributes. The proposed scale ranges from 0 to 5; where 0 does not apply, 1 is very low and 5 is very high. For the assignment, the existing technical criteria that support the decision to assign a differentiated rating must be considered. The valuation of alternatives for each topic or subtopic are assigned, based on the coverage, degree, level and even; existence or not of services or infrastructures. This is to identify each geographic element, through an integer (from 1 to 5), i.e. for a quantitative metric, expressed in percentages of coverage of homes with internet, a value of 5 would be assigned to those geographic units with lower percentages and 1 to those with higher coverage (as long as the objective is the identification of problems or shortages); if the objective is the opposite, it is qualified in an inverse manner. To determine the desired slices and number of classes, GIS *software* has stratification methods (one of the most commonly used in automated mapping is *Jenks*Natural Breaking).

Figure 8
Geographical analysis scheme

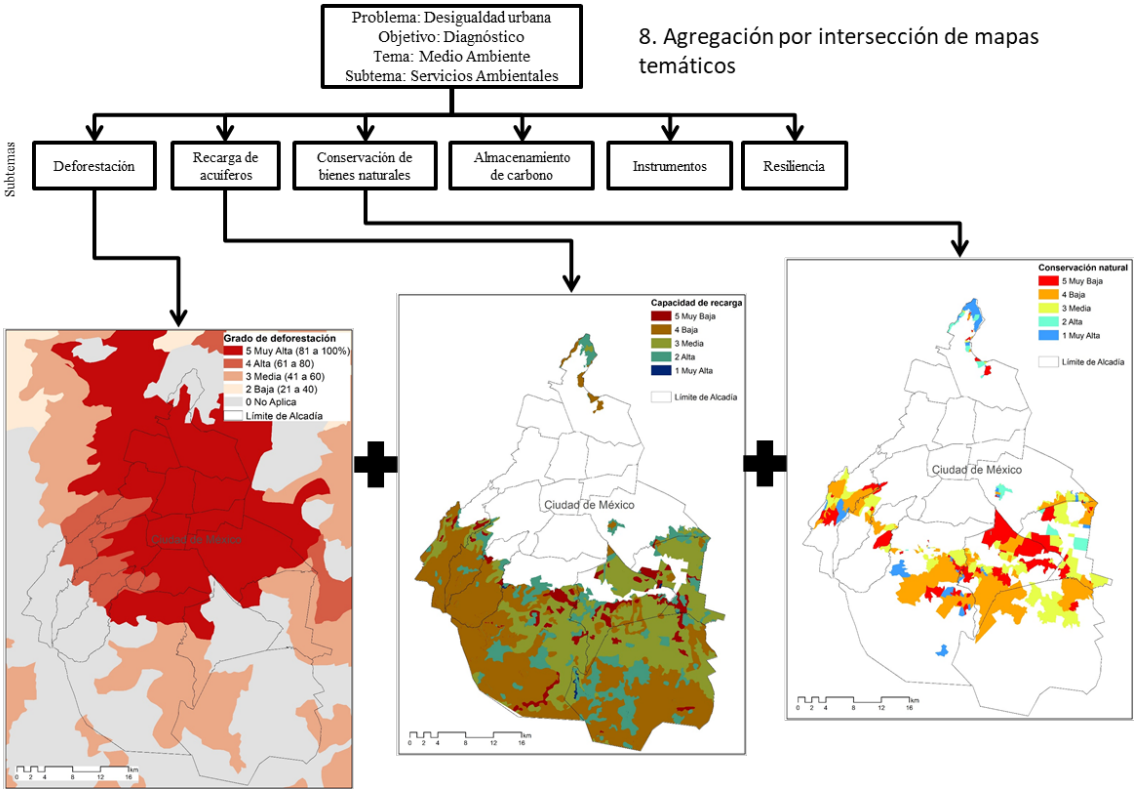


Note. The content of the maps is merely illustrative. Prepared by the authors, based on data from CONABIO: http://geoportal.conabio.gob.mx/metadatos/doc/html/degra250kgw.html

8. Aggregation by intersection of thematic maps. Once the assignment of ratings for each geographic layer has been completed, they are integrated into a map, which summarizes all the thematic maps obtained for each sub-theme. It is a process of aggregation, through the intersection of layers to obtain sets of integrated maps, -with a greater number of geographic units; since some are subdivided, but do not lose their features-. This allows a summation of all the ratings to be applied, so that they can be reclassified again, using the six alternatives mentioned in process 7. Each subtopic will have a synthesis map, which will be added to the general model; in other words, this process of aggregation and synthesis is repeated until the initial level of topic or criterion is reached.

Figure 9

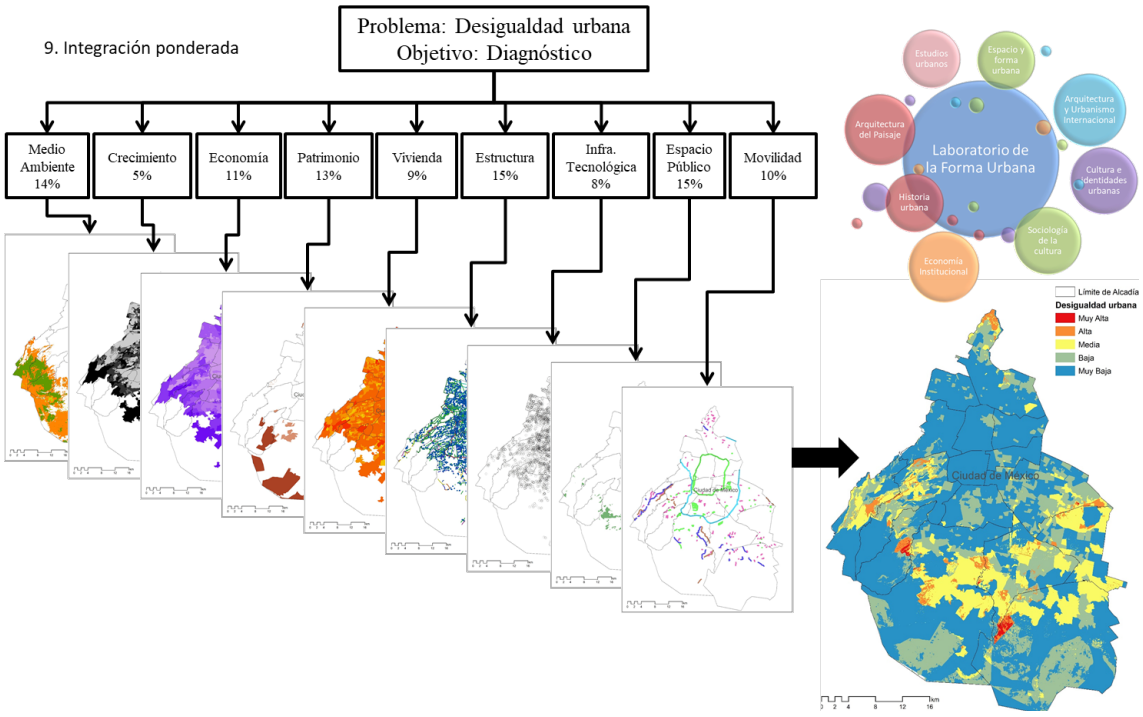
Spatial analysis scheme based on map algebra.



Note. The content of the maps is merely illustrative. Own elaboration, based on data from CONABIO: http://geoportal.conabio.gob.mx/metadatos/doc/html/degra250kgw.html y http://pgot.centrogeo.org.mx/geocontext/viewer/4

9. Weighted integration. In this last step, the integration of all the summary maps of each topic is sought. Each one must be qualified (normalized) on the scale of the alternatives, to be multiplied by the weight or weighting defined collegially in process 3. The intersection between geographic layers is applied and a synthesis map is obtained, which integrates all the cartographic products of the themes and sub-themes.

Figure 10
Scheme for weighted integration of criteria



Note. The content of the maps is merely illustrative. Prepared by the authors, based on data from CONABIO: http://geoportal.conabio.gob.mx/metadatos/doc/html/degra250kgw.html y http://pgot.centrogeo.org.mx/geocontext/viewer/4

The set of maps for each sub-theme, in addition to those that synthesize the results, are extremely important elements, both for the analysis and for the design of intervention proposals. Each represents a relevant input to the understanding of the problem, supports the arguments and identifies causal relationships of expressed problems, and is useful for policy design or decision making. Finally, they provide a methodological structure for teamwork and promote the transition and/or consolidation of collaborative spaces.

Discussion and conclusions

The daily work of teachers, researchers and students has been sharply affected by the effects of the pandemic and the containment policies established by governments around the world. This situation led to the use of technological communication tools that were used as a practical and emergent measure. Many HEIs used educational platforms or developed their own at a fast pace. However, their sudden use forced all sectors to use them without much familiarity. Tools were used without having clear scopes and objectives.

Academic programs became "emergent" but not necessarily innovative. The social distance and the closing of facilities caused a pause in the forms of teamwork. Some academic programs predicted a resounding failure for distance education; however, research and teaching processes were triggered in this modality -which would be pertinent to analyze in other research-. There are other less pessimistic views on the case. These point out that the reduction of travel time to work, school and other places served to increase productivity and reduce

environmental impacts, among others; valid opinions even when there is no clear data on the effects of teleworking and distance education.

In this reality, the ways of working are increasingly provocative and also require new processes for working at a distance, in hybrid or semi-presential formats -the latter referring to the educational context-. Thus, in the midst of the conceptual crisis and social, economic and health uncertainty, the forms of collaborative work and the technological and methodological tools are added to the discussion and reflection. Responding to these new demands suggests taking up existing methodological approaches and adapting them to particular needs.

In relation to this work, the proposed methodological strategy is explained in a structured manner, responding to the needs and availabilities detected in the object of study. This is intended to be motivating, not only for the community analyzed, but also to trigger processes in similar institutions. The methodological exercise takes up different concepts and perspectives, whose categories and descriptions served as a basis for the analysis of primary variables. In this sense, teamwork, collaborative spaces, co-research and spatial analysis were relevant throughout the research. Their presentation gives meaning to the collaborative strategy proposed and described.

Teamwork was considered as the intentional collaboration to actively participate in the generation of knowledge. These collaborative forms should consider the design and implementation of innovative and proactive strategies that encourage collective participation. In HEIs, these collectives should be consolidated through the work of teachers, researchers and students, to enrich and strengthen the teaching-learning processes, in all directions and scales. The aim is for institutions to define and build their organizational culture, based on complementarity, in order to increase their intellectual capital.

In university environments, especially teachers and students have received countless work programs, guides, methods and instructions, as well as training courses for the technical management of ICT and alternative methods on distance, blended or hybrid educational systems. Collaborative environments have mainly referred to virtual environments and have shown their advantages in a short time. Taking up the approaches of methods such as AHP in this environment and adapting it to the work methods characteristic of each type of organization will have positive consequences for its own development and improvement. It also provides an opportunity to publicize its usefulness and benefits to the organization and, above all, to working groups, whether they are social, educational, public or private. The AHP takes advantage of technological skills - by necessity developed in practically all sectors of society - to combine them with technical work tools for the production of information.

It is a proposal that proposes to detonate teamwork, strengthen pre-existing collaborative spaces for the integral development of research and teaching; it is also a methodologically structured strategy that can be adapted to similar cultures, institutions and organizational forms.

The main conclusions derived from this research are as follows:

1. The AHP is a method that can be adjusted to different realities and types of organizations. In IES, it can be implemented by collaborative research groups, by student teams, or mixed -the role of the professor-researcher becomes relevant in his role as facilitator and/or coordinator-.
2. The AHP, when complemented with diagnostics based on the theory of organizational studies, allows the technical and/or managerial group to form balanced teams, strengthened by the capabilities, skills and interests of its elements.

3. Its adaptability allows its use in work teams for the integration of research and teaching, the latter through the active incorporation of students in the former.
4. Its structure is very simple, allowing the problem to be broken down for analysis and understanding at different scales.
5. It allows for group work through participatory techniques without diverting attention from the objective.
6. It does not require for its operation a robust technical team, but it does require technical capabilities in the management of GIS, digital platforms and participatory techniques.
7. It is increasingly common for working groups to use spatial analysis as a tool that allows them to develop procedures for the analysis of geographic data. These make it possible to obtain additional knowledge about the dynamic characteristics and behaviors of the multiple processes occurring in a given space. For this reason, spatial analysis is considered as one of the articulating axes of this proposal.
8. Information management is simple for two reasons: a) Hierarchical schemes give direction to data and information flows and b) They allow control of information based on time, space and action variables.
9. Through its development, it generates organizational learning in two directions: a) In the way work teams react and operate, and b) In terms of the production of information, knowledge and learning.
10. Although it is not a new method, it manages to unleash innovative processes, it tightens links, finds affinities and complementarities; and above all, it enriches the research-teaching-learning process.
11. Both the organizational diagnosis and the AHP put people at the center. The first, by identifying their needs and availabilities; the second, by considering the human factor as the main decision-maker for the allocation of alternatives, which are not based solely on expert knowledge.

Although several advantages are mentioned, it must also be recognized that within the working groups there are divergences and opposing points of view. Most of the complications faced by this proposal for its application in HEIs are caused by a working environment of low trust - derived in part from the competition and individual production of research -; the lack of adequate and unconsolidated spaces that encourage group or team work; the absence of technical teams specialized in multi-criteria spatial analysis, - neglect of continuous training - and weak promotion and application of organizational techniques to encourage collaborative work. To face these challenges, it is suggested that HEIs be receptive to ways of working that prioritize the co-production of knowledge through the work of research groups and consolidate collaborative spaces. The role of teacher-researchers becomes indispensable for the promotion and application of methodological tools for co-research, both in their work spaces and in the classroom. These are just some of the challenges and suggestions; however, it is necessary to further study their weaknesses in practice, in order to identify those factors to be considered in order to solve possible conflicts and respond assertively to current and future challenges. The concepts of democratization of research, open or citizen science would help to continue to deepen in this regard.

References

Alvargonzález, D. (2011). Multidisciplinarity, Interdisciplinarity, Transdisciplinarity, and the Sciences. *International Studies in the Philosophy of Science, 25*(4), 387-403. https://doi.org/10.1080/02698595.2011.623366

ANUIES, (2018). *Visión y acción 2030. Propuesta de la ANUIES para renovar la educación superior en México*. ANUIES. http://www.anuies.mx/media/docs/avisos/pdf/VISION_Y_ACCION_2030.pdf

Ávila Mogollón, R. M. (2002). Proyecto Regional: Información sobre tierras y aguas para un desarrollo agrícola sostenible. El caso Brasil. *Informe Técnico 2*. FAO-Project GCP/RLA/126/JPN.

Avila, Jimenez F. G., De la Torre, Galindo F. J., Sanchez, Martinez Ma. E., Bernández, de la Granja M. C., Fajardo, Montaño D., & Barreto, Rentería Ma. A. (2021). La interdisciplina en el estudio de la forma urbana. [Document in opinion for publication]. In *XII Seminario de la Red de Estudios de la Forma Urbana (REFU)*.

Boavida, A. M. & Da Ponte, J. P. (2011). Investigación colaborativa: Potencialidades y problemas. *Revista Educación y Pedagogía*, 23(59). https://www.researchgate.net/publication/277042351_Investigacion_colaborativa_potencialidades_y_problemas

CONACYT, (2019). Informe General del Estado de la Ciencia, la Tecnología y la Innovación. Mexico. https://www.siicyt.gob.mx/index.php/transparencia/informes-conacyt/informe-general-del-estado-de-la-ciencia-tecnologia-e-innovacion.

Diario Oficial de la Federación. DOF (2021). Reglas de Operación del Programa Fortalecimiento a la Excelencia Educativa. Ejercicio 2021. https://www.educacionsuperior.sep.gob.mx/pdfs/2021/ROS300.pdf

Fayol, H. (1916). *Industrial and General Administration. Ed.* Bulletin de la Société de l'Industrieminerale.

Gamboa Rodríguez F. (2016). Diseño de Espacios Colaborativos Interactivos para el aprendizaje. In Z. García Judith & Rama, V. C. *La Educación a Distancia en México.* Open University and Distance Education (CUAED). Virtual Educa-Secretaría General https://www.researchgate.net/publication/298787735

Gutiérrez Nieto, C. (2019). *Conceptos básicos de cartografía. Pensamiento espacial. MOOC: Introducción al uso y representación de información geoespacial.* Centro de Investigación en Ciencias de Información Geoespacial, A.C.

Hartley, J., & Benington, J. (2000). Co-research: A new methodology for new times. *European Journal of Work and Organizational Psychology, 9*(4), 463-476. https://doi.org/10.1080/13594320050203085.

Núñez Paula, I. A. (2008). La gestión de información dentro del enfoque holístico o ecológico contemporáneo de la gestión organizacional. *Reencuentro* [online] http://www.redalyc.org/articulo.oa?id=34005102

Núñez, P.I. (2004). La gestión de la información, el conocimiento, la inteligencia y el aprendizaje organizacional desde una perspectiva socio-psicológica. *Acimed*. *12*(3). http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1024-94352004000300004&lng=es&nrm=iso&tlng=es

Ollarves, Y. & Chivico, N. (2008). Propuesta de Proyectos Colaborativos como Herramienta Integradora de las TIC en la Investigación Universitaria. *Revista de Educación*, 14(26), 89-111. http://www.redalyc.org/articulo.oa?id=76111491005

Pérez, Zapata J. & Cortés, Ramírez J. A. (2007). Barreras para el aprendizaje organizacional. *Pensamiento & gestión*, *22*.

Ramírez Martínez, G., Vargas Larios, G., & De la Rosa Alburquerque, A. (2001). Estudios Organizacionales y Administración. Contrastes y complementariedades: Caminando hacia el eslabón perdido. *Revista electrónica Forum Doctoral*, 3.

Rendón Cobián, M. & Montaño Hirose, L. (2004). Las aproximaciones organizacionales. Caracterización, objeto y problemática. *Contaduría y Administración*, *213*, 1-15. https://www.redalyc.org/articulo.oa?id=39521305

Rendón, Hidalgo V., Escamilla, Casas, J., Montaño, Arango O., & Navarro, Gómez I. (2018). Priorización del suelo para la vivienda al desarrollo metropolitano de la ciudad de Pachuca Hidalgo, mediante Proceso Analítico Jerárquico, AHP. *Publicación Semestral Pädi*, *11*, 48-51. https://repository.uaeh.edu.mx/revistas/index.php/icbi/article/view/3041/3125

Rodríguez, D., Bertone, R., & García-Martínez, R. (2009). Consideraciones sobre el Uso de Espacios Virtuales en la Formación de Investigadores. *Revista de Informática Educativa y Medios Audiovisuales*, *6*(11), 35-42. https://www.researchgate.net/publication/258628394

Saaty, T. L. (1980). *The Analytical Hierarchical Process.* J. Wiley.

Santizo Rodall C. A. (2016). Condiciones institucionales del trabajo colaborativo como estrategia de cambio del sistema educativo. *Perfiles Educativos*, *153*. http://www.scielo.org.mx/scielo.php?pid=S0185-26982016000300154&script=sci_abstract

Senso, J. A. & De la Rosa Piñero, A. (2003). El concepto de metadato. Algo más que descripción de recursos electrónicos. *Ci. Inf., Brasília,*32(2), 95-106. https://www.scielo.br/j/ci/a/ZHtZZfYnJfKqVn4tGNSw4yv/?format=pdf&lang=es

Siabato, W. (2018). Sobre la evolución de la información geográfica: las bodas de oro de los SIG. *Cuadernos de Geografía: Revista Colombiana de Geografía* 27 (1), 1-9. https://doi.org/10.15446/rcdg.v27n1.69500.

Stallman, R. (2020). The definition of Free Software. *Communiars*, *3*, 151-154. https://idus.us.es/bitstream/handle/11441/100711/03_10_REVISTA_COMMUNIARS_STALLMAN.pdf?sequence=1&isAllowed=y

Taylor, F. (1911). *Los Principios de la Administración Científica.* Ed. Harper & Brothers Publishers.

Toskano Hurtado, G. B. (2005). *El proceso de Análisis Jerárquico (AHP) como herramienta para la toma de decisiones en la selección de proveedores.* Universidad Nacional Mayor de San Marcos. https://sisbib.unmsm.edu.pe/bibvirtual/monografias/basic/toskano_hg/toskano_hg.htm

UNAM, (2018). *Hacia la Consolidación y Desarrollo de Políticas Públicas en Ciencia, Tecnología e Innovación. Objetivo estratégico para una política de Estado 2018-2024*. National Autonomous University of Mexico. https://www.comecso.com/publicaciones/consolidacion-desarrollo-politicas-publicas-cti

Date received: 20/03/2022
Revision date: 07/06/2022
Date of acceptance: 19/09/2022

PROJECT, DESIGN AND MANAGEMENT

https://www.mlsjournals.com/Project-Design-Management

ISSN: 2683-1597

How to cite this article:
Muñoz Rodríguez, J. & Velázquez Ramírez, J.M. (2023). Diseño de matriz como herramienta para la evaluación de requerimientos de calidad, medio ambiente y seguridad. *Project, Design and Management, 5*(1), 79-101. doi: 10.35992/pdm.5vi1.1129

MATRIX DESIGN AS A TOOL FOR THE ASSESSMENT OF QUALITY, ENVIRONMENTAL AND SAFETY REQUIREMENTS

Jesús Muñoz Rodríguez
Universidad Internacional Iberoamericana (Mexico)
jesusmunoziso@gmail.com - https://orcid.org/0000-0002-3830-6086
Juan Manuel Velázquez Ramírez
Instituto Tecnológico y de Estudios Superiores de Occidente (Mexico)
juanmv@iteso.mx - https://orcid.org/0000-0002-3791-2906

Summary. The general objective of this research is the design of a matrix as a tool for the evaluation of quality, environmental and safety requirements for an automotive company located in Reynosa Tamaulipas, Mexico, addressing the problem that is generated due to the impact on the organization by breaches in the lack of standardization and evaluation of customer and regulatory requirements. This research is presented and developed using the logical methods of deduction, analysis and synthesis of continuous improvement, the Ishikawa methodology or fish diagram, the methodology of cause and effect analysis and risk assessment. Analyzed the changes of the norms and their requirements, it is observed that the main findings in the audits are in relation to the compliance in the evaluation of the client's requirements, due to the fact that the implementations of the management systems in the organizations are carried out in different stages. and this mismatch in project management complicates standardization and creates the potential for risk. The matrix as a tool for the evaluation of quality, environment and safety requirements provides us with guidelines to make the management of the organization more efficient, by eliminating the duplication of documents, non-applicable controls and repetitive training, it also allows us to minimize the workload and efforts generated due to the analysis of system requirements as isolated sections and not globally.

Key words: Matrix, tool, evaluation, requirements, management.

DISEÑO DE MATRIZ COMO HERRAMIENTA PARA LA EVALUACIÓN DE REQUERIMIENTOS DE CALIDAD, MEDIO AMBIENTE Y SEGURIDAD

Resumen. El objetivo general de esta investigación es el diseño de una matriz como herramienta para la evaluación de requerimientos de calidad, medio ambiente y seguridad para una empresa automotriz ubicada en Reynosa Tamaulipas, México, abordando el problema que se genera debido al impacto en la organización por los incumplimientos en la falta de estandarización y evaluación de requerimientos de cliente y normativos. Esta

investigación se presenta y desarrolla con el uso de los métodos lógicos de deducción, análisis y síntesis de mejora continua, la metodología de Ishikawa o diagrama pescado, la metodología de análisis de causa y efecto y de evaluación de riesgos. Analizados los cambios de las normas y sus requerimientos se observa que los principales hallazgos en las auditorias son con relación al cumplimento en la evaluación de requerimientos del cliente debido a que las implementaciones de los sistemas de gestión en las organizaciones se llevan a cabo en diferentes etapas y este desfase en la gestión de los proyectos complica la estandarización y genera la posibilidad de riesgos. La matriz como herramienta para la evaluación de requerimientos de calidad, medio ambiente y seguridad nos brinda la pauta para eficientizar la gestión de la organización, al eliminar la duplicidad de documentos, de controles no aplicables y entrenamientos repetitivos, también nos permite reducir al mínimo la carga de trabajo y esfuerzos que se genera debido al análisis de requerimientos de los sistemas como apartados aislados y no de forma global.

Palabras clave: Matriz, herramienta, evaluación, requerimientos, gestión.

Introduction

The world is changing as we know it; the future is today…

Intelligent, electric, autonomous, more efficient and less polluting cars are not concepts reserved for the distant future, a voracious and increasingly demanding market that seeks a set of comprehensive energy solutions and as a result of previous research into the impact on production, which translates into more quality, environmental and safety requirements for companies in the automotive sector.

The justification of this study to design this tool is part of the need for a working model to improve the efficiency and effectiveness of managers of organizations during the processes of standardization of customer requirements, this being an original idea because currently there is no tool that facilitates the harmonization of management inputs even when customers send us the requirements, this project is important for the implementation of all sources of input but from the same perspective.

As the book the 4th industrial revolution points out "We are on the brink of a technological revolution that will fundamentally change the way we live, work and relate to each other" (Klaus 2016, cited by Velazquez, 2018).

Many countries are now looking to take the lead in assessing their suppliers with an operational risk approach, it is no longer just about meeting customer expectations, it is about assessing the entire supply chain and exceeding expectations with a high level of best practice and systems maturity. Sustainability through innovation and compliance with customer requirements.

The predominant globalization of products for different markets gives us a guideline for the design of this tool, as a personal motive for the development and continuous improvement of my management in quality systems in organizations.

The current national and international scenario is unprecedented, to address the research topic I will establish a general overview of quality systems using ISO international standards.

The ISO 9001 standard that we will use as a reference belongs to the a family of standardization and mentions "Think of them as a formula that describes the best way to do something". (ISO, 2021).

All types of companies, from small, medium and large companies, can be certified with the ISO 9001 standard, regardless of their economic activity. For this research we will also use the international automotive standard of IATF 16949:2016 which "Represents an innovative document, given the strong customer focus, with the inclusion of a number of previous consolidated customer specific requirements." (IATF, 2021).

I consider that, during the development of this research, that even though most of the concepts and models are based on plan, do, check and act, there is no consolidation as a tool or

a guide on how to use these concepts, nor is it clear how to put them into practice. The model is still valid "In the area of quality, the PDCA cycle for continuous improvement, now 81 years old, has proven to be an effective and still current tool". (European School of Excellence, 2020).

In this way, it allows us to quantify the impacts and evaluate the potential risks in the inputs of the identified processes that make up the quality system, risk management and its impact are key during the development of a project.

Stakeholders in this research include direct customers throughout the manufacturing processes of a product, end users, suppliers and partners, regulators and others. Others could include owners/shareholders and even the corporation.

In relation to occupational health and safety management during the development of this doctoral research, another important requirement of the automotive industry ISO 45001 is included as a reference in "Requirements with guidance for use". (ISO 45001, 2018).

ISO 45001:2018 is one of the international standards for the management of occupational health and safety systems formerly OHSAS 18001, also considering the harmonization ISO 14001:2015 as "The backbone of environmental management". (AENOR, 2020).

Focused especially on management, ISO 45001's ultimate goal is to help businesses provide a safe working environment for employees and anyone else in the workplace.

The requirements for the organization of the automotive sector in which this research is developed are extensive so the research raises the areas of opportunity and gray areas that arise in the implementation of projects and objectives presented taking into account their restrictions and constraints.

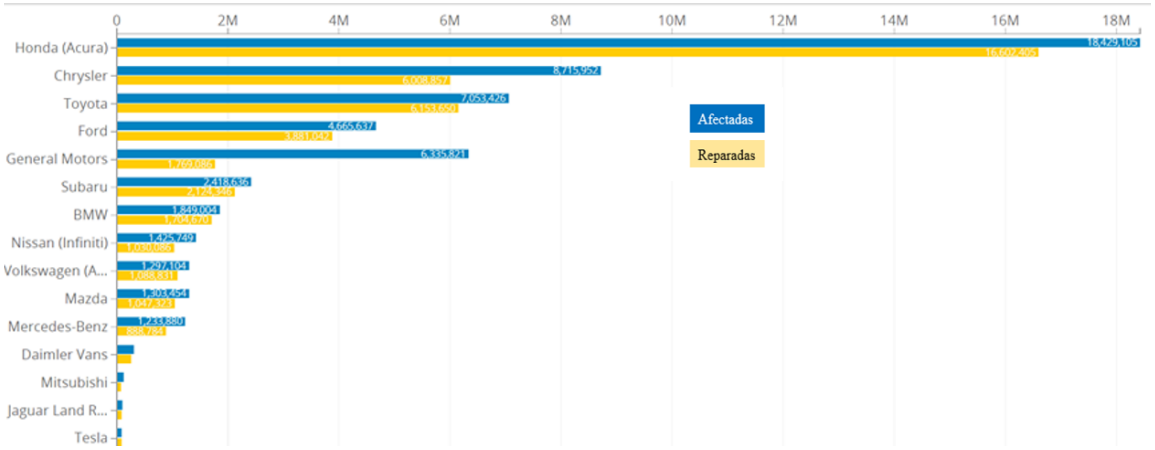
One of the sections included during the development of this research is how the lack of standardization of requirements limits and conditions their compliance and directly impacts the quality of the product with effects that can even lead to the death of the end user.

Cases of product quality failure are presented in detail with the findings of the NHTSA (U.S. Department of Transportation) which urges vehicle owners to take some simple personal steps to protect themselves and others from potential threats to personal safety due to poor quality by failing to meet customer requirements for quality, environment and safety.

NHTSA describes its mission as "Saving lives, preventing injuries, reducing vehicle-related crashes".

Airbags are a vitally important component in a vehicle, currently as part of the monitoring of complaints and warranties for non-compliance with customer requirements "Approximately 67 million Takata airbags have been recalled". (NHTSA, 2021). One of the automakers with the greatest impact due to the lack of quality and safety in airbags is Honda with 18,492,105 bags replaced or repaired. Figure 1 shows the number of air bags detected by brand:

Figure 1
Total number of air bags repaired and total number of affected air bags



Note. Source: NHTSA - National Highway Traffic Safety Administration

Method

For the procedures related to the research, the author presents the methodological design of the instrument with the use of data analysis of external audits carried out in the organization, the participation of different departments, processes, customer requirements, research instruments used during the phase descriptions and requirements planning.

The data analysis shows that the standardization of inputs from a harmonized requirements structure allows us to visualize the scope and focus of each essential point of the project. The final focus is how to harmonize the input requirements in an organization in the early stages of project development with the assessment of risk and outcome impacts.

As mentioned in the main theories of project management, the development of the research work will take into consideration the processes and activities where responsibilities, objectives and quality policies are determined in the different stages of development and evaluation of the project.

This project was carried out in the organization of the automotive sector in question in the areas of Quality, Environment and Safety management that are directly related to the issues of certification and regulation by international standards or in compliance with international agreements, official standards, treaties or protocols to be accepted their products in the market.

The final instrument is the evaluation matrix of customer requirements, international quality, regulatory, statutory, environmental and safety standards, taking into consideration the variables of the cause and effect analysis.

Taking into account the type of study presented in the report of the research work foundation and in the research methodological outline, I consider the concordance with the research objective to define as method a descriptive research approach, exploratory type, quantitative and qualitative oriented where applicable:

Exploratory:

- Secondary information.
- Survey results.
- Simulations.

- Case studies.

Counselor:

- Secondary information.
- Interviews.
- Session results.
- Projections.
- Observation techniques.

This method was used to determine the quality of information to narrow down the presentation results and confirm the continuity of the project.

The structure for the documentary research is based on the analysis of the results of certified organizations.

Phases used*:*

- Planning.
- Requirements evaluation analysis.
- Verification of project resources.
- Training and Coaching.

Compliance through:

- Collection of information.
- Data organization.
- Classification of information and data analysis.
- Research report.

The resources used for the design:

Direct sources of information, official web sites. Hierarchization and interpretation according to the hypotheses presented.

The scientific disciplines or as a field of study for this topic are engineering and management as part of the branch of knowledge that is investigated at the levels of higher secondary education or careers already defined with this focus and scope.

For this research, the representativeness of the sample was considered and participates, which allows us to extrapolate and therefore generalize the results observed in the organization of the automotive sector where I currently work for the certification of the quality system in the last audit cycles.

Statistics presented from 181 organizations that completed the transition from ISO/TS to IATF in accordance with the requirements of the standards and resulted in an average of 5.3 minor nonconformances and 1 major nonconformance per audit with considerable impact as OMNEX mentions "The end result was a major change for the approximately 6226 North American automotive industry sites." (OMNEX, 2021)

The research hypothesis in relation to the case study presented in this proposal:

should the design of a quality, environmental and safety requirements assessment tool include customer requirements for systems management and ISO standardization?

Presented in more detail below is a breakdown:

- Consideration of customer requirements.
- Changes in quality, environmental and safety standards.
- Improved process inputs on a continuous basis.

The variables of the hypothesis of this project allow the identification of impacts on the quality, environmental and safety systems in the organization, the customer requirements

identified by risk level are a fundamental part of the process.

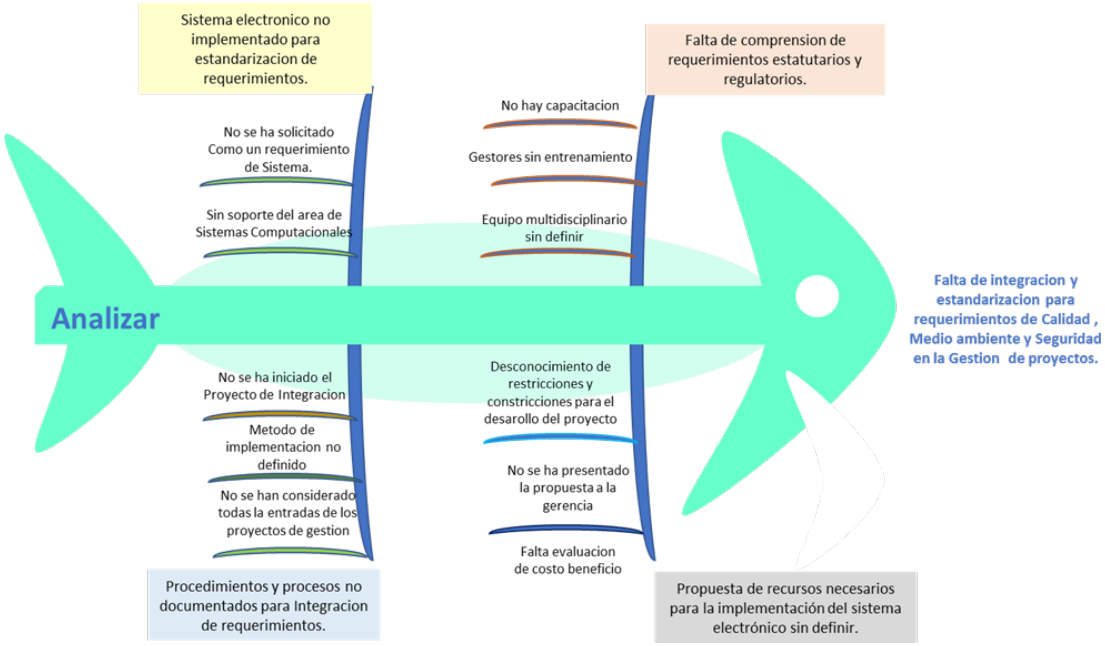
As part of the data analysis for the study variables considering the classification criteria as independent/dependent methodological criteria, variables of quantitative/qualitative nature, and for the determined value of nominal/ordinal/ratio/interval measurement, Table 1 shows:

Table 1
Variable classification criteria

Variable	Independent or Dependent	Quantitative or Qualitative	Measured value
Customer Requirements	Dependent	Quantitative	Interval
Standards and requirements System.	Dependent	Quantitative	Interval
Budget. Monetary resources required for the project.	Independent	Quantitative	Interval
Human factor. Labor	Dependent	Qualitative	Nominal
Documentation of management systems.	Dependent	Qualitative	Ordinal
Implementation cost.	Dependent	Quantitative	Reason
Number of non-compliances during the evaluation of the Project.	Dependent	Quantitative	Ordinal

The analyzed variables that are negatively impacting are described in a cause and effect analysis in the following diagram Figure 2:

Figure 2
Ishikawa Diagram or Cause and Effect



Following this method, comments on the approach are added to the work presented in order to determine the most important aspects included in the problem under investigation:

The next tool presented in this proposal for the analysis of problem variables is the 4 M's approach or the four types of causes that can create problems in a process.

The 4 main causes and effects in relation to the analysis of variables are:

- Machinery
- Labor
- Method
- Materials

Also as part of this method evaluation I define the relevance index of the 4 M's and cause-effect analysis.

- Machinery: Machinery refers to the equipment to be used in this case we consider it as the physical infrastructure, system and/or automatic process, which is what is used to carry out the activities. Cause-Effect Analysis: Standardization of requirements such as a database or a program due to lack of vision of the organization's managers in the different management systems, also due to the fact that it has not been requested to the information systems area (IT). In some organizations it is also defined as a lack of support from the systems development area.
- Labor: For Manpower we refer to the human capital, to the managers who are responsible for the execution of the activities of the processes either in a system or database. Cause-Effect Analysis: Lack of understanding of statutory and regulatory requirements of those responsible for the quality, environmental and safety management system. Not in all cases and organizations the managers have defined a training program for the multidisciplinary team that participates in the development of the projects, so it is very common that there are repetitive tasks or lack of focus towards efficiency and effectiveness in the implementation and maintenance of requirements and requirements.
- Method: For the method we refer to the procedures or processes duly documented in the

different management systems of the organization so that a methodology is followed in the operations in a standardized manner, thus reducing variability in the execution of tasks when the defined, documented and explicit rules are followed, applying concepts in an effective manner. Cause-Effect Analysis: Undocumented procedures and processes for requirements integration at the input of project management processes, this effect is common in organizations that have not initiated a project to standardize or integrate the different levels of systems documentation, for example: Manuals that include quality, environment and safety, as the inputs for each management system are not properly identified.

- Materials: The last M used in this cause-effect analysis refers to the materials and/or raw materials that we will use or consider using for the execution of the project in question from the individual point of view or with other materials. Cause-Effect Analysis: Proposal of necessary resources undefined due to the lack of knowledge of restrictions and constrictions for the development of the project of integration and standardization of requirements, even when the initial idea has been presented to the management, the proposal has not been submitted, so the resources are not obtained by the financial area without first presenting a return on investment as a cost-benefit evaluation.

For the data analysis of this research and its significant positive impact on the organization the author of this research used the specific customer requirements for "OEM - Original equipment manufacturer". (International Automotive Task Force, 2021).

The organization's current customers with their specific requirements for suppliers:

American automotive industry.

Ford Motor Company CSR for IATF 16949:2016 - Jan 2021.

Minimum automotive QMS requirements IATF 16949 - Sep. 2017.

General Motors CSR IATF 16949:2016 - Dec. 2020.

Minimum Automotive QMS Requirements IATF 16949 - Sep. 2017.

German automotive industry.

BMW Group customer specific requirements for IATF 16949:2016 - Apr. 2021.

Japanese automotive industry.

Honda CDA-07-001 - Honda Motor Supplier Quality Manual (Japan) - Nov. 2020.

NISSAN 3.1_changes - CDA-08-001 ANPQP Allience New Product Quality Procedure ver 3.1 NISSAN Motor Co., Ltd. - Jan. 2017.

French-Italian automotive industry.

Stellantis (ex FCA) Customer specific requirements:

FCA EMEA/LATAM Regions CSR IATF 16949:2016 - Mar. 2021.

Minimum automotive QMS for IATF 16949 - Sep. 2017.

The research instruments used during the phase descriptions and requirements planning are presented as shown in tables 2,3,4,5,6.

Research Instrument

Table 2
Planning of activities

Phase 1	**Planning.**		
Phase description	**Requirements evaluation planning.**		
No. Description of activities	**Variables involved**	**Proposed techniques**	**Estimated goals**
1 Research the organization's current customers.	Requirements of Customers	Research	2 weeks at the beginning of the project
2 Obtain the minimum requirements of the different quality, environmental and safety systems.	Requirements for the systems	Research	2 weeks after previous activity.

Table 3
Requirements Analysis

Phase 2	**Requirements evaluation analysis.**		
Phase Description	**Presentation of the status of the system vs. the project.**		
No. Description of activities	**Variables involved**	**Proposed techniques**	**Estimated goals**
3 Generate a report of system status results.	Norms and standards.	Comparison	1 week per complete 2nd activity.
4 Confirm evaluation results of the systems where opportunities for improvement are considered for integration and standardization.	Regulatory and statutory requirements and requirements.	Observation	2 weeks per complete the activity previous.

Table 4
Resource verification

Phase 3	**Verification of project resources**			
Phase Description	**Approval of the Project of Integration and standardization**			
No.	**Description of activities**	**Variables involved**	**Proposed techniques**	**Estimated goals**
5	Analyze project requirements for material resources and system.	Norms and standards.	Analysis	1 week upon completion of the previous activity.
6	Present return on investment for project approval.	Cost - benefit.	Negotiation	2 weeks upon completion of the previous activity.

Table 5
Development of competencies

Phase 4	**Training and Education**			
Phase description	**Development of competencies**			
No.	**Description of activities**	**Variables involved**	**Proposed techniques**	**Estimated goals**
7	Generate training plan for system managers.	Norms and standards.	Planning	1 week upon completion of the previous activity.
8	Provide training for those responsible as defined in the planning.	Training plan.	Debate	4 weeks upon completion of the previous activity.

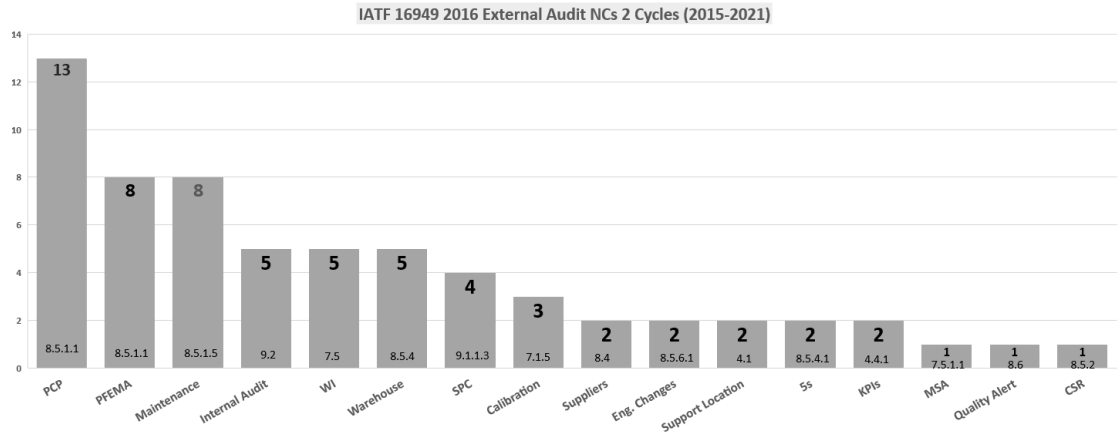
Table 6
Project execution

Phase 5		**Project execution**		
Phase description		**Integration and standardization**		
No.	**Description of activities**	**Variables involved**	**Proposed techniques**	**Estimated goals**
9	Share requirements assessment tool and requirements for execution of the project.	Project tool.	Communication	1 week upon completion of the Previous activity.
10	Generate cross matrix of requirements and Requirements.	Standards and Standards.	Planning	1 week upon completion of the Previous activity.
11	Unification of Quality, Environment and Safety Manuals.	Documentation of the systems.	Execution	2 weeks upon completion of the previous activity.
12	Updating of the document control procedure for integration.	System procedures and instructions.	Analysis	6 weeks upon completion of the previous activity.
13	Standardization of processes and risk assessments for the quality, environmental and safety systems.	Processes of System.	Analysis and execution.	4 weeks upon completion of the previous activity.
14	Implement lessons learned from previous phases of the project	Continuous improvement	Feedback	3 weeks upon completion of the previous activity.

Results

Once analyzed the 29 changes of the ISO 9001:2015 - IATF 16949:2016 standards and their requirements of the quality system we take as a sample the 2 cycles of 3 years with the certification of the organization where this research is carried out the results are observed in Figure 3.

Figure 3
Results of external audits IATF 16949:2016



The non-conformities identified by the certification body under the IATF 16949:20106 & ISO 9001:2015 standard are mostly under point 8 of the standard where the organization's compliance is evaluated for operation, control, customer requirements for quality, control of non-conforming product, as well as its environmental compliance, regulatory, statutory and process safety requirements.

Table 7 shows the results of minor non-conformities obtained in the external audit cycles by requirement of clause described by the certifier in the company under the applicable requirements according to the IATF 16949:2016 standard and "Frequently Asked Questions (FAQ)". (IATF, 2019).

Table 7
Non-conformities as audit results external audit IATF 16949:2016

IATF 16949 2016 External Audit NCs 2 Cycles (2015-2021)			
Year	**Process**	**Requirement**	**Summary**
2016	Quality systems Manufacturing	8.2.2.4 7.6.2 / 7.5.1.4/ 8.5.1.2	SPC Job Setup / Process Control Plan / Maintenance
2017	Supplier Quality Manufacturing Production Quality Quality System Quality Manufacturing	7.4.1 7.3.1.1 7.5.1.4 4.2.3.1 / 4.1 8.2.2 8.2.2.1.1 7.6 / 7.5.1	Suppliers PFMEA / Maintenance Engineering changes Support location Score card Customer Internal audit process Calibration / PCP
2018	Manufacturing & Assembly Product/Process Change HR01 Employee Hiring Product Development Process Infrastructure Maintenance Manufacturing - Molding Manufacturing - Assembly	8.5.1.1 / 8.5.1 8.3.5.2 5.3.2 8.2.3.1.2 / 8.5.1.5 10.2.1/ 9.1.1.2 8.3.2.1 / 10.2.4 7.1.4.1 / 8.5.1	PCP / Maintenance PFMEA Job description PCP / Maintenance PCP / SPC PFMEA / Maintenance Non conforming products / Work instructions
2019	Manufacturing - Assembly Management Calibration	7.1.3.1/ 8.5.1.2 4.4.1 7.1.5.3.2 / 8.3.3.3	Safety ID / Sample board Key performance indicators Calibration / Special Characteristics
2020	Manufacturing - Assembly Calibration Materials Manufacturing - Assembly Calibration	8.5.6.1 / 8.3.3.3 8.6.2 / 7.5.3.2 8.5.4.1/ 8.3.2.1 8.7.1.1 7.1.5.1.1	PCP/ Special characteristics Full lay out / Scope Storage of materials/ PFMEA PCP MSA
2021	Alps Logistics QMS Molding Engineering	8.5.4.1 4.3.1 / 9.3.1 8.5.2 /6.1.2.3 / 8.5.1.5 / 9.1.1.1 8.6.1 / 8.5.1.1 / 10.2.4	Alps Logistics QMS Engineering Molding

With the evaluation of regulatory requirements without including in detail the specific requirements of customers and results of the quality system, the complexity of alignment and compliance is observed, where the design of a matrix as a tool for integration and standardization of customer requirements for Quality, Environment and Safety can be used as an improvement, harmonizing at the highest level the management of these standards in the organization.

The following is the main cover page and the fields of the tool design for evaluation in the different phases.

Matrix design as a tool for the evaluation of quality, environmental and safety requirements for an automotive company.

Table 8 shows the main general information cover page of the tool.

Table 8
Cover page requirements evaluation matrix

QMS - EMS - OHSM Evaluation Matrix Requirement			
General Information			
Reason for evaluation:			
Evaluation date:			
Completed by:			Department:
Responsible of verification:			Department:
Organization name:			Department:
Contact information			
Top management responsible:			Department:
Street / Production site (city) **Production site (postal code)** **Country:**			Quality management Operation management Human resources
Authorized person of organization:			
Phone:			
Mobile:			
E-mail:			
Management Systems evaluation			
Last 3rd party audit date	ISO/9001 -	IATF 16949 -	ISO 14001 - ISO 14001 - ISO 14001 - ISO 14001 - ISO 14001 - ISO 14001 - ISO 14001 - ISO 45001 - ISO 45001 - ISO 45001 - ISO 45001 - ISO 45001 - ISO 45001
Certificates	ISO/9001 -	IATF 16949 -	ISO 14001 - ISO 14001 - ISO 14001 - ISO 14001 - ISO 14001 - ISO 14001 - ISO 14001 - ISO 45001 - ISO

	45001 - ISO 45001 - ISO 45001 - ISO 45001
Issue-date:	
Conducted by:	
Result POSITIVE / NEGATIVE	

For presentation and communication of the evaluation of the results of the management systems matrix, see Figure 4.

Figure 4

Customer requirements evaluation matrix

Evaluation Matrix Quality, Enviromental and Safety systems

Requirement QMS

	Chapter / Section	ISO 9001:2015	IATF 16949:2016	Chapter / Section
1		Introduction		
2	0.1	General		
3	0.2	Quality management principles		
4	0.3	Process approach		
5	0.3.1	General		
6	0.3.2	Plan-Do-Check-Act cycle		
7	0.3.3	Risk-based thinking		
8	0.4	Relationship with other management standards		
	1	Scope		

Requirement

EMS		OHSMS	
Chapter / Section	ISO 14001:2015	Chapter / Section	ISO 45001:2018

For each of the sections, the details to complete in this tool are included to achieve a global view of ISO 9001, IATF 16949, ISO 14001, ISO 45001 requirements for "The most common standards related to the automotive industry". (NQA, 2021). Example of the filling of the above table by applicable standard:

Figure 4
Customer requirements evaluation matrix

Requirement					
QMS			EMS		OHSMS
ISO 9001:2015	IATF 16949:2016	Chapter / Section	ISO 14001:2015	Chapter / Section	ISO 45001:2018

Continuing with the applicability for quality, environmental and safety management systems in the different international standards.

Customer Specific Requirements ※:CSRs applicability				
GM	FCA-STELLANTIS	FORD	BMW	VW Group

Requerimientos especificos del cliente donde se utilizará la herramienta de evaluación.

Evaluation of results to define actions and priorities to achieve the goal of the management systems requirement.

JUDGMENT Satisfactory (S) Actions necessary (A)	SCORE RESULT GREEN(G) Yellow (Y) RED (R)	PRIORITY Low (L) High (H) Urgency (U)

Score	Requirement	Result
Yes Green	(0) High/ low risk questions	High result / meet expectations and intent of questions
(No) Low Risk	(1) or more low risk questions	Marginally meets expectations and intent of question
(No) High Risk	(1) or more High risk questions	Unacceptable result and does not meet expectation and intent of question / No plan or indequate.
N/A	Items does not apply	Items does not apply

The summary of results for communication with management on compliance in percentage is shown in table 10.

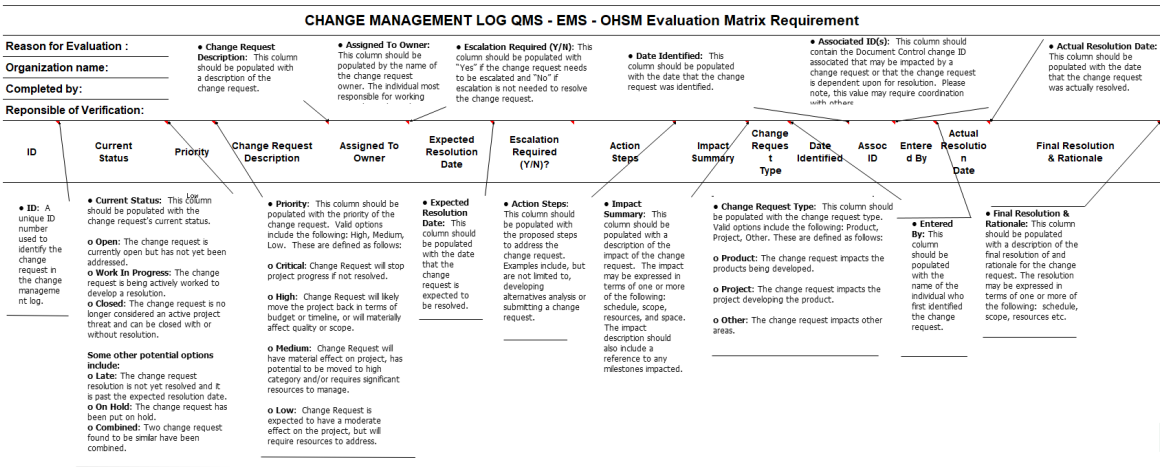
Table 10
Evaluation summary by applicable section

Summary Section Evaluation Matrix Requirement				
Requirement Section		Meet Expectation		
		QMS	EMS	OHSMS
4	**Context of the organization**	Evaluation Global Score (G,Y,R)		
4.1	Understanding the organization and its context			
4.2	Understanding the needs and expectations of interested parties			
4.3	Determining the scope of the QMS			

4.4	Quality management system and its processes	
5	**Leadership**	Evaluation Global Score (G,Y,R)
5.1	Leadership commitment	
5.2	Policy	
5.3	Organizational roles, responsibilities, authorities	
6	**Planning**	Evaluation Global Score (G,Y,R)
6.1	Actions to address risks and opportunities	
6.2	Quality objectives and planning to achieve them	
6.3	Planning of changes	
7	**Support**	Evaluation Global Score (G,Y,R)
7.1	Resources	
7.2	Competence	
7.3	Awareness	
7.4	Communication	
7.5	Documented Information	
8	**Operation**	Evaluation Global Score (G,Y,R)
8.1	Operational planning and control	
8.2	Requirements for products and services	
8.3	Design and development of products and services	
8.4	Control of externally provided processes, products and services	
8.5	Production and service provision	
8.6	Release of products and services	
8.7	Control of nonconforming outputs	
9	**Performance evaluation**	Evaluation Global Score (G,Y,R)
9.1	Monitoring, measurement, analysis and evaluation	
9.2	Internal audit	
9.3	Management review	
10	**Improvement**	Evaluation Global Score (G,Y,R)
10.1	General	
10.2	Nonconformity and corrective action	
10.3	Continual improvement	

As part of the evaluated results, Figure 5 includes the actions and follow-up from a systematic perspective.

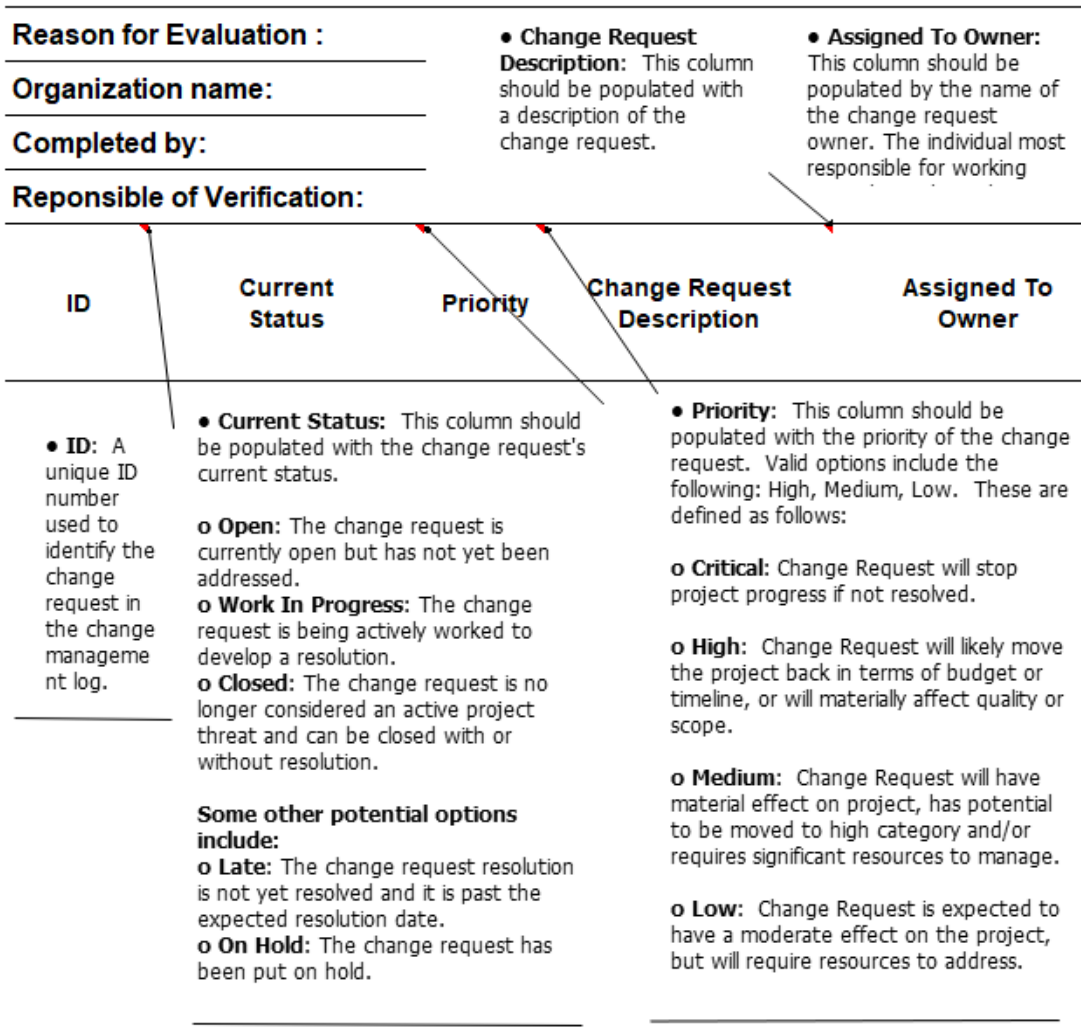
Figure 5
Follow-up of actions by applicable system



The following sections are shown in detail for a detailed view of the follow-up of actions in the initial sections for those responsible, where the general data of the system, actions and escalation for defined dates are included against the compliance status for the follow-up of dates and escalation.

Figure 6

Follow-up of actions by applicable system



The following part of the follow-up design for the conclusion of the actions taken for the items evaluated in the management systems matrix presented.

Figure 7
Follow-up of actions by applicable system

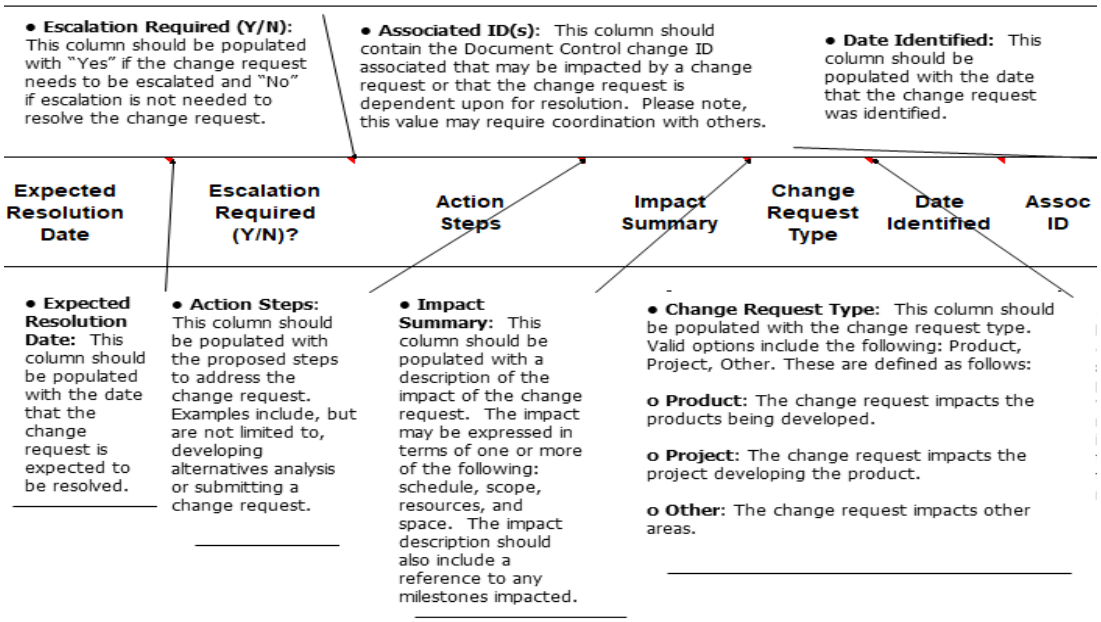


Table 12 presents the integration of the systems as a matrix that is part of the tool for the evaluation of quality, environmental and safety requirements, which also includes the harmonization of management requirements confirmed with the current operation of the organization where this study was carried out.

Table 12
Integration matrix for quality, environment and safety

Integrating Processes between QMS- EMS - OHSMS	
Process integration matrix	
Process Name	**QMS, EMS, and OHSMS**
Strategic Planning	4.1 Understanding the organization and its context 5.1 Leadership and commitment 5.2 Policy 6.2 Objectives and planning to achieve them
Determining Customer / Interested Parties expectations	4.2 Needs and expectations of interested parties 5.1.2 Customer focus
Business Review	9.3 Management review
Internal Auditing	9.2 Internal Audit 9.1.2 Evaluation of compliance (EMS & OHSMS)
Corrective and Preventive Actions	10.2 Nonconformity and corrective action
Customer Complaints	8.2.1 Customer communication
Continual Improvement	10.3 Continual improvement
Document Control	7.5 Documented information
Quality Records	7.5 Documented Information
Recruiting and Training	7.1.2 People 7.2 Competence 7.3 Awareness
Marketing	7.4 Communication
New Product Development	8.2 Determination of requirements of products and service
Risk Identification Prioritization	6.1 Opportunities to address risks and opportunities
Mange the Change	6.3 Planning of changes
Managing Organizational Knowledge	7.1.6 Organization knowledge 8.5.6 Control of changes
Process Control	4.4 Quality Management System and its Processes 8.1 Operational Planning and Control
Storage and Distribution	4.4 Quality Management system and its processes 8.1 Operational planning and control 8.5.4 Preservation (QMS only)

Facilities Planning	4.4 Quality management System and its Processes 8.1 Operational planning and control 7.1.3 Infrastructure (QMS only)
Purchasing	8.4 Control of externally provides products and services
Material Control	8.5.2 Identification and traceability (QMS only) 8.5.3 Property or external parties (QMS only) 8.6 Release of products and services
Manufacturing Process Control	8.5.1 Control of production and service provision (QMS only)
Post Delivery Processes	8.5.5 Post-delivery activities
Control of Nonconforming	8.7 Control of Nonconforming processes, products and services

Discussion and conclusions

Organizations are currently facing a very important challenge, to achieve efficiency and effectiveness objectives, but with limited resources, less implementation time, difficult knowledge management, stricter and more complex requirements, to name a few.

The matrix as a tool for the evaluation of quality, environmental and safety requirements gives us the guideline to make the management of the organization more efficient, by eliminating the duplication of documents, non-applicable controls and repetitive training, it also allows us to minimize the workload and efforts that are generated due to the analysis of each of the systems as isolated sections and not as a whole as presented here in the previous chapters.

The integration of systems in the evaluation tool allows maintaining an effective approach to decision making by senior management. With the correct application of these concepts, the time required to evaluate requirements in projects produces significant savings that are summarized in advantages for the organization.

Project management with strict execution times has arrived to organizations, a new order of applying concepts of integration and standardization, the use of tools in the face of the urgent sense of contribution to face the current crises of components, logistics, act on the main safety factor for employees, environmental impacts and maintain the quality of products, as part of this important industrial transformation, which, in our experience allows the use of such tools as a solution to this problem that we face the administrators of management systems.

The conclusion of the methodological aspects of this instrument provides a standardized identification of potential risks for each situation and the risks associated with similar processes or products based on the results of evaluation by severity of requirements, a non-compliance with greater severity requires a systematic identification of occurrence and increase early detection of events that impact the fulfillment of customer requirements and product quality and if there are specific customer requirements that must be managed by determining systematic action plans that provide an efficient and effective monitoring of results.

With this tool you can also observe the compliance with the service requirements, which are established in the relevant functions and levels within the organization, the organizational objectives of the certifications required by customers and the industry can also be measured consistently and compared with the defined quality policy.

The matrix as a tool for the evaluation of quality, environmental and safety requirements

also allows to establish and maintain the communication of aspects at the different levels and functions of the organization.

The development of this tool has also allowed the conclusion of advantages by phases identified in this design and standardize the work style with greater management of goods or services, saving time in the execution of work tasks and saving resources that translate into positive economic impacts.

Simplifying operations allows strengthening and advancing the organization's competitiveness by avoiding repetitive operations or unproductive activities.

The application of changes in standards and requirements are increasingly with a shorter implementation time allowed; To address the evaluation of requirements and standards from the high-level perspective of the organization is necessary the use of an evaluation tool as an integrative solution, standardized, allowing the application of lessons learned and describes from the multiple inputs of the processes a clear definition of multiple tasks to multidisciplinary project teams but maintaining an effective approach to processes and their proper interaction, this compliance gives us a benefit as mentioned above in the expectations of our customers and the ability to maintain without significant deviations a successful and operational quality system.

A key to managing requirements efficiently is to use the approach of commonality and interrelated expectation among them.

Another advantage of using this tool is the ability to receive, document and respond to the results to the different departments in a systematic and standardized way through a higher level of standardization in project management which translates into less response time for the requirements; More satisfaction of our customers which in turn strengthens the organization and ensures additional value as an integrating system for business objectives.

The implementation of this tool also allows the quality system manager to evaluate the requirements and simultaneously the methodological execution of tasks allowing to maintain a feedback to the design of the projects in the corresponding phases.

To conclude, to maintain a sustainable compliance approach to the organization's duties is to think outside the box by creating added value with a clear focus on evaluation through the use of innovation tools as part of a solution to the changing global requirements and dynamic and increasingly stringent requirements in relation to quality, environment and safety.

References

AENOR (2020). *El eje central de la gestión ambiental.* Certificacion ISO 14001 sistemas de gestión ambiental. https://www.aenor.com/certificacion/medio-ambiente/gestion-ambiental

Escuela Europea de Excelencia (2020*). ¿En qué consiste el ciclo PDCA para la mejora continua?* https://www.escuelaeuropeaexcelencia.com/2020/07/en-que-consiste-el-ciclo-pdca-para-la-mejora-continua/

IATF 16949 (2021). *International Automotive Task Force.* About IATF. https://www.iatfglobaloversight.org/iatf169492016/about/

IATF 16949 (2019) *International Automotive Task Force*. *Preguntas más frecuentes* https://www.iatfglobaloversight.org/wp/wpcontent/uploads/2019/11/IATF-16949-FAQs_Oct2019_es.pdf

International Automotive Task Force (2021). *Customer Specific Requirements*. https://www.iatfglobaloversight.org/oem-requirements/customer-specific-requirements/

ISO 9001 (2021). *ISO standards are internationally agreed by experts. Think of them as a formula that describes the best way of doing something*. https://www.iso.org/standards.html

ISO 45001 (2018). *Sistemas de gestión de la seguridad y salud en el trabajo. Requirements with guidance for use.* https://www.iso.org/obp/ui/#iso:std:iso:45001:ed-1:v1:es

National Highway traffic safety (2021 *Retiros (Recalls)Takata primer plano. Total de bolsas de aire afectadas.* https://www.nhtsa.gov/es/equipo/retiros-recalls-takata-en-primer-plano

NQA (2021) *Normas en el sector automotriz. Normas aplicables a la industria automotriz certificadas por NQA.* https://www.nqa.com/es-mx/certification/sectors/automotive

OMNEX (2021) *Impact of Electric vehicle, automotive vehicle standards on IATF 16949 Quality Management Systems*. *Driving worldwide business excellence*. *https://my.omnex.com/webinars/impact-of-ev-av-standards-on-iatf-16949-qms*

Velazquez, M. (2018). *La cuarta revolución industrial no hará desaparecer tu empresa... ¿o sí?. Tecnologías exponenciales, organizaciones exponenciales*. https://blog.growthinstitute.com/es/-la-cuarta-revolución-industrial-no-hará-desaparecer-tu-empresa...-o-sí

Date received: 18/02/2022
Revision date: 04/04/2022
Date of acceptance: 19/05/2022

PROJECT, DESIGN AND MANAGEMENT

https://www.mlsjournals.com/Project-Design-Management

ISSN: 2683-1597

How to cite this article:
Medina Minaya, A. E. & Moreno Briceño, F. (2023). Análisis de la innovación en los procesos y la productividad respecto al uso de TIC en las empresas panificadoras del Municipio de Campeche, México. *Project, Design and Management, 5*(1), 102-119. doi: 10.35992/pdm.5vi1.1263.

ANALYSIS OF INNOVATION IN PROCESSES AND PRODUCTIVITY REGARDING THE USE OF INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT) IN BAKERY COMPANIES IN THE MUNICIPALITY OF CAMPECHE, MEXICO

Alberto Eliceo Medina Minaya
Universidad Internacional Iberoamericana (Mexico)
alberto.medina@doctorado.unini.edu.mx - https://orcid.org/0009-0004-6510-4035
Fidel Moreno Briceño
CNCI Virtual University (Mexico)
fidel_briseno@cncivirtual.mx - https://orcid.org/0000-0002-0057-4042

Summary. The objective of this research is to analyze the use of ICT that favor the innovation of processes and the factors that affect the productivity of bakery companies in the Municipality of Campeche, Mexico, it is a non-experimental type of research, it corresponds to a cross-sectional design with descriptive scope and a quantitative approach, whose population is 135 companies with a sample of fifty-seven (57); a convenience sampling was carried out (20 companies), since the units to be studied were chosen according to their easy availability, this motivated by the existing implications generated by the COVID-19 pandemic; an instrument was elaborated and validated in its content by management experts and its reliability was calculated, it was applied to the owners or managers of the mentioned companies. Among the conclusions, the following stand out: the incorporation and use of ICTs is necessary due to the need to modify and adapt to new technologies and changes in the market, which are so necessary for subsistence. The reasons that prevent innovation are based on: not having enough information about the elements that make them up, high costs to innovate, lack of financing from the state and the private sector, not having enough capital. Finally, there is evidence of a marked influence of internal and external factors that affect productivity, which is why it is important that they be studied and analyzed in depth in the future.

Key words: ICT, Productivity, Innovation, Internal Factors, External Factors

ANÁLISIS DE LA INNOVACIÓN EN LOS PROCESOS Y LA PRODUCTIVIDAD RESPECTO AL USO DE LAS TECNOLOGÍAS DE LA INFORMACIÓN Y COMUNICACIÓN (TIC) EN LAS EMPRESAS PANIFICADORAS DEL MUNICIPIO DE CAMPECHE, MÉXICO

Resumen. El objetivo de esta investigación es analizar el uso de las TIC que favorecen la innovación de los procesos y los factores que inciden en la productividad de las empresas panificadoras del Municipio de Campeche, México, es una investigación de tipo no experimental, se corresponde con un diseño transversal con

alcance descriptivo y un enfoque cuantitativo, cuya población es de 135 empresas con una muestra de cincuenta y siete (57); se realizó un muestreo por conveniencia (20 empresas), toda vez que las unidades a estudiar se eligen de acuerdo a su fácil disponibilidad, esto motivado a las implicaciones existentes generadas por la pandemia del COVID-19; se elaboró un instrumento que fue validado en su contenido por expertos en gerencia y calculada su fiabilidad, fue aplicado a los dueños o gerentes de las citadas empresas. Entre las conclusiones se destacan: es necesaria la incorporación y uso de las TIC debido a que se requiere la modificación y adaptación a las nuevas tecnologías y cambios presentes en el mercado tan necesarios para la subsistencia. Los motivos que impiden la innovación están sustentados en: no tener información suficiente sobre los elementos que las conforman, costos elevados para innovar, falta de financiamiento por parte del estado y sector privado, no disponer de capital suficiente. Finalmente se evidencia una marcada influencia de los factores internos y externos que inciden en la productividad, por lo que es importante que en el futuro se estudien y analicen a profundidad.

Palabras clave: TIC, Productividad, Innovación, Factores internos, Factores externos

Introduction

The present work is based on the analysis of innovation in processes and productivity through the use of Information and Communication Technologies (ICT) in bakery companies in the Municipality of Campeche, Mexico, whose objective is to analyze the use of ICT that favor innovation in processes and the factors that affect productivity in bakery companies in the Municipality of Campeche, and thus provide information regarding the companies in question, since to date there is no research available in this productive sector, which represents an important segment within the market of the municipality of Campeche.

Currently, it is observed that companies that tend to modernity face great challenges, due to the demands of customers, suppliers, users and consumers, among others, however, to meet these challenges, one of the ways to achieve it is through the added value generated by innovation, creativity, continuous growth, and competitiveness (Cordero-Guzmán and Rodríguez-López, 2017), within which ICTs are incorporated, which have currently set the tone for the management of companies in terms of the possibility of offering their products and services (Flores and Flores, 2021).

In relation to the benefits of ICT to improve productivity and quality in its products and services, its implementation within the organization, must be done in a planned manner, considering that its incorporation is not synonymous or a guarantee of achieving all the benefits they offer; every time that to achieve them it is relevant to have a knowledge of the processes of the company, plan the ICT needs and incorporate technological systems gradually (Cano-Pita, 2018).

Likewise, the author in question states that, "90% of the time, failure is not due to software or systems, but to the fact that people do not have enough knowledge about their own company or its business processes" (2018, p. 504), coupled with this, it is vitally important to make a thorough analysis of both service and production processes, in order to generate innovation activities and consequently an increase in productivity. These activities include research and experimental development, engineering and design, marketing and image, intellectual property, employee training, software and database development, asset acquisition or leasing, and innovation management (Organisation for Economic Co-operation and Development [OECD], 2018).

Currently the use of information and communication technologies is a tool that is no longer optional, but must be adopted and incorporated in companies, it is also key to increase purchases, sales, services, among others, and also allows them to improve their production

activities by innovating their processes using ICT, and as a result they will have an increase in productivity, since innovation and technological changes are considered pillars of economic development.

Innovation. Conceptual basis

There is a great deal of literature on the subject of innovation, but all this information refers to changes in products and processes in organizations in order to be in constant growth and adaptation to what the market requires and more particularly the final consumer.

Based on the above, several writers and researchers have expressed definitions of innovation, but it is pertinent to highlight that all of them start from a need which in turn generates a question and that, by answering it, an opportunity for knowledge is created. In this regard, reference is made to the Oslo Manual definition "An innovation is a new or improved product or process (or a combination of both) that differs significantly from previous products or processes of the institutional unit and that has been made available to potential users (product) or implemented in the institutional unit (process)" (OECD, 2018, p.32). Likewise, innovation is understood as "industrial technological development, where science and technology have played a fundamental role in the growth and economic development of countries" (Espinosa and Romero, 2016, p.2).

Similarly, special mention is made of innovation as a process through which society extracts social and economic benefits from knowledge, since it has become a mandatory subject in any organization and even more so in developing countries where the adoption of this concept is fundamental (Ramírez, Martínez, Castellanos and Colmenares, 2012), benefits that are important in every company, because transforming products or processes with the intention of economic growth depends on it and therefore being better positioned at national and international level.

As stated before, innovation is applied to new ideas, products, processes and services, all with the purpose of keeping the final consumer satisfied, which in equivalence maintains the market demand, hence when making innovations the material and economic resources necessary for adaptation and implementation must also be included (Diaz and Guambi 2018).

Process innovation

In the Oslo handbook (OECD, 2018) process innovation is defined as "New or improved business process for one or more business functions that differs significantly from previous business processes and has been implemented in the company" (p. 21), in this sense, processes are a fundamental element in organizations, for the production of goods or services.

In companies it is convenient to analyze all production activities and within these the processes that need to be changed, considering that if they are identified and in turn divided into sub-processes, specialized tasks can be assigned, resulting in an improvement and therefore an added value (Medina et al., 2019), since changes in the sub-processes are easier to make, because at the slightest variation in market demand, they can be made immediately, that is, in very short times.

Based on the above, process innovation becomes more functional when the identified processes have that sense of being able to access a change, always taking into account to make the most of innovation and also consider working methods that allow modifying the tasks in such a way that a totally different process can be obtained, this leads to the effectiveness of any change or modification will be reflected in an increase in productivity and profitability, otherwise, process innovation does not get the expected effect.

Production of goods and services

It is appropriate to point out that the economic activity of companies aims to produce a good or service that is directed to the market to be acquired by the final consumer, consequently, to produce it, essential components such as raw materials, machinery and the most important element, which is labor, are needed. A good is something that can be perceived, it is a material object that can be manipulated, accumulated or in its case, transformed, and a service by its nature is intangible, in a way it has and must be consumed instantly, and this means that it is not possible to be stored.

In this order of ideas, "production is related to the creation of goods and services, comprises the planning, design, operation and control of the systems that produce goods and services and covers a wide range of activities and not only those of manufacturing goods" (D'Alessio, 2004, p. 2). 2), in this definition refers to the process that begins with the planning that represents the objectives and activities necessary to achieve the goals, the design allows the team to establish patterns, the operations are immersed in the transformation of the products and in the control the possible deviations between the planned and the result of producing a good or service are updated.

In the production process, the production area should be considered as a substantial part of the company due to the responsibility it has, as well as two other areas that are of great importance which are marketing and finance, which have activities that support production in the form of bringing goods and services to customers (D'Alessio, 2004). Importance is given to marketing because its purpose is to bring together factors and facts that influence the market, to create what the consumer wants or needs, and finance is responsible for raising funds, and the provision of the capital that is used for the operation of the company.

In relation to the incorporation of ICT in the production of goods and services, companies within the global approach have the need to add them in each of the activities, such as software, digital technologies and tools, artificial intelligence, among others, thereby facilitating and streamlining the performance of tasks, which ultimately contribute to their economic growth**.**

Productivity

Productivity is a strategic objective present in companies; without it, the products or services derived do not reach the necessary levels of competence to remain in the market. Tejada (2007) defines it as "the relationship between economic production and the resources invested to generate it, which depends on the capacity to innovate products with an increasing added value, while the efficiency in the use of production inputs is optimized to the maximum" (p. 289), i.e., it seeks to improve the efficiency with which resources are used.

According to Chiavenato (2009) "is a measure of performance that includes efficiency and effectiveness. Efficiency is the appropriate use of available resources, i.e., it emphasizes means and processes. Effectiveness is the achievement of goals and objectives" (p.13).

Among the resources that support an adequate relationship between the company and the market are ICTs. Their incorporation is not only an option, but a commitment, considering that day by day, with technological advances, productivity is improved. In this sense, some countries are formulating policies to develop emerging technologies such as robotics and artificial intelligence, to mention a few, all in order for companies, and therefore countries, to optimize their productivity (OECD, 2020).

In this order of ideas, the Economic Commission for Latin America and the Caribbean (ECLAC, 2021), points out that the challenge of obtaining productivity quickly can be

achieved through an exhaustive analysis of how to incorporate new technologies, determine the training of the personnel who operate the equipment, as well as risk planned investments, among others, all of them in function of achieving an increase in productivity.

One aspect that countries need to keep in mind is that productivity represents an increase in the standard of living and quality of life of the population, but the downside, so to speak, is that a decrease in productivity will be reflected in a slowdown in economic growth (International Labor Organization, 2020).

The concept of productivity can be considered from various levels (international, national, industrial, sectoral, business, or sections of a company). In this referential framework, it is conceptualized as "the improvement of productive capacity and the general environment, seeking efficiency, i.e. improving the product, effectiveness, salaries, etc., without improving any other indicator" (Villamizar and Villamizar, 2011, p.160), since, by seeking to improve the good or service, efficiency and effectiveness are guaranteed.

In this context, "total productivity is the result of dividing the outputs by the inputs, that is, the value of all the inputs used for it" (Jiménez and Espinoza, 2007, p. 529), which indicates that, if a company's purpose is to manufacture and sell, the outputs should be reflected in sales.

In Mexico, INEGI (2021) states that total productivity is framed within the accounting of economic growth, it allows to know the productive factors that contribute to production and therefore the performance of the sector, so the development of economic public policies must be in the hands of managers who make the right decisions, especially when technology and the globalization of markets play an important role, as well as the installation and operation of multinational consortiums.

Technological change

Technological change can be considered as a mechanism that promotes economic growth, increases the quality of products, restructures the standards with which the organization works and improves the level of competitiveness in the organization, it can also be seen as an instrument of power and control (Garcia, n.d.). For Turriago (2014), it is "the process and transformations derived from modifications in production techniques, of whatever nature these productive techniques may be" (p.30). The aforementioned definitions refer to changes in technology, in the process, i.e., there will always be the need to modify what is already obsolete for what is current or more recent, in order to adapt to new techniques, in accordance with updated equipment that allows for greater productivity.

With the adaptation to new techniques, knowledge is acquired as a result of the experience and training given to employees, that is to say, technological change goes hand in hand with technological learning, which refers to the "form of business development that has to do with the increase and diversification of information, with the application of technology and the realization of innovations" (Salado, 2002, p. 73), since innovations are the result of technologies and knowledge of workers, which promote changes in products or services, for the economic growth of companies), since innovations are the result of technologies and the knowledge of workers, which promote changes in products or services, in favor of the economic growth of companies.

Technological changes are present at all times, they are totally variable, they are based on the needs of the user or the companies, their adoption in the production phases favors the fulfillment of the processes according to the market demand. Nowadays, almost all work activities are carried out through computers and devices commonly used by any person and

because of this, they are considered the means by which the interaction between the organization or industry with the client or final consumer is generated.

In this sense, it is considered that technological changes improve production, resulting in products and services that meet the requirements of customers and the market, as well as the effects on productivity and the increase of the economy, since they provide products and offer quality services, and therefore their permanence in the market is guaranteed**.**

New technologies

Today, companies face a market in which it is necessary to meet the demands of these and customers at a fairly fast speed, so it is essential to have technological equipment with which you can respond in the same way, all with the firm conviction to stay in the market. With respect to this equipment, which is used as a means for the flow of information between the company, the market and customers, its renewal should be taken into account as far as possible, in line with consumer demands**.**

It is clear that these new technologies have not been adopted by all companies, perhaps due to lack of knowledge, lack of resources, resistance to change, and lack of opportunity to manage them efficiently, among others. However, those that have incorporated new technologies are possibly based on an adequate management of innovation in their products or services, interest in being competitive, and investment possibilities, which allow the implemented changes to be successful**.**

The inclusion of new technologies in companies or organizations must follow certain phases in a planned manner, i.e., first, management must be convinced of the need for change, then the establishment of strategies to achieve it, and finally its implementation. It is not advisable for companies to make changes without having carried out the previous phases.

New technologies "basically comprise the study and application of digital technologies and telecommunication systems; that is, multimedia computers and peripherals such as scanners, printers, digital cameras, and computer networks, whose maximum exponent is the Internet" (Pérez, 2005, parr.5), that is, means capable of transmitting information and communication, which are currently integrated to the main network that is the Internet.

According to Joyanes (2006), a computer "is an electronic device used to process information and obtain results. Data and information can be entered into the computer through the input and then processed to produce an output" (p.4); in other words, means that it is simply placing data for the computer to process to produce a result that can be text, multimedia or images. Multimedia refers to "any object or system that uses multiple means of expression (physical or digital) for the purpose of presenting information. These multiple media are text, images, animation, sound, video, etc." (Domínguez, Paredes and Santa Cruz, 2015, p. 96), i.e., there is the possibility of combining multiple media whether physical or digital that are processed by a computer, so the user can perform his activities more fluently and thus obtain information.

Referring to the peripheral computers are "technological devices with which information (data) is introduced to the computer; to then process them, transform them into electrical signal and store them in memory" (Acosta et al., 2014, p. 17), i.e., includes those devices in which the computer has direct communication with the user and with the system, perform input or output interventions, they are used as essential devices since it depends on them that there is such communication, within these are the keyboard, mouse, scanner, bar code readers, touch screens, digitizer table, stylus, among others.

In relation to computer networks, "a network is formed by a set of devices connected to each other, either physically or through logical connections, in order to allow the exchange of information between them" (Carceller, 2013, p.7), in other words, networks refer to the need to connect two or more computers to the Internet, either by wired or wireless means, in order to establish communication, or for a specific purpose.

Regarding the internet, it can be defined as "a large global computer network formed by a multitude of small networks and individual computers connected to each other so that it is possible to exchange information between them" (Molina and Polo, 2015, p. 28), currently allows interconnection between computers or computers worldwide, with the purpose of distributing information between users.

Internal and external factors that influence productivity of bakery companies

Since a company is conceived and established, it aims to achieve its objectives, economic growth, permanence in the market, profitability, among others, but the basis of all this is to have a close relationship of the productive factors, that is, to have a solid production system (inputs, processes, products and information flow), which are connected to customers, suppliers and the environment (Carro and Gonzales, 2015), in order to obtain a product or service, whose purpose is to satisfy the consumer.

In this sense, companies need to maintain a high level of production based on activities that allow them to improve their production processes, taking into account those external and internal factors that in one way or another influence the quality of their products or services and, therefore, their productivity.

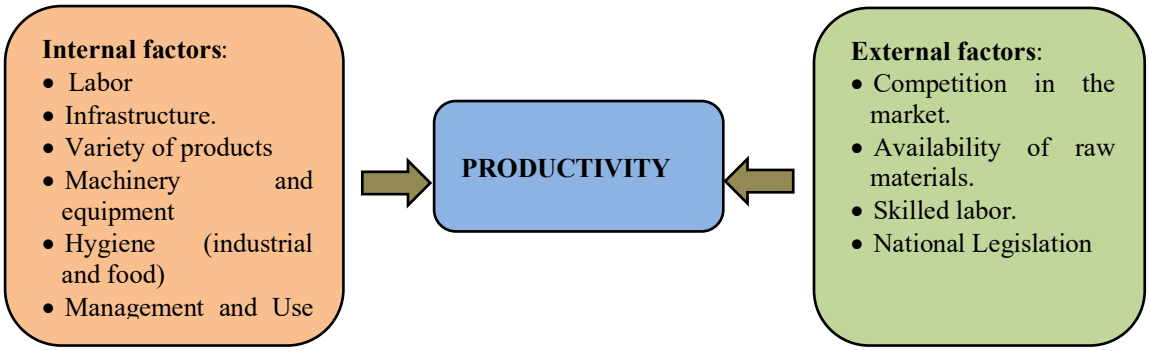
In relation to external factors, management has no control, so it is necessary to generate strategies to anticipate situations; therefore, a permanent analysis of the variations in the company's external environment is recommended. Regarding internal factors, they are controllable and are considered opportunities for productivity improvement, because they occur within the company (Velásquez, Rodríguez and Guaita, 2012).

In this order of ideas, it is pertinent to mention the research conducted by Mena (2011, p. 42), in which he states that, in bakery companies, the internal factors that influence productivity correspond to: land and buildings, materials, energy, machinery and equipment, infrastructure, and human resources; as external factors: availability of materials or raw materials, skilled labor, state policies, allocation and tariffs, and adjustment measures.

Taking into account what is expressed by Mena (2011) and motivated by the fact that the present research is located in the same context, it is proposed to use some factors and include others that will be adjusted based on local characteristics, considering that these can influence the productivity of the bakery companies located in the Municipality of Campeche.

Being the object of study, bakery companies, where the internal and external factors that influence productivity play an important role, the authors assume as internal the following: infrastructure, variety of products, machinery and equipment, hygiene (industrial and food), and the management and use of ICT. External factors include: market competition, availability of raw materials, skilled labor, and national legislation (see Figure 1).

Figure 1
Internal and external factors that influence the productivity of bakery companies in the in the municipality of Campeche. Mexico



Considering the internal and external factors that can influence the productivity of the bakery companies in the municipality of Campeche, the following is a description and theoretical support for each one of them.

Internal factors

Labor: It is defined as "It is the human effort involved in the process of transforming raw materials into finished products" (García, 2013, p.75), in this case the labor referred to comes from the specialized labor of external factors, having with this the control of quality in raw materials and products.

Infrastructure: It corresponds to "any system, physical structure (work), network or organization necessary that give functional, optimal and efficient support for the proper functioning of a society and its economy" (Cerón, 2018, p.18), in this sense the facilities of the bakery companies require to be in accordance with the performance of their activities and their production processes, in relation to accessibility to customers and suppliers, buildings that comply with the construction standards established in Article 1 of the Construction Regulations for the municipality of Campeche (1989), which states that:

> The provisions of these regulations shall govern in the municipality of Campeche and their purpose is to regulate all construction, installation, modification, extension, repair and demolition works executed on public or private property, as well as urban development, planning, safety, stability and hygiene, limitations and modalities imposed on the use, destination and reservation of land or buildings of public or private property.

Variety of products: The variety of products offered "is given by the flexibility in terms of the speed with which the company can change from producing one product to producing another or in terms of (the inverse of) the costs of these changes" (Roberts, 2006, p. 38), in this case the bakery companies produce a great diversity of products in order to meet the demand of their customers, considering that bread is a product of high consumption in the country.

Machinery and equipment: In bakery, machinery is the set of motorized or mechanical devices that facilitate the work to maintain quality and improve performance. The equipment are stainless steel tables, scales, kneader-batterers, dividers and bread slicers (Buendía and Berrocal, 2016). The machinery and equipment to be used must have favorable accessories to

facilitate the work and process the products with quality, and also be sufficient to meet the daily demand.

Hygiene (industrial and food): Regarding the objective of industrial hygiene is the prevention of occupational diseases caused by physical, chemical or biological contaminants acting on workers" (Baraza, Castejón and Guardino, 2014, p. 23) and for food hygiene "a series of work routines will be carried out for all processes of receiving raw materials, cleaning and disinfection of facilities and utensils, handling and manufacture of the food product and its storage" (Jiménez, 2012, para. 5). Hygiene in these processes allows the consumer to maintain confidence in the product he/she is acquiring, so he/she knows that it is guaranteed, thus representing consumer loyalty.

Management and Use of ICT: In bakery companies, information technology offers multiple advantages, especially because it improves (hygiene in food handling, order and cleanliness, management since information can be accessed from any point, such as sending it, sharing it with customers and suppliers). In addition, there are computer applications specifically adapted to the sector, which collect all the processes that take place in a bakery (premises where work is carried out in a manual activity with the help of tools or simple machinery), from the request for raw materials to the sale (Moreno and Morales, 2021).

External factors

Competition in the market: arises from interactions in the market to the extent that rivalry between companies, in order to obtain customers or money from customers, leads them to offer higher quality and lower prices. This rivalry process forces each company to look inward in order to ensure that all resources are being used efficiently (Joekes and Phil, 2008). Today it is considered necessary to have competition in order to offer quality and value-added products.

Availability of raw materials: It is essential that the company's management relates with suppliers in order to ensure production, that is, to have identified various alternatives for each consumable or raw material and above all prices that give the opportunity to obtain the maximum profit, in this sense "the selection and evaluation of suppliers has become increasingly a key element of business strategy for its high competitive impact" (Sarache, Castrillón and Ortiz, 2009, p.155)

Specialized labor: the person with this category is generally "the person responsible for production and at the same time who has the greatest technological knowledge in the company and consequently is also the one who controls the quality of raw materials and products" (Kohli, Díaz and Castro, 2003, p. 191). As a result, specialized and experienced labor is required for the production of the variety of products, so this type of personnel must be trained in the production of these products.

National Legislation: A regulatory body that operates at the national level and is composed of laws that develop the precepts of the country's Political Constitution, Regulations that regulate the implementation of the laws, and Standards that specify characteristics of products and services, in compliance with regulations and laws**.** Likewise, the national legislation on: adequate standard of living, health, education, labor, food, healthy environment, water, housing, social security and culture, which are directly related to the activities of the companies, regardless of the sector in which they operatethese are directly related to the activities carried out by companies, regardless of the sector in which they operate.

Method

The purpose of all research is to provide information on a topic of interest, for which certain activities are required to obtain results, which would have no value if there is no support, i.e., a scientific method, or in any case a methodology that explains how it is going to be done (Gómez, 2012).

In this sense, this research is based on the positivist paradigm, which is based on assumptions that seek to relate to the interpretation of the world, and also indicates the problems that should be addressed and have a reference to provide answers to any doubt (Ramos, 2015), positivism then, considers that only knowledge that has its origin in real facts and that are verified can be considered knowledge (Guamán, Hernández & Lloay, 2020).

This is a non-experimental type of research, because the object of study is observed in its natural state and then the corresponding analysis is performed. It also corresponds to a cross-sectional design, with descriptive scope, which is the one where data are obtained at a single time (Paz, Salomón, García and Suárez, 2020). Likewise, will have its support in the quantitative approach, that is, the realization of analysis and studies of reality, through the development of certain measurements and values of discrete type and thus have reliable data (Escudero and Cortez, 2018). It is carried out using a field design, in order to obtain information directly on the scene.

Regarding the study population, in this case, about the bakery companies located in the Campeche Municipality of Mexico, the information contained in the National Statistical Directory of Economic Units (DENUE) of the National Institute of Statistics and Geography of Mexico (INEGI, 2020) was investigated. All sizes of establishments are taken as a reference (according to the number of people working), which resulted in 135 companies. It is appropriate to point out that the population is considered broad, therefore, it is necessary to calculate a sample that provides information in a meaningful way to the totality of the subjects to be studied (managers, directors or owners of bakeries).

In relation to the sample, understood as "portion of the population that have the necessary characteristics for the research, clear enough so that there is no confusion" (Ñaupas et al., 2018, p.334), by virtue of this, the formula for calculating samples for finite populations is used, a total of fifty-seven (57) companies were determined.

Once the sample size was obtained, the type of sampling was selected in order to determine which companies were to be surveyed. In this sense, this research uses non-probabilistic sample size and sample selection by convenience "procedure that consists of selecting the sample arbitrarily. The sample units are self-selected or chosen according to their easy availability" (Mejía, 2002, cited by Escribano, 2007, p.37), in this case only 20 (twenty) bakery companies were considered. This was motivated by the existing implications in the country, generated by the COVID-19 pandemic.

The measurement instrument, for Hernández-Sampieri, Fernández and Baptista (2010), is "that which records observable data, which truly represent the concepts or variables that the researcher has in mind" (p. 276), in this research, the questionnaire is used, which is defined by Arias (2012), as "the survey modality that is conducted in written form by means of an instrument or paper format containing a series of questions. It is called a self-administered questionnaire because it must be filled out by the respondent, without the intervention of the interviewer" (p. 74).

Based on the objective of the research, the variables involved are identified and operationalized in order to develop the instrument to collect the information. In this sense, a questionnaire was elaborated, which consisted of fifteen (15) items, distributed in three sections: ICT, Innovation in processes through the use of new technologies and Productivity through technological changes. Content validity was determined for the aforementioned instrument, which "refers to the degree to which an instrument actually measures the variable it intends to measure" (Hernández-Sampieri et al., 2014, p. 200). This validity was carried out by three experts in business management. Likewise, the reliability for each section of the instrument is determined through Cronbach's coefficient, obtaining for ICT (0.707); innovation in processes through the use of new technologies (0.718) and Productivity through technological changes (0.808), values that indicate that the instrument is reliable and therefore its application allows achieving optimal results.

The questionnaire was applied to the study subjects, the information obtained from the respondents was organized and descriptive statistical methods were used, using the statistical programs Statgraphics and SPSS (Statistical Package for Social Sciences) version 25, which were used to process the data and obtain the results, which are analyzed and interpreted below.

Results

As a scope of the questions formulated in the instrument applied to the managers, directors or owners of the bakery companies located in the municipality of Campeche bakery companies located in the Municipality of Campeche. The analysis is then carried out based on the sections: ICT, Innovation in processes through the use of new technologies and Productivity through technological changes.

Section I: ICT.

In relation to the need to incorporate technologies to the processes or services within the bakery companies of the municipality of Campeche, 85% of those interviewed consider that their incorporation is necessary due to the need to modify and adapt to new technologies and changes in the market, which are so necessary for their subsistence 85% of those interviewed consider that their incorporation is necessary because it requires modification and adaptation to new technologies and changes in the market, which are so necessary for their subsistence, in addition to the fact that they do not affect the costs of the company, on the contrary, being more updated with modern equipment and systems, they will be more competitive; the remaining 15% prefer to maintain the traditional style, which allows inferring that if they are not updated with the use of ICTs they run the risk of disappearing.

Regarding the use of business platforms as digital infrastructures that enable the interaction of two or more sectors, 90% of the companies do not use them, reflecting a very personalized operation, a situation that limits the coordination between users (customers, advertisers, service providers, producers, suppliers and even physical objects), which allows optimizing its operation within the market where it operates; the remaining 10% do use them, being considered a small number that are applying new technologies, giving advantages to be competitive and inserted within the globalizing process in which companies are currently immersed.

When analyzing the opinion of those surveyed in relation to the experience in the use of ICT by employees at the time of implementing new technologies, they start from the principle that even though they consider it important, it is not essential; however, they indicate that having basic knowledge helps them to take advantage of this training when they need to be trained for the acquisition of new equipment or tools, they are in a better position to take advantage of this training.

Among the responses referring to the use of social media to offer products or follow up with customers, the most used are Google, then Facebook, followed by Instagram, WhatsApp and, to a lesser extent, Twitter. The Pinterest, YouTube and LinkedIn options were not selected. They also indicated that Google, Facebook and Instagram are the applications most used by customers to search for products or services.

Section II: Innovation in processes through the use of new technologies.

In relation to the importance of making changes in the operations of the production process when new technologies are incorporated in the bakery companies of the municipality of Campeche, 95% consider that it is important to incorporate them, arguing that this will improve internal operations.

With respect to modifications in the product, process or image during the time of operation, it was asked about what type of modifications have been made, highlighting that 40% are made in the image, particularly the adequacy of shelves and camera equipment, 40% have made modifications to the product, adding QR to the packaging, 10% to the process, by means of machinery and equipment that can be programmed in time, and the remaining 10% have not made any modifications, although they stated that they do not rule out implementing any of them if necessary.

When analyzing the opinion of the respondents on the reason for the modifications in the product, process or image, it was found that such changes were made with similar frequency at the request of the client and due to the owner's experience, followed by the suggestion of a specialist, and in a smaller proportion only one company indicated that it was due to research; the respondents who indicated the other option did not indicate what the reason was.

Respondents' answers regarding the reasons that prevent the company from generating innovation are based on: not having enough information about the elements that make them up, high costs to innovate, lack of financing from the public and private sector, not knowing aspects related to technologies, not having enough capital and a small percentage of lack of personal interest on the part of the owner.

Section III: Productivity due to technological changes

Regarding the need for training to increase productivity, 65% strongly agreed, 20% agreed, 10% neither agreed nor disagreed, and the remaining 5% strongly disagreed, which allows us to infer that, in this last percentage, the trend of traditional companies is maintained. In accordance with the above, when asked whether training is provided to employees when incorporating new technologies, 85% of those interviewed said yes, a result that coincides with those who indicated that they strongly agreed and agreed with the options.

When asked whether they considered it necessary to incorporate technology to increase production volume and customer service, 95% said yes, changes that are undoubtedly reflected in productivity, while the remaining 5% said no. Consequently, these results reflect a clear trend towards the need to incorporate new technologies in bakery companies.

In relation to the internal and external factors that affect the productivity of the companies, the following results are generated: 25% of the interviewees stated that the internal factors (infrastructure, variety of products, machinery and equipment, hygiene (industrial and food), management and use of ICT; 15% indicated that the external factors (market competition, availability of raw materials, skilled labor, and national legislation), and 60% considered that both factors; this last result shows a marked influence of internal and external factors that in one way or another affect productivity in these companies, so it is important that in the future they are studied and analyzed in depth.

Discussion and conclusions

Derived from the answers obtained in each section of the instrument applied to the managers of the bakery companies in the Municipality of Campeche, Mexico. This is followed by a discussion and conclusions.

In the first section on ICTs, there is a clear trend towards the need to incorporate them in companies, since they provide them with agile and timely information in real time, which improves decision making by the managers of these organizations. One of the main uses of ICTs at the enterprise level are the digital business platforms, which, as can be seen in the bakeries of the Municipality of Campeche, there is a lack of knowledge of this digital infrastructure.

It should be noted that the ERP (Enterprise Resource Planning) platform is a complete system and provides integrated tools that are necessary as a technological support resource, since it is a software designed to manage and integrate business functions such as finance, human resources, supply chain and inventory management in a single system, supply chain and inventory management in a single system, which is why, it is considered important that, in this case bakeries, can use this type of platforms, as well as continue to provide the proper use of social media, such as Google, Facebook and Instagram, which are the most used by customers of bakeries to search for products.

It is important to note that digital business platforms are often confused with social media used to promote offers, follow up with customers, show new presentations of the goods produced and know directly what their customers think about the service provided, which in many cases allows to improve the quality and presentation of the products.

It is well known that when implementing a new technology, it is necessary to have specialized personnel, i.e., technically prepared to undertake the activities, and if they are not available, they must be trained. However, they recognize that if the employee has basic knowledge of ICTs, the training process is facilitated by the fact that it reduces costs, time, human and technical resources.

The results of the second section related to innovation in processes through the use of new technologies show that the interviewees consider it important to incorporate them. It should be noted that when companies have tools and equipment with new technologies, they are able to improve internal operations and have adequate resources to produce the good or service with quality, and therefore, meet the requirements of their customers and market demand, becoming more competitive resources to produce with quality the good or service, and therefore, meet the requirements of its customers and market demand, becoming more competitive, while those that do not invest in technology are lagging behind, thus losing their

ability to compete with other companies within the same sector where it operates, and therefore not be inserted into the process of globalization of markets.

Regarding the modifications in the product, process or image during the time of operation in the companies under study, in the opinion of the interviewees, the greatest modifications are made in the internal and external image, in their products specifically adding some technological advances in the presentation of these and in a lesser proportion in their processes with the acquisition of machinery and equipment to modernize production.

It is pertinent to point out that the modifications that are implemented in bakery companies in products, processes or image, come from suggestions from customers, which are considered important, since they generally emanate from people when they use social media, who have the role of demanding a better quality of the product they receive; also the experience of the owner for being in that market gives him the necessary knowledge to value the quality of the product that his company is offering, and he can receive the opinion of specialists in the same field. In relation to the modifications made using research are more precise, these are supported by institutions that perform such functions, so they are generally very scarce. Any modification made in the production process of a company is important because it allows each of them (products, processes or image) to adapt to new technologies.

Regarding the reasons that impede innovation in bakery companies. In the opinion of the interviewees, they are practically concentrated in the lack of knowledge of the managers or owners about the new technological advances in the productive processes, in agreement with the indifference they show towards the management of technology, which is supported by the high costs that they cause, since they do not have sufficient capital, encountering a barrier such as the lack of financing from the state and the private sector that in many cases do not contribute to facilitate credits for the interested parties.

Finally, in the third section, the increase in productivity due to technological changes is analyzed, where it is discussed whether it is necessary to train employees when acquiring new technologies. Thus, the interviewees stated that it is necessary for personnel to be trained in the use of new equipment or tools. It is pertinent to mention that this training in many cases is provided by the company itself, however they start from the principle that it is important that the selected personnel should have basic knowledge, which allows minimizing costs and the estimated time for training, considering that the implementation of updated technologies contributes to the increase of productivity, which is reflected in competitiveness, higher income to the organization, being able to insert itself within the global market, as well as to create companies in other regions, which in one way or another allow the consolidation in new markets and/or in global markets.

In reference to the internal and external factors that influence the productivity of the companies; in this sense, in the external factors (competition in the market, availability of raw materials, specialized labor, and national legislation), the management has no control, so it is necessary to generate strategies to foresee situations, therefore, a permanent analysis of the variations in the external environment of the company is convenient. Unlike internal factors (infrastructure, variety of products, machinery and equipment, hygiene (industrial and food), management and use of ICT), these are controllable and are considered opportunities for productivity improvement because they occur within the company. In the opinion of those interviewed, 60% of the companies, both internal and external factors affect their productivity, a situation that is not studied in depth in this research because it is not the objective, however, motivated by the results generated, it is suggested to carry out a study in which these factors are analyzed in the bakery companies.

References

Acosta, R., Miquilena, E. and Riveros, V. (2014). La infraestructura de las tecnologías de la información y comunicación como mediadoras y el aprendizaje de la biología. *Telos, 16* (1),11-30. https://www.redalyc.org/articulo.oa?id=99330402008

Arias Odón, F. (2012). *El proyecto de investigación. Introducción a la Metodología Científica* (6th Ed.). Episteme C.A.

Baraza Sánchez, X, Castejón Vilella, E., and Guardino Solá, X. (2014). *Higiene industrial.* UOC. https://elibro.net/es/ereader/itcampeche/57709?page=23

Buendía, M, M. and Berrocal O. N. (2016). *Panadería y Pastelería Comercial.* Empresa editora Macro EIRL.

Cano-Pita, G. (2018). Las TICs en las empresas: evolución de la tecnología y cambio estructural en las organizaciones. *Revista científica, Dominio de las ciencias*, *4*(1),499-510. http://dx.doi.org/10.23857/dom.cien.pocaip.2017.4.núm.1.enero.499-510

Carceller Cheza, R. (2013). *Servicios en red*. Macmillan Iberia, S.A.

Carro Paz, R. and Gonzales Gómez, D. (2015). *El Sistema de producción y operaciones*. Universidad Nacional de Mar del Plata.

Cerón López, M. U. (2018). *La infraestructura y su relación con el desarrollo económico de un país: caso de América Latina y El Caribe*. [Bachelor's thesis]. https://repositorio.unam.mx/contenidos/238938.

Chiavenato, I. (2009). *Gestión del talento humano.* (3rd ed.). McGraw-Hill/Interamericana Editores, S.A. de C.V.

Economic Commission for Latin America and the Caribbean (ECLAC), (2021). *Tecnologías digitales para un nuevo futuro* (LC/TS.2021/43), Santiago, 2021.

Cordero Guzmán, D., & Rodríguez-López, G. (2017). La inteligencia de negocios: una estrategia de gestión de las empresas productivas. *Revista Ciencia UNEMI, 10*(23), 40-48. https://doi.org/10.29076/issn.2528-7737vol10iss23.2017pp40-48p.

D'Alessio Ipinza, F. A. (2004). *Administración y dirección de la producción, enfoque estratégico y de calidad.* Pearson Education.

Díaz Muñoz, G. and Guambi Espinosa, D. (2018). La innovación: baluarte fundamental para las organizaciones. *INNOVA Research Journal*, *3*(10.1), 212-229. https://doi.org/10.33890/innova.v3.n10.1.2018.843

Domínguez Mateos, F., Paredes Velazco, M. and Santacruz Valencia, L. P. (2015). *Programación multimedia y dispositivos móviles*. RA-MA Editorial. https://elibro.net/es/ereader/itcampeche/62496?page=96.

Escribano, A. (2007). *El proceso de investigación social cualitativo*. Prometeo Libros.

Escudero Sánchez, C.L. and Cortez Suárez L.A. (2018). *Técnicas y métodos cualitativos para la investigación científica*. UTMACH.

Flores, M. G., and Flores, J. D. (2021). Impacto de la globalización en las estrategias de negocios en las empresas ecuatorianas. *E-IDEA Journal of Business Sciences*, *3*(11), 1-14. https://doi.org/10.53734/eidea.vol3.id88

García Colín, J. (2013). *Contabilidad de costos* (4th ed.). McGraw Hill

García, R. (n.a). El cambio tecnológico y sus implicaciones. Una revisión general. http://acacia.org.mx/busqueda/pdf/Rosalba_pon2.PDF

Gómez Bastar, S. (2012). *Metodología de la investigación*. Red Tercer Milenio.

Guamán Chacha, K. A., Hernández Ramos, E. L., and Lloay Sánchez, S. I. (2020). El positivismo y el positivismo jurídico. *Revista Universidad y Sociedad, 12*(4), 265-269. http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S2218-36202020000400265&lng=es&tlng=es.

Hernández Sampieri, R., Fernández Collado, C. and Baptista Lucio, P. (2010). *Metodología de la Investigación* (5ta. ed.). Mc Graw-Hill Interamericana Editores.

Hernández Sampieri, R., Fernández Collado, C. and Baptista Lucio, P. (2014). *Metodología de la Investigación* (6ta. ed.). Mc Graw-Hill Interamericana Editores.

Jiménez Padilla, B. (2012). *Seguridad e higiene en un obrador de panadería y bollería.* IC editorial. https://www.iceditorial.com/panaderia-y-bolleria-inaf0108-ina0152/4815-seguridad-e-higiene-en-un-obrador-de-panaderia-y-bolleria-mf00362-9788483646328.html

Jiménez, Boulanger, F. and Espinoza Gutiérrez, C.L. (2007). *Costos industriales*. Technological Institute of Costa Rica. https://www.perlego.com/book/1925475/costos-industriales-pdf

Joekes, S.P. and Phil Evans, P. (2008). *Competencia y desarrollo: el poder de los mercados competitivos.* International Development Research Center (IDRC).

Joyanes Aguilar, L. (2006). *Programación en C++*. Mc Graw Hill.

Kohli, M.M.; Diaz, M. and Castro, M. (2003) *Estrategias y metodologías utilizadas en el mejoramiento de trigo: un enfoque multidisciplinario*. International Seminar. La Estanzuela, Uruguay. CIMMYT-INIA (International Maize and Wheat Improvement Center-Instituto Nacional de investigación Agropecuaria)

Medina León, A., Nogueira Rivera, D., Hernández-Nariño, A., & Comas Rodríguez, R. (2019). Procedimiento para la gestión por procesos: métodos y herramientas de apoyo. *Ingeniare. Revista chilena de ingeniería, 27*(2), 328-342. https://dx.doi.org/10.4067/S0718-33052019000200328

Mena Castro, A.F. (2011). *Planificación Estratégica para incrementar la Productividad de Panificadora Ambato de la ciudad de Ambato* [Trabajo de obtención de título] Universidad Técnica de Ambato. https://repositorio.uta.edu.ec/jspui/handle/123456789/1018

Molina Robles, F. J. and Polo Ortega, E. (2015). *Servicios en red*. RA-MA

Moreno Santacreu, R. and Morales Caraballo, M. G. (2021). *Materias primas y procesos en panadería, pastelería y repostería* (1ra. ed.). Ediciones Paraninfo, S.A.

Ñaupas Paitán, H., Valdivia Dueñas, M., Palacios Vilela, J. and Romero Delgado, H. E. (2018). *Metodología de la investigación cuantitativa-cualitativa y redacción de la tesis*. (5th Ed.). Ediciones de la U.

Organisation for Economic Co-operation and Development (OECD)/Eurostat (2018), Oslo Manual 2018: *Directrices para la recopilación, presentación de informes y uso de datos sobre innovación, 4ª edición, La medición de las actividades científicas, tecnológicas y de innovación*, Paris / Eurostat, Luxembourg OECD Publishing. https://doi.org/10.1787/9789264304604-en.

Organization for Economic Co-operation and Development (OECD) (2020). *Perspectivas económicas de América Latina 2020: Transformación digital para una mejor reconstrucción,* OECD Publishing, Paris. https://doi.org/10.1787/f2fdced2-es.

International Labor Organization (2020). *Impulsando la Productividad – Una Guía para Organizaciones Empresariales*. Lima: ILO / Regional Office for Latin America and the Caribbean, Bureau for Employers' Activities (ACT/EMP). https://www.ilo.org/actemp/publications/WCMS_759690/lang--es/index.htm

Paz Marcano, A. I., Salomón Crespo, J.A., García Guiliany, J. and Suárez Barros, H. B. (2020). Perfil emprendedor en la formación universitaria venezolana. *Revista de Ciencias Sociales (RCS), 26*(1), 161-174.

Pérez Lorido, M. (2005). Nuevas tecnologías y educación. *Cuadernos de Psicopedagogia*, *5*(9). http://pepsic.bvsalud.org/scielo.php?script=sci_arttext&pid=S1676-10492005000100007&lng=pt&tlng=es.

Ramírez Martínez, D.C., Martínez Ruiz, L.C., Castellanos Domínguez, O.F. and Colmenares Moreno, W.E. (2016). *Divulgación y difusión de conocimiento: Las revistas científicas* (2nd Ed.). National University of Colombia.

Ramos, C.A. (2015). Los paradigmas de la investigación científica. *Avances En Psicología, 23*(1), 9-17. https://doi.org/10.33539/avpsicol.2015.v23n1.167

Reglamento de construcciones para el municipio de Campeche (1989) in Microsoft Word - Reglamento de Construcción.

Roberts, D. J. (2006). *La empresa moderna: Organización, estrategia y resultados*. Antoni Bosch, editor.

Salado Hernández, J. (2002). *Aprendizaje tecnológico en la cultura empresarial*.

Sarache Castro, W. A., Castrillón Gómez, Ó. D., and Ortiz Franco, L. F. (2009). Selección de proveedores: una aproximación al estado del arte. *Cuadernos de Administración, 22* (38),145-167. https://www.redalyc.org/articulo.oa?id=20511730008

Tejada, B. D. (2007). *Administración de servicios de alimentación. Calidad, nutrición, productividad y beneficios* (2nd Ed.). Universidad de Antioquia.

Turriago Hoyos, Á. (2014). *Innovación y cambio tecnológico en la sociedad del conocimiento* (2nd Ed.). University of La Sabana.

Velásquez de Naime, Y., Rodríguez Monoy, C. and Guaita, W. (2012). Modelos de los factores que afectan la productividad. In *XVI Congreso de Ingeniería de Organización*, (pp. 847-854). Vigo.

Villamizar Alvargonzález, R. and Villamizar Villegas, M. (2011). *Transmutación competitiva: Cómo determinar y mejorar su competitividad. Manual para empresarios, gobiernos y territorios* (1ª. Ed.). Editions of the U.

Date received: 08/04/2022
Revision date: 19/05/2022
Date of acceptance: 27/05/2022

PROJECT, DESIGN AND MANAGEMENT

https://www.mlsjournals.com/Project-Design-Management

ISSN: 2683-1597

How to cite this article:
Contreras Rangel, J. & López Ifill, N. (2023). Factores de gestión gerencial que afectan la innovación en las MIPYMES agropecuarias del norte de Santander. *Project, Design and Management, 5*(1), 120-141. doi: 10.35992/pdm.5vi1.1316

MANAGERIAL MANAGEMENT FACTORS THAT AFFECT THE INNOVATION OF AGRICULTURAL MSMES IN THE NORTH OF SANTANDER, COLOMBIA

Jael Contreras Rangel
University of Santander (Colombia)
ja.contreras@mail.udes.edu.co · https://orcid.org/0009-0003-4543-9711
Norma López Ifill
University of Flores (Argentina)
norma.lopez@uflouniversidad.edu.ar · https://orcid.org/0000-0003-2335-0997

Abstract. A main problem in agricultural MSMEs is the deficiency in managerial management and innovation. This situation allows us to establish as an objective of the study to analyze the factors associated with managerial management deficiencies that affect innovation in agricultural MSMEs in Norte de Santander. The level of research is correlational; it was carried out between the years 2020-2022. To this end, a quantitative approach was used. The data collection instruments were applied to fifty (50) agricultural producers, owners, managers or sideman's in the farms of Rice, Coffee, and Piaractus brachypomus and Oreochromis sp., in Norte de Santander. The results determine a direct and significant correlation between the lack of competence of managers and the lack of articulation with the public sector as factors that affect innovation in agricultural MSMEs ($p < 0.05$). Likewise, a positive correlation was evidenced between the lack of managerial skills and the lack of articulation with the private sector, the lack of technology transfers and knowledge management, as factors that affect innovation in agricultural MSMEs ($p<0.05$). There is also a positive and significant correlation between the lack of technology transfer and knowledge management, as determining factors of little innovation ($p < 0.05$). It is concluded that there is a deficiency in agricultural management that limits innovation in agricultural MSMEs in Norte de Santander.

Keywords: Management, agricultural MSMEs, competitiveness, innovation.

FACTORES DE GESTIÓN GERENCIAL QUE AFECTAN LA INNOVACIÓN EN LAS MIPYMES AGROPECUARIAS DEL NORTE DE SANTANDER DE COLOMBIA

Resumen. Un problema principal en las MIPYMES agropecuarias, es la deficiencia en la gestión gerencial y la innovación esta situación permite establecer como objetivo del estudio analizar los factores asociados a las deficiencias de gestión gerencial que afectan la innovación las MIPYMES agropecuarias del Norte de Santander. El nivel de investigación es correlacional, se realizó entre los años 2020-2022. A tal fin se utilizó un enfoque cuantitativo. Los instrumentos de recolección de datos se aplicaron a cincuenta (50) productores agropecuarios

propietarios, gerentes o mayordomos en las fincas de Arroz, Café, y Piaractus brachypomus y Oreochromis sp., del Norte de Santander. Los resultados determinna correlación directa y significativa entre la falta de competencia de los gerentes y la falta de articulación con el sector público como factores que afectan la innovación en las MIPYMES agropecuarias ($p < 0.05$). Igualmente se evidenció correlación positiva entre la falta de competencias de los gerentes y la falta de articulación con el sector privado, la falta de transferencia tecnológica y gestión del conocimiento, como factores que afectan la innovación en las en las MIPYMES agropecuarias ($p< 0.05$). También hay correlación positiva y significativa entre la falta de transferencia tecnológica y gestión del conocimiento, como factores determinantes de la poca innovación ($p < 0.05$). Se concluye que existe deficiencia en la gestiòn agropecuaria que limita la innovación en las MIPYMES agropecuarias del Norte de Santander.

Palabras clave: *Gestión gerencial, MIPYMES agropecuarias, competitividad, innovación.*

Introduction

In this regard, Gibson, Brenes and Barahona (2011) comment that innovation goes beyond laboratories and must include new management practices. Likewise, Plaza and Blanco (2015) point out that agricultural MSMEs, face high deficiencies in administrative organization, are not managed as companies but as a family estate, with low competitiveness and innovation, with little use of technologies, factors that limit their possibilities of staying in the market. Therefore, the GG in agricultural MSMEs, must innovate in their management practices to improve the productivity and sustainability of MSMEs, as a fundamental sector in the contribution to the Gross Domestic Product (GDP), according to Asobancaria (2018) they contribute approximately between 41% and 81% to the GDP favoring formal jobs, the multiplicity of services to favor innovation and competitiveness.

In this sense, Silva (2021) and Chesbrough (2020) emphasize that the contingency approach to which these companies are accustomed contrasts with situations that do not allow improvisation and put the organization at risk of extinction, such as what is currently posed by the pandemic scenario generated by Covid19, therefore, therefore, they suggest that open innovation should be strengthened in order to increase the probabilities of success by establishing collaborative relationships with other organizations when seeking to innovate, since in this way new knowledge is accessed, which allows the evolution of new strategies suitable for responding to the turbulent conditions that exist in the environment.

In this context, other authors such as García (2017), Asobancaria (2018), Mora (2012) agree on the need to transform the GG of agricultural MSMEs, in such a way, that they contribute to overcome their innovation and survival problems, leave aside the contingency approach and implement alternatives of new management tools, articulation with the environment and open innovation. They must overcome the empirical management used by their owners and proprietors, without paying attention to the scientific and technical foundations of management and the empowerment of workers, stop making personal decisions, without considering the different factors of production, the context, give due importance to knowledge management, the training of human talent, include innovation among the priorities of the owners or managers of MSMEs, disinterest in each of these variables limits the possibilities of innovation and therefore their possibilities of growth and development.

Another aspect that affects the shortcomings in the GG of these companies is that academia has not sufficiently addressed this issue, it is necessary to know the different concerns of stakeholders and reflect, from different perspectives, from universities, governments and entrepreneurs themselves, although there is articulation between these actors formally, in practice it is deficient. Also, Mora (2012), Finca y Campo (2015), and Chong (2012) highlight the lack of knowledge about agricultural management tools, the low adoption of technology,

innovation and low competitiveness, among others, factors that limit the GG, in the generality of the Colombian Rural Areas. Consequently, one of the problems of agricultural MSMEs is the underdevelopment of the management factor and, consequently, their development and innovation. This situation of deficiency in management management limits the use of the potential and opportunities for innovation of the Agricultural Production Units (UPA).

Among the antecedents on this problem in the international context, Camacho (2018), conducted an analysis in Mexico of the managerial profile of managers in farms in which he determined the need to improve written and strategic communication skills, teamwork competence, interpersonal skills, organizational knowledge, and talent development. Meanwhile, Hernandez, Hernandez, Perdomo, Garces, and Carrasco (2018) identified the need to improve the training of actors in farming, knowledge management. Egas, Shik, Inurritegui and De Salvo (2018), explain that agricultural policy, should be oriented to reduce market price support and favor interventions that have a lower impact on market distortion. Other studies such as those of García (2017), Milagros (2015), and Chong (2012) among the various problems of the UPAs, the deficiency of financial management, migration to the urban world generating the rupture of the social fabric, there is a need to integrate the public, private and academic sectors, which support public management and business management in line with the requirements of innovation, dynamics and reality of agricultural MSMEs.

In the National context, authors such as Villanueva (2018), Corporación Colombiana de Investigación Agropecuaria (2016), Melo and Fonseca (2014), Castaño and Cardona (2014), García, Malagón and García (2017), point out among the problems of the UPAs, are barriers to innovation in the bioeconomy due to low levels of technology maturity and not complying with national and international standards, these are at level TRL3 and TRL4, therefore, they require levels TRL5, TRL6, TRL7, TRL8, and TRL9; lack of evidence to determine the degree of progress and development in Knowledge Management (KM), in the context of KM in networks, tacit knowledge predominates over explicit knowledge, contrary to the essence of KM and organizational learning; lack of strengthening in strategic and operational planning, KM and innovation; low productivity and high production costs, limiting competitiveness.

In the regional context, Cala (2019), García, Malagón and García (2017) highlight the need for owners or managers to emphasize quality management and environmental management, they also point out the deficiencies in business management and the need to develop new competencies of human talent, carry out technology and knowledge transfer, improve knowledge management, and there is little capacity to adapt to the dynamics of changes in agricultural MSMEs.

In the approach to the object of study of business management (MB), the different definitions of MB, Project Management, related disciplines, main related theories, scientific disciplines involved, innovation management and national, departmental and municipal development plans were considered.

Regarding the definition of GE there are diversity of definitions, however, there is coincidence among some authors such as Guzman (2016), Franco, Zartha, Solleiro, Montes, Vargas, Palacio, and Hoyos (2018), Suarez (2018) and Terrazas (2009), Hernandez (2011) point out that GE is based on the most important information to exist and prosper, every organization has to become an agent of change and technology will be the main agent for economic change. They also specify that the GE refers to the elements, measures, strategies and skills used in an economic or business activity to make it financially viable. For this to be possible, four functions must be fulfilled: (a) planning, (b) organization, (c) direction, management and leadership, and (d) control. In the area of project management (PM) Franco et al. (2018), Terrazas (2009), Puentes and Guevara (2015), Todorovic, Petrović, Mihić, Obradović, and

Bushuyev (2015), Espinoza (2009) point out that this area is a fundamental discipline for the implementation, development and operation of projects that need to measure and evaluate the results that are achieved, partial and final results, estimate and compare deadlines, costs, quality, objectives, risks among others; these actions and parameters can be addressed based on the concepts and techniques of project management, whose standards are established in the PMBOK7 Guide 2021. The GP implies the adequate control of the development of the implemented plans and it is at the control points where the monitoring and follow-up of metrics or performance indicators are a useful measurement tool to establish the levels of achievement of the deliverable, quality and success of the project, in this case of the agricultural MSMEs. Therefore, the management of any company must be developed and treated in a scientific manner, consequently, empiricism and improvisation must be replaced by scientific management techniques.

In relation to related disciplinesrobles and Alcérreca (2009), Ramírez and Ramírez (2016), Zamora (2015) specify that GE receives contributions from other scientific disciplines among which stand out: engineering, psychology, sociology, anthropology, operations research and statistics; as well as, economics, mathematics are fundamental knowledge and competencies to solve administrative problems.

The main related theories include real options theories, planning theories, financial theory, administrative theories, business management theories, and decision making theories. Among the authors who explain these theories are Calle and Tamayo (2009), Pascale and Pascale (2011), Carrasco, Cuzco, Correa, Vinueza, and Cabrera (2018), Vidal (2012), Agüero (2007), Forcael, Andalaft, Schovelin, and Vargas (2013). In relation to the theory of real options, these are applied in the valuation of non-financial assets, such as investment in research; it is a complementary tool in the evaluation of projects, which allows implementing and evaluating the strategic component of the projects in a systematic and methodical manner, and can also use information regarding financial markets. Finance is a branch of economics applied to microeconomics. Strategic planning from the point of view of the administrative sciences includes the systematically ordered set of results of an organization, and management theory in its different approaches attempts to know, understand, describe, explain and predict the behavior of organizations. There are two decision theories. The first is based on the decision process from a critical theory of linear multirationalism, which states that the decision is a process of interactions, being considered as an institutional process based on the freedom of the subject. The second is based on the theory of self-referential systems, which conceives the organization as a decision system, and understands the concept of decision, in its purely epistemological specificity, by abstracting from the decision all the elements and organizational variables related to it, that the theory of real options is a complementary tool in the evaluation of projects, which allows implementing and evaluating the strategic component of projects in a systematic and methodical manner, and can also use the information on financial markets.

The scientific disciplines involved in the subject are management, economics, finance and geopolitics. Among the authors who explain this topic are Álvarez (2016), Pampliega (2014), Ortega (2002), Muñoz and Avendaño (2014) who explain that organizational capabilities, as administrative, operational and project management enablers and their continuous improvement, are fundamental elements to deliver products and services to the customer. In this sense, projects are a necessity in organizations in order to assume the changes involved in adapting to the current market. Project Management, therefore, provides more advantages than any other management approach, both in terms of maximizing quality and efficiently managing resources, and becomes a priority competency for the leaders of these organizations. On the other hand, finance is a discipline that, with the help of other disciplines such as accounting, law and economics, seeks to optimize the management of the company's

human and material resources. Geopolitics constitutes a tool that allows the recognition of institutions as mental representations, useful to man in society for the definition of rules of the game that allow him to interact and reduce uncertainty, in his categorical relations of space-time, nature, population-economy.

Regarding Project, HMD Project Management (2016), defines project as a temporary effort that is undertaken to create a unique product, service or result. Insight Projets (2020) and Perez (2020) also point out that projects must deliver value to the business. This value creation system is related to corporate strategy. In the creation of value, the capacity for innovation and the efficient use of technology play a fundamental role in achieving better results.

Concerning Project Management the Universidad Internacional Iberoamericana (UNINI, 2018), defines project management as the set of processes that lead to the optimization, in the use of human and material resources for the achievement of project objectives. The Project Management Institute (2017) defines it as the application of knowledge, skills, tools and techniques to project activities in order to meet each of the project requirements. Likewise, Wallace (2014), the Association for Project Management (2019), and Estrada (2015), define project management as strategic competence, resource management, application of competencies, achievement of cost, time and quality objectives, useful tool for future business operations.

Regarding Innovation Management (IM) Robledo (2019), Guerra, Pérez and Fornet (2014), Mejías and Morejón (2017), the Economic Commission for Latin America and the Caribbean (ECLAC, 2016), Maravert, Molina, and Molina (2016) explain that IM is a systemic model of organizational congruence, whose performance is the complex result of the congruent interaction of environment, strategy and innovation capabilities. Its relevance lies in the fact that the socioeconomic development of nations and organizations is related to innovation. The development of innovative capacity is an essential factor for the business system and its quality according to international standards. There are three essential aspects of innovation: (a) development of new products, processes and ways of organizing production, its economic and social structures with quantitative and qualitative changes; (b) that all sustained growth processes drive the generation of scientific and technological capabilities; and (c) that investment in R&D is one of the main indicators of technological and innovative effort.

Another fundamental aspect of the approach to the object of study was the analysis of the

national, departmental and municipal development plans that promote development, competitiveness and innovation in the rural and agricultural sector. Therefore, Duque (2018) in the National Development Plan 2018-2022, "establishes an alliance to energize the development and productivity of rural Colombia" (p.50). Serrano, (2020, p. 4) in the Development Plan of Norte de Santander 2020-2023, establishes in its vision 2050, a model of sustainable territorial development that has as its main commitment agribusiness, Science, Innovation and Technology. Meanwhile, Yáñez (2020), in the Municipal Development Plan, elaborated the Cúcuta plan: Siembra y Transforma, with the purpose of promoting productive transformation, improving the performance of agricultural and livestock items in rural areas, through the promotion of the following factors: (a) Improvement of productivity and sustainability of different crops, (b) Generation of value added to agricultural and agroindustrial products, (c) Promotion of technological tools that encourage planning, (d) Coordination with the educational sector to bring together the academic training offer with technical emphasis.

From the analysis of the background, the approach to the object of study and the national development plans, the need to answer the following question has been identified: what are the management factors that affect innovation in agricultural MSMEs in Norte de Santander?

Method

In order to answer the research question, a quantitative, correlational and field design study was developed, and data were collected through the application of scale instruments to the different study units that will make up the research sample. The study was carried out in Norte de Santander, one of the thirty-two (32) departments that, together with Bogotá, Capital District, make up the Republic of Colombia. It is a territorial entity, whose capital is the city of Cúcuta, which enjoys autonomy for the administration of sectional affairs and the planning and promotion of economic and social development within its territory, has an area of 22,648 km², equivalent to 1.91% of the national territory, located in the northeastern region of Colombia. It is a border area with the State of Táchira and Zulia State of the Bolivarian Republic of Venezuela, which stands out for its industrial activity and the exploitation of its natural resources such as coal and oil, is the main axis of the economy and exports are directed to neighboring countries such as Venezuela and Ecuador. Agriculture is the basis of the economy with products such as cotton, tobacco, cocoa, sugar cane, rice, coffee, cachama and red tilapia; where the study units were observed, and the observation units, broken down from the operationalization of the variables. The procedures were contemplated in 3 phases, as follows: (a) preparation phase: design and validation of instruments; (b) interactive phase: application of instruments; (c) analytical phase: correlation of variables. The data collection instrument was validated by experts in management sciences.

The hypothesis system guiding the research is as follows:

H1: The lack of competence of managers and the lack of coordination with the public sector positively affect innovation in agricultural MSMEs in Norte de Santander.

H0: The lack of managerial competence and articulation with the public sector negatively affects innovation in agricultural MSMEs in Norte de Santander.

H2: The lack of managerial skills, coordination with the private sector, technology transfer and knowledge management affect innovation in agricultural MSMEs in Norte de Santander.

H0: The lack of managerial skills, articulation with the private sector, technology transfer and knowledge management do not affect innovation in agricultural MSMEs in Norte de Santander.

H3: The lower the managerial knowledge, the lower the investment in technical services, training and knowledge transfer in agricultural MSMEs in Norte de Santander

H0: The lesser the managerial knowledge, the lesser the investment in technical services, training and knowledge transfer in agricultural MSMEs in Norte de Santander

H4: The lack of articulation, knowledge transfer and knowledge management in the agricultural MSMEs of Norte de Santander positively affects the innovation of the UPAs.

H0: The lack of articulation, knowledge transfer and knowledge management of agricultural MSMEs in Norte de Santander negatively affects the innovation of the UPAs

H5: The lack of articulation with the private sector positively affects knowledge transfer and knowledge management in agricultural MSMEs in Norte de Santander.

H0: The lack of coordination with the private sector negatively affects knowledge transfer and knowledge management in agricultural MSMEs in Norte de Santander.

H6: The less articulation with the private sector, the less investment in knowledge transfer for innovation in agricultural MSMEs in Norte de Santander.

H0: The lesser the articulation with the private sector, the lesser the investment in knowledge transfer for innovation in agricultural MSMEs in Norte de Santander.

H7: The lesser the transfer of technology and knowledge management, the lesser the innovation in agricultural MSMEs in Norte de Santander.

H0: The lesser the technology transfer and knowledge management, the lesser the innovation in agricultural MSMEs in Norte de Santander.

H8: The greater the investment in technology transfer training courses for workers provided by universities, the smaller the technology transfer and innovation gap in agricultural MSMEs in Norte de Santander.

H0: The greater the investment in training courses for workers in technology transfer provided by universities, the greater the gap in technology transfer and innovation in agricultural MSMEs in Norte de Santander.

H9: The lack of investment in worker training services provided by universities negatively affects knowledge management in agricultural MSMEs in Norte de Santander.

H0: The lack of investment in worker training services provided by universities does not affect knowledge management in agricultural MSMEs in Norte de Santander.

The population consisted of 854 agricultural MSMEs in the Department of Norte de Santander. From this population, 50 study units were selected to form the research sample; the type of sampling used was non-probabilistic and intentional. The operationalization of the variable breaks down the following variables: (a) managerial management: pragmatic management, competent management, innovation, knowledge management, managerial competence, managerial knowledge and (b) agricultural factors: science, technology, agricultural manager competencies and workers and investment.

The instruments were applied to 50 information units (farm owners, managers or administrators). The research data collection instruments used were scaled instruments. The validation of the instruments was carried out ad hoc for this research by three doctors in management sciences, who were formally requested to review the instrument and analyze it according to four criteria, namely: (a) consistency of the items with the objectives, (b) relevance, (c) wording, and (d) content validity, the reliability score was 0.8.

For the analysis of the data, the Kolmogorov Smirnow test was applied, which evaluates the assumption of normality in each of the variables linked to the multivariate analysis, and it was concluded that none presented normal behavior ($p<0.05$).05), so the correlation and analysis of variance tests used were Kendal's Tau b correlation coefficient and the Kruskall Wallis H test, the nonparametric equivalent of ANOVA in independent groups.

Results

The results of the correlations between the variables of interest in the multivariate analysis determined that determined the following:

Table 1
Normality tests for variables of interest in multivariate analysis

Group	Variable	Kolmogorov-Smirnov[a]		
		Statistician	gl	Sig.
Competent management	Timing of training activities.	0,305	50	0,000
Pragmatic management	Approximate amount of payment to universities, in the last five years 2017-2021 for training of workers of agribusiness MSMEs	0,467	50	0,000
	MSMEs workers participate in knowledge transfer processes	0,500	50	0,000
	Approximate amount paid to universities or formal institutions for technical services provided to agricultural MSMEs.	0,401	50	0,000
	Amount invested in the transfer of knowledge by its management on the farm	0,370	50	0,000
	Trainings in knowledge transfer processes involve owners, manager or workers of agricultural MSMEs, in the last five years 2017-2021.	0,447	50	0,000
	Agricultural software used in management processes	0,529	50	0,000
	Number of programs or projects developed between the university and producer associations or chambers of commerce to promote and develop on-farm innovation.	0,540	50	0,000
Management and innovation	Management competencies	0,279	50	0,000
	Articulation with the public sector	0,271	50	0,000
	Articulation with the private sector	0,300	50	0,000
	Technology transfer	0,320	50	0,000
	Knowledge management	0,267	50	0,000

Table 1. It includes the results for the Kolmogorov Smirnow test, which evaluates the assumption of normality in each of the variables linked to the multivariate analysis, concluding that none presented normal behavior ($p< 0.05$), so the correlation and analysis of variance tests used were Kendal's Tau b correlation coefficient and the Kruskall Wallis H test, the nonparametric equivalent of ANOVA in independent groups.

Table 2

Bivariate correlation matrix between the variables of pragmatic management, competent management and innovation

Correlation coefficient Kendall's Tau B correlation coefficient		Timing of training activities.	Managerial competencies affect innovation in agricultural MSMEs.	The lack of coordination between the public sector and agricultural MSMEs affects on-farm innovation.	The lack of coordination between the private sector and agricultural MSMEs affects on-farm innovation.	The lack of technology transfer in agricultural MSMEs affects on-farm innovation.	Lack of knowledge management in agricultural MSMEs affects on-farm innovation.	Approximate amount of payment to universities, in the last five years 2017-2021 for training of workers of agricultural MSMEs	MSMEs workers participate in knowledge transfer processes	Approximate amount paid to universities or formal institutions for technical services provided to agricultural MSMEs.	Amount invested in the transfer of knowledge by its management on the farm	Trainings in knowledge transfer processes involve owners, manager or workers of agricultural MSMEs, in the last five years 2017-2021.	Agricultural software used in management processes	Number of programs or projects developed between the university and producer associations or chambers of commerce to promote and develop on-farm innovation.
Timing of training activities.	Correlation coefficient	1	0,013	-0,115	-0,105	0,111	-0,059	0,133	0,015	0,046	0,114	0,014	-0,201	0,117
	p-value	.	0,920	0,371	0,412	0,387	0,641	0,316	0,908	0,735	0,399	0,914	0,138	0,387
Managerial competencies affect innovation in agricultural MSMEs.	Correlation coefficient		1	0,474**	0,479**	0,602**	0,622**	-0,175	0,135	-0,310*	-0,420*	-0,213	-0,199	-0,033
	p-value		.	0,000	0,000	0,000	0,000	0,183	0,313	0,021	0,002	0,106	0,139	0,808
The lack of coordination between the public sector and agricultural MSMEs affects on-farm innovation.	Correlation coefficient			1	0,693**	0,298*	0,608**	-0,117	0,099	0,051	-0,179	-0,105	0,012	-0,033
	p-value			.	0,000	0,020	0,000	0,380	0,461	0,710	0,188	0,428	0,929	0,807
The lack of coordination between the private sector and agricultural MSMEs affects on-farm innovation.	Correlation coefficient				1	0,545**	0,586**	-0,153	0,081	0,061	-0,272*	-0,151	-0,072	-0,048
	p-value				.	0,000	0,000	0,249	0,545	0,655	0,045	0,256	0,597	0,726
The lack of technology transfer in agricultural MSMEs affects	Correlation coefficient					1	0,645**	-0,258*	0,134	-0,191	-0,291*	-0,163	-0,045	-0,058
	p-value					.	0,000	0,049	0,316	0,156	0,031	0,216	0,739	0,668

on-farm innovation.									
Lack of knowledge management in agricultural MSMEs affects on-farm innovation.	Correlation coefficient	1	-,275*	0,061	-0,206	-0,243	-0,17	-0,054	-0,043
	p-value	.	0,036	0,647	0,125	0,071	0,196	0,687	0,748

Table 2. Corresponds to the matrix of bivariate correlations between the variables of pragmatic management, competent management and innovation. A direct and statistically significant correlation was found between the lack of managerial competence and the lack of coordination with the public sector as factors affecting innovation in agricultural MSMEs ($p < 0.05$). There was also a positive correlation between the lack of managerial skills and the lack of coordination with the private sector, the lack of technology transfer and knowledge management, as factors affecting innovation in agricultural MSMEs ($p< 0.05$).

On the other hand, an inverse and statistically significant correlation was observed between the lack of managerial competence and the amounts paid to universities or formal institutions for technical services, as well as the amount paid for training and knowledge transfer processes, determining that the greater the lack of managerial knowledge, the lower the investment in this type of services that would result in the improvement of production processes ($p < 0.05$). There was a positive and significant correlation between the lack of articulation by MSMEs with the public and private sectors, as well as with the lack of articulation with the public sector and knowledge transfer, and with the lack of articulation with the public sector and the lack of knowledge management, these aspects being reflected in the low level of innovation of these companies ($p < 0.05$). An inverse and significant correlation was found between the lack of articulation with the private sector and the lack of knowledge transfer and knowledge management ($p < 0.05$).

There was also an inverse and statistically significant correlation between the lack of articulation with the private sector and the amount of investment in knowledge transfer, showing that, in the absence of articulation with the private sector, there is less investment in knowledge transfer for innovation ($p < 0.05$).

There is a positive and statistically significant correlation between the lack of technology transfer and knowledge management as determinants of low innovation in these agricultural enterprises ($p < 0.05$).

An inverse and statistically significant correlation was observed between the lack of technology transfer and the approximate amount of payment to universities, in the last five years 2017-2021 for training workers of agricultural MSMEs, as well as with the amount invested in knowledge transfer for their on-farm management, so that in these companies there is little investment in training workers and knowledge transfer, which translates into a greater gap in technology transfer and innovation ($p < 0.05$). Likewise, an inverse and statistically significant correlation was evidenced between the lack of knowledge management and the approximate amount of payment to universities, in the last five years 2017-2021 for training workers ($p < 0.05$). There was no significant correlation between the variables corresponding to pragmatic management and the time spent in training activities, since, as was identified, there is very little investment and time given to workers to carry out this type of activity ($p > 0.05$). There was also no significant correlation between the innovation variables and the time spent in training activities, which affects the competitiveness of this sector ($p > 0.05$).

For the analysis of variance, all variables related to management and innovation were defined as dependent variables, and variables related to pragmatic management were defined as random factors.

Table 3
Kruskall Wallis H-test for management variables with respect to the approximate amount paid to universities in the last 5 years for employee training

	Managers' competencies affect innovation in agricultural MSMEs.	The lack of coordination between the public sector and agricultural MSMEs affects on-farm innovation.	The lack of coordination between the private sector and agricultural MSMEs affects on-farm innovation.	The lack of technology transfer in agricultural MSMEs affects on-farm innovation.	The lack of knowledge management in agricultural MSMEs affects on-farm innovation.
Kruskal-Wallis H	2,284	0,863	1,444	3,869	4,431
gl	2	2	2	2	2
Asymptotic sig	0,319	0,650	0,486	0,144	0,109

a. Kruskal Wallis test

b. Grouping variable: Approximate amount of payment to universities, in the last five years 2017-2021 for training of workers of agribusiness MSMEs

Management management and innovation do not differ with respect to the amount of investment in training programs for their workers with the educational sector ($p < 0.05$). This is due to the fact that most of these companies have invested less than 2 million pesos in the last five years.

Table 4
Kruskall Wallis H-test for managerial variables with respect to the number of workers participating in the knowledge transfer processes

	Managers' competencies affect innovation in agricultural MSMEs.	The lack of coordination between the public sector and agricultural MSMEs affects on-farm innovation.	The lack of coordination between the private sector and agricultural MSMEs affects on-farm innovation.	The lack of technology transfer in agricultural MSMEs affects on-farm innovation.	The lack of knowledge management in agricultural MSMEs affects on-farm innovation.
Kruskal-Wallis H	3,061	2,414	2,295	3,528	1,757
gl	2	2	2	2	2
Asymptotic sig	0,216	0,299	0,317	0,171	0,415

a. Kruskal Wallis test

b. Grouping variable: MSMEs workers participate in knowledge transfer processes

Management and innovation management do not show statistically significant differences with respect to the number of workers participating in knowledge transfer processes ($p < 0.05$). This is explained by the fact that most of the companies have employed only 5 or less workers in these processes.

Table 5
Kruskall Wallis H-test for managerial variables with respect to the amount paid to universities or formal institutions for technical services

	Managers' competencies affect innovation in agricultural MSMEs.	The lack of coordination between the public sector and agricultural MSMEs affects on-farm innovation.	The lack of coordination between the private sector and agricultural MSMEs affects on-farm innovation.	The lack of technology transfer in agricultural MSMEs affects on-farm innovation.	The lack of knowledge management in agricultural MSMEs affects on-farm innovation.
Kruskal-Wallis H	5,288	0,138	0,2	2,013	2,358
gl	1	1	1	1	1
Asymptotic sig	0,021	0,710	0,655	0,156	0,125

a. Kruskal Wallis test

b. Grouping variable: Approximate amount paid to universities or formal institutions for technical services provided to agricultural MSMEs.

Source: Jael Contreras Rangel (2021).

It was possible to determine that managerial management, specifically managerial competencies are affected and differ significantly with respect to the investments made by the entrepreneurs in the payment of technical services to universities or institutions, observing a greater lack of managerial competencies in those entrepreneurs who have invested few resources in the provision of technical services ($p < 0.05$).

Table 6
Kruskall Wallis H-test for management variables with respect to the amount invested in knowledge transfer

	Managerial competencies affect innovation in agricultural MSMEs.	The lack of coordination between the public sector and agricultural MSMEs affects on-farm innovation.	The lack of coordination between the private sector and agricultural MSMEs affects on-farm innovation.	The lack of technology transfer in agricultural MSMEs affects on-farm innovation.	Lack of knowledge management in agricultural MSMEs affects on-farm innovation.
Kruskal-Wallis H	9,751	1,733	4,015	4,667	3,269
gl	1	1	1	1	1
Asymptotic sig	0,002	0,188	0,045	0,031	0,071

a. Kruskal Wallis test

b. Grouping variable: Amount invested in the transfer of knowledge by its management on the farm

It was possible to determine that innovation management differs significantly with respect to managerial competencies, articulation with the private sector and technology transfer, with respect to the amount of investment in knowledge transfer, with a greater lack of

managerial and innovation competencies being observed in those companies with little investment in knowledge transfer ($p < 0.05$).

Table 7
Kruskall Wallis H-test for management and innovation variables with respect to the number of trainings in knowledge transfer processes

	Managerial competencies affect innovation in agricultural MSMEs.	The lack of coordination between the public sector and agricultural MSMEs affects on-farm innovation.	The lack of coordination between the private sector and agricultural MSMEs affects on-farm innovation.	The lack of technology transfer in agricultural MSMEs affects on-farm innovation.	Lack of knowledge management in agricultural MSMEs affects on-farm innovation.
Kruskal-Wallis H	2,656	0,702	1,422	3,745	1,892
gl	2	2	2	2	2
Asymptotic sig	0,265	0,704	0,491	0,154	0,388

a. Kruskal Wallis test

b. Grouping variable: Trainings in knowledge transfer processes involve owners, manager or workers of agricultural MSMEs, in the last five years 2017-2021.

Although it was found that the lower the number of training courses, the greater the lack of management and innovation, there were no statistically significant differences, which suggests that the lack of innovation does not differ with respect to the number of training courses in the knowledge transfer processes ($p > 0.05$).

Table 8
Wallis H-test for managerial management and innovation variables with respect to the use of agricultural software used in management processes

	Managers' competencies affect innovation in agricultural MSMEs.	The lack of coordination between the public sector and agricultural MSMEs affects on-farm innovation.	The lack of coordination between the private sector and agricultural MSMEs affects on-farm innovation.	The lack of technology transfer in agricultural MSMEs affects on-farm innovation.	The lack of knowledge management in agricultural MSMEs affects on-farm innovation.
Kruskal-Wallis H	2,194	0,008	0,28	0,111	0,162
gl	1	1	1	1	1
Asymptotic sig	0,139	0,929	0,597	0,739	0,687

a. Kruskal Wallis test

b. Grouping variable: Agricultural software used in management processes

There were also no statistically significant differences in the level of management skills and innovation with respect to the use of agricultural software in production processes ($p > 0.05$), although clearly most of these companies have invested little in this type of technology.

Table 9
Kruskall Wallis H-test for management and innovation variables regarding the number of programs or projects that are developed jointly with the educational and business sectors to promote and develop innovation on their farms

	Managers' competencies affect innovation in agricultural MSMEs.	The lack of coordination between the public sector and agricultural MSMEs affects on-farm innovation.	The lack of coordination between the private sector and agricultural MSMEs affects on-farm innovation.	The lack of technology transfer in agricultural MSMEs affects on-farm innovation.	The lack of knowledge management in agricultural MSMEs affects on-farm innovation.
Kruskal-Wallis H	0,059	0,06	0,123	0,184	0,103
gl	1	1	1	1	1
Asymptotic sig	0,808	0,807	0,726	0,668	0,748

a. Kruskal Wallis test

b. Grouping variable: Number of programs or projects developed between the university and producer associations or chambers of commerce to promote and develop on-farm innovation.

Given that most of the companies have only developed 2 or less projects related to the promotion and development of innovation on their farms (96%), the lack of general and innovation competencies is similar among them, and cannot be differentiated with respect to the number of projects implemented ($p > 0.05$).

Discussion and conclusions

With the application of the Kolmogorov Smirnow test, the use of correlation tests and analysis of variance of Kendal's Tau b correlation coefficient and the Kruskall Wallis H-test, the nonparametric equivalent of ANOVA in independent groups, is determined.

Regarding the bivariate correlations between the variables of pragmatic management, competent management and innovation, a direct and significant correlation is determined between the lack of competence of managers and the lack of articulation with the public sector as factors affecting innovation in agricultural MSMEs ($p < 0.05$), a result that corroborates H0: The lack of managerial competence and articulation with the public sector negatively affects innovation in agricultural MSMEs in Norte de Santander. There is also a positive correlation between the lack of managerial competencies and the lack of articulation with the private sector, the lack of technology transfer and knowledge management, as factors affecting innovation in the UPAs ($p< 0.05$), which corroborates H2: The lack of managerial skills, coordination with the private sector, technology transfer and knowledge management affect innovation in agricultural MSMEs in Norte de Santander. These results are consistent with those of Melo and Fonseca (2014), who show the predominance of pragmatic management, based on what is learned through experience and not on professional studies, since only 36% of the managers had a professional degree; they also point out that managers must improve their ability to innovate, these results differ from those found by Camacho (2018), who determined with respect to the professional level, that 60% were professional graduates, 20% were university

graduates, 20% were not professionals, however, none were in the area of agronomy or agricultural sciences, but he did observe high effectiveness and efficiency in their performance.

On theother hand, there is an inverse and significant correlation between the lack of managerial competence and the amounts paid to universities or formal institutions for technical services, training and knowledge transfer, a situation that corroborates that the greater the lack of managerial knowledge, the less investment in this type of services ($p < 0.05$), this result corroborates H3: The lower the managerial knowledge, the lower the investment in technical services, training and knowledge transfer in agricultural MSMEs in Norte de Santander. These results are similar to those of Melo and Fonseca (2014) who find that only 39% developed research and development activities, these results differ from those of Zayas (2018) who obtained that 100% have made technological innovations, both in their machinery and seed, adds regarding economic expenditure that 81.25% do not cause economic problems to implement innovations, 12.5% if it causes economic problems and 6.2% answer that sometimes causes economic problems.

Also, there is a positive and significant correlation between the lack of articulation by MSMEs with the public and private sector, and knowledge transfer, knowledge management, with little innovation ($p < 0.05$), as well as an inverse and significant correlation between the lack of articulation with the private sector, with the lack of knowledge transfer and knowledge management ($p < 0.05$), results that corroborate the following hypotheses: H0: The lack of articulation, knowledge transfer and knowledge management of agricultural MSMEs in Norte de Santander negatively affects the innovation of the UPAs and the H0: The lack of coordination with the private sector negatively affects knowledge transfer and knowledge management in agricultural MSMEs in Norte de Santander. These results are consistent with those of Ferrer, González and Mendoza (2015) who observe in their study that the small company presents by its family character, the almost absolute control exercised by the owner over it, almost total absence of formal strategies, scarcity of information systems, low productivity and low investment in innovation due to the lack of innovation, little activity in R+D; these results differ with those of Tarapuez, Guzmán, and Parra (2016) who determine that the profile of award winning companies innovate, which are small, belong to the industrial sector, have formal processes for the formulation, implementation and monitoring of the strategic plan that take innovation into account and stimulate it, as well as initiatives and processes of change, relate to the environment to address research and development processes, have the capacity to adapt and incorporate new technologies. However, this profile contrasts with that of agricultural MSMEs, as pointed out by Ferrer at al. (2015) because of the family nature and the absence of formal strategies.

There is also a significant inverse correlation between the lack of coordination with the private sector and the amount of investment in knowledge transfer, which corroborates that, in the absence of coordination with the private sector, there is less investment in knowledge transfer for innovation ($p< 0.05$). Likewise, there is a positive and significant correlation between the lack of technology transfer and knowledge management as determinants of low innovation in these agricultural enterprises ($p < 0.05$), results that corroborate H6: The less articulation with the private sector, the less investment in knowledge transfer for innovation in agricultural MSMEs in Norte de Santander and H7: The lesser the transfer of technology and knowledge management, the lesser the innovation in agricultural MSMEs in Norte de Santander. These results are similar to those of Pereira (2019), who highlights that among the problems derived from weak management with the environment there are problems such as poor technical and business training, as well as their administrative, financial and operational management, among others; another problem is the very short time of sustainability only 50% of them survive the first year and 20% in the third year, due to the little importance they give

to innovation and knowledge. These results contrast with those of the diagnosis by Gómez and Borda (2020), who state that there are actions to support agricultural MSMEs, as well as the rest of the business development policy, focused on increasing the competitiveness of the companies; however, they identify that there are differentiated strategies according to the characteristics of the companies in terms of innovation and productivity. At the same time, cross-cutting measures have been implemented to improve the environment for MSMEs, including regulatory and normative issues and the development of support ecosystems.

Likewise, an inverse and statistically significant correlation is observed between the lack of technology transfer and the approximate amount paid to universities for training workers of agricultural MSMEs, as well as with the amount invested in knowledge transfer for their on-farm management, which implies a greater gap in technology transfer and innovation ($p <$ 0).this situation implies a greater gap in technology transfer and innovation ($p < 0.05$).05). There is also an inverse and statistically significant correlation between the lack of knowledge management and the approximate amount paid to universities for worker training ($p < 0.05$), results that corroborate H8: The greater the investment in training courses for workers in technology transfer provided by universities, the smaller the technology transfer and innovation gap in agricultural MSMEs in Norte de Santander and H9: The lack of investment in worker training services provided by universities negatively affects knowledge management in agricultural MSMEs in Norte de Santander. There was no significant correlation between the variables corresponding to pragmatic management and the time spent on training activities, since it was found that there is little investment and time given to workers to carry out this type of activity ($p > 0.05$). There is also no significant correlation between innovation variables and time spent in training activities, which affects the competitiveness of this sector ($p > 0.05$). These results are similar to those of Morales, Ortíz, and Arias (2012) who determine that interventionist governments, weak educational and financial systems, and low rates of investment in R&D activities, below 1% of GDP, which UNESCO considers to be the minimum to achieve development processes in science, technology and innovation. They also identified that the MSMEs that carry out R&D activities do not follow rigorous processes, in addition these activities are not clearly articulated with the business strategy; the activities focused on technological development are beginning to include it, there are also low rates of participation and training of human resources both at national and internal level of the organizations; regarding the relationship of the companies with their environment, the organizations with which the weakest links are established are the universities and research centers, unlike industrialized countries. These results are not similar to those of Astudillo (2015) who finds that innovation in MSMEs in Argentina and Ecuador evidences internal variables that determine the propensity to innovation in the product and in the process, the variable with a positive and significant effect in both countries and in the two typologies of innovation is research and development. In product innovation, other determinants are not revealed, and in process innovation, internal variables of the companies are associated, such as qualified human resources through training programs carried out by the companies and the certification of international quality standards.

In relation to the management factors that affect innovation, it is concluded that they are: the competencies of managers, the lack of coordination with the public and private sectors, the lack of technology transfer and knowledge management.

Regarding the limitations of the study, it is pertinent to highlight the following: (a) COVID-19 was one of the main limitations for the transfer and direct contact with the owners, managers and stewards of the farms; (b) government regulations by COVID-19, to control the transfer from one municipality to another, also constituted a limitation in the execution of the research.

As for the continuity of the study, although it is true that the information obtained in this research is useful for decision making to improve managerial management, nevertheless, in view of the deficiencies in managerial management and innovation in these MSMEs, it is proposed to continue with the line of research to design an adaptive model of projects as an alternative to the managerial management of agricultural MSMEs in Norte de Santander.

References

Agüero, J.O. (2007). Teoría de la Administración: un campo fragmentado y multifacético. *Revista Científica Visión de Futuro*. *7* (1), 1-27. https://revistacientifica.fce.unam.edu.ar/index.php/visiondefuturo/issue/view/33

Alvarez, M. (2016). El poder de la gestión de proyectos en la cultura organizacional. *Revista Ciencias Estratégicas. 24* (36), 345-363.

Asobancaria. (2018). Supervivencia de las Mipymes: un problema por resolver. *Semana Económica.* (1145), 1-11. https://www.asobancaria.com/wp-content/uploads/1145.pdf

Astudillo, S. and Briozzo, A.E. (2015). Factores determinantes de la innovación en las MIPYMES manufactureras de la Argentina y el Ecuador. *Faedpime International Review, 4*(7). https://doi.org/10.15558/fir.v4i7.98

Cala, F.A. (2019). *Análisis de la gestión competitiva de las medianas empresas familiares del sector agroindustrial del área metropolitana de Bucaramanga*. [Unpublished master's thesis]. Universidad Cooperativa de Colombia.

Calle, A.M. and Tamayo, V.M. (2009). Decisiones de Inversión a través de Opciones Reales. *Estudios Gerenciales*. *25*(3), 107-126. http://www.scielo.org.co/pdf/eg/v25n111/v25n111a06.pdf

Carrasco, A. Cuzco, M., Correa, M., Vinueza, J., & Cabrera, A. (2018). Análisis de la Planificación Estratégica para las actividades artesanales. *Revista Espacios, 39*(34),1-13. http://w.revistaespacios.com/a18v39n34/a18v39n34p01.pdf

Castaño, N. E. and Cardona, M.A. (2014). Factores determinantes en la inestabilidad del sector agrícola colombiano. *En Contexto*, (2), 91-107. https://ojs.tdea.edu.co/index.php/encontexto/article/view/137/122

Chesbrough, H. (2020). To recover faster from Covid-19, open up: Managerial implications from an open innovation perspective. *Industrial Marketing Management*, *88*, 410-413. https://doi.org/10.1016/j.indmarman.2020.04.010

Chong, M. (2012). *Diseño de un modelo de gestión para el desarrollo sostenible y competitivo de las pequeñas unidades agrícolas rurales del Perú. Una Experiencia Aplicada en el Valle de Virú*. [Unpublished doctoral dissertation]. Universidad Nacional Mayor de San Marcos.

Latin American and Caribbean Economic Commission (ECLAC) (2016). *Ciencia, tecnología e innovación en la economía digital*. ECLAC. https://repositorio.cepal.org/bitstream/handle/11362/40530/3/S1600833_es.pdf

Colombian Agricultural Research Corporation (CORPOICA). (2015). *Misión para la Transformación del Campo: Diagnostico Ciencia, Tecnología e Innovación en el Sector Agropecuario*. https://cutt.ly/FjEcDFK

Duque, I. (2108). *Plan Nacional de Desarrollo 2018-2022, pacto por Colombia pacto por la equidad.* https://colaboracion.dnp.gov.co/CDT/Prensa/Resumen-PND2018-2022-final.pdf

Espinoza, R. (2009). El fayolismo y la organización contemporánea. *Visión Gerencial*, *8*(1), 53-62. https://www.redalyc.org/pdf/4655/465545880010.pdf

Estrada, J.N. (2015). Analysis of project management worldwide. *Palermo Business Review*, (12), 61-98. https://www.palermo.edu/economicas/cbrs/pdf/pbr12/BusinessReview12_02.pdf

Ferrer, L.E., Gonzalez, K.P. and Mendoza, L.M. (2015). Innovation as a key factor to improve the competitiveness of SMEs in the Department of Atlántico, Colombia. *Dictamen Libre*, (16), 21-36. https://doi.org/10.18041/2619-4244/dl.16.3066

Finca y Campo. (2015). *Factores de éxito de la agroempresa*. http://www.fincaycampo.com/2015/08/factores-de-exito-de-la-agroempresa/

Franco, A.F., Zartha, J.W, Solleiro, J.L., Montes, J.M., Vargas, E.E, Palacio, J.C., & Hoyos, J.L. (2018). Propuesta de modelo de gestión de innovación para una empresa de ventas al consumidor final. *Revista Lasallista de Investigación*. *15*(1), 75-89. https://doi.org/10.22507/rli.v15n1a8

Forcael, E., Andalaft, A., Schovelin, R., & Vargas, P. (2013). Aplicación del método de opciones reales en la valoración de proyectos Inmobiliarios. *Obras y Proyectos*, (14), 58-70. https://www.scielo.cl/pdf/oyp/n14/art05.pdf

Garcia, S. L. (2017). Agricultural and Livestock Companies and Financial Management. *Mexican Journal of Agribusiness*, *21*(40), 583-594. https://www.redalyc.org/jatsRepo/141/14152127007/html/index.html

García, A.M., Malagón, E., & García, J.M. (2017). Modelos de negocios en pymes agroindustriales: desafíos en el siglo XXI. *Vestigium Ire*, *11* (2), 41-67. https://cutt.ly/QjEvnDt

Gibson, R., Brenes, E.R., & Barahona, J.C. (2011). Campeones de la innovación en Latinoamérica. *Incae Business Review,* *2*(3), 1-5. https://www.researchgate.net/publication/288895383_Campeones_de_la_Innovacion_en_America_Latina#fullTextFileContent

Guerra, K., Pérez, C.R., & Fornet, C.E. (2014). Propuesta de una tecnología para la gestión de proyectos de innovación en el sistema territorial de ciencia e innovación en Cuba. *Revista Cubana en Información en Ciencias de la Salud*, *25*(4), 367-381. http://scielo.sld.cu/pdf/ics/v25n4/rci02414.pdf

Gómez, H. J. & Borda, S. (2020). Diagnóstico de las micro, pequeñas y medianas empresas: políticas e instituciones de fomento en Colombia. In M. Dini & G. Stumpo. *MIPYMES en América Latina: Un frágil desempeño y nuevos desafíos para las políticas de fomento*. United Nations. ECLAC. https://repositorio.cepal.org/bitstream/handle/11362/44176/S1900361_es.pdf?sequence=1&isAllowed=y

Guzman, A. (2016). Gestión Empresarial e Innovación desde la Educación Especial. *UCA Professional*. (1), 14-16. https://www.uca.ac.cr/wp-content/uploads/2017/10/Revista-Profesional-Vol-1.pdf

Hernández, H. (2011). La gestión empresarial, un enfoque del siglo XX, desde las teorías administrativas científica, funcional, burocrática y de relaciones humanas. *Escenarios, 9*(1), 38-51. https://onx.la/216d7

HMD Project Managers (2016). *Plan para la Dirección de Proyectos. Epígrafes Principales*. HMD. https://cutt.ly/mjEbdvn

Insight Projects. (2020). La nueva edición del estándar para la Dirección de Proyectos - PMBOK 7ma edición. *Insight Projects*. https://cutt.ly/3hEbgNu

Mejías, Y.Y., & Morejón, M.M. (2017). Procedimiento de Gestión de Innovación. Grupo Empresarial de la Construcción de Holguín. *Ciencias Holguín, 23*(1), 1-13. https://www.redalyc.org/journal/1815/181549596001/html/

Melo, L.I. & Fonseca, D.E. (2014). Descripción y análisis de la gerencia en Mipymes agroindustriales del departamento de Boyacá, Colombia, *Acta Agronómica, 63*(4), 297-310. https://cutt.ly/FjWEdrr

Mora, S. B. (2012). Las empresas del sector agropecuario: racionalidad económica y gestión. *Ad-minister*, (21), 87-99. http://www.scielo.org.co/pdf/adter/n21/n21a6.pdf

Morales, M.E., Ortíz, C., & Arias, M.A. (2012). Factores determinantes de los procesos de innovación: una mirada a la situación en Latinoamérica. *Rev. neg. adm. sc.* (72), 148-163. http://www.scielo.org.co/pdf/ean/n72/n72a10.pdf

Muñoz, L.A. & Avendaño, J.L. (2014). Geopolítica, ciencia y tecnología en las sociedades con instituciones políticas y mercados no inclusivos. *Administración & Desarrollo*, *43*(59), 41-51. https://n9.cl/dilye

Ortega, A. (2002) *Introducción a las Finanzas*. McGraw Hill

Pampliega, C.J. (2014). *La Gestión de Proyectos como herramienta estratégica de la empresa*. PMI Ideas. https://cutt.ly/YjEnfbj

Pascale, R. & Pascale, G. (2011). Teoría de las Finanzas: sus supuestos, neoclasicismo y psicología cognitiva. In *XXXI Jornada Nacionales de Administración Financiera*. Córdoba, Argentina. https://acortar.link/afyY6V

Pereira, C.A. (2019). Actualidad de la gestión empresarial en las Pymes. *Apuntes contables.* (24), 39-53. https://doi.org/10.18601/16577175.n24.03

Perez, A. (2020). *El PMBOK 7 (Séptima Edición) incluirá 12 nuevos principios ¿Los conoces?* CEOLEVEL.

Plaza, P.M., & Blanco, B.E. (2015). Análisis de los problemas que enfrentan las Pymes Agrícolas para su participación en el desarrollo económico local. *Revista Publicando*, *2*(5), 256-264. https://revistapublicando.org/revista/index.php/crv/article/view/92/pdf_62

Project Management Institute. (2017). *A guide to the Project Management body of knowledge*. https://cutt.ly/4hEUzul

Puentes, N., & Guevara, C.A. (2015). *Indicadores de desempeño en la gestión de proyectos, un análisis del estado del arte basado en las publicaciones científicas actuales*. [Unpublished graduate thesis]. Francisco José Caldas District University.

Robledo, J. (2019). *Introducción a la Gestión de la Tecnología y la Innovación*. National University of Colombia, Medellin. https://minas.medellin.unal.edu.co/descargas/Robledo2019Introduccionagestiondelatecnologiaylainnovacionempresarial.pdf

Serrano, S. (2020). *Plan De Desarrollo Para Norte De Santander 2020-2023. Más Oportunidades para todos*. https://cutt.ly/ThEIVjI

Silva, T. (2021). Factores que impulsan la innovación abierta en PyMes del sector hortofrutícola. *Desarrollo Gerencial*, *13*(2), 1-30. https://doi.org/10.17081/dege.13.2.5503

Tarapuez, E., Guzmán, B.E., & Parra, R. (2016). Estrategia e innovación en las Mipymes colombianas ganadoras del premio Innova 2010-2013. *Estudios Gerenciales*, (32), 170-180. http://dx.doi.org/10.1016/j.estger.2016.01.002

Terrazas, R. A. (2009). Modelo Conceptual para la Gestión de Proyectos. *Perspectivas*, (24), 165-168. https://www.redalyc.org/pdf/4259/425942160009.pdf

Todorovic, M.L., Petrović, D.C., Mihić, M.M., Obradović, V.L., & Bushuyev, S.D. (2015). Project success analysis framework: A knowledge-based approach in project management. *International Journal of Project Management, 33*(4), 772-783. https://doi.org/10.1016/j.ijproman.2014.10.009

Universidad Internacional Iberoamericana (UNINI) (2018). *Definiciones Básicas, Contexto y Marco Referencial*. UNINI.

Yáñez, J. T. (2020). *Plan de Desarrollo Municipal. Cúcuta 2050, estrategia de todos*. https://cutt.ly/mhEPW2Q

Vidal, J. (2012). Teoría de la Decisión: proceso de interacciones u organizaciones como sistemas de decisiones. *Cinta Moebio*, (44), 136-152. https://www.scielo.cl/pdf/cmoebio/n44/art04.pdf

Villanueva, D. F. (2018). *Análisis del Sector Agrícola y Pecuario*. *Bioeconomy Studies in Colombia.* https://cutt.ly/AhEOZqb

Wallace, W. (2014). *Gestión de Proyectos*. Edinburgh Business School. https://ebs.online.hw.ac.uk/documents/course-tasters/spanish/pdf/pr-bk-taster.pdf

Zamora, I. (2015). *Disciplinas que se relacionan con la administración.* https://acortar.link/yVECvJ

Zayas, I. (2018). El desarrollo tecnológico y la innovación como ente principal de competitividad en las empresas del sector agropecuario en el municipio de angostura, Sinaloa. *Revista Mexicana de Agronegocios*, *42*, 866-877. https://www.redalyc.org/articulo.oa?id=14156175006

Date received: 07/05/2022
Revision date: 08/07/2022
Date of acceptance: 05/10/2022

PROJECT, DESIGN AND MANAGEMENT

https://www.mlsjournals.com/Project-Design-Management

ISSN: 2683-1597

How to cite this article:
Pérez-Lafont, J. E. (2023). Intención emprendedora en la agricultura de Puerto Rico: una mirada hacia el agro-cannabis. *Project, Design and Management, 5*(1), 142-157. doi: 10.35992/pdm.5vi1.1451.

ENTREPRENEURIAL INTENTION IN PUERTO RICO'S AGRICULTURE: A LOOK AT AGRO-CANNABIS

Javier E Perez-Lafont
University of Puerto Rico - Mayaguez (Puerto Rico)
perezlafont@gmail.com - https://orcid.org/0000-0002-4310-8770

Abstract: The agricultural entrepreneurial intention is an activity that seeks to improve agricultural productivity and therefore the competitiveness of agro businesses. The changing market environment, together with the development of new information and communication technologies, means that the modern agribusiness must take on the challenge of modifying its management to compete successfully. Puerto Rico's economy has experienced a remarkable decline in recent years. The new incorporation of cannabis production on the island offers a new paradigm. The use of the intention model based on the theory of planned behavior (TPB) is presented as a method in this quantitative research to determine whether the production of cannabis for medicinal use forms entrepreneurial intentions in agricultural students at the undergraduate level. The research aims to respond and provide information to the academic community in relation to whether the entrepreneurial intention to agro cannabis is influenced by exogenous factors that in turn influence the attitudes, subjective norms, and perceived control of undergraduate students of agriculture at the University of Puerto Rico at Utuado and the University of Puerto Rico at Mayagüez.

Key words: Entrepreneurship, agriculture, theory of planned behavior.

INTENCIÓN EMPRENDEDORA EN LA AGRICULTURA DE PUERTO RICO: UNA MIRADA HACIA EL AGRO-CANNABIS

Resumen: La intención emprendedora agrícola es una actividad que persigue mejorar la productividad y la competitividad de los agronegocios. Los cambios y el desarrollo de nuevas tecnologías de información y comunicación provocan que la empresa agropecuaria moderna deba modificar su gestión para poder competir con éxito. La economía de Puerto Rico ha decrecido notablemente en años recientes. La nueva incorporación de la producción de cannabis en la agricultura de Puerto Rico ofrece un nuevo paradigma. La utilización del modelo de intención basado en la teoría del comportamiento planificado (TCP) se presenta como método en esta investigación cuantitativa para determinar si la producción de cannabis para uso medicinal forma intenciones emprendedoras en estudiantes de agricultura a nivel subgraduado. La investigación tiene como propósito responder y aportar información a la comunidad académica en relación con: si la intención emprendedora al agro-cannabis está influenciada por factores exógenos que a su vez influye sobre las actitudes, normas subjetivas y control percibido de los estudiantes subgraduados de agricultura de la Universidad de Puerto Rico en Utuado y Universidad de Puerto Rico en Mayagüez.

Palabras clave: Emprendimiento, agricultura, teoría del comportamiento planificado.

Introduction

Throughout its history, Puerto Rico's economy, and particularly its agriculture, has undergone profound changes. Catalá (1998) pointed out that Puerto Rico had to participate as a supplier of a primary good such as sugar. Sugar production increased. Catalá (1998) stated that the increase in sugar production was both extensive and intensive. The land dedicated to sugar cane increased from 72 thousand one hundred and forty-six acres (74 thousand two hundred and ninety-one cuerdas) at the beginning of the change of sovereignty to 251 thousand eighteen acres (258 thousand five hundred and forty-nine cuerdas) in 1930. The extension of the cultivated area increased from 15% to 44%.

Rodriguez (2008) argued that, from 1947 to 1973, the island's public policy focused on capital industrialization by invitation. This development changed the order of importance of Puerto Rico's economic sectors.

Since the U.S. economic crisis of 1974, Puerto Rico has been characterized by a long period of economic stagnation. The International Monetary Fund (IMF) (2016) considered that Puerto Rico's economy ended fiscal year 2016 with a contraction of -1.3%. For 2017, the economy again fell -1.4%. According to data from the Economic Report to the Governor (2016) between the years 2013 to 2016 the gross national product decreased: - 0.1%, - 1.8%, - 0.7% and - 1.1% respectively each year. The Economic Report to the Governor (2021) highlighted that Puerto Rico's economy in 2020 suffered a significant decline of 5.0 percentage points when compared to fiscal year 2019 which manifests a consistent reduction in its economic activity.

The current crisis motivates the search for new opportunities. Entrepreneurship is an important production factor that visualizes business opportunities. Puerto Rico's critical economic evolution in recent years has raised concerns about future development.

According to Wompner (2012) the real key to professional success is the ability to adapt to a changing, globalized and cross-cultural world. This means that future professionals must be able to be flexible, interested in learning and able to cross borders.

Entrepreneurial intention, according to Osorio and Londoño (2015) has often been studied through the use of intention models; Ajzen's theory of planned behavior (TCP) offers a coherent and robust framework for understanding the entrepreneurial process. This is the reason why this model was chosen for the present analysis. Krueger and Brazeal (1994); Krueger and Carsrud (1993) and Krueger, Reilly and Carsrud (2000) state that the Theory of Planned Behavior (TCP) is a general model that serves to explain individual behavior.

The benefits of entrepreneurial business activity in the agricultural sector together with the therapeutic and economic properties that can be derived from the activity of agro-cannabis for medicinal use constitute a framework of opportunity. The need for food security for the island harbors new business possibilities and intentions to generate employment and activate the island's economy. Data from the 2012 and 2017 Agricultural Census validated a decreasing trend in the

number of farms in Puerto Rico from 13 thousand one hundred and fifty-nine in 2012 to 8 thousand two hundred and thirty in 2018.

Some causes of this phenomenon were explained by Irizarry (2012), who details the urbanization process experienced in Puerto Rico, which caused the transformation from a rural society to an urban one. In addition, Pol (2001) argued that Puerto Rico's economic profile reflected a reduction of the industrial system, high unemployment, among other factors.

By 2017, Cannabis was incorporated on the island for medical use made viable by means of Act 42 of the Legislative Assembly of Puerto Rico, which was subsequently amended by means of Act 15 of the year 2021. Considering the above facts, the following article evaluates, by means of the theory of planned behavior model, whether entrepreneurial intention to agro-cannabis is influenced by external circumstances such as the environment and individual factors that in turn influence the attitudes, subjective norms and perceived control of undergraduate agriculture students at the University of Puerto Rico at Utuado and the University of Puerto Rico at Mayaguez.

Method

Through the model of planned behavior theory, the researcher intends to answer and provide information to the academic community regarding: whether the entrepreneurial intention to agro-cannabis is influenced by exogenous factors that in turn influence the attitudes, subjective norms and perceived control of undergraduate students of agriculture at the University of Puerto Rico at Utuado and the University of Puerto Rico at Mayaguez. The research questions involved in the analysis of the study are as follows:

- Does the environment influence the attitudes of undergraduate agriculture students at the University of Puerto Rico at Utuado and the University of Puerto Rico at Mayagüez?
- Does the environment influencing subjective norms promote entrepreneurial intention to engage in agro-cannabis activity in undergraduate agriculture students at the University of Puerto Rico at Utuado and University of Puerto Rico at Mayagüez?
- Does the environment influence in facilitating or hindering the entrepreneurial realization (perceived control) of agro-cannabis in undergraduate students of agriculture at the University of Puerto Rico at Utuado and University of Puerto Rico at Mayagüez?
- Do individual factors influence the attitudes of undergraduate agriculture students at the University of Puerto Rico at Utuado and University of Puerto Rico at Mayagüez to agro-cannabis entrepreneurial intention?
- Do individual factors influencing subjective norms promote the intention to engage in agro-cannabis entrepreneurship in undergraduate agriculture students at the University of Puerto Rico at Utuado and University of Puerto Rico at Mayaguez?
- Do individual factors influence facilitating or hindering the entrepreneurial realization (perceived control) of agro-cannabis in undergraduate students of agriculture at the University of Puerto Rico at Utuado and University of Puerto Rico at Mayagüez?

- Do attitudes positively impact the intention to agro-cannabis entrepreneurship by undergraduate students of agriculture at the University of Puerto Rico at Utuado and University of Puerto Rico at Mayagüez?
- Do subjective norms positively impact intention to agro-cannabis entrepreneurship by agriculture students at the University of Puerto Rico at Utuado and University of Puerto Rico at Mayagüez?
- Does perceived control positively impact intention to agro-cannabis entrepreneurship by agriculture students at the University of Puerto Rico at Utuado and University of Puerto Rico at Mayagüez?

For the research question the researcher presents the following hypotheses:

H_1: The environment influences attitudes of undergraduate agriculture students at the University of Puerto Rico at Utuado and the University of Puerto Rico at Mayagüez.

H_2: The environment influences subjective norms that impact undergraduate agriculture students at the University of Puerto Rico at Utuado and the University of Puerto Rico at Mayagüez.

H_3: The environment influences the perceived control of undergraduate agriculture students at the University of Puerto Rico at Utuado and the University of Puerto Rico at Mayagüez.

H_4: Individual factors influence the attitudes of undergraduate agriculture students at the University of Puerto Rico at Utuado and the University of Puerto Rico at Mayagüez.

H_5: Individual factors influence subjective norms impacting undergraduate agricultural students at the University of Puerto Rico at Utuado and University of Puerto Rico at Mayagüez.

H_6: Individual factors influence the perceived control of undergraduate agricultural students at the University of Puerto Rico at Utuado and the University of Puerto Rico at Mayagüez.

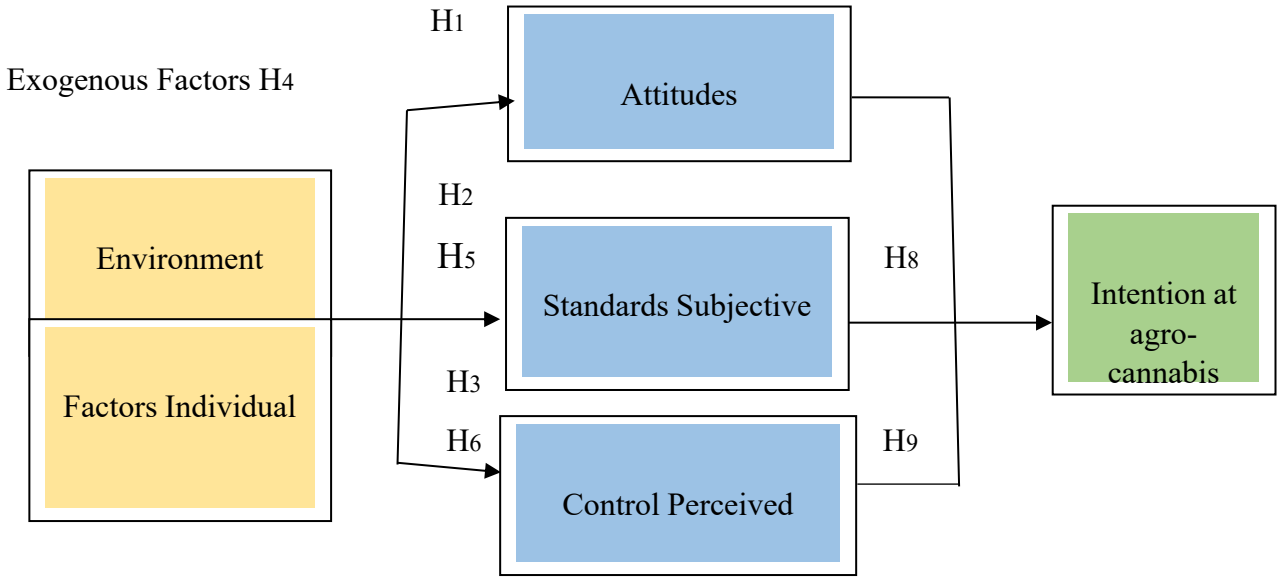
H_7: Attitudes positively impact agro-cannabis entrepreneurial intention of undergraduate agriculture students at the University of Puerto Rico at Utuado and University of Puerto Rico at Mayagüez.

H_8: Subjective norms positively impact agro-cannabis entrepreneurial intention of undergraduate agriculture students at the University of Puerto Rico at Utuado and University of Puerto Rico at Mayagüez.

H_9: Perceived control positively impacts agro-cannabis entrepreneurial intention of undergraduate agriculture students at the University of Puerto Rico at Utuado and University of Puerto Rico at Mayagüez. The hypotheses are explained in the following map showing the relationship between variables

Figure 1

Map of Relationship between Variables



This research developed a positivist design, quantitative in nature and with a survey technique. The PLS-SEM test was used with the bootstrapping technique in order to support or reject the researcher's hypotheses. The reasons for using the PLS-SEM test were two as stated by Osorio and Londoño (2015): which consisted in the measurement of the external model that aims to determine the reliability and validity of the model. The instrument was made by the researcher. It was developed through literature review and as a complement, it was submitted to a group of three (3) experts to validate the instrument. It was also evaluated by the Institutional Review Board of the University of Puerto Rico Mayagüez Campus and the University of Puerto Rico at Utuado, which determined that it met the objectives of the study. The study had a valid sample of 191 students using those subjects available on a non-probabilistic basis; which aimed to explore whether entrepreneurial intention to agro-cannabis is influenced by external circumstances such as the environment and individual factors that in turn influence the attitudes, subjective norms and perceived control of undergraduate agriculture students at the University of Puerto Rico at Utuado and the University of Puerto Rico at Mayaguez. In the present study, these students have been selected because they are oriented to one type of entrepreneurial activity, agriculture. This characteristic determined the incorporation of this group of people to analyze the entrepreneurial intention to agro-cannabis for medicinal use. To guide the study the researcher was concerned with: (1) developing the research questions, (2) constructing the questionnaire, (3) determining data collection areas, (4) establishing a schedule of deadlines, (5) establishing participation criteria, (6) taking the field sample, (7) determining the data interpretation instrument, (8) establishing the evaluation process, (9) defining the limitations of the research, (10) complying with the ethical statutes applied in the research process, (11) analyzing the data collected, and (12) presenting the results and their conclusions.

Results

To determine the existence of evidence to accept or reject each of the hypotheses, the t-value statistic was examined. These values were calculated using the bootstrapping technique of the SmartPLS program. Hair et al. (2014) states that the t value is calculated by the division between the path coefficient of the original sample and the standard value according to bootstrapping. Using a 90% confidence level test with a one-way hypothesis, the path coefficient will be significant if the theoretical t-value is equal to or greater than 1.28 according to Hair, Wolfinbarger, Money, Samouel, and Page (2015).

The following is a breakdown of the questions and hypotheses to provide the results of the study

- Question 1: does the environment influence the attitudes of undergraduate agriculture students at the University of Puerto Rico at Utuado and the University of Puerto Rico at Mayagüez?
    - H_1: The environment influences attitudes of undergraduate agriculture students at the University of Puerto Rico at Utuado and the University of Puerto Rico at Mayagüez.

      When performing partial least squares structural equation modeling (PLS-SEM), and using the bootstrapping technique, a t-value equal to 3.385 was found. A test with a 90% confidence level and a one-way hypothesis, the theoretical t-value should be greater than 1.28 Hair et al. (2015). Since the t-value found of 3.385 is greater than 1.28, it is affirmed that there is a significant impact in the form that influences to support the hypothesis stated by the researcher. Therefore, it can be concluded that the environment is a factor that impacts students' attitudes.
- Question 2: Does the environment influencing social pressure promote entrepreneurial intention to undertake agro-cannabis activity in undergraduate students of agriculture at the University of Puerto Rico at Utuado and the University of Puerto Rico at Mayagüez?
    - H_2: The environment influences subjective norms that impact undergraduate agriculture students at the University of Puerto Rico at Utuado and the University of Puerto Rico at Mayagüez.

      When performing partial least squares structural equation modeling (PLS-SEM), and using the bootstrapping technique, a t-value equal to 4.828 was found. A test with a 90% confidence level and a one-way hypothesis, the theoretical t-value should be greater than 1.28 Hair et al. (2015). Since the t-value found of 4.828 is greater than 1.28, it is affirmed that there is a significant impact in the form that influences to support the hypothesis stated by the researcher. Therefore, it can be concluded that the environment is a factor that impacts the subjective norms that impact students.
- Question 3: does the environment influence in facilitating or hindering the entrepreneurial realization (perceived control) of agro-cannabis in undergraduate students of agriculture at the University of Puerto Rico at Utuado and University of Puerto Rico at Mayagüez?

- H_3: The environment influences the perceived control of undergraduate agriculture students at the University of Puerto Rico at Utuado and the University of Puerto Rico at Mayagüez.

  When performing partial least squares structural equation modeling (PLS-SEM), and using the bootstrapping technique, a t-value equal to 4.386 was found. A test with a 90% confidence level and a one-way hypothesis, the theoretical t-value should be greater than 1.28 Hair et al. (2015). Since the t-value found of 4.386 is greater than 1.28, it is affirmed that there is a significant impact in the form that influences to support the hypothesis stated by the researcher. Therefore, it can be concluded that the environment is a factor that impacts students' perceived control.

- Question 4: do individual factors influence the attitudes of undergraduate agriculture students at the University of Puerto Rico at Utuado and the University of Puerto Rico at Mayagüez to the entrepreneurial intention of agro-cannabis?

  - H_4: Individual factors influence the attitudes of undergraduate agriculture students at the University of Puerto Rico at Utuado and the University of Puerto Rico at Mayagüez.

    When performing partial least squares structural equation modeling (PLS-SEM), and using the bootstrapping technique, a t-value equal to 10.971 was found. A test with a 90% confidence level and a one-way hypothesis, the theoretical t-value should be greater than 1.28 Hair et al. (2015). Because the t-value found of 10.971 is greater than 1.28, it is affirmed that there is a significant impact in the form that influences to support the hypothesis stated by the researcher. Therefore, it can be concluded that individual factors is a factor that impacts students' attitudes.

- Question 5: do individual factors influencing social pressure promote the intention to engage in agro-cannabis entrepreneurship among undergraduate students of agriculture at the University of Puerto Rico at Utuado and the University of Puerto Rico at Mayagüez?

  - H_5: Individual factors influence subjective norms impacting undergraduate agriculture students at the University of Puerto Rico at Utuado and University of Puerto Rico at Mayagüez.

    When performing partial least squares structural equation modeling (PLS-SEM), and using the bootstrapping technique, a t-value equal to 2.802 was found. A test with a 90% confidence level and a one-way hypothesis, the theoretical t-value should be greater than 1.28 Hair et al. (2015). Since the t-value found of 2.802 is greater than 1.28, it is affirmed that there is a significant impact to support the hypothesis put forward by the researcher. Therefore, it can be concluded that individual factors is a factor that impacts on students' subjective norms.

- Question 6: To identify whether individual factors influence the facilitation or hindering of the entrepreneurial realization (perceived control) of agro-cannabis in undergraduate students of agriculture at the University of Puerto Rico in Utuado and the University of Puerto Rico in Mayagüez.

- H_6: Individual factors influence the perceived control of undergraduate agriculture students at the University of Puerto Rico at Utuado and the University of Puerto Rico at Mayagüez.

  When performing partial least squares structural equation modeling (PLS-SEM), and using the bootstrapping technique, a t-value equal to 2.578 was found. A test with a 90% confidence level and a one-way hypothesis, the theoretical t-value should be greater than 1.28 Hair et al. (2015). Since the t-value found of 2.578 is greater than 1.28, it is affirmed that there is a significant impact to support the hypothesis put forward by the researcher. Therefore, it can be concluded that individual factors is a factor that impacts on students' perceived control.

- Question 7: do attitudes positively impact the intention to agro-cannabis entrepreneurship by undergraduate students of agriculture at the University of Puerto Rico at Utuado and the University of Puerto Rico at Mayagüez?

  - H_7: Attitudes positively impact Agro Cannabis entrepreneurial intention of undergraduate agriculture students at the University of Puerto Rico at Utuado and University of Puerto Rico at Mayagüez.

    When performing partial least squares structural equation modeling (PLS-SEM), and using the bootstrapping technique, a t-value equal to 12.617 was found. A test with a 90% confidence level and a one-way hypothesis, the theoretical t-value should be greater than 1.28 Hair et al. (2015). Since the t-value found of 12.617 is greater than 1.28, it is affirmed that there is a significant impact to support the hypothesis put forward by the researcher. Therefore, it can be concluded that attitudes impact students' Agro-Cannabis entrepreneurial intention.

- Question 8: do subjective norms positively impact the intention to agro-cannabis entrepreneurship by agriculture students at the University of Puerto Rico at Utuado and University of Puerto Rico at Mayagüez?

  - H_8: Subjective norms positively impact the entrepreneurial intention of Agro Cannabis of undergraduate students at the University of Puerto Rico at Utuado and University of Puerto Rico at Mayagüez.

    When performing partial least squares structural equation modeling (PLS-SEM), and using the bootstrapping technique, a t-value equal to 3.603 was found. A test with a 90% confidence level and a one-way hypothesis, the theoretical t-value should be greater than 1.28 Hair et al. (2015). Since the t-value found of 3.603 is greater than 1.28, it is affirmed that there is a significant impact to support the hypothesis put forward by the researcher. Therefore, it can be concluded that subjective norms impact students' entrepreneurial intention to impact the entrepreneurial intention to Agro-Cannabis of the students.

- Question 9: does perceived control positively impact intention to agro-cannabis entrepreneurship by agriculture students at the University of Puerto Rico at Utuado and University of Puerto Rico at Mayagüez?

- H_9: Perceived control positively impacts the entrepreneurial intention of Agro Cannabis of undergraduate students at the University of Puerto Rico at Utuado and University of Puerto Rico at Mayagüez.

  When performing partial least squares structural equation modeling (PLS-SEM), and using the bootstrapping technique, a t-value equal to 2.359 was found. A test with a 90% confidence level and a one-way hypothesis, the theoretical t-value should be greater than 1.28 Hair et al. (2015). Since the t-value found of 2.359 is greater than 1.28, it is affirmed that there is a significant impact to support the hypothesis put forward by the researcher. Therefore, it can be concluded that perceived control is a factor that impacts students' agro-cannabis entrepreneurial intention.

A predictive model was developed, using five predictor variables for the entrepreneurial intention to use medicinal agro-cannabis. The results were obtained during the period from September to December 2017. They presented support for all the proposed hypotheses, which reflects an important contribution given the scarcity of studies on agro-cannabis in Puerto Rico. Likewise, this study reflects data of interest through the Theory of Planned Behavior, as it is the first study that analyzes agro-cannabis. Through the literature review, no previous studies analyzing this issue were identified.

Discussion and conclusions

This is the first research in Puerto Rico to study the factors that lead to entrepreneurial intention for medical agro-cannabis using Ajzen's (1991) Theory of Planned Behavior. Among the most significant findings was that the highest proportion of respondents in the study were male. The majority of the participants were young people between the ages of 18 and 28, almost all of whom were studying. The place of study of almost ¾ of the respondents came from the University of Puerto Rico in Utuado while the remaining corresponded to the University of Puerto Rico in Mayagüez. The degree of study of more than half of the participants was the associate degree. The largest proportion of students did not work while only 26.3% did. 8.1 in 10 survey participants had an income level of $10,000 or less.

This demographic profile proved to be attracted to the agro-cannabis industry. It showed that 9 out of 10 respondents are interested in news about agriculture applied to agro-cannabis. 7.8 out of 10 subjects consider medicinal agro-cannabis as a serious option to agro-enterprise. 86.9% considered that agro-cannabis activity appeals to them as a good business opportunity. 79.1% considered being their own entrepreneur in the agricultural sector and 61.4% feel motivated to produce Cannabis. These findings demonstrate that undergraduate agricultural students at the University of Puerto Rico in Utuado and Mayagüez have a strong interest in this sector. They see it as one full of opportunities.

The final research model was able to predict 75% of the entrepreneurial intention to medical agro-cannabis by the selected sample. The key variables that allowed predicting entrepreneurial intention were: Environment, Individual Factors, Attitudes, Subjective Norms and Perceived Control.

Individual factors and attitudes were found to be the factors that most directly impact entrepreneurial intention to medical agro-cannabis, while subjective norm was the least influential factor. The different models of intentions state that business intentions are the result of a process of knowledge and understanding of beliefs, expectations and values. These models consider that individual factors are a key factor in entrepreneurial activity; both the individual's knowledge and intellect and intentions act as mediators of the influence of other factors such as demographic variables, attitudes, social and cultural variables on entrepreneurial behavior and action, according to Chattopadhyay and Ghosh (2008).

Individual factors become precedents that provoke entrepreneurship aimed at medicinal Agro-Cannabis in the present study. Naktiyok, Karabey and Gulluce (2010) emphasize that individual factors such as entrepreneurs' competence and motivation stimulate the development of entrepreneurial activity. Other reasons for this behavior are pointed out by Quevedo, Izar and Romo (2010) and Gnyawali and Fogel (1994) who state that some of the circumstances that stimulate such activity may be: being unemployed, family factor, moving to a new place, business education in agriculture, reliability in the use of cannabis for medicinal use, employment promotion, learning about cultivation, and the economic situation are reasons to undertake agro-cannabis. Naktiyok et al. (2010) state that the phenomenon of entrepreneurship is composed of individuals. This makes this variable one of the most significant in the study.

According to Ajzen (1987) attitudes explain fifty percent of the variation in behavioral intentions. Most of the studies that attempt to predict behavior do so using the attitude variable and this variable was studied under the framework of Ajzen's (1991) Theory of Planned Behavior. According to the aforementioned theory, attitudes are determined by the total set of beliefs and behaviors, which include affective and evaluative estimations. Quevedo, Izar and Romo (2010): consider values such as passion, motivation, creativity, opportunity and innovation as motives for action. The present research shows that the attitude towards agro-cannabis activity activates passion for agricultural enterprise and creativity. It is seen as an opportunity to put into practice knowledge and experience in the agricultural sector. In addition, it is intuited that agro-cannabis offers unexplored agribusiness opportunities. Students have a positive perception of agro-cannabis, which allows for a possibility of management and a different adventure of entrepreneurship in the agricultural sector. The probable economic gains motivate them to enter this activity. Attitudes obtained an explanatory power of 67% of the predictor variables environment and individual factors. This is one of the most important contributions of the research since it can be concluded that individual factors significantly impact the attitudes and this in turn the entrepreneurial intention to agro-cannabis of the subjects of the study.

Gnyawali and Fogel (1994) argue that the environment is an exogenous factor within the framework of the business environment. Its most significant components are: government policies and procedures, socioeconomic conditions, entrepreneurial and business skills, financial aid and non-financial assistance. North, Wallis and Weingast (2006) emphasize that institutions create the rules of the game that govern and set limits on individuals' relationships. The socioeconomic conditions encompass a diversity of activities. In the case of Puerto Rico, both in the agricultural economy sector and in the prevailing social aspects, there are important effects on: economic reality, social uncertainty, access to financing, technological advances, decriminalization of cannabis for medical use, interest rates, tax payments, climate change, public policy, technological advances, cannabinoid alternatives in the treatment of different health conditions, impact the entrepreneurial intention of students.

Subjective norms according to Ajzen's (1991) Theory of Planned Behavior refers to how the social environment influences the behavior of subjects. This suggests that individuals have perceptions of the people in their environment that are important to them which drives them to think about what these individuals should or should not do, according to which they manifest a particular behavior according to Ajzen and Fishbein (1980). In this case, social pressure was significant but was not the most influential variable in the students' reaction.

Perceived control according to Ajzen (1991) refers to the perceived ease or difficulty of performing a given behavior. The students participating in the study expressed that they have the ability to undertake medicinal agro-cannabis. They envision themselves with the ability to use marketing concepts, business resources, read, develop new businesses, manage cash flow, develop field work, observe new business opportunities in medical agri-cannabis, tolerate risks, incorporate new technologies and make decisions in critical situations.

The results prove that Ajzen's (1991) Theory of Planned Behavior is an effective study tool for the analysis of business entrepreneurship. Martin, Martinez and Rojas (2011) highlighted that the theory of planned behavior is one of the most widely used and empirically supported psycho-social theoretical models in a wide variety of behaviors. Belchior and Liñán, (2017) posit that Ajzen's (1991) theory of planned behavior (TCP) has become the predominant specification within the general category of models of entrepreneurial intentions. Tarrant, Mussons, and Ferrás (2015) argue that Ajzen's (1991) TCP is the most widely used psychological theory to explain and predict human behavior. Medina, Bolívar and Lemes (2014) state that this theory is the one that has been most extensively analyzed, constituting the predominant specification, while providing theoretical support to the international research project Global University Entrepreneurial Spirits Students Survey (GUESSS).

Given that Puerto Rico has been going through economic difficulties, as described by Rodríguez (2008). Importantly, consider intent as a first step in understanding how new businesses can influence an economy. The study exhibits a significant pathway to entrepreneurship through individual factors and attitudes that precede entrepreneurial intention to Agro-Cannabis. This possibility of creating new agribusinesses involves the intervention of different actors. Individual factors according to Vesalainen and Pihkala (1999) predominate entrepreneurial behavior, in addition to entrepreneurial behavior linked to attitudes that lead to entrepreneurial activity. Although each approach offers partial contributions, it is recognized that all are necessary to enable an understanding of the entrepreneur. A review of the research literature shows that the different approaches are usually interrelated, according to Hankinson, Bartlett and Ducheneaut (1997).

The analysis of entrepreneurial intentions allows us to understand the factors that stimulate entrepreneurial activity. The present research demonstrates that Ajzen's (1991) Theory of Planned Behavior is a model that predicts entrepreneurial intentions to medical Agro-Cannabis applied to undergraduate students of agriculture at the University of Puerto Rico in Utuado and Mayagüez. The results highlight that the most significant variables that stimulate student action correspond to the pathway involving individual factors that impact attitudes and these in turn precede entrepreneurial intention to medical Agro-Cannabis.

However, limitations were identified. One of them was related to data collection at the University of Puerto Rico at Mayagüez. Candidates were invited to participate in the research by e-mail. An informative letter was sent to them that provided information related to the correct way

to access the research questionnaire link, security measures to manage data confidentiality and their rights as participants.

The participation of students from the Mayagüez Campus was relatively low. Only 48 people registered out of the 191 responses received, approximately 25.4%. This is explained by the fact that the questionnaire was provided a week and a half before Hurricane Maria hit Puerto Rico. Although the students were invited, infrastructure limitations prevented a massive participation of these students.

As this is the first research that evaluates the entrepreneurial intention of undergraduate students of agriculture in Puerto Rico towards medicinal Agro-Cannabis, our search did not find a precedent literature review that would offer a background of the perspective of the topic presented.

This research definitely opens doors for future research. The Theory of Planned Behavior is a widely used theoretical framework on the topic of entrepreneurial intention. Future research should ask why people perceive entrepreneurship opportunities differently. How do institutions and public policy influence entrepreneurial activity?

The gender perspective through a comparative study can offer valuable information related to determining the stimuli that precede the intention to entrepreneurship in the agricultural sector as well as in other sectors of the economy. On the other hand, the line of research can be extended to include other professional groups and industries. Some possibilities that could be considered for the extension of the study could be: the agro-industrial sector, animal nutrition, construction industry, textile industry, paper industry, biodegradable plastic industry, cosmetic industry and pharmaceutical industry, among others.

A better understanding of the factors that promote entrepreneurial intent is vital. The state must understand these factors so that measures can be developed to promote entrepreneurship policies tailored to the country's needs. The wealth of information provides a better understanding of the importance of entrepreneurship and its prospects for economic development. The research highlights the interest generated by this sector among undergraduate agriculture students at the University of Puerto Rico, Utuado and Mayagüez campuses. Therefore, the state should seriously address this interest expressed by the students and exposed in this research.

References

Ajzen, I. (1987). Attitudes, Traits and Actions: Dispositional Prediction of Behavior in Personality and Social Psychology. *Advances in Experimental Social Psychology, 20*(1), 63.

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational behavior and Human Decision Processes, 50*(2), 179-211.

Ajzen, I., & Fishbein, M. (1980). Understanding Attitudes and Predicting Social Behaviour.

Belchior, R. & Liñán, F. (2017). Individual and cultural values as psychosocial cognitive antecedents and moderators of entrepreneurial intentions. In *The Emergence of Entrepreneurial Behaviour Intention, Education and Orientation* (pp. 66-87). Edward Elgar, Editors.

Catalá, F. A. (1998). La Economía de Puerto Rico, 1898-1998. In *Centenario 1898-1998* (pp. 1-37). Puerto Rican Athenaeum.

Chattopadhyay, R., & Ghosh, A. (2008). Entrepreneurial Intention Model-Based Qualitative Approach to Estimate Entrepreneurial Success. *Journal of Small Business and Entrepreneurship, 21*(1), 1-22. https://doi.org/10.1080/08276331.2008.10593410

Cordero, R. (1949). La Economía de Puerto Rico y sus Problemas. In *Foro Público sobre Diversos Aspectos de la Economía del País, auspiciado por la Facultad de Ciencias Sociales de la Universidad de Puerto Rico* (pp. 1-22). Faculty of Social Sciences, University of Puerto Rico.

Commonwealth of Puerto Rico, Legislative Assembly, House of Representatives. (2017). *Ley 42* (pp. 1-28). San Juan, Puerto Rico: Cámara de Representantes.

Estado Libre Asociado de Puerto Rico, Asamblea Legislativa, Cámara de Representantes. (2021). *Ley 15* (pp. 1-5). House of Representatives.

International Monetary Fund. (2016). *Informe de Perspectivas de la Economía Mundial: Demasiado Lento por Demasiado Tiempo.* Washington.

Gnyawali, D. R. & Fogel, D. S. (1994). Environments for Entrepreneurship Development: Key Dimensions and Research Implications. *Entrepreneurship Theory and Practice, 18* (4), 43-62.

Hair, J. F., Ringle, C.M., & Sarstedt, M. (2014). PLS/SEM: Indeed, a silver bullet. *Journal of Marketing Theory and Practice, 19* (2), 139-152. https://doi.org/10.2753/MTP1069-6679190202

Hair Jr, J. F., Wolfinbarger, M., Money, A. H., Samouel, P., & Page, M. J. (2015) Essentials of Business Research Methods. Routledge.

Hankinson, A., Bartlett, D., & Ducheneaut, B. (1997). The Key Factors in the Small Profiles of Small-Medium Enterprise Owner-Managers that Influence Business Performance: The UK (Rennes) SME survey 1995-1997 An International Research Project UK survey. *International Journal of Entrepreneurial Behavior & Research, 3* (3), 168-175.

Hernández Sampieri, R., Fernández Collado, C., & Baptista Lucio, P., (2010). Metodología de la Investigación. (Fifth Edition) McGraw Hill.

Irizarry, E. (2012). Evolución Histórica de la Economía de Puerto Rico. Encyclopedia of Puerto Rico.

Irizarry, E. (2016). *Situación y Perspectivas de la Agricultura del Sector Agroalimentario del País.* Mayagüez University Campus.

Junta de Planificación de Puerto Rico (2016). Apéndice Estadístico Informe Económico al Gobernador y a la Asamblea Legislativa en el Año Fiscal 2015.

Junta de Planificación de Puerto Rico (2021). Apéndice Estadístico Informe Económico al Gobernador y a la Asamblea Legislativa en el Año Fiscal 2020.

Krueger, N. & Brazeal, D. (1994). Entrepreneurial Potential and Potential Entrepreneurs. *Entrepreneurship Theory and Practice, 19(*3), 91-104.

Krueger, N. (1993). The impact of prior entrepreneurial exposure on perceptions of new venture feasibility and desirability. *Entrepreneurship Theory and Practice, 18* (1), 5-21.

Krueger, N. Reilly, M., and Carsrud, A. (2000). Competing models of entrepreneurial intentions. *Journal of Business Venturing, 15* (5/6), 411-432.

Martín, M. J., Martínez, J. M., & Rojas D., (2011). Teoría del comportamiento planificado y conducta sexual de riesgo en hombres homosexuales. *Revista Panamericana Salud Pública, 29* (6), 433-443.

Medina, P., Bolívar, A., & Lemes, A. I. (2014). Un Paso Más en la Investigación de la Intención Emprendedora del Estudiante Universitario: guess. *Revista de Estudios Empresariales*, *2014* (2), 63-80. https://revistaselectronicas.ujaen.es/index.php/REE/article/view/1758

Naktiyok, A., Karabey, C. N., & Gulluce, A. C. (2010). Entrepreneurial Self Efficacy and Entrepreneurial Intention: the Turkish Case. *International Entrepreneurship and Management Journal, 6*(4), 419-435. https://link.springer.com/article/10.1007/s11365-009-0123-6

Osorio, F. & Londoño, J. (2015). Intención emprendedora de estudiantes de educación media: extendiendo la teoría de comportamiento planificado mediante el efecto exposición. *Cuadernos de Administración*, 28-51.

Pantojas, E. (2016). Is Puerto Rico Greece in the Caribbean? Crisis, Colonialism, and Globalization. *The Fletcher Forum of World Affairs, 40*(1), 57-71. https://www.jstor.org/stable/45290060

Pol, J. C. (2001). Determinantes económicos de la migración entre Puerto Rico y Estados Unidos. http://economia.uprrp.edu/ensayo 119.pdf

Quevedo, L. M., Izar, J. M., & Romo, L. (2010). Factores endógenos y exógenos de mujeres y hombres emprendedores de España, Estados Unidos y México. *Investigación y Ciencia*, *18*(46), 57-63. http://www.redalyc.org/articulo.oa?id=67413508008

Rivera, B., & López, S. (2011). Percepción de los Estudiantes Universitarios sobre las Empresas, los Empresarios y el Ambiente Empresarial en Puerto Rico y su Intención de Emprender un Negocio. In *XLVI Asamblea Anual de CLADEA* (pp. 1-20). University of Puerto Rico.

Rivera, L. (1958). La Agricultura en una Economía en Desarrollo. In *Seminario de Planificación Económica* (pp. 1-22). Secretary of Agriculture and Commerce, Commonwealth of Puerto Rico.

Rodríguez, C. A. (2008). La Evolución Histórica, la Teoría Económica y el Sistema Económico deseable como las Bases Fundamentales para Desarrollar una Estrategia de Desarrollo Económico en Puerto Rico. *Unidad de Investigaciones Económicas, Departamento de Economía, Universidad de Puerto Rico, 136*, 1-15.

Tarrant-Pons, E., Torras, M. M., & Hernández, X. F. (2015). Del modelo del evento emprendedor al modelo sistémico de emprendimiento. *3C Empresa*, *4*(2), 124. https://dialnet.unirioja.es/servlet/articulo?codigo=5093286

United States, U.S. Department of Agriculture, National Agricultural Statistics Service. (2014). *2012 Census of Agriculture* (Vol. 1, Part52, AC-12-A-52, pp. 1-350). United States Department of Agriculture.

United States, U.S. Department of Agriculture, National Agricultural Statistics Service. (2020). In *2017 Census of Agriculture* (Vol. 1, Part52, AC-12-A-52, pp. 1-350). United States Department of Agriculture.

Vesalainen, J., & Pihkala, T. (1999). Entrepreneurial Identity, Intentions and the Effect of the Push Factor. *Academy of Entrepreneurship Journal, 5*(2), 1-24.

Wompner, F. (2012). El Emprendimiento como Factor de Movilización Social. *Nómadas. Revista Crítica de Ciencias Sociales y Jurídicas*, *36*(4), 1-6. http://www.redalyc.org/articulo.oa?id=18126450015

Date received: 12/07/2022
Revision date: 06/09/2022
Date of acceptance: 20/09/2022

PROJECT, DESIGN AND MANAGEMENT

https://www.mlsjournals.com/Project-Design-Management

ISSN: 2683-1597

How to cite this article:
Rivera Manzano, L. D. (2023). Liderazgo directivo y desarrollo productivo del sector automotriz. *Project, Design and Management, 5*(1), 158-170. doi: 10.35992/pdm.5vi1.1371.

LEADERSHIP AND PRODUCTIVE DEVELOPMENT IN THE AUTOMOTIVE SECTOR

Lisbeth Daniela Rivera Manzano
Universidad Internacional Iberoamericana (Ecuador)
lisbeth.rivera@doctorado.unini.edu.mx - https://orcid.org/0000-0002-7716-6709

Abstract. The present research study aimed to determine the relationship between managerial leadership and the productive development of the automotive sector in Guayaquil. It includes the theory of high-performance equipment of Peñalver (2019), based on trust, commitment, results and recognition. The confidence of a leader who leads and supports the team safely is relevant. The confidence expressed by a leader who leads and supports the team securely generates a high degree of commitment to the team for the achievement of results expected from the manager with the ability to transmit vision and assign responsibilities for the fulfillment of goals and development of each individual. The study complies with a methodology of Non experimental research - Transversal, Basic and with a Descriptive-Correlative level. In the census study, relevant data were obtained with the contribution of 14 collaborators through two questionnaires for the corresponding analysis and an interview with the manager of an automotive company to know the work of the collaborators in the company, whose purpose is to visualize how managerial leadership is associated with productive development. Within the results a significant relation of the variables was obtained, in it the null hypothesis (Ho) was rejected, and the alternative hypothesis, whose association is significant of 0.05, with a strong positive Spearman correlation coefficient = ,564 to be this an approach to take a better planning and correct the shortcomings to obtain optimal results in the automotive company.

Keywords: Management leadership, productive development, high performance teams, Ecuador.

LIDERAZGO DIRECTIVO Y EL DESARROLLO PRODUCTIVO del SECTOR AUTOMOTRIZ

Resumen. El presente estudio investigativo tuvo como objetivo determinar la relación del liderazgo directivo y el desarrollo productivo del sector automotriz en Guayaquil. Se incluye la teoría de equipos de alto rendimiento de Peñalver (2019), basada en la confianza, compromiso, resultados y reconocimiento. Es relevante la confianza que manifiesta un líder que dirige y apoya al equipo con seguridad. La confianza que manifiesta un líder que dirige y apoya al equipo con seguridad genera un alto grado de compromiso al equipo para el logro de resultados que se espera del directivo con capacidad de trasmitir visión y asignar responsabilidades para el cumplimiento de metas y el desarrollo de cada individuo. El estudio cumple con una metodología de una investigación No experimental – Transversal, Básica y con un nivel Descriptivo-Correlacional. En el estudio censal, se obtuvo datos relevantes con la contribución de 14 colaboradores a través de dos cuestionarios para el análisis correspondiente y una entrevista al gerente de una empresa automotriz para conocer el trabajo de los colaboradores en la empresa, cuyo fin es visualizar como el liderazgo directivo se asocia al desarrollo productivo. Dentro de los resultados se obtuvo una relación significativa de las variables, en la misma se rechaza la hipótesis nula (Ho), y se acepta la hipótesis

alternativa, cuya asociación es significativa de 0,05, con un coeficiente de correlación de Spearman positivo fuerte = ,564 [a] siendo esto un enfoque para llevar una mejor planificación y corregir las falencias para obtener resultados óptimos en la empresa automotriz.

Palabras clave: *Liderazgo directivo, desarrollo productivo**,** equipos de alto rendimiento, Ecuador**.***

Introduction

Globally, it can be seen how management leadership generates a high relationship with the productive development of the automotive sector marked in the market, in which companies report the decisions taken to promote a change and improve every day the different administrative aspects it manages, in order to create innovative techniques for the enhancement of the productive development of the same. The automotive industry is one of the main sectors that allows for economic growth, which has had a high impact at the international level, generating jobs to meet the basic needs of workers.

Within the automotive industry worldwide, one of the major market leaders is Japan, considering the most relevant companies it manages, such as Honda, Toyota and Nissan, which, due to their high production capacity and managerial leadership, attract more foreign consumers. In addition, Japan has an advantage over neighboring countries in the automotive market, which is China, as it has a greater productive development when generating sales. According to statistical data, at international level China is leading the automotive industry with a production of 28,118,794 units, the United States with 12,198,137 units, Japan has a production of 9,204,590 units, Germany with 6,062,562 units, which is located in fourth place and India with 4,488,965 units, being the fifth place in the automotive industry (Valle, 2017).

According to data from the National Chamber of Automotive Commerce of Chile (CAVEM, 2019) the brands that lead the market is Chevrolet, Suzuki, Hyundai and Volkswagen with respect to the productive development they implemented in 2018, but this presents an imbalance today, allowing brands such as Toyota, Mercedes-Benz and BMW to displace these brands; with greater investment in technology and at a lower cost in sales, with managers of great global prominence that expand their range of vehicle models for advanced productive development.

For Latin America, the automotive industry is undergoing changes with respect to trade relations with the United States, economic crises in some countries, and the opening of local markets to Chinese suppliers. China, the United States, Japan and Germany are the leading markets with the highest technological level for the development of automotive production; therefore, Mexico is the world's fifth largest auto parts producer, with a projected production of 95 billion for the current year. Brazil's automotive industry is stable, according to Elaine Colnago, Development and Export Advisor of the National Union of the Automotive Components Industry; in her projection, she states that the auto parts turnover will be 27.8 billion, with Argentina, the United States and Mexico as the main export destinations. For the international markets of the automotive industry, they establish as strategies to generate greater production, of better quality, at low costs and personalized service to stay in the market (Alcántara and Rodríguez, 2019).

The United Nations Organization (UN, 2019) in its publication "World Economic Situation And Prospects" states that, at present, the existing progress of productive development through innovation has generated a delay in developing countries. Despite the difficulties in measuring innovation on a large scale, it combines economic, technological and institutional

aspects to provide a comprehensive assessment. The countries with a high degree of productive development and innovation are: China, Malaysia and Vietnam, for which corrective measures must be taken to maintain production stability in the global automotive industry.

With respect to data obtained from the Internal Revenue Service (SRI) and National Customs Service of Ecuador (SENAE), indicates a variation in the generation of employment in 2018 in the automotive industry, for the manufacture of vehicles has 1,401 workers, the manufacture of auto parts there are only 1,309; this promotes the inclusion of strategies by the managers who manage each company, in order to create distribution channels that allow decreasing delivery time, increasing the installed capacity to improve the productive development of the automotive industry. On the other hand, trade and repair of vehicles for maintenance represents 22,857 workers, auto parts sales have 22,116 workers, giving a high rate in the automotive industry to enhance the country's economy (Asociación de empresas automotrices del Ecuador [AEADE], 2018).

García (2018) Minister of Industries and Productivity, in her analysis on "Challenges of the Automotive Industry", indicates that, industrial policy is based on five pillars: investment, productivity, quality, innovation and markets. Likewise, the Automotive Policy is focused on three axes: low local content for assembly activities, development of auto parts suppliers and incentives for assemblers. The automotive industry is a major source of foreign exchange, due to the export of vehicles and auto parts to different countries in the region. The main objective is to expand production in a competitive manner, with a high added value and a greater generation of sources of employment. The automotive industry needs to develop its supply chain, based on the quality requirements of its production.

The Labor and Business Dynamics Laboratory of the National Institute of Statistics and Census (INEC), through data obtained from the Ecuadorian Institute of Social Security (IESS) indicates that, in 2018 the total number of jobs in the automotive industry in Ecuador was 68,115, being an index of great relevance for the creation of new entities that help generate new innovative techniques and increase the employment item in the automotive industry, in order to promote the stability of financial performance and improve productive development to be high performance leaders in the automotive market. In 2018, 137,615 units of vehicles entered Ecuador, which were sold in a given time. The country is among the first places with respect to the growth of vehicles marketed with 30.9% in the automotive sector, generating a relevant activation to the economy of the companies, also a positive change in the entire marketing chain, considering the companies that provide repair service, washing and installation of spare parts as the case presented, being a benefit to the growth of the automotive industry (MotorTerra, 2019).

In 2018 for Ecuador, it was a year of recovery for the automotive sector, considering the economic situation of the country, a trade policy of great openness, and the help of financial institutions through credit; this had an impact on the productive performance of the sector. As of the entry into force of the Trade Agreement with the European Union, vehicles extended their share of the Ecuadorian automotive market with 6.4% in 2018. Market growth has allowed companies to optimize costs, which has led to improved consumer prices (El Universo, 2019).

The automotive service companies do not have the necessary tools for a good management of resources optimization to establish an adequate production process to deliver in an optimal time to the final consumer; this is a shortcoming that should be analyzed by the management leader to find the skills that generate a high relationship in order to improve internal management with greater installed capacity for productive development in the companies to provide a quality service. Therefore, this research aims to make a determined analysis to know the shortcomings of the company, how it is carrying out the leadership

capacity of senior management, if workers have the necessary training to work in the same, as well as to know if consumers are satisfied with the service provided, and how to use resources for the optimal delivery of the repaired vehicle, based on this seek possible solutions to compete with other markets worldwide.

This is of great importance because it allows an adequate control over the performance of a company's organization, to achieve the projected goals, which helps to make decisions for the good performance of the leader in order to improve the productive development of the company. Within the automotive sector it can be seen how this has influenced the establishment of strategies to improve the productive performance of workers, promoting the optimization of resources to achieve the efficiency and effectiveness required by the company for productive development internationally.

The managerial leadership and the relationship with the productive development of the automotive sector, represents a high potential within the global economic market, being a relevant element to develop the competitiveness of the company and accelerate long-term economic growth, which allows improving the conditions currently presented, in order to organize and generate employment with an index of added value that helps to enhance the service provided by the company's employees to customers. Therefore, it is a primary objective of the company to increase its competitiveness through productive levels, in order to differentiate itself in the automotive market and to be recognized nationally and internationally for its management leadership processes.

The General Objective is to determine the relationship between managerial leadership and the productive development of the automotive sector in Guayaquil, Ecuador. The specific objectives are: To evaluate the relationship of managerial leadership with decision making in the automotive sector, Guayaquil, Ecuador and to establish the relationship of managerial leadership with organizational performance in the automotive sector, Guayaquil, Ecuador. The general hypothesis is that there is a significant relationship between managerial leadership and the productive development of the automotive sector in Guayaquil, Ecuador. In hypothesis 1, there is a high relationship of managerial leadership with decision making in the automotive sector, Guayaquil, Ecuador and hypothesis 2, there is a positive relationship of managerial leadership with organizational performance in the automotive sector, Guayaquil, Ecuador.

It is necessary to consult a series of theories on which the research is based; considering the case of Peñalver (2019) raises in his theory about high performance teams that is based on a formula: Trust + Commitment + Results + Recognition. Confidence is of utmost importance because it provides positive expectations despite uncertainty. Therefore, trust is generated by having a managerial leader who supports the team and leads them with confidence. Team commitment is measured through the results obtained, which are expected from the manager's ability to transmit vision, assign responsibilities, develop people, and rotate personnel for the fulfillment of activities.

Within the assigned theories, the theory of high performance teams is considered as the main one for the evaluation of the study, since a managerial leader generates confidence in his subordinates according to the degree of credibility that exists with respect to any circumstance presented, the commitment he has to establish clear objectives for decision making that is given in consensus with the members that form the work team, this allows to obtain the expected results in the fulfillment of goals to increase the productive development of the company, also the managerial leader is directed with new strategies that generate organizational profitability, given the participation of its collaborators with efficiency in the activities that are assigned to them, this through a good control in the personnel, allows to grant recognition to the

collaborators by its performance in the functions carried out generating a benefit for the finances of the company.

This work is of great importance because it allows to determine the relationship between management leadership and productive development in the automotive sector, Guayaquil, Ecuador; where a variety of factors that affect the company in its labor situation are observed, with this purpose, the research work has been implemented as a contribution to the improvement of strategies and approach that exists in the company with new techniques of management leadership for productive development, which allows to increase performance and achieve the established goals.

In the research with respect to its practical contribution, its purpose is to provide the necessary tools to companies about management leadership techniques that allow employees to enhance their skills for productive development in the field they perform and the performance of the organization, this also allows to achieve high levels of personal satisfaction, optimal performance, quality of life, competitiveness in the market and provide an innovative service to the customer's taste.

Method

The research study complied with the methodological techniques proposed in a non-experimental, cross-sectional, basic, descriptive-correlational research. It is of a basic type, because through the research, it sought to identify and know which were the problems presented by the workers and the opinions regarding some situation that they did not agree with within the company, in order to provide key ideas and adequate conditions to provide an improvement in the productive development within the company.

Variable 1: Managerial leadership: It is the one that proposes new approaches that motivate companies to have a clear vision to develop strategies to achieve an established goal. This evaluates the productive performance; therefore, the managerial leader inspires his work team to improve the skills with a high level of communication, this as a vision to the correct management of functions to obtain favorable results based on decision making.

Variable 2: Productive development: Productive development is based on how much is produced in goods or services for each component implemented (worker, capital, time, costs, etc.), during a defined period. This is measured through the production efficiency per resource implemented, in order to acquire the maximum benefit using few resources (Sevilla, 2016).

In this research study, the population corresponds to 14 employees and 1 manager of an automotive company. Due to a small population, a census study was considered, which did not require a sample or sampling, the population was taken directly for the analysis and corresponding results, in order to find the necessary solution for the research study. The study was approached in the following way: with respect to leadership, the managers, and with respect to productivity, the workers. Through the variables identified the problems generated in the company to find solutions to help optimize the productivity of workers through the proper performance by senior managers.

With respect to the inclusion criteria, we considered the companies in the automotive industry, taking as the main point the men and women who work in an automotive company in the city of Guayaquil, including collaborators who provide their services externally to the company. In the research process, the exclusion criteria did not include children under 18 years

of age and clients, who did not participate in the study carried out to obtain the corresponding results.

Surveys based on a Likert scale with frequency expressions were conducted with data that are easy to analyze for decision making by the researcher collecting the data for the study. A structured interview was also proposed, according to (Mejia, 2019), it is directed by standardized questions, which are set out in an organized manner for each study objective, this interview of the proposed study was set in the formulation of questions, where the most relevant of the research were included; this in order to facilitate the unification of criteria and opinions by the interviewee.

Surveys and interviews were conducted in an automotive company in Guayaquil, to acquire information on the variable management leadership and productive development, this was considered through a census study of 14 employees and 1 manager of the automotive company. This in order to make known the problems, aspects, behaviors and economic or social situation presented within the company by the individuals who participated in the same with respect to the objectives given in the research study, to analyze in a concrete way and grant the validity of the given hypothesis.

The instrument used was a questionnaire of questions to study the corresponding variables, which allowed the acquisition of results in a concrete form, which was given to each employee surveyed. A series of questions were also asked through an interview with the general manager to evaluate his degree of leadership within the company. For the management leadership and productive development variable, a questionnaire of 10 questions was used for each variable, with multiple choice results. Questionnaire 1 was designed to analyze the variable Management Leadership, questionnaire 2 was also presented, which analyzed the variable Productive Development, and to corroborate the statistical data obtained in the survey, an interview guide was applied to the general manager.

The questionnaire was presented in two ways: one is to see the conditions that presented the staff within the company, and the other which was the behavior of managerial leadership of its administrative area; considering also that, this was analyzed through an interview with the manager of the company to verify the information collected by the team that make up the company. In the measurement of the questions a scale was implemented that are equivalent in: Never, Sometimes, Sometimes, Sometimes, Almost always, Always.

The present research study was carried out through the application of two questionnaires and an interview that allowed measuring the variables management leadership and productive development; therefore, the validation of the instruments was carried out through specialized judges with a high degree of experience in the area of the corresponding variables to qualify and provide suggestions regarding the proposed instruments with a truthful opinion if the given study is acceptable.

With respect to the reliability of the research work, an instrument reliability test called Cronbach's alpha was performed to establish the reliability of consistency of the respective questionnaires given for each study variable. This pilot test was carried out with 10 employees of an automotive company in Guayaquil, Ecuador, with similar characteristics to the present population analyzed. When the statistical data collection was obtained, the corresponding calculation was made by means of Cronbach's Alpha factor, which measured the reliability of the dimensions given in the questionnaires. Within the reliability of the instruments through the formulation carried out, it was found that questionnaire 1 has a reliability of 0.90 and questionnaire 2 0.80, which means that the measurement scales are homogeneous and are directed to the same approach to correctly carry out the proposed research study.

The procedure was carried out starting from the authorization of the manager of the automotive company, in order to apply all the corresponding processes of data collection to the collaborators. The date and time were established to apply the instruments on an appropriate day without interrupting each person's work. This was done through a survey to 14 collaborators of the automotive company and an interview to a manager to corroborate the information acquired from the company, being carried out in an average of 10 minutes for the execution of the survey and interview; in the questionnaire established for the survey was presented according to categories such as; 1.- Never, 2.- Sometimes, 3.- Sometimes, 4.- Almost always, 5.- Always; once the information was received, the respective tabulation was made in Excel, generating a data base, which later allowed to enter it to the program "Stadistical Package for Social Sciences (SPSS v.25)". In addition, a pilot test was applied to evaluate the reliability of the instruments, in order to see if it is feasible to be applied to the entire study population.

In the analysis of the present study, a database was used, where the information collected through the survey was entered to demonstrate the reliability through the Cronbach's Alpha statistic obtained through the Excel program. This research is supported by relevant theories in order to demonstrate the veracity of the hypothesis proposed. Therefore, specific information related to the objectives given with respect to the variables was collected to obtain the results through cross tables about the corresponding correlations of the study, and to see the significance of the hypotheses presented, the Spearman correlation coefficient method was used in the SPSS program, to know the situation of the automotive company and provide new guidelines to help its internal improvement.

Results

With respect to table 1, 75% of the employees consider that productive development is almost always good, when managerial leadership is almost always generated at a high level; likewise, sometimes productive development is regular, when managerial leadership is sometimes average with 62.5%; this shows the relationship between management leadership and productive development is good, due to how the manager of the company carries out his planning for an adequate process of functions by the collaborators, but management leadership is directly associated with productive development, because productive development, despite the shortcomings of the company, seasonally obtains work to perform functions with excellence.

Table 1
Descriptive analysis Management leadership and productive development

			PRODUCTIVE DEVELOPMENT			
			Sometimes	Sometimes	Almost always	Total
MANAGEMENT LEADERSHIP	Sometimes	Count	1	1	0	2
		% within Management Leadership	50,0%	50,0%	0,0%	100,0%
	Sometimes	Count	0	5	3	8
		% within Management Leadership	0,0%	62,5%	37,5%	100,0%
	Almost always	Count	0	1	3	4
		% within Management Leadership	0,0%	25,0%	75,0%	100,0%
Total		Count	1	7	6	14
		% within Management Leadership	7,1%	50,0%	42,9%	100,0%

Regarding table 2, 50% of the collaborators consider that, almost always the decision making is good, when almost always the managerial leadership is generated at a high level, in its majority the manager sometimes encourages the decision making in a regular way, when the managerial leadership is high in 25%; being a feasible relationship of managerial leadership within the company, but it should be taken into consideration that it is important the equity of all in the team; therefore, it is necessary to work on this aspect with the managers and collaborators to obtain favorable results in the decision making with respect to some event presented in the company.

Table 2
Descriptive Analysis Management Leadership and Decision Making

			DECISION MAKING				
			Sometimes	Sometimes	Almost always	Always	Total
MANAGEMENT LEADERSHIP	Sometimes	Count	1	1	0	0	2
		% within Management Leadership	50,0%	50,0%	0,0%	0,0%	100,0%
	Sometimes	Count	0	6	2	0	8
		% within Management Leadership	0,0%	75,0%	25,0%	0,0%	100,0%
	Almost always	Count	0	1	2	1	4
		% within Management Leadership	0,0%	25,0%	50,0%	25,0%	100,0%
Total		Count	1	8	4	1	14
		% within Management Leadership	7,1%	57,1%	28,6%	7,1%	100,0%

With respect to table 3, 87.5% of the collaborators state that, sometimes the organizational performance is regular, when sometimes the managerial leadership is generated at a medium level, as well as sometimes the organizational performance is given incorrectly, when sometimes the managerial leadership is medium in 12.5%, the organizational performance is considerably associated with the managerial leadership, even though, the manager of the company does not take an adequate control to the collaborators, the organizational performance is the one that is in charge of improving the capacities of the company, its internal and external operation.

Table 3
Management Leadership and Organizational Performance Analysis

			ORGANIZATIONAL PERFORMANCE			
			Sometimes	Sometimes	Almost always	Total
MANAGERIAL LEADERSHIP	Sometimes	Count	1	1	0	2
		% within Management Leadership	50,0%	50,0%	0,0%	100,0%
	Sometimes	Count	1	7	0	8
		% within Management Leadership	12,5%	87,5%	0,0%	100,0%
	Almost always	Count	0	2	2	4
		% within Management Leadership	0,0%	50,0%	50,0%	100,0%
Total		Count	2	10	2	14
		% within Management Leadership	14,3%	71,4%	14,3%	100,0%

Ho. There is no significant relationship between management leadership and the productive development of the automotive sector, Guayaquil, Ecuador.

Ha. There is a significant relationship between management leadership and the productive development of the automotive sector, Guayaquil, Ecuador.

Table 4 shows that there is a significant relationship between managerial leadership and productive development. The null hypothesis (Ho) is rejected and the alternative hypothesis (Ha) is accepted because the steam p=.036 is less than p=.05, so there is a statistically significant variation of 0.05 of the variables, with a strong positive Spearman correlation coefficient = ,564[a] which shows that one is associated with the other in the automotive sector of Guayaquil, Ecuador.

Table 4
Correlation coefficient Management leadership and Productive development

			MANAGEMENT LEADERSHIP	PRODUCTIVE DEVELOPMENT
Spearman's Rho	MANAGEMENT LEADERSHIP	Correlation coefficient	1,000	,564*
		Sig. (bilateral)	.	,036
		N	14	14
	PRODUCTIVE DEVELOPMENT	Correlation coefficient	,564*	1,000
		Sig. (bilateral)	,036	.
		N	14	14

Note. *The correlation is significant at the 0.05 level (bilateral).

Ho. There is not a high relationship between management leadership and decision making in the automotive sector, Guayaquil, Ecuador.

Ha. There is a high relationship between managerial leadership and decision making in the automotive sector, Guayaquil, Ecuador.

Table 5 shows that there is a high relationship between managerial leadership and decision making, in which the null hypothesis (Ho) is rejected and the alternative hypothesis (Ha) is accepted, given that the level of p= ,012 is less than p=.05, so there is a statistically significant variation of 0.05 of the variables, with a strong positive correlation coefficient = ,652[a], which shows that there is a high relationship in the study variables in the automotive sector of Guayaquil, Ecuador.

Table 5
Correlation coefficient Management Leadership and Decision Making

			MANAGEMENT LEADERSHIP	DECISION MAKING
Spearman's Rho	MANAGEMENT LEADERSHIP	Correlation coefficient	1,000	,652*
		Sig. (bilateral)	.	,012
		N	14	14
	DECISION MAKING	Correlation coefficient	,652*	1,000
		Sig. (bilateral)	,012	.
		N	14	14

Note. *The correlation is significant at the 0.05 level (bilateral).

Ho. There is no positive relationship between managerial leadership and organizational performance in the automotive sector, Guayaquil, Ecuador.

Ha. There is a positive relationship between managerial leadership and organizational performance in the automotive sector, Guayaquil, Ecuador.

Table 6 shows that there is a positive relationship between managerial leadership and organizational performance; therefore, the null hypothesis (Ho) is rejected, and the alternative hypothesis (Ha) is accepted, because the steam p= .015 is less than p=.05, so there is a statistically significant variation of 0.05 of the variables, with a strong positive Spearman correlation coefficient = ,634[a] which shows that one is associated with the other, in the automotive sector of Guayaquil, Ecuador.

Table 6
Correlation coefficient Management Leadership and Organizational Performance

			MANAGEMENT LEADERSHIP	ORGANIZATIONAL PERFORMANCE
Spearman's Rho	MANAGEMENT LEADERSHIP	Correlation coefficient	1,000	,634*
		Sig. (bilateral)	.	,015
		N	14	14
	ORGANIZATIONAL PERFORMANCE	Correlation coefficient	,634*	1,000
		Sig. (bilateral)	,015	.
		N	14	14

Note. *The correlation is significant at the 0.05 level (bilateral).

Discussion and conclusions

In this research study, management leadership and productive development in the automotive sector, Guayaquil, Ecuador, were analyzed. Based on the information compiled in the study, a variety of data is visualized for each variable established in the study, so that the veracity of the same with other studies carried out in periods prior to the present study is known.

With respect to the general objective: To determine the relationship generated by managerial leadership with the productive development of the automotive sector, through the statistical study it is shown that the variables are associated with each other; therefore, with the correlation coefficient method, the result in Table 1 is ,564[a], strong positive, with p=.036, thus determining that there is a significant relationship between managerial leadership and productive development. This is based on the theory of Peñalver (2019), who considers of utmost importance to include a high level of trust and commitment from the members that make up the company to achieve optimal results in the process in order to be recognized by the managers who lead the group, who have the ability to transmit vision, assign responsibilities, develop people and the rotation of personnel to achieve the fulfillment of established goals, with the purpose that the leader provides the necessary tools to his collaborators for an adequate productive development of the company.

Within the results proposed with the established theoretical foundation, the research work has relevance and is within the parameters considered as positive ranges to demonstrate that there is an association of the study variables compared to the variables studied from other periods that have a moderate degree of similarity, therefore, the theory given by Peñalver (2019) is considered as the main entity, which emphasizes a set of necessary aspects within the managerial leadership with high performance teams that allow achieving economic performance through a high productive development in the company in order to generate a positive impact to motivate employees and attract new customers to the company.

When evaluating the relationship of managerial leadership with decision making of an automotive company, in which it is considered that, there is a high relationship of managerial leadership with decision making, considering the result in table 2, the level of p= ,012, with a strong positive correlation coefficient = ,652[a], this shows that, there is a high relationship in the study variables, of the automotive sector. According to Hernandez (2016) on the relationship

between leadership styles and decision making, they applied a Kurtt leadership test to know the style that the collaborators handle at work, where the highest positive relationship of liberal leadership with 0.37 stands out; while the relationship is negative with a low level of Ego state with -0.20, it is visualized that, not all the items have been taken into consideration to maintain an adequate level in the processes that help to make better decisions, in which a low relation of the variables is presented, demonstrating that, there is no significant correlation of leadership and decision making, contrasting to what concerns the variables of studies, a considerable relation of managerial leadership and decision making within a work team of the present analysis is identified; in which, it is necessary to evaluate different factors within the company, where there is a team with equity for all, being necessary to work in this aspect with the collaboration of the whole team to obtain favorable results within the decision making with respect to any event presented.

To establish the relationship of managerial leadership with organizational performance in the automotive sector, as shown in Table 3, there is a positive relationship of managerial leadership with organizational performance, with the steam p= ,015, with a strong positive correlation coefficient = ,634[a] to this shows that, it is associated one with the other, of the automotive sector. It is of vital importance to see how within the proposed studies a significant relationship of the variables is considered; in which, it is required for a good organizational performance to grant roles to each member of the company, to provide incentives for the adequate improvement generating labor balance, being a pillar to support the guidance of the managerial leader who directs them in the process of the work they perform.

In the research process of several authors, the relevance of managerial leadership in different professional areas or institutions is visualized, being the main entity to carry out a correct management and order within a company or institution; given that, in the proposed study a significant relationship is generated within the management of the variables, this is positively associated, demonstrating that managerial leadership helps the productive development of a company and the financial enhancement of the same.

The managerial leadership achieves in different theories as a result that, there is association with the productive development within the institutions that require it, but this must be associated as one of the most relevant entities to maintain the stability of a company with the purpose that, when including strategies help to the improvement of the productive development of the same one and generating for the execution of functions high performance teams that, help to the achievements or goals raised of the company.

Conclusion: In the approach of the work on managerial leadership and productive development, Table 1 shows that there is a relevant relationship between the variables, given that 75% of the collaborators consider that productive development is almost always good, when managerial leadership is almost always generated at a high level, table 4 also shows a rho= ,564[a], being strong positive, with p-value=,036, this allows us to see how the study variables are associated, which should be analyzed as an approach to carry out a better planning to correct the shortcomings presented and obtain optimal results in the automotive company.

The process to establish the relationship between managerial leadership and decision making is also analyzed; it is shown in Table 5, through the strong positive rho with a value of ,652[a], with p=.012, resulting in a high significant relationship, and demonstrates the associativity that exists in the study variables, but an equitable work team should be fostered to make appropriate decisions that benefit the automotive sector. It is concluded the relationship of managerial leadership with organizational performance; it is shown in table 6 that the strong positive rho has a value of ,634 [a], with p value=,015; in which, there is a statistically significant variation, being in constancy the expected relationship in the same, taking into consideration

that, the performance of the collaborators should be evaluated to optimize time and to see the level of efficiency for the good organizational performance that, is needed in the automotive sector.

It is necessary to implement training programs about management leadership through coaching techniques in the automotive sector to generate an assertive communication that motivates managers and collaborators as highly qualified teams; in this way, with the inclusion of innovative strategies allow to be recognized in the market to increase productivity through the achievement of goals and decision making as an improvement of organizational performance in the automotive sector.

References

Alcántara, V., & Rodríguez, C. (2019, Agosto). *Reportero Industrial*. http://www.reporteroindustrial.com/temas/Industria-automotriz-en-Latam,-entre-la-recuperacion-y-la-incertidumbre+131363?pagina=1

Asociación de empresas automotrices del Ecuador. (2018). *Asociación de empresas automotrices del Ecuador AEADE*. http://www.aeade.net/perfil-del-sector-automotor-del-ecuador/

Cámara Nacional de Comercio Automotriz de Chile. (2019). *Mercado Automotor Nacional 2018 CAVEM.* https://www.cavem.cl/informes/5c34b4552981e.pdf

El Universo. (2019, Marzo). *El Universo*. https://www.eluniverso.com/noticias/2019/03/18/nota/7240196/expectativa-mercado-automotor-ecuador-2019-comparacion-2018

García, E. (2018). *Anuario de la Industria Automotriz Ecuatoriana.* http://www.cinae.org.ec/Anuario/anuario_2018.pdf

Mejia, T. (2019). *Lifeder*. Retrieved from https://www.lifeder.com/entrevista-de-investigacion/

MotorTerra. (2019, Mayo). *MotorTerra*. https://www.motorterra.com/industria-automotriz-ecuador-2019/

Organización de las Naciones Unidas. (2019, Noviembre). *World Economic Situation And Prospects.*

Peñalver, A. (2019, Agosto). *Grandes Pymes*. https://www.grandespymes.com.ar/2019/08/25/la-formula-de-los-equipos-de-alto-rendimiento/

Sevilla, A. (2016). *Economipedia*. https://economipedia.com/definiciones/productividad.html

Valle, A. V. (2017, Julio). *Fierros industrial*. https://fierrosindustrial.com/noticias/se-proyecta-mercado-internacional-la-industria-automotriz/

Date received: 09/06/2022
Revision date: 08/07/2022
Date of acceptance: 11/07/2022

PROJECT, DESIGN AND MANAGEMENT

https://www.mlsjournals.com/Project-Design-Management

ISSN: 2683-1597

Cómo citar este artículo:
Pereira Da Silva, M., Argôlo Donegá, A., & Marques Carvalho, M. T. (2023). Systematic review of current academic production of the concepts of BIM, thermal performance, energy efficiency and sustainability. *Project, Design and Management, 5*(1), 171-191. doi: 10.35992/pdm.5vi1.1352.

SYSTEMATIC REVIEW OF CURRENT ACADEMIC PRODUCTION OF THE CONCEPTS OF BIM, THERMAL PERFORMANCE, ENERGY EFFICIENCY AND SUSTAINABILITY

Matheus Pereira Da Silva
Universidade de Brasilia (Brasil)
matheuslv2012@gmail.com · https://orcid.org/0000-0002-3754-5747
Alyria Argôlo Donegá
Universidade de Brasilia (Brasil)
alyria.donega@gmail.com · https://orcid.org/0000-0001-7546-8474
Michele Tereza Marques Carvalho
Universidade de Brasilia (Brasil)
micheletereza@unb.br · https://orcid.org/0000-0001-7969-9341

Abstract. This paper aims to discuss the current applications of Building Information Modelling along with Thermal Performance, Energy Efficiency, and Sustainability. It proposes one integrative matrix of concepts, containing information about the practical applications of high-impact papers within the academic knowledge, exposing the discussion to other stakeholders such as constructors, students, and managers. With the integrated matrix the study aims to present a state-of-the-art synthesis in terms of BIM applied, along with energy and thermal efficiency and sustainability, which may aid BIM practitioners in developing BIM applications in the context presented. This paper will perform a critical review of the existing literature, using the science web knowledge base, analysing works published between 2018 and 2021, with a higher impact factor. This research has a focus on works that perform practical applications of BIM tools to perform thermal performance and energy efficiency analysis, presenting the sustainability factor as a topic of discussion. After the systematic review, the works are selected to compound the integrated matrix was analyzed in pursuance of clarify its practical applications. After selecting 29 (20% of the most relevant) high-impact academic papers, they were schematized in an integrated matrix that summarizes the discussion about the applications of each paper. The paper provides qualitative data about the current applications of BIM, summarizing high-impact applications into an integrated matrix, allowing BIM practitioners and academics to use these results to find new applications, authors, discussions, and data more efficiently.

Keywords: BIM, thermal performance, energy efficiency, sustainability.

REVISIÓN SISTEMÁTICA DE LA PRODUCCIÓN ACADÉMICA ACTUAL DE LOS CONCEPTOS DE BIM, RENDIMIENTO TÉRMICO, EFICIENCIA ENERGÉTICA Y SOSTENIBILIDAD

Resumen. Este documento tiene como objetivo discutir las aplicaciones actuales del Modelado de Información de Construcción junto con el Rendimiento Térmico, la Eficiencia Energética y la Sostenibilidad. Propone una matriz integradora de conceptos, que contiene información sobre las aplicaciones prácticas de trabajos de alto impacto dentro del saber académico, exponiendo la discusión a otros actores como constructores, estudiantes y gestores. Con la matriz integrada, el estudio tiene como objetivo presentar una síntesis de vanguardia en términos de BIM aplicado, junto con la eficiencia energética y térmica y la sostenibilidad, que puede ayudar a los profesionales de BIM a desarrollar aplicaciones BIM en el contexto presentado. Este artículo hizo una revisión crítica de la literatura existente, utilizando la base de conocimiento de la web científica, analizando trabajos publicados entre 2018 y 2021, con un factor de impacto más alto. Esta investigación tiene un enfoque en trabajos que realizan aplicaciones prácticas de herramientas BIM para realizar análisis de desempeño térmico y eficiencia energética, presentando el factor sustentabilidad como tema de discusión. Después de la revisión sistemática, los trabajos seleccionados para componer la matriz integrada fueron analizados con el fin de aclarar sus aplicaciones prácticas. Luego de seleccionar 29 (20% de los más relevantes) trabajos académicos de alto impacto, estos fueron esquematizados en una matriz integrada que resume la discusión sobre las aplicaciones de cada trabajo. El documento proporciona datos cualitativos sobre las aplicaciones actuales de BIM, resumiendo las aplicaciones de alto impacto en una matriz integrada, lo que permite a los profesionales y académicos de BIM utilizar estos resultados para encontrar nuevas aplicaciones, autores, discusiones y datos de manera más eficiente.

Palabras clave: BIM, rendimiento térmico, eficiencia energética, sostenibilidad

Introduction

Sustainability-oriented buildings have integrating design flexibility as one of the key design aspects (Cavallieri, Dell'osso, et al., 2019). Healthy buildings are directly related to the safety and health of their users. Building evaluation in this context has grown over the years (Ding, Niu, et al., 2020). Decisions based on sustainability, maintenance in time, and occupational operations in time represent three ways to reduce energy consumption (Ghaffarianhoseini, Zhang, et al., 2017).

Energy efficiency is not only related to energy consumption reduction but also includes building-user comfort maintenance (Ghaffarianhoseini, Zhang, et al., 2017). It is recommended to reduce the building's energy consumption to reduce the building maintenance operational costs, increase its economic performance, reduce the environmental impact and increase the sustainability of the entire chain, taking into account the reduction of consumption. (Ding, Niu, et al., 2020).

In the natural resource consumption and BIM context, the thermal performance and building energy efficiency studies arise, suggesting that one can improve building thermal and energy performance using BIM integrated simulations with a focus on reducing electricity consumption. The present paper is inserted in the bibliographic research on recent studies, classified in the last 5 years, according to its relevance, to acknowledge how BIM technology has been approached when related to the thermal performance and energy efficiency issues.

Post-occupation energy consumption represents the largest proportion of a building's energy consumption, and user behavior is a key factor in the retrofit assessment study (Ghaffarianhoseini, Zhang, et al., 2017). Energy consumption is one of the great environmental impact agents, and the simulation application has been presented as a useful tool for sustainable

design (Li, Ma, et al., 2020). Each building has a different thermal performance and contributions to energy consumption, and the implementation of renewable energy generation systems will not always be sustainable, considering the importance of simulations regarding the thermal and energy performance of buildings (Yi, Braham, et al., 2017).

However, barriers to the simulation programs' integration to BIM are identified, as there is a loss of information in the interoperability process between the tools (Li, Ma, et al., 2020). The problem of interoperability has been addressed by the various developers of public research programs and organizations (Montiel-Santiago et al., 2020). It is considered that according to the interoperability-related problems that have been minimized, increasingly more accurate energy models and simulations tend to be obtained (Utkucu and Sözer, 2020).

In terms of thermal performance, the reduction of energy consumption through the reduction of air conditioning consumption systems in buildings is amenable to application. The use of air conditioning is directly related to the reduction of ambient humidity, in addition to registering greater satisfaction and lesser environmental impact by users in cases of hybrid ventilation and conditioning systems (De Oliveira Et Al., 2021). Studies show the potential of using a non-mechanical conditioning system in the thermal comfort felt by users and presents itself as a more sustainable solution (Yi, 2018).

The choice for low-cost construction systems with low thermal performance is a source of increased energy consumption, in contrast to the fact that better construction systems tend to present a reduction in operating costs (González Mahecha, Rosse Caldas, Et Al., 2020). In other words, the use of great envelopes in a building can increase the energy life cycle in terms of a building's use/cost by more than 50%, reducing the environmental impact by up to 3 times - including the impact to heat transmission of materials to the medium (Najjar, Figueiredo, et al., 2019). In some cases, the retrofit of facades presents itself as the greatest potential for reducing energy consumption by reducing the demand for mechanical systems, a sector in which there is a greater need for technologies aimed at increasing the performance of facade materials (Alkhatib, Lemarchand, et al., 2021).

Method

The methods adopted for the development of this paper were based on three main steps, as seen in the Figure 1. The first is the study of currently published papers in the Building Information Modelling, Energy Efficiency, and Sustainability field, selecting papers published between 2017 and 2021 in the Web of Science platform.

Due to the significant number of papers published on BIM, some filters were applied, being used mostly Boolean operators and keywords for the sake of finding the most appropriate research regarding a theme.

The Keywords' definition was made after determining the problem and the knowledge gap that this paper intends to investigate, associating the words Building Information Modelling, Energy Efficiency, and Sustainability.

Search Mechanisms

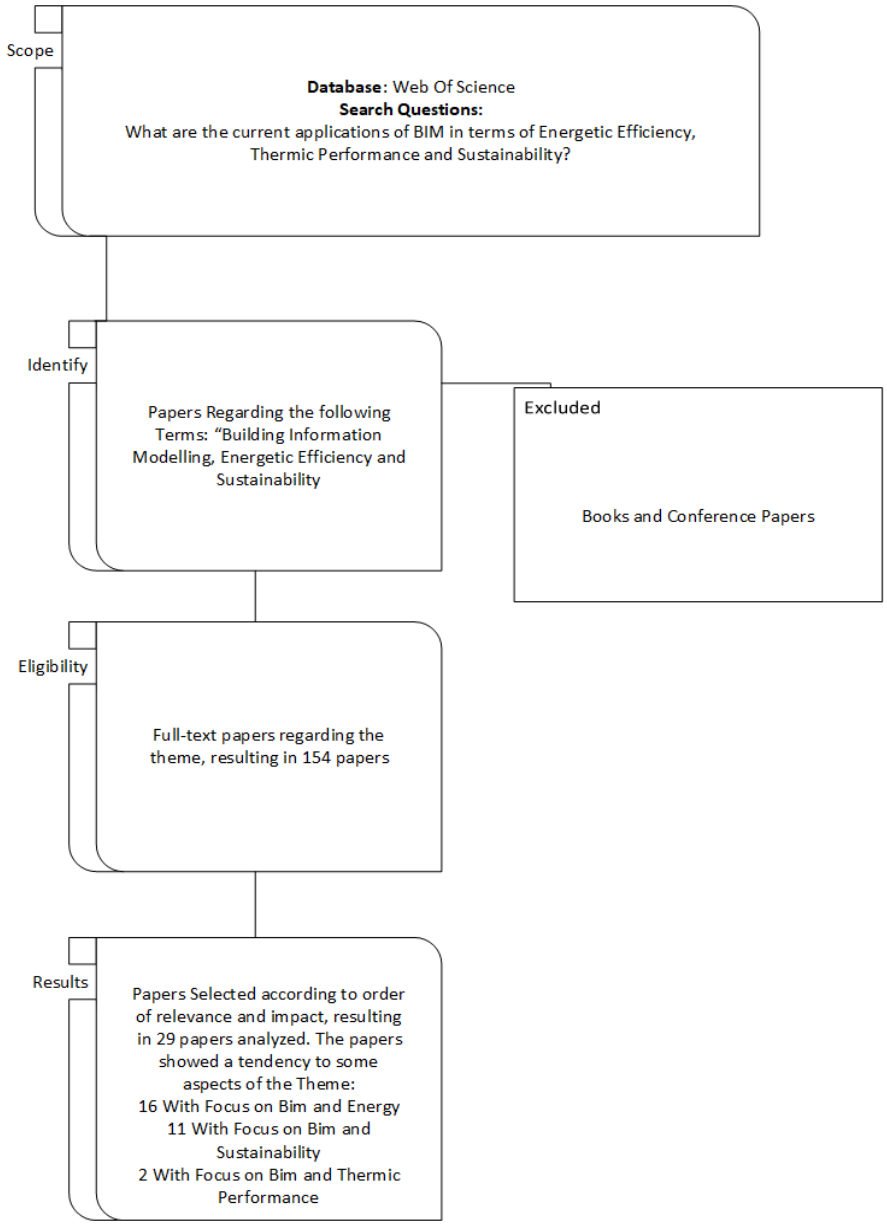
To define the most relevant articles that jointly address the themes of Building Information Modeling, Energy Efficiency, and Sustainability, a literature scan using a search algorithm called "string" was carried out to filter publications on the Web Of Science platform;

the string adopted: TS (Building Information Modelling) AND TS (Energy Performance) AND TS (Sustainability).

The research resulted in a total of 154 publications, consisting majorly of high-impact papers in relevant journals. Among these 154, a total of 29 articles are selected according to a crescent order of impact, according to the Pareto logic, of the sufficient representative share, being 20% a significant amount of papers, able to consistently represent the concepts and development of the currently published papers.

Figure 1

Framework of Research



Analysis of The Papers

After being selected, the papers are individually analyzed, allowing each article's synthesis definition, with short answers to the questions: (I), Does the paper present a sustainable improvement along with BIM? and (II), Does the paper present a framework for BIM Application?

The results regarding these two questions allow the review to identify and characterize the content and focus of the current papers regarding the theme.

Analysis of Clusters and Bibliometric Data

Even though this paper does not intend to exclusively present a systematic review of the BIM topics, Energy Efficiency, and Sustainability to introduce the actual state of the art in the field, bibliometric information is presented and discussed in the next session, in clusters of keywords for the string adopted.

Matrix of Applications

The result of the research is a matrix that translates the results and synthesizes them into the key concepts of the most relevant papers to allow one elucidative review of the state of the art of research in Building Information Modelling applied in the improvement of Energy Efficiency and Sustainability. To demonstrate a complete and integrated result, three matrices are presented.

The Matrix of Classification brings an Index and resumes the BIM practical application presented in the paper. The Integrated Matrix is related to the association of the most common problematics presented in the 29 papers, regarding Sustainability, Thermal Performance, and Energy Efficiency, to the most common practices adopted within BIM to present a solution to those problems.

The Matrix of Discussions summarizes the relation between the problem presented in each paper and how BIM was applied to solve those problems, to bring a contribution in terms of allowing BIM students and professionals to find references that present a solution within BIM to the several difficulties in adopting green criteria.

Results

Bibliometric Data

The most relevant year of publishing was 2019, with 45 papers published, while 2017 was the year with the fewest papers published. As 2021 is the current year of this paper's publishing data, most of papers are still being published. The years before 2019 presented a crescent in the numbers of papers published until 2020, where the total of published papers severely reduced as shows the Figure 2 and Figure 3, which may have occurred due to the covid 19 pandemic.

Figure 2

Publishing in the last 5 years

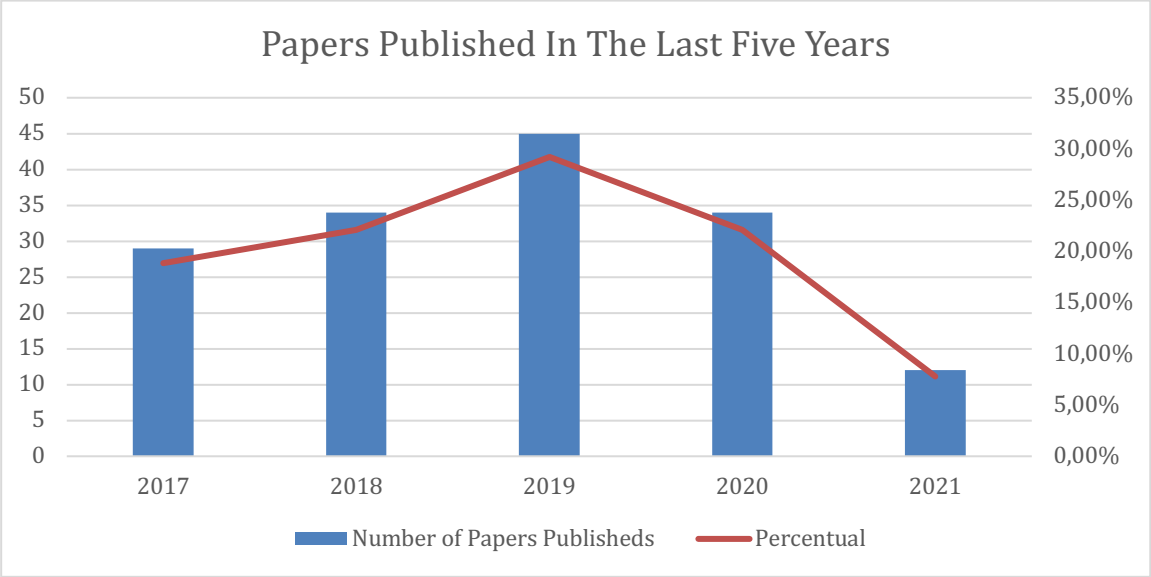
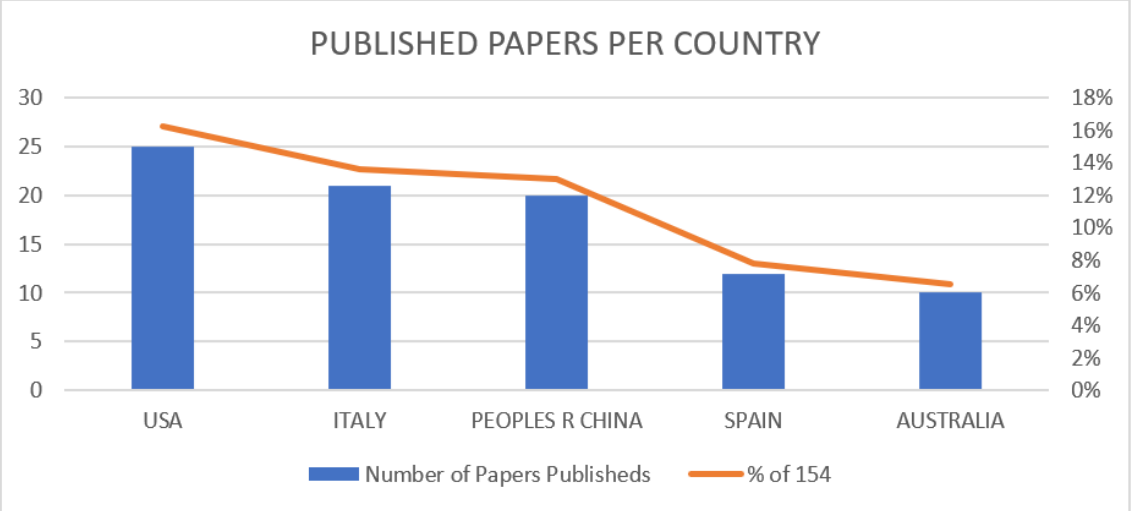


Figure 3

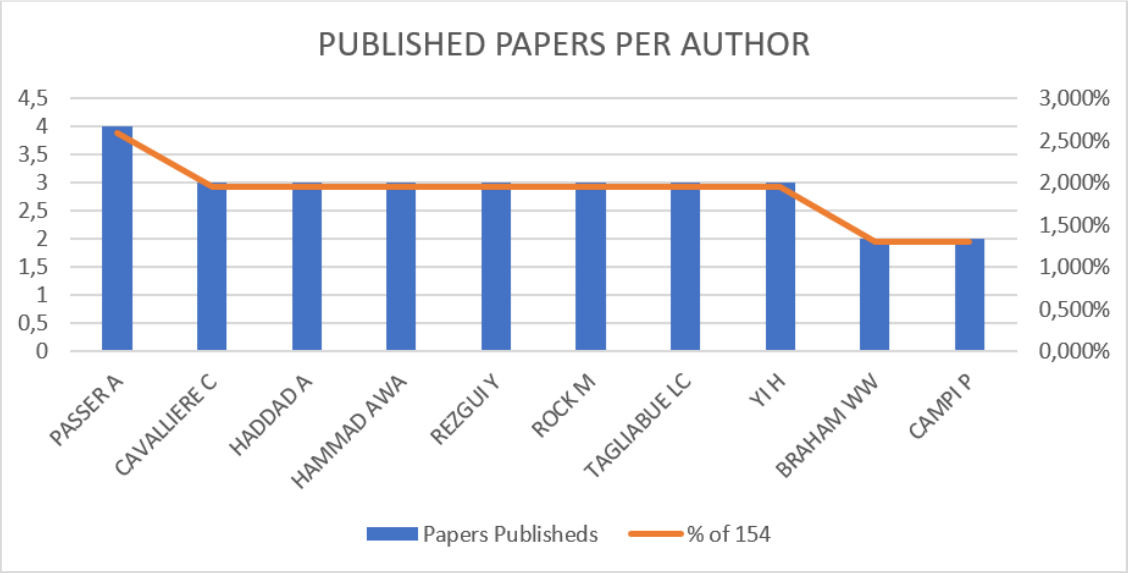
Published papers per country



The country with the most papers published was the United States of America, followed by China and Italy. Malaysia, even being a relatively small country, has a high ranking with a considerable number of publishing in the field of BIM, Energy efficiency, and Sustainability, however, was not among the countries with most papers published. The most relevant Authors were Passer, Cavalliere, and Haddad, each with 4, 3, and 3 papers published, respectively, as seen in Figure 4.

Figure 4

Published papers per author



The analysis of the Clusters of the 154 papers from the Web Of Science Platform was obtained from results of the string applied in the Web of Science Platform, which related to the topics of BUILDING INFORMATION MODELLING, ENERGY PERFORMANCE, and SUSTAINABILITY.

The cluster is generated from the correlation of common concepts cited in the title and abstract of the papers, which allow the researcher to establish a correlation between the interconnection of the concepts in the cluster and the current state of development of those concepts in the academy. The software used to generate the Cluster is VOSVIEWER 1.6, the counting method is the binary method, which means that only a term's presence or absence in a paper count.

Of a total of 5186 terms in the papers, only 30 of them present reoccurrence in at least 20 papers, and to generate the cluster, only 60% of the most relevant terms will be selected.

The correlation between terms has at its center as the most interconnected terms Performance and Building, which are the core concepts of the papers. The term Life Cycle Assessment indicates that there is a strong influence of papers discussing the Life Cycle of Buildings considering sustainability as a relevant criterion to define building performance. Sustainable criteria such as Environmental Impact are concepts widely connected to the field of study.

Figure 5

Interconnection Between Clusters

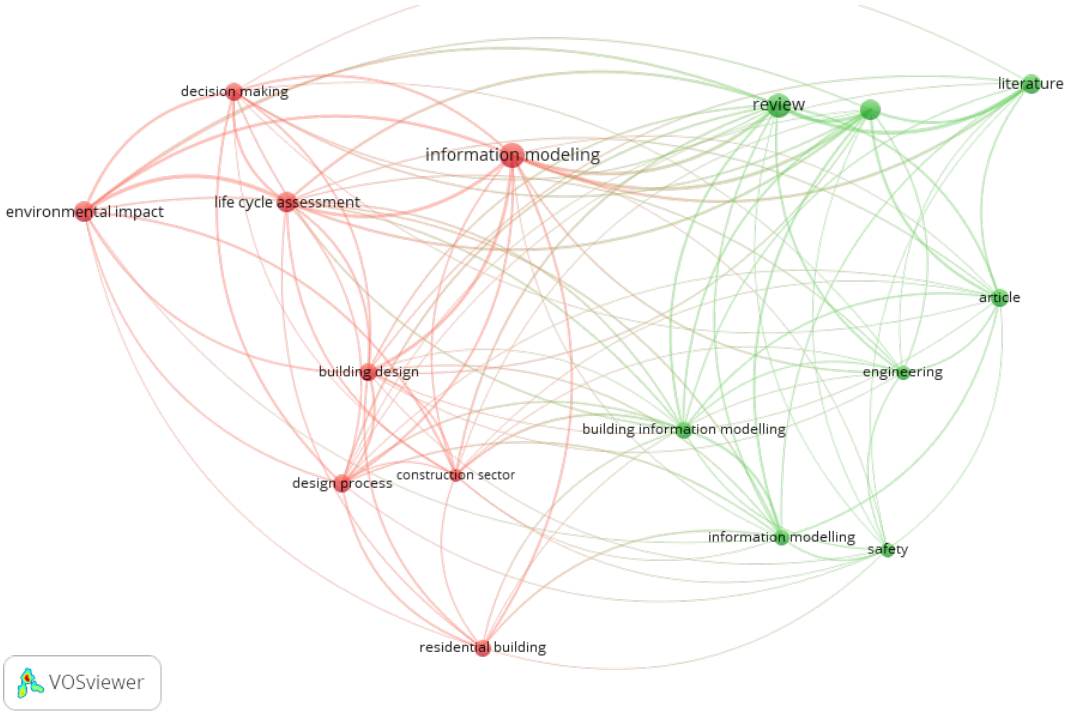
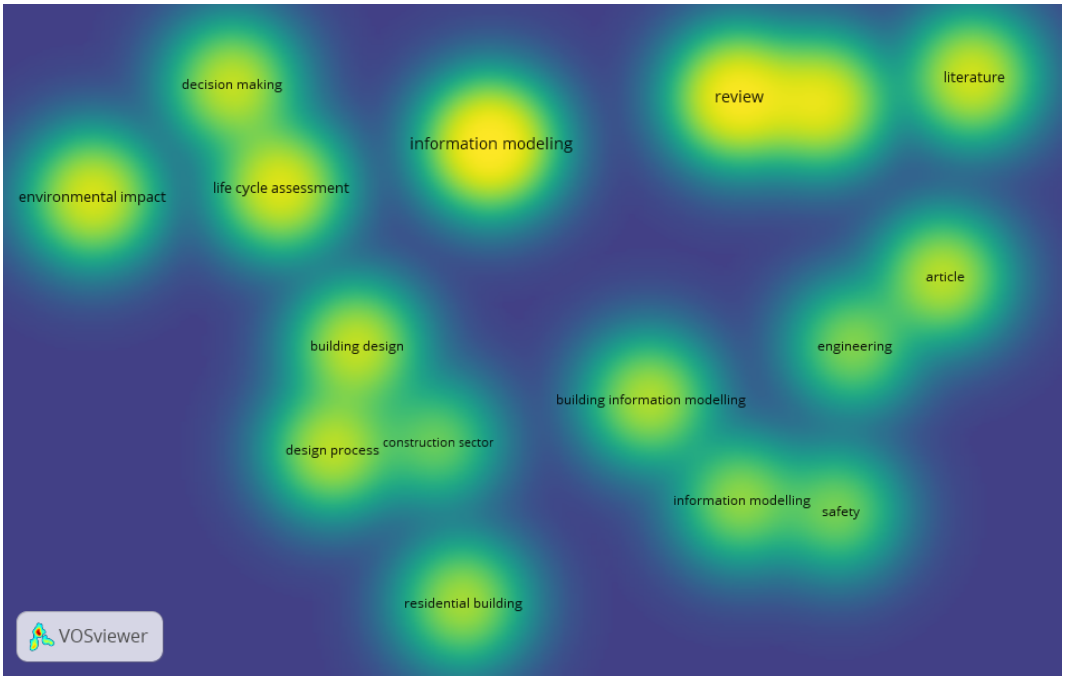


Figure 6

Density of Clusters



The cluster in Figure 5 and Figure 6 presented demonstrates the concern of the published papers with the correlation between energy efficiency, Building Information Modelling, and Sustainability. BIM is seen as an intermediary concept between general performance and

sustainable concepts as it is connected to the general concepts of civil construction, performance, and the environment.

Figure 6 translates the density of the concepts, being the general terms of Building, Performance and, Sustainability more common than Life Cycle Assessment, Energy Efficiency, and Environmental Impact. That result is expected since general terms are more often occurrent in different papers. This indicates, however, that environmental impact criteria are not widely occurrent in the papers, not being as relevant as most common concepts of civil construction.

Current Discussions in BIM and Sustainability

Beach et al. (2017) discussed the problem caused by the lack of frameworks and parameters for defining sustainability. The absence of well-defined methodologies for defining sustainability parameters in projects causes the AEC (Architects, Engineers, and Constructors) to sometimes overlook those criteria to reduce costs (Raouf And Al-Ghamdi, 2018).

There is also a high volume of information required for defining and optimizing sustainability in civil construction Cavalliere et al. (2019) stated that the high number of variables in sustainability analyses is a factor that makes the analysis even more complex.

The industry sometimes does not accept the elevated costs of acquiring and integrating all information required for some of the most common green certifications or implementing sustainable criteria in retrofitting buildings.

Relevant papers published in the last five years, however, have presented some solutions to fill those gaps. Petri et al. (2017) presented a framework of two major steps toward defining a practical methodology for optimizing sustainability in projects.

Ozarisoy and Altan (2018) proposed the adoption of two commercial plug-ins used in the Autodesk Revit software, “Green Building Studio” and “Insight 360”, alongside a well-defined methodology to assess the Sustainable criteria of the retrofitted buildings.

Current Discussions in BIM and Thermal Performance

The most relevant papers found in this research are not exclusively related Thermal Performance, but they regard to Thermal Performance as a part of the energy efficiency study. Within the 29 most relevant papers concerning BIM, Energy, and Sustainability, only two treat the Thermal Performance with utmost relevance as a more individual discipline of civil construction projects.

Pessoa et al. (2021) performed a systematic mapping of the literature to find the gaps in thermal performance analysis in 3D printed buildings. A systematic review paper being among the most relevant papers means that there is still an incipient field in the area.

Current Discussions in BIM and Energy Efficiency

Cavalliere (2019) discussed the need for a more automatized application method for energy efficiency criteria in buildings, as most of the usual methods are currently applied manually, which increases the project cost.

Zou et al. (2017) stated that the actual methods of determining energy consumption are not precise, the real consumption in some cases being 2,5 times greater than predicted.

The main problems in this field of study are like those related to BIM and Sustainability. The lack of practical frameworks, and the need for high information volume required, are the most common problems presented in the most relevant papers.

Montiel - Santiago et al. (2020) claimed a poor use of BIM 6D in current applications, proposing a framework of BIM 6D use in sanitary buildings, such as hospitals. Thus, the current

discussion in energy efficiency, thermal efficiency, and sustainability presents mostly the same problems and some similar solutions.

Tabla 1
Matrix of Classifications of the Papers Analyzed

Index	Year	Author	Category of Paper	BIM Element Applied	Impact On Sustainability
1.	2017	Ioan Petri, Sylvain Kubicki, Yacine Rezgui , Annie Guerriero and Haijiang Li	Case Study	BIM was used in modelling for testing hypotheses.	The paper proposes a practical framework for optimizing energy efficiency criteria, which may subsidize knowledge and know-how for less toxic gas-emitting projects.
2.	2018	Shaohua Jiang, Na Wang and Jing Wu	Application	Use of criteria inside BIM to evaluate the project	The presented method allows the integration of pre-defined certification criteria regarding sustainability in an automated way, which allows a greater diffusion of projects with sustainable bias.
3.	2018	Bertug Ozarisoy, Hasim Altan	Application	Incorporation of different plugins with the capability of assessing the development of innovative projects	Retrofitting is a way to adapt a building to a certain need without generating the impacts of a new construction, the incorporation of a methodology that allows an efficient analysis can reduce costs and favor the adoption of sustainable criteria.
4.	2018	Ayman M. I. Raouf and Sami G. Al-Ghamdi	Literature Review	This paper is a systematic review, without direct application.	Understanding the theoretical mechanisms that allow qualitative assessments of green buildings is essential to apply such techniques. The dissemination of knowledge in terms of systematic review allows for greater adoption of the concepts of sustainable bias.
5.	2018	Luís P. Sanhudo and João P. Martins	Application	Use of automatized pre-defined criteria inside BIM applications	Allowing greater speed in building projects' elaboration with a sustainable bias is an attraction for the market to adopt sustainable practices.
6.	2020	Mariangela Zanmi and Kirti Soenanto	Application	Incorporation of flowcharts inside a BIM application with defined criteria for projects assessment.	This work collaborates with sustainability by defining clear mechanisms and established processes for using BIM to specify sustainable criteria in previous stages of the project.
7.	2019	Ernesto Velázquez, Denis Bruneau, Zakaria Aketouane, and Jean-Pierre Nadeau	Application	This paper is a framework proposal, without direct application.	The work aims to assist and subsidize professionals in the development of sustainable projects, through practical definitions to determine improvements in this regard.
8.	2017	Yabin Jiménez-Roberto, Juan Sebastián-Sarmiento, Adriana Gómez-	Application	BIM Models can be used to test efficiency criteria due to the possibility of testing projects combinations.	Practical bias papers allow the market to find subsidies for practical applications, which distinguishes the

		Cabrera, Gabriel Leal-del Castillo			implementation of sustainable methodologies.
9.	2017	Egwunatum I. Samuela, Esther Joseph-Akwarab, Akaigwe Richard	Case Study	BIM Models can be used to test post-construction consumption due to the possibility of using BIM platforms to evaluate several different criteria.	The work presents theoretical and practical flowcharts for incorporating BIM for energy consumption analysis and a correlation proving the applicability of BIM, which provides the market with subsidies and more security in the adoption of analysis methodologies in sustainable terms.
10.	2017	Lorenzo Belussia, Ludovico Danzaa, Matteo Ghellerea, Giulia Guazzia, Italo Meronia, Francesco Salamonea	Application	BIM Platforms can be used to perform analyses in larger and integrated projects in urban areas.	Determining methodologies for analyzing the sustainability of projects allows a more significant diffusion among professionals and academics, which can make sustainability analysis in urban projects a more applied topic.
11.	2018	Carmine Cavalliere, Guido Raffaele Dell'Osso, Alessandra Pierucci, Francesco Iannone	Application	BIM platforms can be used to aid the development of projects in early phases with sustainable criteria.	Frameworks may support the adoption of analyzes by professionals and academics, which can assist in knowledge dissemination and sustainable projects practice.
12.	2017	Lufan Wang and Nora M. El-Gohary	Application	BIM can incorporate automated tools for analysis that allows more efficient analysis.	Machine Learning practices aim to meet the demand for more agile and efficient projects through information collection and application. More agile processes can enable more applications with sustainable bias on the market.
13.	2017	Abhinaya K.S., V.R. Prasath Kumar, L. Krishnaraj	Case Study	BIM Platforms often allow the user to incorporate parameter analysis to attend to certain criteria, which allows for an early evaluation of impacts.	Parameters and practical applications serve as a subsidy for subsequent implementations, which diffuses the practice of applying sustainable criteria in a BIM environment.
14.	2020	S. M. Hosseini, R. Shirmohammadi, A. Aslani	Case Study	BIM Platforms can integrate secondary plugins to optimize project parameters.	The paper contributes to the adoption of sustainable practices when reporting an analysis of the readjustment of buildings, which has different complexities related to construction, which can subsidize and encourage the readjustment instead of the demolition and construction of new projects from a sustainable perspective.
15.	2019	G. Stegnar and T. Cerovsek	Application	BIM can be used to provide more reliable information about different criteria.	The paper is an addition to the definition of criteria for energy remodeling of existing buildings. Remodeling buildings in terms of energy efficiency is a way to improve the sustainable criteria of existing buildings, which

					complements the progress towards sustainable civil construction.
16.	2020	Cheng Fan, Da Yan, Fu Xiao, Ao Li, Jingjing An, and Xuyuan Kang	Application	BIM can be complemented by Big Data, assessing and integrating information on the assessment of different projects.	Identifying more agile and less costly ways to define the project life cycle is an efficient way to allow the market to adopt this sustainability bias more easily.
17.	2021	S. Pessoa, A.S. Guimaraes , S.S. Lucas, and N. Simoes	Review of Literature	This paper is a systematic review, without direct application.	Still, insipient issues demand that their knowledge gaps be filled so that in fact they advance. The article, however, does not focus on sustainable issues, but rather on the identification of the state-of-the-art regarding the construction system.
18.	2019	Haidar Alhaidarya, Adil K. Al-Tamimia, and Hashim Al-Wakil	Case Study	BIM can be used to provide reliable quantitative analysis in terms of consumption of resources.	The work allowed an efficient analysis, which subsidized in practice a reduction in energy consumption through efficient thermal performance analysis.
19.	2018	Hwang Yi	Case Study	BIM can be integrated with different formulations to take into consideration human factors in the definition of project parameters.	The work focuses on the anthropocentric analysis of the energy analysis of a building, which is a distinct bias in relation to the usual application.
20.	2018	Patrick X.W. Zou, Xiaoxiao Xu, Jay Sanjayan, Jiayuan Wang	Review of Literature	This paper is a systematic review, without direct application.	The reliability of methodologies in analysis is one of the main challenges to be overcome for a concept to be applied in the market and generate observable results in society. In this context, the work contributes to improving the assertiveness of analyzes through a framework.
21.	2020	Cheng Fan, Da Yan, Fu Xiao, Ao Li, Jingjing An, Xuyuan Kang	Application	BIM can parametrize analysis integrating Big Data into its core.	Facilitating analysis processes, allowing them to be carried out without the need to provide information, can attract practical applications of methodologies across the market, spreading the methodology.
22.	2020	Yu Qian Ang, Zachary Michael Berzolla, Christoph F. Reinhart	Application	BIM can be integrated with georeference software to optimize models, parametrizing several urban criteria.	The energy efficiency of cities is still a deficient Sector. The work proposes a practical methodology that allows an efficient analysis. Agile definitions in the definition of criteria tend to allow easier absorption of concepts by the market.
23.	2019	Carmine Cavalliere, Guido Raffaele Dell'Osso, Fausto Favia, Marco Lovicario	Application	Applying Visual Programming Language in a BIM envirnoment allows the user to calculate several different criteria in projects.	This paper can assist building maintenance managers to define criteria for assessing the health of their buildings, allowing for the appropriate maintenance criteria adoption.

24.	2020	Zhikun Ding , Jindi Niu , Shan Liu , Huanyu Wu C, Jian Zuo	Application	BIM can be integrated with other software to perform integrated analysis of economic, environmental, and post-construction analysis.	The article provides a framework for adopting BIM based on 96 published articles allowing for reliability in terms of the framework presented, which can foster the diffusion of these concepts.
25.	2017	Ali GhaffarianHoseinia, Tongrui Zhanga, Okechukwu Nwadigoa, Amirhosein GhaffarianHoseinib, Nicola Naismitha, John Tookeya, Kaamran Raahemifarb	Application	BIM can be used to calculate the efficiency of the project throughout the whole life cycle of the building.	Practical models can foster market applications, mainly due to the practical bias of the implemented application.
26.	2019	Abdullah Badawy Mohammed	Case Study	This paper does not perform a practical application of BIM.	Practical models can foster market applications, mainly due to the practical bias of the implemented application.
27.	2020	Francisco Javier Montiel-Santiago, Manuel Jesús Hermoso-Orzáez, and Julio Terrados-Cepeda	Case Study	BIM can be applied in different constructions, such as sanitary buildings, to perform efficiency analysis.	BIM has a potential that is still underutilized to define energy analysis. Papers that contribute to the dissemination of the application of BIM 6D favor other applications of this methodology.
28.	2019	Mohammad Najjara, Karoline Figueiredo, Ahmed W.A. Hammadb, Assed Haddada,	Application	BIM can be incorporated to calculate the energy efficiency of the whole life cycle of the building.	Sustainability and energy efficiency are sometimes not evaluated in the building's operating stage. It is necessary to develop papers that work on the complete building life cycle, especially in the stage considered to be the most critical in terms of energy consumption.
29.	2019	Premjeet Singh and Ayan Sadhu	Application	BIM can be applied to test hypotheses in the project, evaluating how distinct modifications impact a building's energy efficiency.	Simple changes, such as orientation in relation to the sun and sealing materials, can have a considerable impact on the energy efficiency of a building.

The integrated matrix listed in Table 1 is a relation of the most common problems presented in the papers regarding Sustainability, Thermal Performance, and Energy Efficiency, with the most common solutions adopted within BIM. Aiming to solve those problems, the integrated matrix refers to the indexed numbers in the Matrix of Classifications regarding how they combined different solutions and contributed to solving particular problems.

Table 2
Integrated Matrix of Problems and Adopted Solutions within BIM regarding SUSTAINABILITY, ENERGY EFFICIENCY, and THERMAL EFFICIENCY

		Solution Adopted Within BIM				
		Definition of Frameworks for BIM Applications	**Incorporation of Secondary Softwares**	**Use of BIG DATA**	**Use of VPL**	**Use of Digital Twin**
Problematics	**Sustainability**					
	Lack of models of project analysis	1., 8., 15.	3.,			1., 3.
	Complexity of implementing the information needed in the project	2., 15.,	2., 3.,	12.,		
	Testing Hypotheses to define project modifications are exhaustive	15.,	5., 14.,			1.,2.,5.,9.
	Lack of models for urban analysis	10.,	10.,			6.,
	Implementing sustainable criteria is difficult due to lack of data	7.,9., 11.,		12., 16.,		
	Current non-BIM methods of sustainability analysis within projects are demanding	8., 15.,	13., 14.			9.,
	Depratonization of sustainable criteria	7., 11.		12.,		11.,
	Difficulty in implementing sustainable criteria in early project phases	7., 8., 15.	13., 14.,	16.,		9.,
	High number of variables needed to be analyzed to implement sustainable criteria	7., 8.,11.		12., 16.,		9.,11., 13
	Thermal Performance					
	There is a lack of information in defining thermal performance criteria in 3D printed houses	17.,				
	Lack of methodologies for thermal performance analysis	18.,	19.,			
	Lack of consideration of human factors in thermal performance	19.,	19.,			
	Energy Efficiency					
	High volume of information needed to perform an evaluation	21.,	24.,	21.,	23.,	27.,28.,29.,
	Difficulty of integrated analysis in urban areas		22.,		23.,	22.,
	Lack of automatized methods for calculating energy efficiency within building projects		24.,		23.,	27.,28.
	Difficulty in calculating energy efficiency along the whole life cycle of the building	25.,	24.,		23.,	27.,28., 29.

Observation: The numbers above are related to the index presented in Matrix 01

The integrated matrix in Table 2 presents a descriptive synthesis of how each paper indexed is related to how the BIM solution is adopted to solve one or more particular problems regarding Sustainability, Thermal Performance, and Energy Efficiency. The Discussion Matrix presented in Table 3 is related to a more descriptive and qualitative evaluation of how each paper solved the problems, with a more accurate description of the problems and solutions adopted in terms of applications.

Table 3
Discussion Matrix of Problems and Adopted Solutions within BIM regarding SUSTAINABILITY, ENERGY EFFICIENCY, and THERMAL EFFICIENCY

Index	Year	Author	Problem	Application
1.	2017	Ioan Petri, Sylvain Kubicki, Yacine Rezgui , Annie Guerriero, and Haijiang Li	In civil construction, there is a high volume of carbon emission, demanding sustainable solutions, which optimize the design of buildings.	The paper presents a framework for BIM, to assure the energy efficiency of buildings, through two steps. Parameters and energy consumption data are obtained first, and then framework processes and optimization for modelling readjustments.
2.	2018	Shaohua Jiang, Ph.D, Na Wang, and Jing Wu	There is difficulty in carrying out evaluations of effectiveness in terms of green construction in building projects. Most of the sustainability assessments are carried out manually.	The paper presents the incorporation of the concept of ontology with BIM, the so-called Information-Rich BIM, which will allow obtaining the multidisciplinary information necessary for Green-Building certification.
3.	2018	Bertug Ozarisoy, Hasim Altan	The study of energy efficiency in homes is sometimes deficient due to the difficulty in carrying out analyses. In reforms, there is an even more significant difficulty.	Two commercial plug-ins were used, with Revit, during the remodeling modeling process, the "Green Building Studio" and "Insight 360", to assess the sustainable criteria of the renovated building.
4.	2018	Ayman M. I. Raouf and Sami G. Al-Ghamdi	Within an academic bias, there is an absence of academic works that bring systematic reviews that associate the use of BIM with green building qualification tools.	In this work, there is a systematic mapping associating the theoretical concepts of certification in green buildings using BIM.
5.	2018	Luís Pedro Neves Sanhudo and João Pedro da Silva Poças Martins	There is a difficulty in the manual realization of sustainability indices in building projects. This delay implies an increase in terms and costs that many times the market does not allow.	BIM can be applied as a tool for qualitative assessment of sustainability criteria in buildings, already pre-defining certifications in automatically.
6.	2020	Mariangela Zanmi and Kirti Soenanto	There is depratonization of how to carry out preliminary design analyzes of sustainability criteria, which makes the adoption of sustainable criteria elements taken into account only in later stages of the project.	The Green BIM Box technique allows the definition of a clear computerized flowchart for preliminary checks of sustainability criteria.
7.	2019	Ernesto Velázquez, Denis Bruneau, Zakaria Aketouane, and Jean-Pierre Nadeau	It is necessary to adopt a holistic methodology for building project evaluation that complies with sustainable criteria, which allows subsidizing better solutions in terms of project sustainability.	In this work, the authors propose a work methodology composed of 36 key elements that allow defining the design criteria, 16 elements that allow defining sustainability criteria, and a method for calculating the parameter of 7 simulation models.

8.	2017	Yabin Jiménez-Roberto, Juan Sebastián-Sarmiento, Adriana Gómez-Cabrera, Gabriel Leal-del Castillo	The construction sector has had a problem related to the definition of appropriate solutions for different client need, with the adoption of sustainability criteria implemented after the project definition.	The work proposes a practical analysis of the performance in sustainable terms in Colombia in terms of sustainability, determining energy consumption, energy incorporated into the project and carbon emissions.
9.	2017	Egwunatum I. Samuela, Esther Joseph-Akwarab, Akaigwe Richard	There is a market view about the potential application of BIM to optimize the analysis of projects in terms of sustainability, verifying the amount of carbon emitted, verifying operations for the use of the building that consumes less energy, and other criteria. However, there is a lack of knowledge and methodologies to implement this in terms of project analysis.	The work analyzes the possibility of using BIM-based methodologies for sustainability analysis. The building's energy analysis tool allows for a more economical post-construction in terms of energy consumption.
10.	2017	Lorenzo Belussia, Ludovico Danzaa, Matteo Ghellerea, Giulia Guazzia, Italo Meronia, Francesco Salamonea	Cities have a macro role, possibly the biggest impact factor, in terms of sustainability, and analysis models for the definition of sustainability criteria for urban projects are lacking.	The work defines a methodology for analyzing sustainability criteria in city projects, with a practical framework later corroborated with a case study for the city of Bologna.
11.	2018	Carmine Cavalliere, Guido Raffaele Dell'Osso, Alessandra Pierucci, Francesco Iannone	The high number of variables in sustainability analyses is a factor that makes building analysis even more complex. The lack of practical subsidies, frameworks, and methodologies regarding sustainable criteria adoption tends to prevent a greater diffusion of sustainability among designers.	The work defines subsidies for practical analyses of buildings in terms of sustainability.
12.	2017	Lufan Wang and Nora M. El-Gohary	A sustainable analysis challenging due to the difficulty of finding enough information to support it. This high need for information makes projects expensive and slow, which sometimes makes them unfeasible for the market.	The work proposes a BIM methodology using Machine Learning. The program will study the building, its components, the city's history, and its conditions. The model already allows a more practical and automated forecast of carbon emissions and energy consumption.
13.	2017	Abhinaya K.S., V.R. Prasath Kumar, L. Krishnaraj	There is a shortage of academic articles that present practical applications, correlating analyses of sustainable bias with practical applications.	The author performs, through the Autodesk Revit Software, a parameter analysis, implementing green materials and components for modeling and immediately evaluating their impacts on the sustainable character of the building.
14.	2020	S. M. Hosseini , R. Shirmohammadi & A. Aslani	One of the main CO2 emission sources in the country where the work was developed is fossil fuel burning, mainly caused by civil construction.	The paper proposes BIM use in conjunction with the DesignBuilder program to define sustainable parameters in a readjustment of the facilities at the University of Tehran.
15.	2019	G. Stegnar , T. Cerovsek	There is a large volume of information about the building necessary for an adequate analysis of energy efficiency and sustainable criteria, which makes it	The paper proposes a progressive methodology for implementing BIM to define accurate information about building energy efficiency.

			difficult to apply sustainable criteria in energy remodeling of existing buildings because the necessary information is unknown.	
16.	2020	Cheng Fan, Da Yan, Fu Xiao, Ao Li, Jingjing An, Xuyuan Kang	There is a significant amount of information to be obtained to carry out a life cycle analysis of a building, which sometimes makes this process unfeasible due to an inherent increase in costs and in the time for preparing analyzes.	The work proposes a simplified approach for defining sustainable criteria with a lower volume of data, using of Big DATA for the complementary definition of parameters.
17.	2021	S. Pessoa, A.S. Guimaraes , S.S. Lucas, N. Simoes	3D printing is still a neophyte process in engineering, and its performance in terms of thermal efficiency needs to be further verified.	The work performs a systematic mapping in the literature, aiming to determine the current state-of-the-art on the theme of thermal performance in 3D printing.
18.	2019	Haidar Alhaidarya, Adil K. Al-Tamimia, and Hashim Al-Wakil	Climate change has shed light on the topic of thermal performance, mainly because this discipline is directly related to energy efficiency.	The article proposes a practical methodology for defining a model of energy consumption in a BIM environment, taking into account Infrared Thermography.
19.	2018	Hwang Yi	Few academic papers consider the human factor when calculating energy efficiency, not considering dynamic factors as to the heat flow.	The work carried out a study of 4 different scenarios, with different degrees of human occupation, allowing to characterize human influence on the energy efficiency of different environments.
20.	2018	Patrick X.W. Zou, Xiaoxiao Xu, Jay Sanjayan, Jiayuan Wang	According to the authors, in several works collected, the energy consumption of a building can be up to 2.5 times higher than the usual project estimates, which causes a tremendous deficiency in energy demand.	The work collected 227 relevant publications that proposed to carry out energy efficiency analyses, and based on these, we sought to create a framework that allows greater assertiveness in energy demand forecasts.
21.	2020	Cheng Fan, Da Yan, Fu Xiao, Ao Li, Jingjing An, Xuyuan Kang	The high number of necessary information sometimes makes an adequate analysis of energy efficiency unfeasible.	The paper uses the concepts of BIG DATA to parameterize energy efficiency analysis criteria, simplifying the computational analysis process in a BIM environment.
22.	2020	Yu Qian Ang, Zachary Michael Berzolla, Christoph F. Reinhart	The analysis of energy efficiency in cities has a low volume of published works, with a gap in academic production in this regard.	The article proposes an integrated framework between BIM and other georeferencing software to define optimized models, allowing parameterizing energy efficiency criteria in urban projects and defining energy consumption.
23.	2019	Carmine Cavalliere, Guido Raffaele Dell'Osso, Fausto Favia, Marco Lovicario	It is challenging to define sustainable criteria for a building, mainly due to the predominance of laborious manual models to establish these criteria.	The article uses VPL (Visual Programming Language) in a BIM environment to automatically calculate sustainability criteria in building projects.
24.	2020	Zhikun Ding, Jindi Niu, Shan Liu, Huanyu Wu C, Jian Zuo	The health of a building is a topic of increasing popularity, according to the authors. It is necessary to define criteria to define criteria for safety, environmental preservation, and energy efficiency.	The paper performs an analytical hierarchy process, incorporating other software and methods to determine criteria, such as thermal comfort, environmental performance, and economic and maintenance performance. This set of analyses makes it possible to assess the health of a building.
25.	2017	Ali GhaffarianHoseinia, Tongrui Zhanga, Okechukwu Nwadigoa, Amirhosein	It is necessary to balance the demands of the users with energy efficiency criteria, being essential to obtain an adequate performance concerning the life cycle of	The article investigates the potential of BIM for calculating energy efficiency and defining the environmental performance of the building's life cycle.

		GhaffarianHoseinib, Nicola Naismitha, John Tookeya, Kaamran Raahemifarb	the building. Manual definitions of this criterion are sometimes insufficient for more accurate life cycle definitions.	
26.	2019	Abdullah Badawy Mohammed	According to the author, there is no well-known model for analyzing sustainability criteria and analyzing the life cycle of buildings that allow to obtain the benefits inherent to BIM.	The author lists a series of environmental performance indicators, characterizing design aspects and relating them to BIM, further demonstrating the potential for joint application of different BIM platforms.
27.	2020	Francisco Javier Montiel-Santiago, Manuel Jesús Hermoso-Orzáez and Julio Terrados-Cepeda	One of the least used aspects of BIM is the orientation towards the energy efficiency analysis, mainly due to the absence of academic production and frameworks for implementing this aspect at work.	The article proposes a framework for using BIM 6D for energy analysis in sanitary buildings, in this case, hospitals. The paper defined a high potential for improving energy efficiency in simple elements, such as lighting. This analysis is possible through the use of BIM.
28.	2019	Mohammad Najjara, Karoline Figueiredo, Ahmed W.A. Hammadb, Assed Haddada,	The building's operational demand is, according to the authors, the largest share of energy consumption throughout the building's life cycle, which is a fundamental factor for optimizing energy performance and efficiency.	The authors develop a framework for optimizing energy efficiency criteria, through parameters adoption through more sustainable design alternatives.
29.	2019	Premjeet Singh, Ayan Sadhu	The current demands of society imply the increasing consumption of electric energy. The older houses have anti-economic and deficient criteria in terms of energy efficiency.	The authors propose simple modelling criteria in a BIM environment using Audodesk Revit in Buildings and analyzing the changes caused by distinct modifications in its consumption and energy efficiency.

Conclusions

The most relevant papers published in the field of BIM, Thermal Efficiency, and Energy Efficiency regarded a great concern about the needs of a high volume of information required to address the optimization of civil construction projects in terms of sustainability and efficiency.

Most of the authors also addressed the problem of the lack of practical framework as a barrier to the implementation in the AEC industry. However, the technological advancements and the use of BIM present a form of reducing costs and work time in implementing those criteria.

The use of Machine Learning presented the potential of gathering common information of several different buildings in the sake of defining parameters and fill the large volume of information required. The use of Big Data also presents a role in filling this gap to address the role of providing more information.

The adoption of energy efficiency frameworks allows the users to follow a more practical and well-defined model to analyze energy consumption in buildings, the reliability of the demand calculations being a current concern.

The common concerns are related to (I) The large information volume needed and the high cost and work necessary to implement the discussed criteria, (II) The lack of practical frameworks that analyze critical success factors and present well-defined steps for practical

applications. The solutions are related to (I) Addressing a practical model and implementation methodology of solutions in the fields discussed, (II) Applying Big Data to fill the information gaps in common buildings, (III) Implementing secondary software or Visual Programming Language.

A gap was identified, from the 29 most relevant papers in the web of science database, only 14 of them presented a valid application of BIM in terms of Sustainability, Energy efficiency, or Thermal performance, and only 9 of them analyzed cases to bring improvement to the sector. This allows us to conclude that there is a great potential for more significant BIM applications in the sector, which may be achieved with a better understanding of the relevance of sustainable criteria within the early phases of projects.

From the 29 papers reviewed, 13 presented a sustainable improvement using BIM tools or applications, while 20 presented a framework for BIM application. This indicates a still neophyte stage of academic development, most papers being about concepts and frameworks and a minor fraction about practical applications.

However, there is a considerable advance in the discussions presented in the most relevant papers in the last five years, which implicates an accelerated evolution of BIM and Sustainability current debate. In terms of scientific contribution, this paper presents a Review of Literature that summarizes in a practical approach how the BIM can be used to solve complex problems regarding Sustainability, Thermal Performance, and Energy Efficiency, allowing academics and professionals to find frameworks, case studies, applications and literature that aids in the solving of those problems listed in the paper.

References

Abhinaya, K. S., Prasath Kumar, V. R., Krishnaraj, L. (2017). Assessment and remodelling of a conventional building into a green building using BIM. *International Journal of Renewable Energy Research, 7*(4),1675–1681.

Alkhatib, H., Lemarchand, P., Norton, B., et al (2021). Deployment and control of adaptive building facades for energy generation, thermal insulation, ventilation, and daylighting: A review. *Applied Thermal Engineering, 185*, 116331, https://doi.org/10.1016/j.applthermaleng.2020.116331

Beach, T., Petri, I., Rezgui, Y., & Rana, O. (2017). Management of collaborative BIM data by the Federatinon of Distributed Models. *Journal of Computing in Civil Engineering, 31*(4).

Cavalliere, C., Dell'osso, G. R., Favia, F., et al. (2019). BIM-based assessment metrics for the functional flexibility of building designs. *Automation in Construction, 107*. https://doi.org/10.1016/j.autcon.2019.102925

De Oliveira, C. C., Forgiarini Rupp, R., & Ghisi, E. (2021). Influence of environmental variables on thermal comfort and air quality perception in office buildings in the humid subtropical climate zone of Brazil. *Energy and Buildings, 243,* 110982. https://doi.org/10.1016/j.enbuild.2021.110982

Ding, Z., Niu, J., & Liu, S. (2020). An approach integrating geographic information system and building information modelling to assess the building health of commercial buildings. *Journal of Cleaner Production, 257*, 120532. https://doi.org/10.1016/j.jclepro.2020.120532.

Fan, C., Yan, D., & Xiao, F. (2020). Advanced data analytics for enhancing building performances: From data-driven to big data-driven approaches. *Building Simulation, 14*(1), 3–24. https://doi.org/10.1007/s12273-020-0723-1.

Gao, X., Pishdad-Bozorgi, P., & Shelden, D. R. (2021). Internet of Things Enabled Data Acquisition Framework for Smart Building Applications. *Journal of Construction Engineering and Management, 147*(2), 04020169. https://doi.org/10.1061/(asce)co.1943-7862.0001983.

Ghaffarianhoseini, A., Zhang, T., & Nwadigo, O. (2017). Application of nD BIM Integrated Knowledge-based Building Management System (BIM-IKBMS) for inspecting post-construction energy efficiency. *Renewable and Sustainable Energy Reviews, 72*, 935–949. https://doi.org/10.1016/j.rser.2016.12.061.

González Mahecha, R. E., Rosse Caldas, L., & Garaffa, R. (2020). Constructive systems for social housing deployment in developing countries: A case study using dynamic life cycle carbon assessment and cost analysis in Brazil. *Energy and Buildings, 227*. https://doi.org/10.1016/j.enbuild.2020.110395.

Montiel-Santiago, F. J., Hermoso-Orzáez, M. J., & Terrados-Cepeda, J. (2020). Sustainability and energy efficiency: Bim 6d. study of the bim methodology applied to hospital buildings. value of interior lighting and daylight in energy simulation. *Sustainability (Switzerland), 12*(14), 1–29. https://doi.org/10.3390/su12145731.

Najjar, M., Figueiredo, K., & Hammad, A. W. A. (2019). Integrated optimization with building information modeling and life cycle assessment for generating energy efficient buildings. *Applied Energy, 250*, 1366–1382. https://doi.org/10.1016/j.apenergy.2019.05.101.

Ozarisoy, B. & Altan, H. (2018). Low-energy design strategies for retrofitting existing residential buildings in Cyprus. In *Proceedings of the Institution of Civil Engineers-Engineering Sustainability* (pp. 241-255). Thomas Telford Ltd.

Pessoa, S., Guimarães, A. S., Lucas, S. S., & Simões, N. (2021). 3D printing in the construction industry-A systematic review of the thermal performance in buildings. *Renewable and Sustainable Energy Reviews, 141*, 110794.

Raouf, A. M. & Al-Ghamdi, S. G. (2020). Framework to evaluate quality performance of green building delivery: construction and operational stage. *International Journal of Construction Management, 23*(2), 253-267. https://doi.org/10.1080/15623599.2020.1858539

Utkucu, D. & Sözer, H. (2020). Interoperability and data exchange within BIM platform to evaluate building energy performance and indoor comfort. *Automation in Construction, 116*, 103225. https://doi.org/10.1016/j.autcon.2020.103225.

Yi, H. (2018). A biophysical approach to the performance diagnosis of human–building energy interaction: Information (bits) modeling, algorithm, and indicators of energy flow complexity. *Environmental Impact Assessment Review, 72*, 108–125. https://doi.org/10.1016/j.eiar.2018.05.007.

Yi, H., Braham, W. W., & Tilley, D. R. (2017). A metabolic network approach to building performance: Information building modeling and simulation of biological indicators. *Journal of Cleaner Production, 165,* 1133–1162. http://dx.doi.org/10.1016/j.jclepro.2017.07.082.

Zou, Y., Kiviniemi, A., & Jones, S.W. (2017). A review of risk management through BIM and BIM-related technologies. *Safety Science, 97*, 88–98. https://doi.org/10.1016/j.ssci.2015.12.027

Fecha de recepción: 25705/2022
Fecha de revisión: 11/07/2022
Fecha de aceptación: 11/08/2022